Australian Standard™

Aluminium and aluminium alloys—Anodic oxidation coatings

This Australian Standard was prepared by Committee MT/9, Metal Finishing. It was approved on behalf of the Council of Standards Australia on 16 June 2000 and published on 19 July 2000.

The following interests are represented on Committee MT/9:

Australasian Institute of Metal Finishing

Australian Chamber of Commerce and Industry

Australian Industry Group

Department of Defence (Australia)

Galvanising Association of New Zealand

Galvanizers Association of Australia

Institute of Materials Engineering Australasia

Powder Coaters Association

Royal Australian Chemical Institute

Society of Automotive Engineers, Australasia

Telstra Corporation

Additional interests participating in the preparation of this Standard:

Aluminium fabricators

Anodisers

Australian Window Association

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We also welcome suggestions for improvement in our Standards, and especially encourage readers to notify us immediately of any apparent inaccuracies or ambiguities. Contact us via email at mail@standards.com.au, or write to the Chief Executive, Standards Australia International Ltd, PO Box 1055, Strathfield, NSW 2135.

This Standard was issued in draft form for comment as DR 99260.

Australian Standard™

Aluminium and aluminium alloys—Anodic oxidation coatings

Originated as AS K150—1963.
AS 1956—1974 and AS 1231—1985 revised, amalgamated and redesignated AS 1231—2000.

Published by Standards Australia International Ltd
PO Box 1055, Strathfield, NSW 2135, Australia

ISBN 0 7337 3481 2

PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee MT/9, Metal Finishing, to supersede AS 1231—1985, *Aluminium and aluminium alloys—Anodised coatings for architectural applications* and AS 1956—1976, *Anodic oxidation coatings on aluminium for decorative and automotive applications*.

These two Standards have been combined because of the similarity of their technical content. During this revision cognizance was taken of the following International (ISO), British and American Standards:

ISO
7599:1983 Anodizing of aluminium and its alloys—General specifications for anodic oxide coatings on aluminium.

BS
1615:1987 Anodic oxidation coatings on aluminium and its alloys.

3987:1991 Anodic oxidation coatings on wrought aluminium for external architectural applications.

ASTM
B 580-79 Specification for anodic oxide coatings on aluminium

This Standard is based primarily on BS 1615 which is considered by Committee MT/9 as the most appropriate and most up-to-date of the four Standards listed.

This Standard is the result of a consensus among the representatives on the Joint Committee to produce it as an Australian Standard.

The term ‘informative’ has been used in this Standard to define the application of the appendix to which it applies. An ‘informative’ appendix is only for information and guidance.

CONTENTS

STANDARDS AUSTRALIA

Australian Standard
Aluminium and aluminium alloys — Anodic oxidation coatings

1 SCOPE

This Standard specifies requirements for anodic oxidation coatings on aluminium and its alloys for general applications and for external architectural applications.

This Standard is not applicable to—

(a) non-porous anodic oxidation coatings of the barrier-layer type;

(b) coatings produced by chromic acid anodising;

(c) hard anodic oxidation coatings that are used mainly for engineering purposes and that have abrasion and wear resistance as their primary characteristics; and

(d) anodic oxidation coatings intended merely to prepare a substrate for subsequent application of organic coatings or the electrodeposition of metals.

NOTES:

1 The coatings covered by this Standard consist mainly of aluminium oxide and are produced by an electrolytic oxidation process during which the aluminium acts as the anode.

2 Advice and recommendations on information to be supplied by the purchaser at the time of enquiry or order are given in Appendix A.

3 Although not specified, the quality and composition of aluminium or aluminium alloys should be suitable for anodising. (See Appendix B).

4 Information on maintenance of coatings is given in Appendix C.

5 Advice on handling and temporary protection of anodised products during transportation and installation is given in Appendix D.

Details of wrought aluminium and aluminium-alloy product types are given in the following Standards:

(i) Sheet and plate ..... AS/NZS 1734.

(ii) Drawn wire, rod, bar and strip ..... AS/NZS 1865.

(iii) Extruded rod, bar, solid and hollow shapes ..... AS/NZS 1866.

(iv) Drawn tubes ..... AS/NZS 1867.

2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS	
1199	Sampling procedures and tables for inspection by attributes
1399	Guide to AS 1199—Sampling procedures and tables for inspection by attributes
1874	Aluminium and aluminium alloys—Ingots and castings
2331	Methods of test for metallic and related coatings
2331.3.3	Method 3.3: Corrosion and related property tests—Copper accelerated acetic acid salt spray (CASS) test

AS/NZS

1734 Aluminium and aluminium alloys—Flat sheet, coiled sheet and plate

1865 Aluminium and aluminium alloys—Drawn wire, rod, bar and strip

1866 Aluminium and aluminium alloys—Extruded rod, bar, solid and hollow shapes

1867 Aluminium and aluminium alloys—Drawn tubes

BS

3745 Method for the evaluation of results of accelerated corrosion tests on metallic coatings

3987 Specification for anodic oxidation coatings on wrought aluminium for external architectural applications

6161 Methods of test for anodic oxidation coatings on aluminium and its alloys

6161.4 Part 4: Assessment of sealing quality by measurement of the loss of mass after immersion in acid solution

6161.7 Part 7: Accelerated determination of light fastness of coloured anodic oxidation coatings using artificial light

6161.11 Part 11: Measurement of total reflectance using a photoelectric reflectometer

6161.12 Part 12: Measurement of specular reflectance and specular gloss at angles of 20°, 45°, 60° or 85°

6161.13 Part 13: Visual determination of image clarity. Chart scale method

6161.14 Part 14: Determination of infra-red reflectance

6161.15 Part 15: Determination of electrical breakdown potential

6161.18 Part 18: Determination of surface abrasion resistance

BS EN

12373 Aluminium and aluminium alloys—Anodizing

12373-2 Part 2: Determination of mass per unit area (surface density) of anodic oxidation coatings—Gravimetric method

12373-3 Part 3: Determination of thickness of anodic oxidation coatings—Non-destructive measurement by split-beam microscope

12373-4 Part 4: Estimation of loss of absorptive power of anodic oxidation coatings after sealing by dye spot test with prior acid treatment

12373-5 Part 5: Assessment of quality of sealed anodic oxidation coatings by measurement of admittance

12373-6 Part 6: Assessment of quality of sealed anodic oxidation coatings by measurement of the loss of mass after immersion in phosphoric acid/chromic acid solution without prior acid treatment

12373-7 Part 7: Assessment of quality of sealed anodic oxidation coatings by measurement of the loss of mass after immersion in phosphoric acid/chromic acid solution with prior acid treatment

12373-8 Part 8: Determination of the comparative fastness to ultra-violet light and heat of coloured anodic oxidation coatings

12373-9 Part 9: Measurement of wear resistance and wear index of anodic oxidation coatings using an abrasive wheel wear test apparatus

12373-10 Part 10: Measurement of mean specific abrasion resistance of anodic oxidation coatings using an abrasive jet test apparatus

ISO

1463 Metallic and oxide coatings—Measurement of coating thickness—Microscopical method

2360 Non-conductive coatings on non-magnetic basis metals—Measurement of coating thickness—Eddy current method

9223 Corrosion of metals and alloys—Corrosivity of atmospheres—Classification

3 DEFINITIONS

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

3.1 Anodised aluminium

Aluminium with an anodic oxidation coating, produced by an electrolytic oxidation process, in which the surface of the aluminium is converted to a coating, generally an oxide, having protective, decorative or functional properties.

3.2 Average coating thickness

The mean value of not fewer than five local thickness measurements that are evenly distributed over the significant surface of a single anodised piece, or the value obtained using the gravimetric method of thickness determination.

3.3 Contact mark

Discontinuity in an anodic coating at the point where electrical contact existed during anodising.

3.4 Finishes

3.4.1 *Bright anodised aluminium*

Anodised aluminium with a soft bright to a high specular reflectance as a primary characteristic.

3.4.2 *Clear anodised aluminium*

Aluminium with a substantially colourless, translucent anodic oxidation coating.

NOTE: Clear anodised aluminium is also referred to as natural anodised aluminium; it can have either a matt finish or a bright finish.

3.4.3 *Colour anodised aluminium*

Anodised aluminium coloured either during anodising or by subsequent processing.

3.4.4 *Dyed anodised aluminium*

Aluminium with an anodic oxidation coating coloured by absorption of dyestuffs or pigments into the pore structure.

3.4.5 *Electrolytically coloured anodised aluminium*

Aluminium with an anodic oxidation coating that has been coloured by the electrolytic deposition of a metal or metal oxide in the pore structure.

3.4.6 *Integral colour anodised aluminium*

Aluminium that has been anodised using an appropriate (usually organic acid-based) electrolyte which produces a coloured coating during the anodising process itself.

3.4.7 *Matt anodised aluminium*

Anodised aluminium with a low specular reflectance.

3.5 Impregnation

A treatment carried out after anodising in order to plug the pores of the anodic oxidation coating, but not involving hydrothermal sealing.

3.6 Local thickness

The mean of not fewer than three thickness measurements, within a small area (10 mm diameter, or less) of the significant surface of a single anodised piece.

3.7 Sealing

A hydrothermal or impregnation treatment carried out after anodising to reduce porosity and absorptivity of the anodic oxidation coating.

3.8 Significant surface

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

4 DESIGNATION

The designation for anodised coatings shall comprise the number of this Standard, i.e. AS 1231, followed by the thickness grade, comprising the letters AA and a number representing the minimum average thickness, in micrometres.

Example of designation: AS 1231 AA25.

5 VISUAL INSPECTION AFTER ANODISING

5.1 General

For control purposes at the anodiser's works, the anodised aluminium shall be inspected at a distance commensurate with that at which it will normally be viewed, either when it is sold or when it is used, depending on which is considered by the purchaser to be the more important.

NOTE: For further advise on the inspection of anodised aluminium, refer to Appendix A, Paragraph A2.2.

For inspection by comparison with agreed samples that show surface texture and/or colour limits, each sample and the article to be inspected shall be held close together and in the same plane.

For external applications, the coating on significant surfaces, when viewed at a distance of not less than 3 m, shall be continuous and have uniform appearance, finish and colour.

NOTES:

1 Guidance on surface texture is given in Appendix E.

2 Guidance on colour is given in Appendix F.

3 Guidance on visual inspection is given in Appendix G.

5.2 Freedom from defects and workmanship

The anodic coatings shall be continuous, smooth, adherent, uniform in appearance, and shall be free of powdery areas (burns), loose films, stains, discolorations, and discontinuities such as pits, breaks and scratches, or other damage. The size and number of contact marks shall be the minimum consistent with good practice. The location of contact marks shall be in areas of minimum exposure to service environmental conditions when important to the function of the part.

NOTES:

1 Defects cannot be completely quantified. Where the presence, size or frequency of defects in the coating is considered to be of concern, appropriate arrangements should be made between the purchaser and the anodiser or supplier.

2 Physical and metallurgical defects resulting from previous processes may still be apparent after anodising (see Appendix G).

6 SAMPLING

If a formal sampling plan is required, it should be determined on a statistical basis and agreed between the purchaser and the anodiser.

NOTE: 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 is drawn randomly from a population of product of known history. The history is required in order to verify 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, guidance to which is given in AS 1399.

Test pieces for destructive tests shall be taken from production components (preferably not from the ends or extremities) wherever practicable.

NOTE: If there is no alternative but to use non-production components for testing, care needs to be taken in their evaluation, as they may not reflect the properties of the production components.

7 THICKNESS OF COATING

7.1 Thickness grade

When determined in accordance with one of the methods specified in Clause 7.2, the minimum average thickness and the minimum local thickness of the coating shall comply with the requirements of Table 1.

NOTES:

1 Guidance on the selection of thickness grades is given in Appendix H.

2 The thickness grade designations given in Table 1 are those that are usually specified. If coatings of intermediate or greater thickness than those given in Table 1 need to be specified, they are designated by the letter AA followed by a number representing the minimum average thickness, in micrometres. In this case, the minimum local thickness is 80% of the minimum average thickness.

3 A description of the atmospheric environments that exist in Australia is given in Appendix I.

TABLE 1

THICKNESS REQUIREMENTS

Thickness grade	Minimum average thickness, μm	Minimum local thickness, μm
AA25	25	20
AA20	20	16
AA15	15	12
AA10	10	8
AA5	5	4

7.2 Thickness determination

The thickness of the coating on a component shall be determined by one of the methods described in either BS EN 12373-2, BS EN 12373-3, ISO 1463 or ISO 2360.

NOTE: The methods described in ISO 1463 and BS EN 12373-2 are destructive; those described in ISO 2360 and BS EN 12373-3 are non-destructive.

7.3 Referee methods for thickness determination

In the event of dispute and in the absence of any prior agreement, one of the following referee methods shall be used:

(a) The microsectioning method described in ISO 1463.

(b) The gravimetric method described in BS EN 12373-2 for coatings on wire, noting the comments therein on anodic oxidation coating density.

8 SEALING

8.1 General

Sealing is essential, whether stated or not, except in the case where an unsealed coating is expressly requested. If a test to determine the quality of sealing is carried out at a time subsequent to production, it shall be assured that no damage has been carried out during service that could affect the results of the test.

8.2 Sealing quality

The sealing quality shall comply with one or more of the following criteria, as appropriate—

(a) a mass loss of not more than 30 mg/dm^2 (3.0 g/m^2) resulting from the immersion in the phosphoric acid/chromic acid solution, when tested by either of the methods described in BS EN 12373-6 or BS EN 12373-7;

(b) a mass loss of not more than 20 mg/dm^2 (2.0 g/m^2), when tested by the method described in BS 6161.4;

(c) a stain intensity of not more than 2 and no peripheral rings of deeper colour, when tested by the method described in BS EN 12373-4; and

(d) an admittance value (corrected to 25°C and 20 µm coating thickness) of not more than 25 µS (equivalent to $500/T$ µS, where T is the thickness of the coating in the same area as that used for the admittance test, in micrometres), when tested in accordance with BS EN 12373-5.

NOTE: This test may not be suitable for electrolytically coloured anodised aluminium as it may indicate that a sealed coating is unsealed.

8.3 Referee method for determination of sealing quality

In case of dispute, the method described in BS EN 12373-7 shall be used as the referee method.

9 ABRASION RESISTANCE

Abrasion testing of anodised coatings produced by sulfuric acid anodising shall be carried out using the method described in BS 6161.18 using glass-coated paper. The test shall not result in abrasion of the coating.

Coatings produced by integral colour anodising shall not be abraded when tested by the method described in BS 6161.18, using garnet coated paper.

NOTE: Other tests that can be employed to determine abrasion resistance are specified in BS EN 12373.9 and BS EN 12373.10 and are described in Appendix J.

10 CORROSION RESISTANCE

If specified by the purchaser, the corrosion resistance of the anodic oxidation coating shall be tested in accordance with AS 2331.3.3 (CASS test) for a period of 8 h and the results evaluated in accordance with BS 3745 (this Standard assigns to the coating a rating that represents the relative freedom from pitting).

NOTES:

1 For thickness grades AA15 to AA25 inclusive, the rating should be at least 8.

2 For thickness grades below AA15 down to and including AA5, the rating should be at least 6.

11 LIGHT FASTNESS AND RESISTANCE TO HEAT

11.1 Light fastness

If a requirement for light fastness of coloured anodic oxidation coatings is specified by the purchaser, testing shall be carried out in accordance with BS 6161.7. The level of light fastness required should be agreed between the purchaser and the anodiser.

NOTES:

1 The ratings for interior and exterior applications should not be less than 5 and 9 respectively.

2 Guidance on light fastness testing is given in Appendix K.

11.2 Ultraviolet light fastness

If a limit is specified by the purchaser for the ultraviolet light fastness of coloured anodic oxidation coatings, testing shall be in accordance with BS EN 12373-8. The level of ultraviolet light fastness required should be agreed between the purchaser and the anodiser (see Appendix K).

11.3 Fastness to heat

If the testing of fastness to heat of coloured anodic oxidation coatings is specified by the purchaser, the coatings shall be subjected to a temperature of 180 ±5°C for 6 h. At the end of the test, no visible colour change shall have occurred.

12 LIGHT REFLECTION PROPERTIES

12.1 Total reflectance

If specified by the purchaser, total reflectance shall be determined using the test method described in BS 6161.11. The test specimens used shall be flat and not less than 75 mm × 75 mm in size. The acceptable values of the total reflectance should be agreed between the purchaser and the anodiser.

12.2 Specular reflectance

If specified by the purchaser, specular reflectance shall be determined using the test method described in BS 6161.12. The test specimens used shall be flat and not less than 75 mm × 75 mm in size. The acceptable values of the specular reflectance should be agreed between the purchaser and the anodiser.

NOTE: Guidance on light reflection properties is given in Appendix L.

12.3 Image clarity

If specified by the purchaser, image clarity shall be determined using the test method described in BS 6161.13. The minimum acceptable value of image clarity should be agreed between the purchaser and the anodiser.

13 INFRA-RED REFLECTANCE

If specified by the purchaser, the infra-red reflectance shall be determined using the test method described in BS 6161.14. The test specimens used shall be flat and not less than 50 mm × 50 mm in size. The acceptable values of infra-red reflectance should be agreed between the purchaser and the anodiser.

14 ELECTRICAL BREAKDOWN POTENTIAL

If specified by the purchaser, the electrical breakdown potential of the anodic oxidation coating shall be determined using the test method described in BS 6161.15. The minimum acceptable value of breakdown potential should be agreed between the purchaser and the anodiser.

APPENDIX A

PURCHASING GUIDELINES

(Informative)

A1 GENERAL

Australian Standards are intended to include the technical requirements for relevant products, but do not purport to comprise all the necessary provisions of a contract. This Appendix contains advice and 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

A2.1 General

The purchaser should supply the following information at the time of enquiry and order, after making due reference to the explanation, advice and recommendations contained in this Appendix.

A2.2 Essential information

The following information should be supplied by the purchaser to the anodiser, if necessary in consultation with the aluminium supplier:

(a) The number of this Standard, i.e. AS 1231.

(b) The intended service use of the article to be anodised.

(c) The composition or specification of the aluminium to be anodised, and the country of origin of this material.

NOTE: Guidance on the choice of aluminium is given in Appendix B.

(d) An indication of the significant surface(s) of the article to be anodised.

NOTES:

1 Significant surfaces are indicated preferably by drawings or by suitably marked samples.

2 In some cases, there may be different requirements for surface finish on different parts of the significant surface(s).

3 Essential jigging on significant surfaces will result in marking and locally reduced thickness of the coating at the contact points.

(e) The surface texture to be produced on the aluminium before anodising.

NOTES:

1 The surface texture is indicated preferably by agreed samples.

2 Guidance on surface texture is given in Appendix E.

(f) The type of anodising and the colouring process to be used.

(g) The anodic oxidation coating thickness grade required (see Clause 7.1).

(h) Whether sealing is by hydrothermal means or impregnation, or if the coating is to be left unsealed (see Clause 8). In the case of impregnated coatings, the materials, methods of test and acceptance criteria to be used for impregnation.

(i) The preferred position and maximum size of contact marks.

(j) Any limits of variation of final surface finish on the significant surface(s).

NOTE: Acceptable limits of variation of final surface finish are defined preferably by agreed samples (see Clause 5).

(k) The colour of the anodised work, the colouring method, if applicable, and any limits of maximum colour variation.

NOTE: Acceptable limits of maximum colour variation are defined preferably by agreed samples (see Clause 5).

(l) The viewing distance for visual inspection after anodising (see Clause 5.1).

(m) Details of any formal sampling plans required (see Clause 6).

A2.3 Additional information

The following additional information, if applicable, should be supplied by the purchaser, if necessary in consultation with the anodiser:

(a) Any requirements for corrosion resistance including the method of test to be used (see Clause 10).

(b) Any limits for light fastness, including ultraviolet light fastness, of coloured anodic oxidation coatings (see Clause 11.1 and 11.2).

(c) Whether a test for fastness to heat of coloured anodic oxidation coatings is to be carried out (see Clause 11.3).

(d) Any requirements for abrasion resistance (see Clause 9).

(e) Any requirements for total reflectance and/or specular reflectance (see Clause 12.1 and 12.2).

(f) Any requirements for image clarity (see Clause 12.3).

(g) Any requirements for infra-red reflectance (see Clause 13).

(h) Any requirements for electrical breakdown potential and the means to be used for the expression of results in the test report (see Clause 14).

(i) An indication of any critical dimensional tolerances and/or acceptable limits of dimensional change.

APPENDIX B

GUIDANCE ON THE CHOICE OF ALUMINIUM GRADE

(Informative)

For general engineering applications of wrought aluminium and aluminium alloys, reference should be made to AS/NZS 1734, AS/NZS 1865, AS/NZS 1866 and AS/NZS 1867. However, alloys containing a high proportion of copper, zinc or silicon are likely to require modified anodising techniques and advice should be sought from the manufacturer and the anodiser.

For general architectural applications, the alloys most commonly used are 1150, 5005, 5251 (sheet), 6060, 6106 and 6063 (extrusions). Special grades and alloys of aluminium are also available as anodising quality materials for architectural applications.

After anodising, some variation in appearance and colour, coating thickness, reflectivity, abrasion resistance, corrosion resistance and electrical breakdown voltage can be expected between different batches of the same material and different forms of the same material, e.g. castings, extrusions, forgings and rolled sheet. Additionally, anodic treatments may reveal lack of homogeneity, if present, in the aluminium. These variations can be kept within acceptable limits by cooperation between the material supplier, the anodiser and the purchaser.

Special grades and alloys of aluminium are available as anodising quality materials to give specific properties. For example, special alloys for bright trim/reflector materials are not necessarily covered in Australian Standards and have been developed for integral colour anodising processes, and other special applications.

For castings, alloys suitable for anodising are AA 150, AA 505 and BA 701 (see AS 1874). It should be noted that aluminium alloys that contain in excess of 0.6% silicon turn a dull grey colour after anodising.

APPENDIX C

MAINTENANCE OF ANODISED ALUMINIUM

(Informative)

Regular cleaning is essential if the finish of anodised aluminium is to be preserved over the years. Deterioration of the anodic oxidation coating can occur mainly as a result of grime deposition and subsequent attack by moisture, particularly when it is contaminated with sulfur compounds. Deposited grime can retain contaminated moisture on the anodised surface, permitting corrosion to proceed and thereby damaging the anodic oxide coating.

The frequency with which cleaning should be carried out will range from monthly to six-monthly intervals according to the degree of contamination of the service environment. The aim of the cleaning operation is the removal of grime deposited on the surface without causing damage to the anodic oxidation coating.

NOTE: Recommended maximum cleaning intervals are given in Appendix H, Table H1.

The cleaning method to be adopted depends on the degree of deterioration that may already have occurred and on the scale of the operation. Hand rubbing is often used for small work, but large expanses of anodised surfaces, as occur in multi-storey buildings, call for carefully controlled methods to loosen adherent deposits.

The anodised aluminium should be washed with warm water containing a suitable wetting agent or with a mild soap solution. Fibre brushes may be used to loosen attached grime but the use of emery paper, sand paper, steel wool or other highly abrasive materials, and acid or alkaline cleaners is not recommended as they damage the anodic oxidation coating. The use of a mild abrasive such as pumice powder and water may sometimes be necessary. It is essential to rinse thoroughly after cleaning using copious applications of clean water, particularly where crevices are present. Where greasy deposits are present, cleaning may be carried out using a soft cloth dipped in white spirit.

Since emulsion cleaners or proprietary chemical agents may attack the coating, they should never be used except in consultation with companies which specialize in the cleaning of anodised aluminium.

After cleaning, the anodised aluminium may be treated with a good quality wax polish.

APPENDIX D

HANDLING AND TEMPORARY PROTECTION DURING TRANSPORTATION AND INSTALLATION

(Informative)

Special care is necessary in the handling, transportation and installation of anodised products in order to avoid surface damage.

Anodised products should not be allowed to rub or slide against each other and significant surfaces should be well protected during transportation, storage and stacking by the use of suitable containers. Wrapping with stout paper, cardboard or other protective media is often a convenient means of protection, but the wrapping should not be allowed to get damp.

It is important to prevent the attack of anodic oxidation coatings by corrosive agents such as contaminated moisture, condensates, cement and plaster splashes. A suitable non-yellowing lacquer, e.g. methyl methacrylate or cellulose acetate butyrate, or a strippable coating or tape, is recommended to protect anodised aluminium from such building hazards. After these coatings have served their purpose they should be removed as soon as possible, except in the case of some lacquers which may be allowed to weather away. Tape and strippable coatings should be easily removable and should not leave residues.

It is essential that anodised components be delivered to site and installed at as late a stage as possible in building operations in order to minimize the possibility of damage.

APPENDIX E

GUIDANCE ON SURFACE TEXTURE

(Informative)

Different surface textures may be produced on aluminium by a variety of treatments, e.g. mechanical polishing to obtain a smooth or a bright surface. Under some circumstances, chemical or electrochemical brightening may be employed with special grades of aluminium to obtain a very bright finish (see Appendix B). More usually, the work, either polished or unpolished, is subjected to a chemical etching procedure to provide a range of textures from satin to fully matt, according to the etching conditions used. Alternatively, the texture may be produced mechanically, by brushes, abrasive belts or wheels, to give a range of matt finishes which are usually lined or directional, in contrast to the essentially non-directional etched finishes. Mechanical finishes are less dependent on metal structure and composition than finishes resulting from chemical pretreatment.

Surfaces which tend to hold dirt and grime, e.g. surfaces with an abrasive blasted or a coarse linished finish, have an adverse effect on durability and are best avoided for all but mild conditions of service.

APPENDIX F

GUIDANCE ON COLOUR

(Informative)

Colour anodised aluminium may be produced prior to sealing, using one of the following methods—

(a) by treating the anodic oxidation coatings with organic dyes;

(b) by treating the anodic oxidation coatings with inorganic pigments by simple immersion or by double decomposition;

(c) by electrodepositing metals or metal oxides into the pores of the anodic oxidation coatings;

(d) by anodising in special electrolytes to give integral colour coatings; or

(e) by using special aluminium alloys where the alloying elements are responsible for producing coloured effects in the anodic oxidation coating.

In some cases, a combination of the above methods may be used.

The light fastness of the coloured anodised aluminium depends on the method of colouring and the colouring medium used. Only a limited range of coloured finishes is suitable for exterior use and advice should be sought from the anodiser.

APPENDIX G

GUIDANCE ON VISUAL INSPECTION AFTER ANODISING

(Informative)

Anodic treatment may accentuate the effect of any lack of homogeneity or differences in metallurgical condition of the aluminium. As a result, some non-uniformity of appearance may be encountered on different areas of a component and/or between different batches of material of the same specification, or where certain welding processes have been used.

With colour anodising in particular, the metal composition, form and surface texture, as well as the viewing angle, can have a profound effect on the subjective impression of colour. Cooperation between the metal supplier, the anodiser and the purchaser is necessary to keep variations within acceptable limits.

It is also possible, on close inspection or from certain viewing angles, to observe variations in brightness, banding, streaking and other visual effects on the significant surfaces. These variations seldom impair the performance of the anodised coating.

It is important that the viewing distance be agreed to; for example, a distance of not less than 3 m is required when viewing external architectural applications.

The samples to be used as colour and texture standards should, if possible, be duplicates of production components, or otherwise be similarly shaped in order to facilitate comparison with production components (see Clause 5).

Anodised finishes are preferably matched in daylight, but not in direct sunlight.

APPENDIX H

GUIDANCE ON THE CHOICE OF COATING THICKNESS GRADES

(Informative)

H1 EXTERIOR USE

The life of anodised aluminium in exterior applications depends not only on the coating thickness but also on the frequency with which atmospheric deposits are removed by washing (see Appendix C). It is particularly important to remove atmospheric deposits regularly from surfaces that are not exposed to rain.

Thickness grade AA25 should be specified for static exterior applications that are subject to moderate to severe atmospheric conditions.

Thickness grades AA20 and AA15 may be specified for static exterior applications in mild atmospheres, or rural environments away from industrial pollution or marine influence, in locations where long-term durability may not be important (e.g. shop fronts), or if frequent washing can be guaranteed.

Thickness grade AA10 may be specified for exterior applications in special circumstances, e.g. if frequent maintenance can be guaranteed, if the installation is not permanent or if some deterioration in appearance is acceptable.

Recommended coating thickness grades and washing requirements for exterior atmospheres are given in Table H1.

NOTE: Additional information on architectural applications is given in BS 3987.

H2 INTERIOR USE

Thickness grade AA25 should be specified for interior use in exceptionally aggressive atmospheres, especially where condensation is likely to occur, e.g. around indoor swimming pools.

Thickness grades AA15, AA10 and AA5 are usually specified for most indoor applications.

Thickness grade AA15 will provide some resistance to wear but for more severe wear conditions, either thickness grade AA20 or AA25 may be required. Thickness grade AA5 is used in a position where little wear or corrosion influence is anticipated while thickness grade AA10 is an intermediate grade suitable for general usage.

Recommended coating thickness grades and washing requirements for interior atmospheres are given in Table H1.

H3 UPPER LIMITS OF THICKNESS

Table 1 gives requirements for thickness grades, but imposes no upper limit. An upper thickness limit may be specified by the purchaser, if necessary, especially where a consistent brightness or appearance is required. If a coating is too thick (in excess of 30 μm), it can have low abrasion resistance which can lead to chalking. The resistance of the coating to abrasion is dependent on the anodising parameters and can be tested in accordance with Clause 9.

TABLE H1

RECOMMENDED THICKNESS GRADES AND WASHING REQUIREMENTS

Description	Atmospheric classification (See Appendix I)	Thickness grade	Cleaning intervals, months Maximum
Interior			
Mild	1	AA5	12
Moderate	2	AA10 and AA15	12
Severe*	—	AA20	6
Very severe*	—	AA25	3
Exterior			
Mild	3	AA15	12
Moderate	3	AA15, AA20 and AA25	9
Tropical	4	AA25	9
Severe	5	AA25	6
Very severe*	—	AA25	1 to 3

* These environments are not defined in this Standard. A severe or very severe interior environment could occur as a result of high moisture condensation, e.g. resulting from an indoor swimming pool.

Very severe exterior environments usually occur at or near the beachfront in regions of rough seas and surf beaches.

APPENDIX I

ATMOSPHERIC ENVIRONMENTS

(Informative)

I1 GENERAL

This Appendix contains general information on factors which affect the corrosion of coated metals and classifies internal and external atmospheres according to their corrosivity. When selecting an appropriate metal finishing system, the overall atmospheric conditions in the intended location of the structure require consideration. A structure situated in an aggressive environment will require a much higher standard of corrosion protection than one in a benign environment.

In addition to climatic effects, the local environmental effects (or microclimate) produced by the erection of a structure or installation of equipment need to be taken into account. Such on-site factors require additional consideration because a mildly corrosive atmosphere can be converted into an aggressive environment by microclimatic effects. A significant acceleration of corrosion rate can occur in the following circumstances:

(a) At locations where the metal surface remains damp for an extended period, such as where surfaces are not freely drained or are shaded from sunlight.

(b) On unwashed surfaces, i.e. surfaces exposed to atmospheric contaminants, notably coastal salts, but protected from cleansing rain.

Other microclimatic effects that may accelerate the corrosion of the substrate or the deterioration of its protective coating include acidic or alkaline fallout, industrial chemicals and solvents, airborne fertilizers and chemicals, prevailing winds which transport contamination, hot or cold surfaces and surfaces exposed to abrasion and impact. These effects can outweigh those of the macroclimatic zones described in Paragraph I2.

As a result of microclimatic effects it is very difficult, if not impossible, to predict accurately the aggressiveness of a given environment and a certain amount of educated judgement is required to assess its influence on the coating life.

Typical on-site factors or types of microclimates which may cause a breakdown of protective coatings include the following:

(i) Industrial contamination.

(ii) Contamination from agricultural fertilizers or insecticides.

(iii) Damp locations not dried by direct exposure to the sun.

(iv) Exposure to sea breezes.

(v) Alkaline or acidic fallout.

(vi) Hot or cold surfaces.

(vii) Abrasion or impact.

(viii) Animal enclosures.

Prevailing winds, which can transport contamination from one location to another, also require consideration.

The designer of a building should take special care to ensure that the possibility of condensation resulting from high humidity is minimized.

I2 ATMOSPHERIC CLASSIFICATIONS

A classification of the corrosivity of an exterior atmosphere into one of five categories is given in ISO 9223. A number of surveys to determine the corrosion rate at various sites in Australia and New Zealand have made it possible to place each of these sites into one of the five ISO categories. It is stressed that the micro-environmental effects described in Paragraph I1 also require consideration. The exterior atmospheric classifications make reference to one-year corrosion rate figures for mild steel. Figures are not given for aluminium which is highly resistant to atmospheric corrosion.

For the purpose of this Standard, atmospheric environments have been classified as follows:

(a) *Interior environments* Interior environments are separated into Classifications 1 and 2, as follows:

(i) *Classification 1—Interior mild* Applicable to interior conditions not subject to moisture condensation.

(ii) *Classification 2—Interior moderate* Applicable to interior conditions subject to moisture condensation.

(b) *Exterior environments* Exterior environments are separated into Classifications 3, 4 and 5, as follows:

(i) *Classification 3—Mild to moderate* A description of these environments is as follows:

(A) *Mild (ISO Category 1–2)* This environment includes all areas remote from the coast, industrial activity and the tropics. Sparsely settled regions such as outback Australia are typical examples, but it also includes rural communities other than those on the coast. The only areas in New Zealand in this category are sheltered areas far inland. Corrosion protection required for this category is minimal.

(B) *Moderate (ISO Category 2)* This environment includes areas with light industrial pollution or very light marine influence, or both. Typical areas are suburbs of cities on sheltered bays such as Melbourne, Adelaide and Hobart (except those areas near the coast), and most inland cities. Most of New Zealand, other than sheltered areas far inland and areas near the coast, is in this environment. The suburbs of Brisbane and Perth that are away from the coast are also in this environment.

(ii) *Classification 4—Tropical (ISO Category 2)* A tropical environment includes coastal areas of north Queensland, Northern Territory, north-west Western Australia, Papua New Guinea and the Pacific Islands, except where directly affected by salt spray. This is the only environment that cannot be delineated by corrosion rate, although measurements would put these areas into ISO Category 2.

NOTE: The characteristics of a tropical environment are as follows:

(a) Subject to high rainfall, greater than 1200 mm annually.

(b) Average humidity high all year round, typically 65% to 100%.

(c) No industrial fallout.

(iii) *Classification 5—Severe* A description of these environments is as follows:

(A) *Industrial (ISO Category 3–4)* The only areas within this environment are around major industrial complexes inland from the sea. Examples occur around smelters in Port Pirie and Newcastle. There are only a few sites within this category in Australia and none in New Zealand. The pollution in these areas requires that coating systems be resistant to mild acid.

(B) *Marine (ISO Category 3)* This environment includes areas influenced to a moderate extent by coastal salts. The extent of the area varies considerably depending on factors such as winds, topography and vegetation. For sheltered areas, such as occur around Port Phillip Bay, it extends from the coastline to about 100 m from the beach, but for most ocean-front areas, such as occur along the south-western corner of Western Australia, the south-eastern coast of South Australia, and the New South Wales, Queensland and New Zealand coasts, it generally extends from about 200 m from the coast to about 5 km inland, depending on the conditions. Large areas of Perth, Wollongong, Sydney and Newcastle are in this environment. A high-performance coating system is required for long-term protection.

APPENDIX J

GUIDANCE ON ABRASION RESISTANCE

(Informative)

J1 GENERAL

The resistance of anodic oxidation coatings to abrasion or wear can be an important property in that it may give information about the quality of the coating and its performance in service. The test specified in Clause 9 evaluates surface abrasion resistance using abrasive papers. This test is specified in BS 6161.18.

Two other standard methods of test are specified in BS EN 12373-9 and BS EN 12373-10 and are described in Paragraphs J2 and J3. Both test methods are intended for all anodic oxidation coatings of thickness not less than 5 μm.

NOTE: The apparatus for the test methods described in Paragraphs J2 and J3 is currently not available in Australia.

Lack of adequate abrasion resistance can arise from inadequate control of the anodising process, e.g. process temperature control, and can be a cause of premature failure, for example, in architectural applications.

J2 MEASUREMENT OF WEAR PROPERTIES WITH AN ABRASIVE WHEEL TEST APPARATUS

The method of test described in BS EN 12373-9 is based on the principle of abrading the anodic oxidation coating under defined conditions by reciprocating motion against a strip of silicon carbide paper. After each complete reciprocating cycle, the strip is indexed to bring an unused portion into contact with the test area.

The test method normally requires a flat test specimen of at least 50 mm × 50 mm, and is suitable for measuring the abrasive wear characteristics of the layers of oxide near the surface, of the whole oxidation coating thickness, or of any selected intermediate zone. The test method in BS EN 12373-9 is particularly suitable for determining the quality of the anodic oxidation coating at the surface.

J3 MEASUREMENT OF ABRASION RESISTANCE WITH AN ABRASIVE JET TEST APPARATUS

The method of test described in BS EN 12373-10 is based on the principle of abrading a small area of anodic oxidation coating with a jet of dry silicon carbide particles projected in a stream of dry air or inert gas under carefully controlled conditions.

This test method is primarily intended for use with small test specimens (the individual test area required is about 2 mm in diameter), or surfaces which are not flat. While it is possible to use BS EN 12373-10 to measure the abrasion resistance of the outer layers (see Paragraph J2), this test method is best suited to evaluate the bulk property of the anodic oxidation coating.

APPENDIX K

GUIDANCE ON LIGHT FASTNESS TESTING

(Informative)

K1 GENERAL

For exterior applications, accelerated light fastness testing is only suitable as a quality control test of coloured anodic oxidation coatings in circumstances where the fastness of a colour has already been established by outdoor exposure tests. Many factors can affect the stability of coloured finishes in the weather, and only outdoor exposure under conditions comparable to actual service use will give reliable information. Tests using accelerated weathering equipment may give additional guidance but these results should always be treated with care.

K2 ULTRAVIOLET LIGHT FASTNESS

Ultraviolet light fastness testing in accordance with BS EN 12373-8 represents very severe conditions, and is only suitable for evaluating finishes with a light fastness number greater than 8. The test gives information on the comparative light fastness of coloured anodic oxidation coatings and, because of its severity, it provides information in relatively short exposure times (less than 100 h). The method is particularly suitable as a production control test for assessing the fastness to light of the very light-resistant colour anodised coatings used in architecture.

K3 DYED FINISHES

Certain dyestuffs used to colour anodised aluminium may show a slight change of colour after a short period of exposure to light fastness testing; thereafter they become resistant to further fading. This initial slight change of colour may involve darkening or a change of shade, e.g. a green colour may become slightly bluer or more yellow. Items that are represented by test pieces which undergo this degree of change may be acceptable if they are to be uniformly exposed to light when in service. More accurate information on the light fastness of dyes should be obtained from the anodiser.

APPENDIX L

GUIDANCE ON LIGHT REFLECTION PROPERTIES

(Informative)

L1 INTRODUCTION

To determine the light reflection properties of an anodic oxidation coating on aluminium, a measurement of one or more of the following properties may be required—

(a) total reflectance (also called reflectivity);

(b) specular reflectance (also called specular reflectivity); or

(c) image clarity.

Other optical properties, such as specular gloss or diffuse reflectance may also be measured using a variety of optical instruments, but these are not referred to in this Standard.

L2 TOTAL REFLECTANCE

The total reflectance is important in defining the visual brightness of a surface and, in some cases, the depth of colour of diffuse surfaces for colour matching purposes. However, the overall appearance of bright anodised aluminium is not adequately defined by measurement of total reflectance alone, as the specular reflectance value and the image clarity are also relevant.

Total reflectance values of 5% upwards can be obtained with anodised aluminium alloys, depending on alloying constituents, metallurgical state, type of surface preparation, anodic oxidation coating thickness and colour. Bright anodised aluminium will typically give total reflectance values of near to 85%, whilst the values of diffuse anodised finishes on pure aluminium will be lower at 70% to 80%.

L3 SPECULAR REFLECTANCE AND IMAGE CLARITY

Bright finishes with a high specular reflectance can only be obtained using special grades of aluminium (see Appendix B); cooperation between the purchaser, the metal supplier and the anodiser is essential if these finishes are to be achieved. For guidance, grade 1150 aluminium (containing 99.5% aluminium), when carefully polished, brightened and anodised, will normally give specular reflectance values of 75% to 90%.

Values greater than 60% are generally indicative of good image clarity, and below this level there is a noticeable deterioration in image clarity.

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ISBN 0 7337 3481 2

Printed in Australia