# Standards for galvanized products

Galvanized products should be specified in accordance with the appropriate national standards, which have been drawn up to provide minimum standards to ensure optimum performance of galvanized products and to give guidance in selection, application, and design.

AS2312 'Guide to the protection of iron and steel against exterior atmospheric corrosion' is a particularly valuable reference in the selection of the most practical, economic coating in particular applications.

## Relevant Australian standards

**AS1214-1983** Hot dip galvanized coatings on threaded fasteners.

**AS/NZS 4680 -1999** Hot-dip galvanized (zinc) coatings on fabricated ferrous articles.

**AS 2312-1994** Guide to the protection of iron and steel against exterior atmospheric corrosion.

## New Zealand standards

**AS/NZS 4680 -1999** Hot dip galvanized (zinc) coatings on fabricated ferrous articles.

**Works Consultancy Services CD 306**
Specification for hot dip galvanizing on structural steel work.

**Works Consultancy Services CD 307**
Specification for protection of structural steel work.

## British standards

**BS/EN/ISO 1461:1999** Hot-dipped galvanized coatings on fabricated iron and steel articles - Specifications and Test methods.

## American (ASTM) standards

**A 90** Methods of test for weight of coating on zinc-coated (galvanized) iron and steel articles.

**A 123** Zinc (hot galvanized) coatings on products fabricated from rolled, pressed, and forged steel, steel shapes, plates, bars, and strip.

**A 143** Recommended practice for safeguarding against embrittlement of hot-dip galvanized structural steel products and procedure for detecting embrittlement.

**A 153** Zinc coating (hot-dip) on iron and steel hardware.

**A 384** Practice for safeguarding against warpage and distortion during hot-dip galvanizing of steel assemblies.

**A 385** Standard practice for providing high quality zinc coatings (Hot dip).

**A 767** Standard specification for zinc coated (galvanized) steel bars for concrete reinforcement.

# Inspection of galvanized products

Visual inspection is the simplest and most important means of assessing the quality of galvanized coatings. A useful characteristic of the galvanizing process is that if the coating is continuous and has a satisfactory appearance it will be sound and adherent, with a zinc coating mass of at least 600 g/m$^2$ on fabricated articles over 6 mm thick, as discussed in more detail on page 13.

## Appearance

A galvanized coating is normally smooth, continuous and free from gross surface imperfections and inclusions. While the heavy zinc coating on general galvanized articles should be smooth and continuous it cannot be compared for surface smoothness to continuously galvanized sheet steel or wire since these are produced by processes which permit close control of coating thickness and appearance.

Differences in the lustre and colour of galvanized coatings do not significantly affect corrosion resistance and the presence or absence of spangle has no effect on coating performance. As discussed under 'Dull grey coating' below, uniform or patchy matt grey galvanized coatings give equal or better life than normal bright or spangled coatings.

It is recommended that inspection of galvanized work should be carried out by a designated party at the galvanizer's works in accordance with the following guidelines, and tested when necessary as detailed under 'Non-destructive testing for coating thickness', page 45.

### Variations in appearance and their relationship to coating quality

Variations in appearance of galvanized coatings listed below and their influence on coating quality are discussed on following pages.

## Dull grey coating

General comment: Acceptable.

A dull grey appearance is caused by growth of the zinc-iron alloy layers through to the surface of the galvanized coating. Grey coatings may appear as localized dull patches or lacework patterns on an otherwise normal galvanized coating or may extend over the entire surface.

Dull grey coatings usually occur on steels with relatively high silicon content which are highly reactive to molten zinc as discussed under 'Composition of steel' page 15.

Welds made with steel filler rods containing silicon may also produce localised grey areas in an otherwise normal galvanized coating, as discussed on page 35.

Dull grey coatings are often thicker than the normal bright or spangled coatings and therefore give longer life. It is rarely possible for the galvanizer to minimise or control the development of dull grey coatings which is dependent basically on steel composition.

## Blisters

General comment: Small intact blisters acceptable.

Extremely rare. Small blisters in galvanized coatings are due to hydrogen absorbed by the steel during pickling being expelled as a result of the heat of the galvanizing process. Their occurrence is due to the nature of the steel and is outside the control of the galvanizer. Blisters do not reduce the corrosion resistance of the coating.

## Rust stains

General comment: Acceptable when present as a surface stain.

Rust staining on the surface of galvanized coatings is usually due to contact with or drainage from other corroded steel surfaces. Steel filings or saw-chips produced during erection and fabrication operations should be removed from galvanized surfaces to prevent possible localised rust staining. Rust staining may also be caused by the weeping of pickling acid from seams and joints causing damage to the galvanized coating, and in such cases requires a modification in design as discussed under 'Overlapping surfaces' on page 37.

A thin brown surface staining sometimes occurs in service when the galvanized coating comprises entirely zinc-iron alloys as discussed under 'Dull grey coating' page 42. Staining arises from corrosion of the iron content of the zinc-iron alloy coating and is therefore outside the control of the galvanizer. It has no effect on the corrosion resistance of the coating. Long term exposure testing has shown that the corrosion resistance of zinc-iron alloys is similar to that of normal galvanized coatings.

## General roughness and thick coatings on welds.

General comment: Acceptable, unless otherwise agreed.

Rough galvanized coatings usually result from uneven growth of zinc-iron alloys because of the composition or surface condition of the steel. Where welding electrodes containing silicon have been used, the galvanized coating on the weld area may be thicker than normal and may also be brittle. Rough coatings of this type are usually thicker than normal and therefore provide longer protective life.

General roughness may also be caused by over-pickling, prolonged immersion in the galvanizing bath, or excessive bath temperature, factors which are frequently dictated by the nature of the work and may be beyond the control of the galvanizer.

In architectural applications where a rough finish is aesthetically or functionally unacceptable, the steel composition and surface preparation should be closely specified and the galvanizer consulted at an early stage. It is rarely possible for the galvanizer to effect any later improvement.

## Lumpiness and runs

General comment: Acceptable unless otherwise specified.

Australian/New Zealand Standard 4680 'Hot dip galvanized (zinc) coatings on fabricated ferrous articles' demands that a galvanized coating shall be 'smooth' but points out that smoothness is a relative term and that coatings on fabricated articles should not be judged by the same standards as those applied to continuously galvanized products such as sheet steel and wire, since these are produced by processes which permit a high degree of control over coating thickness and appearance. Lumps and runs arising from uneven drainage are not detrimental to coating life.

When zinc drainage spikes are present on galvanized articles and their size and position is such that there is a danger they may be knocked off in service removing the coating down to the alloy layers, they should be filed off by the galvanizer and, where necessary, the coating should be repaired as described on page 45.

For architectural applications the galvanizer can sometimes achieve a smoother finish than the normal commercial coating, depending on the shape and nature of the product. The steel should be carefully specified and the galvanizer consulted at the design stage and advised when the order is placed. Extra cost may be involved.

## Pimples

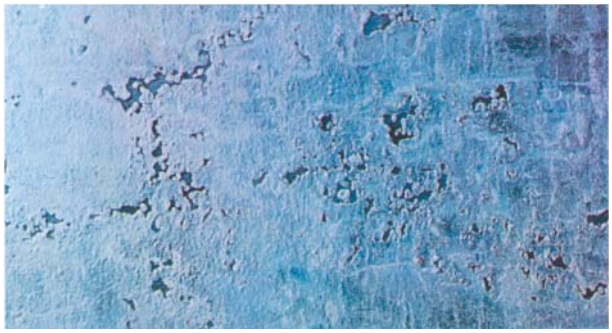
General comment: May be grounds for rejection depending on size and extent.

Pimples are caused by inclusions of dross in the coating. Dross, which comprises zinc-iron alloy particles, has a similar

corrosion rate to the galvanized coating and its presence as finely dispersed pimples is not objectionable. Gross dross inclusions may be grounds for rejection as they tend to embrittle the coating.

## Bare spots

General comment: Acceptable if small in area and suitably repaired, depending on the nature of the product.



Small localised flaws up to about 3 mm wide in a galvanized coating are usually self-healing because of the cathodic protection provided by the surrounding coating as discussed under Cathodic Protection on pages 9, 10 and 11. They have little effect on the life of the coating.

Australian/New Zealand Standard 4680 Appendix E 'Renovation of damaged or uncoated areas' specifies that "... the sum total of the damaged or uncoated areas shall not exceed 0.5% of the total surface area or 250cm$^2$, whichever is the lesser, and no individual damaged or uncoated areas greater than 40cm$^2$. However, as an exception, uncoated areas greater than 40cm$^2$, which have been caused by unavoidable air locks during the galvanizing operation, shall be repaired." Repair methods which accord with AS/NZS 4680 Appendix E are detailed on page 45.

Bare spots may be caused by under-preparation by the galvanizer and by a number of factors outside his control, and for which he cannot be responsible, including the presence of residual welding slags, rolling defects such as laps, folds and laminations in the steel, and non-metallic impurities rolled into the steel surface.

## Wet storage stain or bulky white deposit

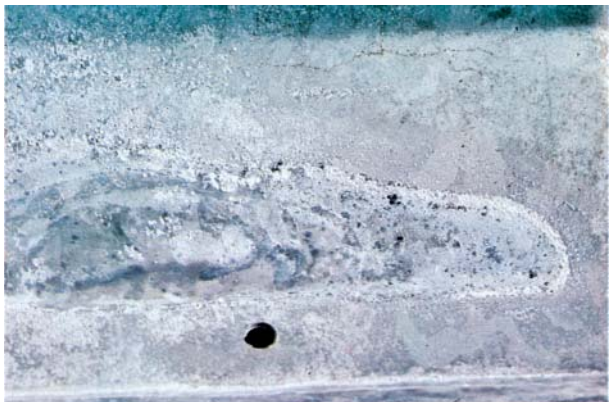
General comment: Not the galvanizer's responsibility unless present before first shipment. Acceptable if non-adherent deposit is removed and the coating meets coating mass requirements.

A bulky white or grey deposit, known as wet storage stain may form on the surface of closely stacked freshly galvanized articles which become damp under poorly ventilated conditions during storage or transit. In extreme cases, the protective value of the zinc coating may be seriously impaired but the attack is often very light despite the bulky appearance of the deposit.

Initiation and development of wet storage staining on new galvanized surfaces is readily prevented as detailed on page 22 by attention to conditions of storage and transport and by application of a chromate passivation treatment.

Where the surface staining is light and smooth without growth of the zinc oxide layer as judged by lightly rubbing fingertips across the surface, the staining will gradually disappear in service and blend in with the surrounding zinc surface as a result of normal weathering.

When the affected area will not be fully exposed in service, particularly on the underside of steelwork and in condensation areas, or when it will be subject to a humid environment, wet storage staining must be removed as detailed below, even if it is superficial. Removal is necessary to allow formation of the basic zinc carbonate film which normally contributes to the corrosion resistance of galvanized coatings.



Medium to heavy buildup of white corrosion product must be removed to allow formation of a basic zinc carbonate film in service. Light deposits can be removed by brushing with a stiff bristle brush. Heavier deposits can be removed by brushing with a 5 percent solution of sodium or potassium dichromate with the addition of 0.1 percent by volume of concentrated sulphuric acid. This is applied with a stiff brush and left for about 30 seconds before thorough rinsing and drying.

A check should be made to ensure that the coating thickness in affected areas is not less than the minimum specified in relevant standards for the various classes of galvanized coatings as detailed on page 42.

In extreme cases, where heavy white deposit or red rust has been allowed to form as a result of prolonged storage under poor conditions, corrosion products must be removed by thorough wire brushing and the damaged area repaired as detailed on page 45.

## Dark spots/Flux staining

General comments: Acceptable if flux residues have been removed.

Smuts of dirt may be picked up on the surface of the galvanized coating from floors and trucks or from contact with other articles. These smuts are readily washed off to reveal a sound coating and are not harmful.

Where a flux blanket is used in the galvanizing process, stale flux may adhere to the surface of the work during immersion and appear as a black inclusion in the coating. Such inclusions tend to pick up moisture forming a corrosive solution and coatings containing them should be rejected.

Black stains or deposits of flux picked up on the surface as

the object is withdrawn from galvanizing the bath do not warrant rejection provided the underlying coating is sound and the deposit is removed.

# Non-destructive testing for coating thickness

Magnetic gauges provide simple non-destructive testing methods for coating thickness which are reliable and more convenient than the physical tests given under the various national standards listed on page 42.

Most gauges described are compact and can be used very quickly. They give coating thickness readings over very small areas and several readings should be taken and averaged. Uniformity as well as actual thickness can thus be easily checked.

These magnetic gauges give reliable thickness readings although some require frequent recalibration against non-magnetic coatings of known thickness and the makers' instructions are followed precisely. Accurate readings cannot be obtained near edges of work and obvious peaks or irregularities in the coating should be avoided. Surface curvature, surface area and steel thickness all affect readings in a predictable manner and allowances must be made.

Guidance on the use of these instruments is given in ASTM E376-68T 'Measuring coating thickness by magnetic field or eddy current (electromagnetic) test methods'.

Calibration curves for corrected readings and additional information on these important non-destructive testing methods are available free of charge from Galvanizers Association of Australia, 124 Exhibition Street, Melbourne Victoria 3000.

### Minitector Model 156, Mitutoyo Neo-derm, and Minitest 500

The Minitector, Neo-derm and Minitest are small portable battery powered units which operate by measuring the changes in magnetic flux which occur when a magnet is separated from contact with a ferrous metal.

### Positector 2000

The Positector 2000 is an easy-to-use digital readout single-point coating measurement instrument which works on a magnetic field simulation principle. It needs no calibration and gives accurate results unaffected by shock, vibration, or temperature.

### Elcometer thickness gauge 101

This Elcometer contains a horseshoe magnet with its two poles exposed and works on a magnetic induction principle. When the instrument is placed with both poles touching the surface to be tested, changes of magnetic field brought about by variations in coating thickness move the bar magnet and the pointer. A mean thickness reading is given over the two points of contact.

### The Inspector magnetic balance

The magnetic balance is based on the calibration of magnetic attraction to the steel beneath a coating. The same principle is used by pull-off type gauges, but the magnetic balance gives a stable reading and incorporates a counterbalanced magnet, allowing use in any position.

### Pull-off type gauges

Simple pull-off magnetic thickness testing gauges such as the Tinsley Pencil Gauge and the Elcometer Pull-off Gauge Model 157 are convenient and inexpensive, but require greater operator skill and in general do not provide the accuracy of the gauges described above.

# Reconditioning damaged surfaces in galvanized steel

When severe damage to the galvanized coating has occurred during welding or as the result of rough handling in transport or erection, protection must be restored.

Small areas of the basis steel exposed through mechanical damage to galvanized coatings are protected from corrosion cathodically by the surrounding coating and may not need repair, depending on the nature of the product and the environment to which it is exposed. Small exposed areas normally have little effect on the life of the coating as discussed under 'Bare spots,' page 44 and 'Cathodic protection,' page 11.

### Repair methods

The coating repair methods detailed below are in accordance with Australian/New Zealand Standard 4680 Appendix E 'Renovation of damaged or uncoated areas'.

**Zinc rich paints.** The application of an organic zinc rich paint is the most rapid and convenient method of repair. The paint should conform to AS/NZS 3750.9:1994 'Zinc rich organic priming paint' applied in two coats by brush to provide a total film thickness of 100 µm and for optimum performance should contain not less than 92% zinc in the dried paint film.

Where colour matching is required aluminium paint may be applied over the hardened zinc rich paint.

**Zinc metal spraying.** In certain circumstances, by prior agreement, zinc metal spraying may be used as a method of coating repair. The damaged area must be grit blasted to Class 3 followed by zinc metal spraying to a coating thickness equivalent to that of the undamaged coating, and seal coated using an aluminium vinyl paint.