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BULLETIN

FINISHING ALUMINIUM

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- Aluminium is light and relatively strong, corrosion resistant, easily fabricated and suitable for a wide range of applied finishes and building-related applications.
- The most common finish for building applications of aluminium is powder coating. Other options are anodising, coil coating, painting and mechanical or chemical treatments.
- This bulletin describes the finishes and their specification, their application and the risks to aluminium performance. It updates and replaces Bulletin 349 *Finishes for Aluminium*.

1 INTRODUCTION

1.0.1 Aluminium has many desirable attributes as a building material. Aluminium alloys are light, relatively strong, and easily fabricated into complex shapes by casting, extrusion or forming. A wide variety of finishing options are possible.

1.0.2 Aluminium has an inherent resistance to corrosion because a thin surface film of oxide forms naturally on the surface when exposed to air. Oxidation occurs when the surface finish is damaged and can form more quickly in aggressive environments. For most building purposes, the application of a protective and/or decorative surface coating will help to minimise corrosion. An inappropriate surface coating system may, in some situations, promote localised corrosion on aluminium.

1.0.3 This bulletin explains the properties of mill-finished aluminium and coated aluminium (anodising, powder coating and coil coating). It describes the factors influencing the selection of an aluminium finish and its likely behaviour in the built environment in a wide range of environmental conditions. Other decorative finishes such as paints and mechanical and chemical treatments are also briefly discussed.

1.0.4 This bulletin updates and replaces Bulletin 349 *Finishes for aluminium.*

2 MILL-FINISH ALUMINIUM

2.0.1 Mill-finish or unfinished aluminium is often used for flashings and structural extrusions and provides good service in most environments. Mill-finish aluminium can also be used for roofing and wall cladding, but aluminium alloys with a higher content of magnesium, chromium or manganese and higher tensile strength must be specified. These are referred to as 5000 or 6000 series alloys.

2.0.2 Mill-finish aluminium relies solely on the material's natural surface oxide film to provide corrosion resistance. Their most frequent forms of corrosion when weathered outdoors are pitting corrosion and galvanic corrosion. Uniform corrosion rate is normally very low.

2.0.3 Many architectural and building products/components are manufactured from mill-finish grade AA6060 aluminium alloy with a T5 temper. Grade AA6060-T5 aluminium alloy is a general purpose aluminium-silicon-magnesium (Al-Si-Mg) extrusion alloy that offers very good corrosion resistance. This aluminium alloy has been used successfully in New Zealand for architectural applications on buildings, such as window frame components, for over 50 years.

2.0.4 The mill-finish 6060 aluminium alloy ensures that extruded shapes, such as sill support bars, have a protective aluminium oxide film present on the alloy surface. This passive film provides very good corrosion resistance and ensures good service life in all environments to which building components are exposed during service. For example, installation of sill support bars extruded from 6060 aluminium, in a drained and ventilated cavity, ensures that access to air movement (oxygen) will maintain the protective oxide film on the aluminium surfaces even at the cut-ends of the bars.

2.0.5 Mill-finish aluminium is more susceptible to corrosion when in contact with or subject to run-off from:

- wet or green or uncured concrete, wet or green cement plaster, mortar or grout, mild steel, sulphur, copper, acidic timbers (such as oak, chestnut and Western red cedar) and timber treated with a copper-based preservative – the risk of corrosion from cement-based materials reduces where the material has cured and remains dry in service
- some acids and strong alkalis such as bird droppings.

2.0.6 Unprotected cut edges of aluminium must not come into contact with any mercury compound such as tin, and lead/tin solders must be avoided.

3 STANDARDS AND CODES

3.0.1 AS/NZS 2728:2013 *Prefinished/prepainted sheet metal products for interior/exterior building applications – Performance requirements* provides performance criteria for durability, impact and corrosion resistance for coating systems in a range of interior and exterior environments. AS/NZS 2728:2013 also lists atmospheric categories derived from AS/NZS 2312:2002 and ISO 9223 *Corrosion of metals and alloys – Corrosivity of atmospheres – Classification, determination and estimation.*

3.0.2 NZS 3604:2011 *Timber-framed buildings* refers to atmospheric corrosivity classes – zone B (low), zone C (medium) and zone D (high). For the purposes of cladding selection, Table 20 in Acceptable Solution E2/AS1 includes an additional zone E (severe marine).

3.0.3 The Window & Glass Association of New Zealand (WGANZ) maintains a registration system and quality assurance programme called Endurocolour for powder-coating applicators. The programme requires registered applicators to meet stringent quality control requirements based on standards designed specifically for New Zealand conditions.

3.0.4 For anodising, WGANZ *Voluntary Specification* SFA 3503-03:2005 provides a useful guide to specifiers, manufacturers and fabricators.

4 FINISH SYSTEMS

4.0.1 The most common finish options for aluminium are:

- powder coating
- anodising
- coil coating.

4.0.2 Section 4.4.4 lists a number of less common finish options for aluminium.

4.1 POWDER COATING

4.1.1 Powder coating is a factory process for applying a tough and durable film to metal surfaces. An electrostatic spray gun is used to apply specially formulated powder to the metal. By earthing the metal item, the electrically charged powder particles are attracted to the surface. This produces a relatively uniform thickness across exposed surfaces. A lower build-up occurs in recesses and internal channels because of an electrical shield effect that attracts the powder particles to the edges of an opening or recess. As surfaces facing away from the spray gun remain uncoated except for a light coating close to the edges, using more than one spray gun is necessary when back surfaces require coating. The coating is then cured under controlled conditions to form a film of even thickness. The 100% solid powders release no volatile organic compounds (VOCs) or solvents into the atmosphere and are considered virtually pollution free during application.

4.1.2 Thermosetting is the powder-coating process most commonly used for building components such as aluminium extrusions, flashings, cladding panels, infill panels and hardware.

4.1.3 Thermosetting powders include the following:

- **Polyesters** – suitable for external use because of their weathering resistance. Resistance to chemical attack is excellent when compounded with appropriate polymers. The typical gloss level of polyesters can range from 20–90 units gloss.
- **High-performance polyesters** – designed to retain their original colour and gloss better than standard polyesters. Some powder-coating applicators recommend using high-performance polyesters for exterior window and door joinery. The powders are less likely to be available in all bright colours such as reds, yellows, oranges and pinks. A guarantee against fading and colour change is usually available for high-performance polyesters such as:
  - **Architectural grade powders** – composed of higher-grade resins and pigments than standard polyester powders to give improved resistance to fading and gloss retention. A range of gloss levels is available with some brands.
  - **Anodic/anotec polyesters** which fall under architectural grade powders as well. Offer a distinctive surface appearance and a matt finish (30% gloss).
- **Fluoropolymers** (pvf3) – made-to-order powders available in lower gloss level and designed to be the most durable (and most expensive) powder-coating system.
- **Epoxies** – slightly harder and more abrasion resistant than polyesters but not as resistant to ultra-violet light. Epoxy coatings tend to chalk and are more suited for indoor use unless appearance is unimportant and/or excellent chemical resistance is required.
- **Anti-graffiti powders** – madeto-order and available in a wide range of colours and designed to provide a hard and chemically resistant surface finish that allows aerosol-based graffiti to be removed with solvent-based cleaners.

4.1.4 Other thermosetting powders based on polyurethanes, acrylics and blends of these are available but are not usually used for exterior building components.

4.1.5 To successfully apply thermosetting powder coatings:

- The surfaces must be thoroughly cleaned to provide maximum coating adhesion and resistance to corrosion. For aluminium extrusions, a multistage cleaning process is used to degrease the surface and remove the aluminium oxide (etching) present on the surface. A thin conversion coating (0.05–0.15 μm) is then obtained in chromate or phosphate baths to form a base layer. It provides a combination of good corrosion resistance and excellent adhesion between the powder coat and the aluminium. Electrostatic spray powder coat is not usually part of the extrusion that will not be visible.
- Specify the use of alloys that will withstand the oven-curing cycle of the powder without loss of strength. Curing temperatures peak around 160–200°C, depending on powder type. For greater production flexibility, the substrate should be able to withstand 220°C for short periods.

4.1.6 For coating durability, the most important parts of the quality control throughout the application process are the use of the correct pre-treatment and the correct curing cycle to ensure proper cross-linking of the powder particles. Articles must be kept clean between the final cleaning process and completion of the coating process.

4.1.7 Applied powders are cured (stoved) by a carefully controlled temperature cycle, making the powder melt and fuse into an even film thickness. To maintain this even film, the stoving (or baking) temperature must be reached as soon as possible to prevent sagging, but not too quickly in order to reduce flow-out time and an 'orange peel' effect developing on the surface. Convection ovens are preferable to infra-red lamps except for flat sheet, since infra-red lamps only provide proper curing on surfaces directly facing the lamps.

4.1.8 When considering thermoset powder-coated products:

- Generally, more-expensive raw materials are used for higher durability finishes. However, the cost of exceeding the minimum specification for durability may offset future maintenance issues.
- The powder coating should be suitable for coating complex shapes.
- Lighter colours tend to perform better than darker colours, in terms of fade resistance over time.
- Performance or adhesion can be variable when applied over existing coatings such as coil-coating.
- Aluminium that has been anodised cannot be powder coated unless the anodising is totally removed.
- Welded or cast aluminium areas may contain cavities that will blow out during the baking.
- Avoid creating areas that will trap moisture.
- Avoid using sizes that cannot be accommodated in the pre-treatment systems.
- Avoid the post-forming of coated articles unless the process has been proven by prior test. Anodic/anotec and architectural powders are generally less tolerant of post-forming.
- Avoid the risk of batch-to-batch powder colour variation by ensuring that entire jobs are coated in a single production run.

4.1.9 The range of powder coating specifications classified by AS/NZS 2728:2013 is given in Table 1. WGANZ standard *Powder coating surface finishing – appearance in-situ* specifies a minimum film thickness of 50 µm on metal surfaces. Powder coating is generally applied to a thickness of 60–120 µm to ensure adequate coverage of significant faces and slightly lower in channels and recesses. Films of less than 40 µm thick are not recommended as they are prone to pinhole penetration of the metal, can have inconsistency of colour and may erode too quickly for an acceptable product life.

4.1.10 Excessively thick films may be unacceptable in appearance because of surface roughness and may lead to problems in matching of extrusions. The WGANZ standard also specifies minimum standards for paint cure and adhesion and quality of the pre-treatment conversion coating.

4.1.11 Table 1 gives minimum and recommended powder-coating specifications for different corrosion zones.

4.1.12 Powder coatings are available in an extensive range of colour and gloss options. Most manufacturers also offer pearlescent, hammered and other special effects.

4.1.13 Gloss and colour loss can be reduced by specifying high-performance polyester powders and lighter rather than darker colours:

- light and pastel colours provide the best performance under exposure to ultra-violet light
- darker colours absorb heat and will chalk and degrade more rapidly than light colours
- bright colours tend to fade and so should be used with caution when selecting for exterior use.

4.1.14 If colour matching of the components is required, the same type of powder coating must be used on each. Differently-based powder coatings may match when installed but change colour in different ways over

Table 1. Corrosion zones and powder-coating specifications (adapted from WGANZ and AS/NZS 2728:2013).

NZBC clause E2/AS1 & NZS 3604:2011/ corrosion zone*	AS/NZS 2728:2013 atmospheric classification	Atmospheric conditions	Minimum powder coating specification	Recommended powder coating specification**
	Category A – very low	Clean air, interior of heated or air-conditioned buildings		
Zone B – low	Category B –low	Inland – little risk of wind-blown sea spray, typically hill country with plentiful rainfall	Extra-durable powder coating	Extra-durable powder coating (conforms to AAMA 2603)
Zone C – medium	Category C –medium	Inland – medium risk of wind-blown sea spray, low salinity	Extra-durable powder coating	Extra durable powder coating (conforms to AAMA 2603)
Zone D – high	Category D –high	Coastal – high risk of wind-blown sea spray – within 50 m of the sea/harbour or 100 m from tidal estuary or sheltered inlets, off shore islands	High-durability powder coating	High durability powder coating (conforms to AAMA 2604)
Zone E – severe (E2/ AS1 Table 20)	Category E –very high	Severe marine, breaking surf beachfronts	Super-durable fluoropolymer coating	Super durable fluoropolymer coating (conforms to AAMA 2605)
Geothermal corrosive microclimates		Geothermal areas, swimming pools, high corrosion/pollution risk areas (close proximity to industrial factories etc.), interiors with high humidity	High-durability powder coating	Super durable fluoropolymer coating (conforms to AAMA 2605)

* Refer to NZS 3604:2011 section 4 Durability and clause E2/AS1 Table 20 for more detailed descriptions of zones and environmental factors.

** The American Architectural Manufacturing Association (AAMA) produces the most widely recognised standard for durability of powder coatings. WGANZ standards are based on performance criteria derived from three AAMA standards used to specify powder coatings:

3 years Florida resistance (AAMA 2603)

5 years Florida resistance (AAMA 2604)

10 years Florida performance (AAMA 2605)

time. Provide the coating applicator with samples to use for colour and gloss matching.

4.2 ANODISING

4.2.1 The thin naturally occurring oxide film on the surface of aluminium provides inherent corrosion resistance. Anodising involves the complete removal and then artificial thickening of the oxide surface film by immersing it in a chemical bath and passing an electric current through the metal. This electrochemical treatment produces a dense, hard, nonreactive surface (Figure 1) that improves adhesion of organic coatings, hardness and resistance to wear, weathering and corrosion.

4.2.2 The anodised finish is integral with the metal and provides a tough and durable finish. Anodising results in a uniform finish, even on sharp edges, which won't chip or peel off.

4.2.3 The treatment first creates a broken porous surface of troughs and peaks to which coloured pigments or dyes may be applied. Different chemical bath contents deliver different final film properties. The surface is then sealed to fill the troughs and just cover the peaks.

4.2.4 Most aluminium architectural components are anodised in a sulphuric bath with aluminium sheet cathodes with the item to be anodised attached to the anode followed by sealing in boiling deionised water, or other similar chemical sealing procedures. Sealing also stops any leaching of colouring materials and prevents corrosion taking place through the open pores.

4.2.5 Anodising can result in a range of gloss levels from deep lustrous matt to brightly polished or heavily etched aluminium. Chemically polishing pure aluminium or magnesium/aluminium alloys before anodising will result in a mirror-like finish.

4.2.6 With anodising sealing the film is critical – a well-sealed 10 μm film provides better resistance than a poorly sealed 25 μm film. A film thickness of 10–15 μm is generally accepted as suitable for most indoor uses. Most of the exterior aluminium joinery in lowrise New Zealand buildings is anodised to either 12 μm or 20 μm. Such coatings, produced under carefully controlled conditions, have proven satisfactory over many years. Table 2 gives minimum and recommended thicknesses for different corrosion zones.

4.2.7 WGANZ Voluntary Specification SFA 3503-03:2005 provides a useful guide to specifiers, manufacturers and fabricators.

4.2.8 Using lacquers, waxes or petroleum jelly as temporary surface sealers provides additional protection during transport or fabrication. Regular maintenance including frequent cleaning will greatly enhance the performance of anodised finish particularly in harsher environments.

4.2.9 The anodised oxide surface can be left in its natural state or coloured through various methods. Anodised films are coloured in several different ways:

- Organic dyes give a wide range of colour options but nearly all fade on exposure to sunlight and weather and are not suitable for external use.
- Inorganic material (metal salts, oxides or hydroxides) is electrolytically deposited at the base of the pores after anodising but before sealing to give a narrow range of more stable colours.
- Integral colours are produced by using special anodising processes. Integral colours are less commonly used because of their higher production cost. They are light-fast and weather resistant

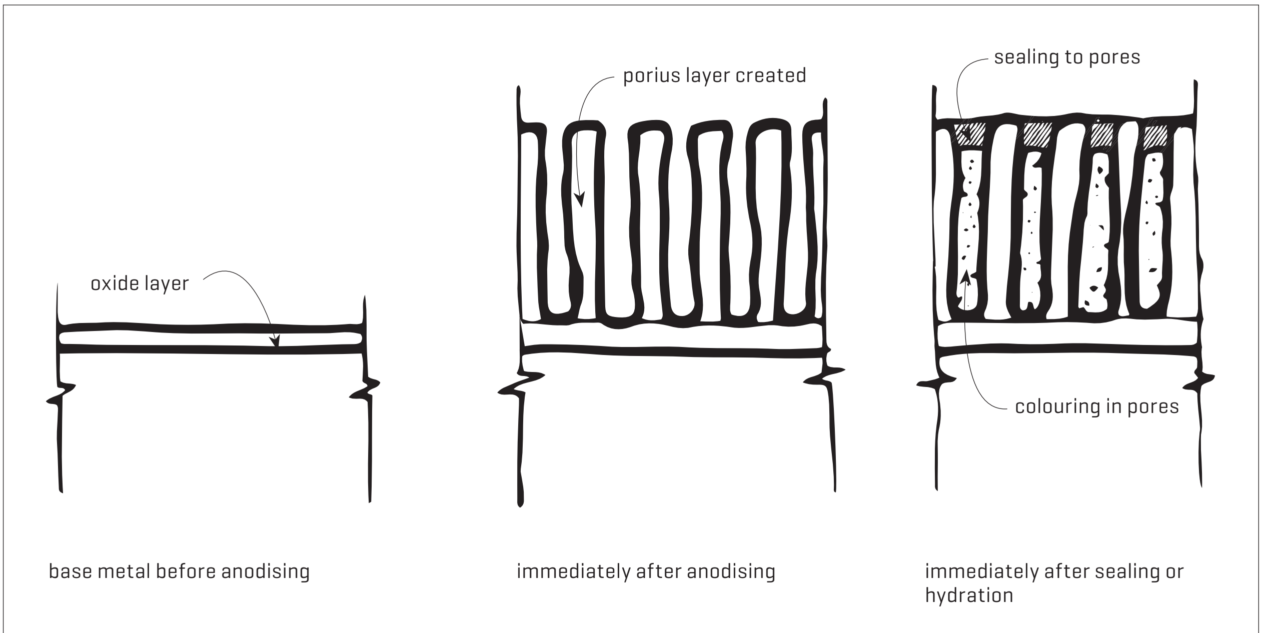

Figure 1. Anodising process.

TABLE 2. New Zealand Corrosion zones and anodising thickness (adapted from WGANZ).

NZBC clause E2/AS1 & NZS 3604:2011 corrosion zone *	WGANZ corrosion zone	Description	Minimum thickness µm	Recommended thickness µm	Window & Glass Association standard
Zone B – low	Zones 2 and 3	Inland – little risk of wind-blown sea spray, typically hill country with plentiful rainfall	12	12	AA12
Zone C – medium	Zone 1	Inland – medium risk of wind-blown sea spray	12	20	AA20
Zone D – high	Sea spray	Coastal – high risk of wind-blown sea spray (within 500 m of the sea/harbour or 100 m from tidal estuaries or sheltered inlets, offshore islands	25	25	AA25
Zone E – severe	Sea spray extreme	Severe marine, breaking surf beachfronts	25	25	AA25
Geothermal, corrosive microclimates	Geothermal	Geothermal areas, swimming pools, high corrosion/pollution risk areas (close proximity to industrial factories etc.)	25	25	AA25

* Refer to NZS 3604:2011 section 4 Durability and clause E2/AS1 Table 20 for more detailed descriptions of zones and environmental factors.

but have a smaller range of colours than can be produced by dyes. The colour may come from using a special anodising solution or by including particles of aluminium alloy in the film that are not dissolved by the anodising solution. Some processes use a combination of these two methods – for example, by anodising special alloys in particular acids.

4.2.10 Colour fastness and tone can vary between batches and manufacturers, especially on large jobs where mixtures of dyes have been used or when production runs are large. Most anodisers furnish a standard sample set to allow limits on colour variation to be fixed.

4.2.11 Colours selected from manufacturers' recommended ranges perform well even in harsh sunlight.

4.3 COIL COATING

4.3.1 The coil-coating process involves unwinding, coating and rewinding a coil of aluminium sheet. The coil is fed through a series of stations where it is cleaned and pre-treated before a paint system is applied. Rollers apply an even film of primer, back and top coats to the sheet. Epoxy-type primers are most common although some polyester primers are used. Primer is applied to both sides of the material, which is then finished with a backer coat on the reverse face and a finish coat on the top surface. The sheet passes through an oven after each coat to cure the film. The durability of paint-applied finishes depends to a large degree on the number of layers of paint applied.

4.3.2 Many of these wet-applied coatings are less environmentally friendly than powder coatings because they contain VOCs and solvents.

4.3.3 Commonly used coil coatings include the following:

- **Polyester** is a flexible coating that can be applied to materials that will be roll-formed or bent, such as roofing, guttering, downpipes and other accessories. The exact coating composition depends on the colour chosen. Chalking and fading rates in exterior situations will depend on the colour – it is generally greater with darker colours and the amount of sun the item receives.
- **Silicone-modified polyester (SMP)** is a relatively inflexible coating not suited for forming sharp profiles. SMPs are suitable for outdoor use in moderate environments. They have better durability and chalking resistance than polyesters.
- **Polyvinylidene fluoride (PVF2 or PVDF)** is a composite acrylic and PVF2 resin coating where the acrylic improves adhesion and reduces water permeability while the resin improves durability and flexibility. PVF2 acrylic coatings are more durable than SMP coatings and can be used in more aggressive (for example, marine) conditions. Despite the higher cost than powder coating, PVF2 finishes are often selected for façade claddings because of their durability. PVF2 coatings are usually limited to matte or satin finishes because of the added cost of applying additional layers to provide high gloss levels.
- **Polyvinylchloride (PVC), plastisol, or polyvinyl fluoride laminates** are recommended by

manufacturers for use in industrial and extreme environments. PVC is a thick plastic film, generally resistant to chemicals and extreme conditions. It has poor resistance to solvents and tends to fade and chalk badly but has good flexibility and corrosion resistance. Edges must be sealed in very corrosive environments and food-processing plants.

- **Polyvinyl fluoride** is a solid film laminated to aluminium using a liquid adhesive. It is flexible and resistant to solvents, chemicals and weathering but has only fair resistance to mechanical damage.

4.3.4 Most coil-coating products are available in a wide range of colours, although the colour selection for certain types of coatings may be more limited. A wide range of colours and a myriad of luminous, micaceous, metallic and textured effects are available on the market (although often only in large minimum quantities).

4.3.5 For some coil coatings (as with powder coating), some chalking and loss of gloss will be more pronounced than for others, the effect being more noticeable with darker colours.

4.3.6 When considering repainting pre-finished aluminium, seek specialist advice from the original coating manufacturer and the paint manufacturer.

4.4. OTHER FINISHES

4.4.1 Other less commonly used coatings suitable for aluminium, which are not covered further by this bulletin, include the following:

- **Thermoplastic powders** are considerably thicker but not as hard as thermosetting powders, but still provide good impact and chip resistance. Precisely controlling the coating thickness can be difficult. Powder application is by spray onto preheated aluminium or by the fluidised bed method. With a fluidised bed the pre-heated object is lowered into a vessel containing the powder and air is diffused through the vessel bottom to lift and distribute the powder particles. Particles will self-adhere to the heated surfaces. Items being coated must be degreased before coating, and for corrosive environments, applying a conversion or protective coating is beneficial. Oven curing may be required for thin aluminium sections to complete the fusing of the powder.
- **Polyethylene** protects aluminium embedded in soil or concrete.
- **PVC** gives chemical resistance particularly to alkalis.
- **Nylon** provides good chemical resistance, particularly where contact with foodstuffs is likely.
- **Electropainting** is where items being coated are suspended in a paint bath and a voltage is applied so that the negatively charged paint particles are attracted and adhere firmly to the positively charged aluminium. The item is then removed from the bath, washed to remove loose paint particles and stoved to cure the coating. Electropainting is often used to coat items that can't be powder coated because of electrical shielding effects.
- **Electroplating** coats the aluminium with a metallic finish. It requires pre-treatment of the aluminium to remove the oxide layer and give adequate coating adhesion. The differences in electro potential between the aluminium and the deposited metal could cause a galvanic corrosion risk in damp or marine environments.

- **Alkaline or acid etching** produces a frosted or diffused surface that disguises scratches and mechanical damage and gives a non-glare finish. It is often followed by anodising or lacquering.
- **Bright etching** chemically etches the aluminium to give it some lustre and sparkle. Common uses are background lighting reflectors and hardware.
- **Chemical brightening** involves immersion in a chemical bath to give a spectacularly reflective or mirror-like finish suitable for lighting reflectors and as a decorative finish for appliances.
- **Electrobrightening** involves using a special acidic electrolytic solution to give a high reflectivity suitable for use in spotlights and lasers.
- **Chemical colouring** is achieved by immersing the aluminium in various solutions. This process has been rendered obsolete by the improved colour range and better performance of anodised finishes.
- **Air-drying paints** involves the application of a conventional paint system to the aluminium. Typically, aluminium will require a thorough clean, then the application of a vinyl etch primer to provide sufficient coating adhesion. Apply a tinted primer/undercoat followed by conventional one or two-pack finish coatings. Dense, stable oxidisation may be able to be painted over. However, getting paint to adhere to highly polished aluminium surfaces can be difficult and these surfaces should be wet sanded to give a matt surface. Round off any sharp edges on the aluminium profile to allow better film build.
- **Mechanical finishes** such as patterning, linishing and polishing are usually applied to aluminium sheet. Grinding and abrasive blasting is used to finish cast material. Mechanical finishing is usually carried out as a first step to subsequent treatments such as anodising or lacquering, which preserve the finish.
- **Laser etching** is a process often used for signwriting and can also be used to apply an infinite variety of complex graphic geometric images to anodised surfaces.

5 RISKS TO ALUMINIUM PERFORMANCE

5.0.1 Galvanic corrosion of uncoated aluminium will almost always occur where it is connected electrically to a different material and moisture is present. This oxidation can occur even between different aluminium alloys if the environment is sufficiently aggressive (such as in exposed coastal areas or areas close to industrial zones with high levels of air pollution).

5.0.2 Contact with copper or its alloys, lead or unprotected mild steel will increase the oxidation rate of aluminium in aggressive environments. Avoid the use of fixings other than aluminium or stainless steel and contact with run-off from copper-containing surfaces such as copper-containing preservative treated timbers. The presence of dissolved copper or lead in water in contact with an aluminium surface may be more risky than direct contact with the metal. This is because the dissolved metal can seek out weak points in the protective coating. Don't use plated brass fittings and fastenings as there is the danger of corrosion damage to the aluminium if the plating is ruptured.

5.0.3 Protect uncoated parts of aluminium in contact with treated timber with a suitable primer before installation, especially if the timber treatment is copper-containing preservative.

5.0.4 Isolating the aluminium from contact with a concrete substrate through use of a building underlay or a bituminous coating applied onto the concrete will prevent any deleterious reaction between these materials.

5.0.5 Wash mortar or cement-based plaster off surfaces ***immediately!*** Powder coating is more resistant to attack by cement mortar than anodised surfaces but can be damaged by mechanical removal of mortar splashes. Apply a coat of suitable primer to any uncoated aluminium surfaces in contact with plaster, mortar or fibre-cement.

5.0.6 Where grade 304 stainless steel screws pass through an AA6060 aluminium component, there is dissimilar metal contact between the materials. Some minor corrosion may occur on the aluminium at screw holes in the early stage of service life. However, over time, the aluminium oxidation produced acts as an insulator (that is, electrical isolation occurs) and galvanic corrosion is stifled at the dissimilar metal contact points.

5.0.7 Wet painted aluminium may suffer filiform corrosion (also known as underfilm corrosion or wormtrack corrosion), particularly at coating defects. This risk is dependent on many environmental and processing parameters, such as permeability (or porosity) and elasticity (or adhesion) of the applied paint coating, surface contamination of hygroscopic salt particles on the aluminium, and humidity. It is a cosmetic form of corrosion and does not significantly weaken or destroy metallic components but can affect the appearance of building components.

5.1 ANODISED FILMS

5.1.1 Anodised films are resistant to mechanical damage, and chemical exposure must be severe and prolonged before the film is eroded. However, the following situations should be avoided:

- General erosion of the film can occur if it comes in contact with strongly acidic or strongly alkaline chemicals. Once the base metal is exposed, oxidation of the surface will occur. Splashes of alkaline plaster or cement, or gases such as sulphur dioxide in a moist atmosphere, may cause this type of corrosion.
- Point attack on the metal can occur at localised sites where the film is damaged or defective or where film erosion has occurred. This type of attack can result in pitting which can form pinholes in very lightweight material, although only a minute amount of material might be lost and the structural strength will be unaffected. The likelihood of this type of attack is increased if the surface is in an environment that contains copper or chloride ions (from sea salt) or where dirt and dust are deposited on the surface.
- Chemo-mechanical erosion results when a mechanical action (such as abrasion) combines with an aggressive environment where neither the

mechanical action nor the environment would have caused problems on their own. An example is the fixing clips on a roof that can abrade the surface as the material expands and contracts.

5.1.2 Pitting of anodised aluminium can occur after long exposures to an aggressive atmosphere, though anodising will resist its occurrence. Pitting is more likely to occur if anodised aluminium is connected to copper or lead, or carbon (as soot) is left lying on the surface.

5.2 POWDER-COATED AND COIL-COATED ALUMINIUM

5.2.1 Powder coated and coil-coated aluminium performance can be affected by:

- use of the material in areas not washed by rain such as under eaves and overlaps
- low pitches where water can pond such as flashings, gutters and end spans on low pitched roofs (the pitch referred to by manufacturers is that measured in the middle of the spans)
- crevices, where dirt and salt can build up and are not easily washed away.

5.2.2 Powder coating can also be affected by sealants and paint splashes:

- Sealants can react unfavourably with the coating. Check with the manufacturer of the sealant, powder coat or joinery before specifying a particular sealant. Sealants that have been stated to be compatible are two-pack polysulphides, silicone and some acrylics.
- Remove paint splashes immediately. If the paint is waterborne, use water. If the paint is solventborne, use isopropyl alcohol or methylated spirits. Rinse with warm soapy water. Although most commonly used paints have poor adhesion to newly produced surfaces, cleaning off the splashes before they dry reduces the risk of damage.

6 ENSURING GOOD IN-SERVICE PERFORMANCE

6.1 INSTALLATION PRACTICES

6.1.1 Avoid contact with incompatible materials. All fittings and fastenings should ideally be of the same alloy as the aluminium they are in contact with. Compatible aluminium alloys, zinc or materials with a thick coherent zinc coating can usually be used with very few problems. In mild environments, where a protective film on both metals will be maintained, aluminium is also compatible with cadmium, chromium and stainless steel. Where these protective films can be broken down, such as in marine or industrial environments, corrosion may occur at the points of contact, and will normally attack the aluminium. When separation of aluminium from another material is required, use a paint coating over a suitable primer, a heavy-bodied bituminous paint, a compatible sealant or a non-absorptive tape or gasket.

6.1.2 Provide temporary protection of surfaces by using a plastic film which can be stripped from the surface when the building is nearly completed. Seek the advice of the aluminium supplier before applying any film. For anodising and powder coating, a methacrylate lacquer that will weather away may be used as a corrosion barrier for aluminium. Temporary protection is particularly important when stucco or other plaster or silicone concrete sealers are being applied to adjoining walls, to prevent etching of either unprotected or finished aluminium by plaster splashes or from sealer overspray. Wash plaster splashes from surfaces when they occur, thoroughly rinsing with clean fresh water after washing to remove all residues, as damage cannot be repaired after the splashes have dried.

6.1.3 Avoid impacts or rough handling. As the finish and the metal have different flexibilities, severe deformation may break the film. Scratches or gouges will expose the base metal. Touch-up paints are available from powder-coating and coil-coating manufacturers, but these paints usually have different properties from the original coating. Seek the advice of the supplier of the coating and follow the recommendations closely when considering a film repair. A suitable primer is desirable if the damage has exposed bare aluminium.

6.1.4 For **anodised or powder-coated aluminium**, performance can be promoted by doing the following:

- Protect cut ends of extrusions because they only rely on their natural oxide film for protection. In aggressive environments, fill joints with cut ends after anodising with a sealant. Fill joints that would trap moisture with a good quality caulking compound and eliminate wherever possible flat surfaces and cavities that trap dirt. For powder-coated products, use solvent-based acrylic and rubberbased sealers.
- Avoid profiles with sharp corners:
  - The minimum rounding radius for anodizing should be about 30 times the specified film thickness (i.e. not less than 0.2 mm and for thick films not less than 0.7 mm). Because the anodised film grows at right angles to the surface, cracking will occur at sharp corners.
  - The minimum rounding radius for powder coating is 0.7 mm. A sharper edge can lead to thinning of paint cover and premature coating failure.
- Arrange for colour-matching standards if using coloured finishes. Different alloys may not colour match even if anodised in the same bath, and weld lines will appear as a different shade after anodising. Also ensure the powder coating specification is consistent.
- Use the correct type of sealant or adhesive, as many adhesives and sealants release damaging chemicals as they cure. Don't apply adhesives and sealants to anodised aluminium surfaces that are intended to remain fair-faced.

6.2 MAINTENANCE

6.2.1 Good in-service performance for all types of coated aluminium requires designing for maintenance. If the surface is not naturally rain-washed, ensure aluminium surfaces are readily accessible to allow washing.

6.2.2 A regular maintenance cleaning regime should begin for exterior aluminium joinery as soon as the installation is complete. While rain-washing assists

with cleaning, some areas such as under overhanging soffits and eaves will soon accumulate dust and dirt. The aluminium frame should be cleaned as often as the glass. Reasonable minimum cleaning frequencies (with appropriate neutral detergent) for anodised and powder-coated aluminium are suggested as:

- rural and unpolluted urban – every 6 months
- polluted urban, geothermal, industrial, and marine – every 3 months.

6.2.3 Coated aluminium should never be cleaned with an abrasive cleaning or cutting compound or solvent-based cleaner.

6.2.4 When carrying out maintenance on other parts of the building, avoid paint or stain splashes by masking off aluminium joinery, and be aware that sunscreen products may leave long lasting marks on many aluminium coatings.

7 REFURBISHING ALUMINIUM

7.0.1 Once corrosion has started on aluminium, remedial treatment is difficult, especially for decorative surfaces. Remove bulky, adherent corrosion products by mechanical abrasion (wetted stainless steel wool but not a wire brush) or, as a last resort, a chemical etch cleaner. Both these cleaning materials will further damage the surface finish. Remove the residues from any cleaning operation by very thorough rinsing with cold water. Coat the prepared surface with a coating of wax, lacquer or paint and maintain the coating to prevent repetition of the corrosion product growth. Maintenance is easier and, in the long term, cheaper, if performed conscientiously from the beginning of a product's life even if corrosion damage is not evident.

7.0.2 Powder coating will lose gloss over the first few years of its life, more noticeably on darker colours and most rapidly on surfaces exposed to direct sunlight. This is because a very thin chalk film develops. Polishing with an acrylic emulsion or light oil will reinstate the gloss, but always check with the supplier before using these products. The appearance of dull and faded powder coatings can also be improved by applying a light automotive cutting compound. Scuff marks on anodised surfaces can be removed by light use of a fine-grained abrasive pad, rubbing gently with the grain. Check with specific coating manufacturers whether these methods can be used for other coating types.

7.0.3 Touch-up paints and spray cans are available for some finishes but should be used with caution. Over time, the touch-up paint will fade differently to the original coating resulting in an even more unsatisfactory blemish. The NZ Metal Roof and Wall Cladding Code of Practice recommends that if a scratch is obviously visible from 3 m, a cladding or roofing sheet should be replaced. If it is not visible from 3 m, it should be left alone.

7.0.4 Under a Window & Glass Association registration programme, an in-situ refinisher tradesperson can be employed to carry out maintenance and refurbishment work to specific industry standards.

8 REFERENCES

Standards New Zealand
NZS 3604:2011 *Timber-framed buildings*

Joint Australian New Zealand Standards
AS/NZS 1734:1997 *Aluminium and aluminium alloys – Flat sheets, coiled sheet and plate*

AS/NZS 2728:2013 *Prefinished/prepainted sheet metal products for interior/exterior building applications – Performance requirements*

Standards Australia
AS 1580.481.0-2003 (R2013) *Paints and related materials – Methods of test – Part 481.0: Guide to assessing paint systems exposed to weathering conditions*

AS 3715-2002 (R2017) *Metal finishing – Thermoset powder coatings for architectural applications of aluminium and aluminium alloys*

British and International standards
BS 3987:1991 *Specification for anodic oxidation coatings on wrought aluminium for external architectural applications*

BS EN 12206-1:2004 *Paints and varnishes. Coating of aluminium and aluminium alloys for architectural purposes. Coatings prepared from coating powder*

BS EN 13438:2013 *Paints and varnishes. Powder organic coatings for hot dip galvanised or sherardised steel products for construction purposes*

BS EN ISO 7599:2018 *Anodizing of aluminium and its alloys. Method for specifying decorative and protective anodic oxidation coatings on aluminium*

BS ISO 10074:2017 *Anodizing of aluminium and its alloys. Specification for hard anodic oxidation coatings on aluminium and its alloys*

ISO 9223:2012 *Corrosion of metals and alloys – Corrosivity of atmospheres – Classification, determination and estimation*

American Architectural Manufacturing Association
AAMA publishes a large range of standards for aluminium coatings

Window & Glass Association of New Zealand:
SFA 3503-03:2005 *Specification for Anodic Oxide Coatings on Wrought Aluminium for External Architectural Applications*

Guide to Anodising - www.wganz.nz/guides/guide-to-anodised-aluminium-joinery/

Guide to Powdercoating - www.wganz.nz/guides/guide-to-powdercoated-aluminium-joinery/

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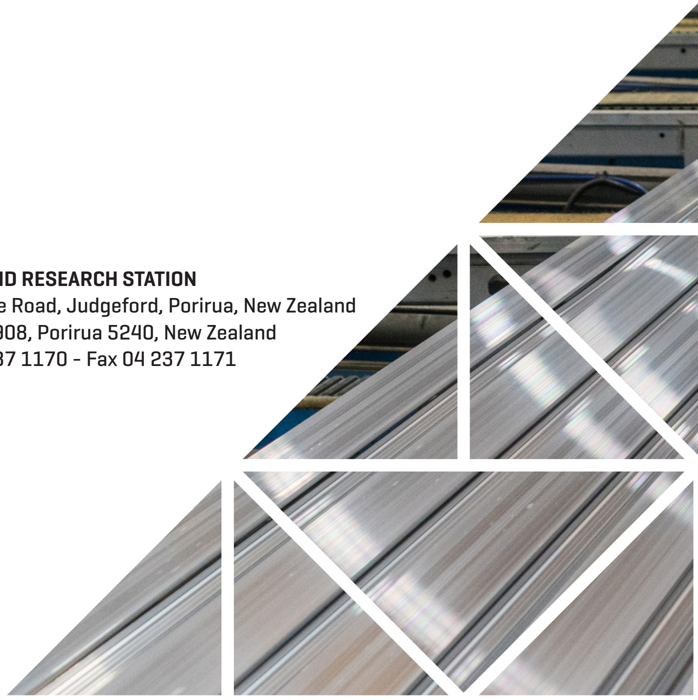

Standards referred to in this publication can be purchased from Standards New Zealand by phone 0800 782 632 or by visiting the website: www.standards.co.nz.

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