galvanizers
ASSOCIATION OF AUSTRALIA

GUIDE TO THE SERVICE LIFE OF HOT DIP GALVANIZED STEEL IN THE AUSTRALIAN ENVIRONMENT

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Guide to the service life of hot dip galvanized steel in the Australian environment

CONTENTS

Cover picture: The Austin Hospital car park extension used approximately 1500 tonnes of hot dip galvanized steel.

INTRODUCTION

No coating has proven to be more serviceable and of such predictable performance in the Australian atmosphere for protecting steel than hot dip galvanizing. The excellent performance of galvanized coatings in the atmosphere, and under many other exposure conditions, is mainly due to the formation of a protective layer of patina which consists of insoluble zinc oxides, hydroxides and carbonates, depending on the environment. When the protective patina has stabilized, reaction between the coating and its environment proceeds at a greatly reduced rate resulting in long coating life. Its good performance in the Australian climate is also largely a result of immunity to the destructive influence of solar radiation of our region. Therefore, in terms of durability alone, such coatings are likely to far outperform organic coatings under this influence.

Even in the more corrosive wetter and coastal climates, the corrosion rate of hot dip galvanized steel is very low compared with that of uncoated steel, as per the examples shown in Table 1. In addition, it is a robust coating, highly resistant to wear and impact during transport, installation and service. Unlike organic coatings that tend to shrink from sharp corners or can be difficult to apply to complex shapes, galvanizing ensures an essentially even coat over all surfaces accessed by the molten zinc. Importantly, it protects the steel substrate until the zinc has corroded away, unlike paints, where corrosion of the steel can progress unobserved under the paint film.

Table 1: Comparative Corrosion Rate (mass loss) of Steel & Zinc in 2 years [(1)]

Location (All USA)	Steel/Zinc Corrosion Rate
Arid – Phoenix Arizona	17:1
Rural – State College, Pa	22:1
Light Ind. – Monroeville, Pa	28:1
Industrial – East Chicago, Ill	52:1
Marine – Kure Beach, NC	80:1

Figure 1: An in-situ pole from the famous Morse Code lines installed from Charters Towers to Thursday Island, Adelaide to Darwin and Adelaide to Perth and abandoned in-situ when overtaken by new technology.

Figure 2: Many of the poles are still standing or have been recently recovered with near original coating thicknesses now at least 130 years on in a variety of severe exposure.

KEY FACTORS AFFECTING THE DURABILITY OF METALS IN THE ATMOSPHERE

The service life of most metals in the Australian atmosphere, including steel and zinc, is dictated by a range of similar factors. A brief summary of the key factors relating to hot dip galvanized steel is shown below.

AIRBORNE SEA SALTS

Figure 3: Galvanized guard rails have a good record of performance along the Great Ocean Road in Victoria

Extensive research in Australia and overseas has shown that the corrosivity of the Australian atmosphere is very much related to the proximity of the coast, the frequency of on-shore prevailing winds and the presence of sheltered, unwashed surfaces. [2 pp. 28-31]

The natural cleansing action of rainwater washes most contaminants off a galvanized surface, where they might otherwise accelerate corrosion. However, in corrosive environments, such as coastal locations, corrosion rates in sheltered locations can be greater than the exposed areas of the same article. Examples of this would be steel surfaces sheltered from sun and wind and prone to long term condensation.

SURFACE WETNESS

The longer a hot dip galvanized surface remains wet, the more likely it is to corrode. Therefore dew, rainfall, melting snow, and a high humidity level will influence the rate of corrosion. Also important is the orientation of the surface, including slope, and the potential for crevices and laps to hold water as these factors will tend to accelerate corrosion.

If a surface is regularly exposed to airborne sea salts and subject to dew, but protected from rainfall, then the corrosion rate of the surface will be significantly accelerated. In contrast, when humidity levels are below 60% (for example, in an air-conditioned building), corrosion rates are very low.

LOCALISED INDUSTRIAL POLLUTION

The impact of industrial activities on hot dip galvanized steel in Australia is generally insignificant [3] [4] [5] [6] [7]. This is essentially because of the low concentration of industrial activity in most areas of the country and the marked reduction in the use of sulphur bearing fuels over the last 50 years, particularly during the early 1970's when environmental protection legislation was strengthened [3] [8]. This change mirrors those throughout the developed world

Figure 4: Galvanized conveyor frames are used successfully in the iron-ore mining industry

due to increasing industry responsibility, particularly in the reduction in air pollution by sulphur dioxide [(5) (9)].

The summary from the "State of the Air" report [(3 p. 6)], in part, states:

> *In the last decade there have been significant decreases in the levels of a number of air pollutants. Carbon monoxide, nitrogen dioxide, sulfur dioxide and lead levels have all declined in urban air to levels significantly below the national air quality standards. The air quality rating for all these pollutants is Good or Very Good in most regions, apart from in a few mining and industrial centres. These improvements are largely because of better standards for fuel quality and motor vehicle emissions.*

With respect to sulphur dioxide which is the major source of accelerated corrosion of hot dip galvanized steel, the report, in part, states [(3 p. 9)]:

> *In Australia the main sources of sulfur dioxide are electricity generation from coal, oil or gas and processing of metal and mineral ores that contain sulfur. Sulfur dioxide levels are low in urban areas across Australia for all of the averaging times and achieve a Very Good air quality rating. No urban sites exceeded the national standards and peak levels were generally less than one-third of the standard.*

Note that other kinds of pollution can also increase the rate of corrosion; for example, nitrous oxides, nitric acid and industrial dust in populated and industrial zones or the specific operational and technological pollution of microclimates; for example chlorine, hydrogen sulphide, and organic acids. These types of pollution require expert analysis.

In general, pollution is no longer a significant influence on the durability of hot dip galvanized steel.

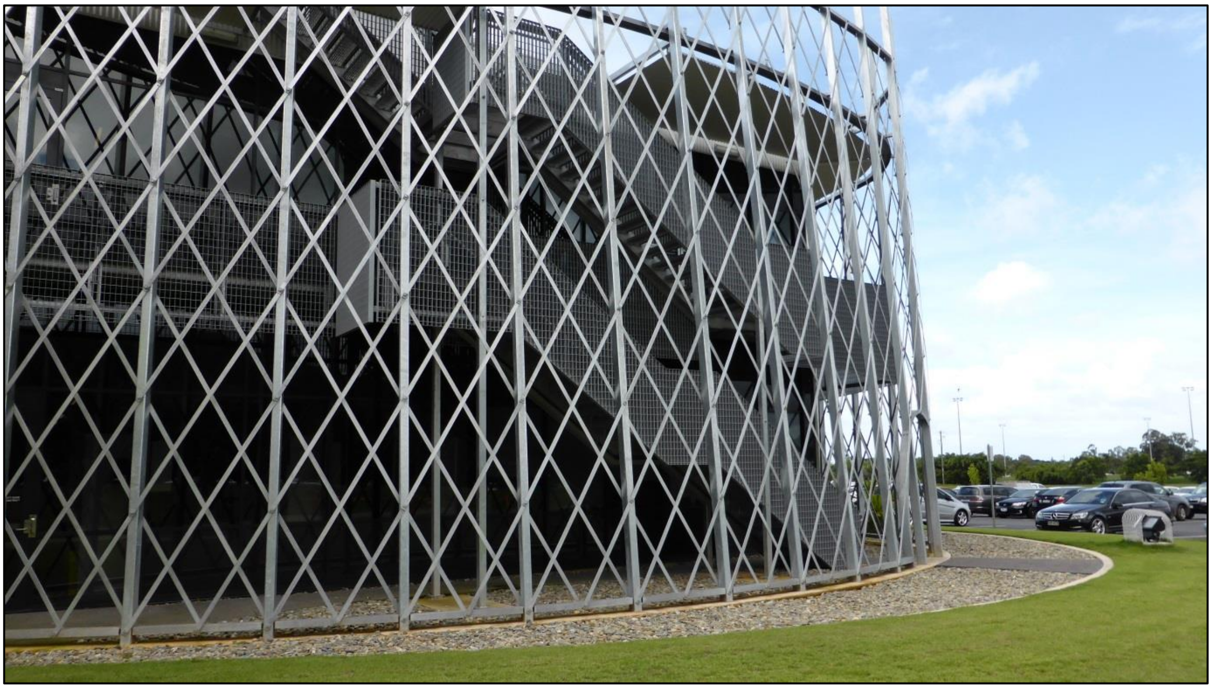

Figure 5: The Cairns Institute uses hot dip galvanized steel as a fabricated lattice facade.

CORROSIVITY IN THE AUSTRALIAN ATMOSPHERE

Two key Australian Standards, AS 4312 (2) and AS/NZS 2312.2 (10) provide considerable information on the corrosion rate of steel and zinc respectively under various conditions of atmospheric service. In addition, over the last few decades the CSIRO and others have carried out extensive mapping to establish the corrosivity of the Australian climate. AS 4312 is the best source of Australian data for corrosivity of steel in the local environment.

It is important to note the corrosion rate estimates for steel and zinc in the various Standards are consistent and the recently produced AS/NZS 2312.2 are interchangeable with the International Standards ISO 9223 (11) and ISO 14713.1 (12) for service life estimate purposes. Table 2, developed from AS 4312 and AS/NZS 2312.2, shows the typical corrosion rates of steel and zinc; dependent on the corrosivity of the environment.

A summary of the various environments seen in Australia is shown in Table 3. Note that Category CX ("extreme") was introduced to ISO 9223 in 2012 and is therefore not covered in AS 4312; however long term Australian research was instrumental in the creation of this category.

Table 2: Typical corrosion rates of steel & zinc in Australia

Category, description & typical environment from AS 4312			Corrosion rate for the first year (µm/y)	
			Mild steel	Zinc
C1	Very low	Dry indoors	≤1.3	≤0.1
C2	Low	Arid/Urban inland	>1.3 to ≤25	>0.1 to ≤0.7
C3	Medium	Coastal or industrial	>25 to ≤50	>0.7 to ≤2.1
C4	High	Calm sea-shore	>50 to ≤80	>2.1 to ≤4.2
C5	Very High	Surf sea-shore	>80 to ≤200	>4.2 to ≤8.4
CX	Extreme	Ocean/Off-shore	>200 to ≤700	>8.4 to ≤25

Figure 6: The RMIT Design Hub in Melbourne is located in a C2 urban zone.

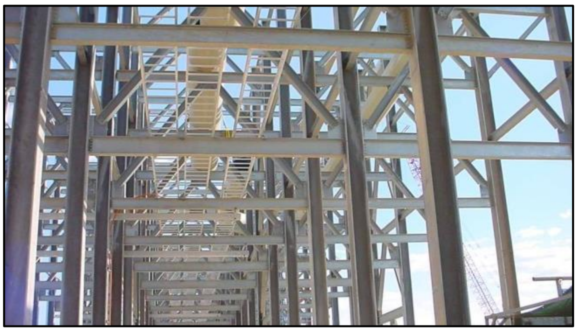

Figure 7: The gas processing facility in the NT is located in a C3 coastal zone.

Table 3: Corrosivity in Australia as described in AS 4312

Category		Generic examples	Specific examples
CX	Severe surf shore-line	Surf beach shoreline regions with very high salt deposition.	Some Newcastle beaches
C5	Surf Sea-shore	Within 200 m of rough seas & surf beaches. May be extended inland by prevailing winds & local conditions.	More than 500 m from the coast in some areas of Newcastle
C4	Calm Sea-shore	From 200 m to 1 km inland in areas with rough seas & surf. May be extended inland by prevailing winds & local conditions.	All coasts
		From the shoreline to 50 m inland around sheltered bays. In the immediate vicinity of calm salt water such as harbour foreshores.	
C3	Coastal	From 1 km to 10 km inland along ocean front areas with breaking surf & significant salt spray. May be extended inland to 50 km by prevailing winds & local conditions.	Metro areas of Perth, Wollongong, Sydney, Brisbane, Newcastle, & the Gold Coast
		From 100 m to 3 – 6 km inland for a less sheltered bay or gulf.	Adelaide & environs
		From 50 m to 1 km inland around sheltered bays.	Port Philip Bay & in urban & industrial areas with low pollution levels
C2	Arid/Urban Inland	Most areas of Australia at least 50 kilometres from the coast.	Canberra, Ballarat, Toowoomba & Alice Springs
		Inland 3 – 6 km for a less sheltered bay or gulf.	Adelaide & environs
		Can extend to within 1 km from quiet, sheltered seas.	Suburbs of Brisbane, Melbourne, Hobart
C1	Dry indoors	Inside heated or air conditioned buildings with clean atmospheres.	Commercial buildings

Note: AS 4312 includes maps showing estimates of corrosivity zones for several major cities of Australia. In addition, detailed corrosivity maps for South Australia (prepared by the SA government) are available at SA Government Corrosion Environment Maps. Other states may have similar resources.

ZINC METAL THICKNESS

The service life of any particular post-fabrication galvanized item is directly proportional to the thickness of the zinc alloy coating [10]. This in turn is a function of the thickness of the metal; the thicker the steel, the thicker the layer of zinc, as shown in Table 4 and Table 5 [13]. Indeed, one of the great advantages of hot dip galvanizing is the predictability of the thickness of the zinc for any given steel thickness. This is particularly important for sharp edges and complex shapes, where conventional paints don't always cover well. Continuous galvanizing and electro-galvanizing processes do not follow this relationship, because the processes deliberately restrict the galvanizing thickness to allow the steel to retain ductility for further manufacturing.

Table 4: Minimum coating thickness and mass on samples that are not centrifuged [13]

Steel thickness (mm)	Local coating thickness minimum (µm)	Average coating thickness minimum (µm)	Average coating mass minimum (g/m²)
> 6	70	85	600
> 3 to ≤ 6	55	70	500
≥ 1.5 to ≤ 3	45	55	390
< 1.5	35	45	320

Table 5: Minimum coating thickness and mass on samples that are centrifuged [13]

Steel thickness (mm)	Local coating thickness minimum (µm)	Average coating thickness minimum (µm)	Average coating mass minimum (g/m²)
≥ 8	40	55	390
< 8	25	35	250

The measured corrosion rate during the first year of exposure for steel and zinc is usually higher than the measured long term rate. The long term corrosion rate for both steel and zinc slows over time and in the first 20 years corrosion rates are not linear. At some point in time after 20 years the corrosion product layer stabilises and, at this point, the corrosion rate becomes linear with time, because the rate of metal loss becomes equal to the rate of loss from the corrosion product layer. In addition, it is known that the rate of corrosion in the first 12 months is affected by the environment experienced by the metal in the first few weeks of exposure but long-term rates are usually unaffected by the first exposure rate. Notwithstanding the issues outlined above, the durability of an item is usually calculated on the estimated first year corrosion rate and this will normally provide a conservative prediction of the durability of an item if long term corrosion protection is desired.

The expected zinc corrosion rate data from Table 3 can also be displayed graphically as per Figure 8, allowing for simple calculations for Life to First Maintenance based on measured coating thicknesses.

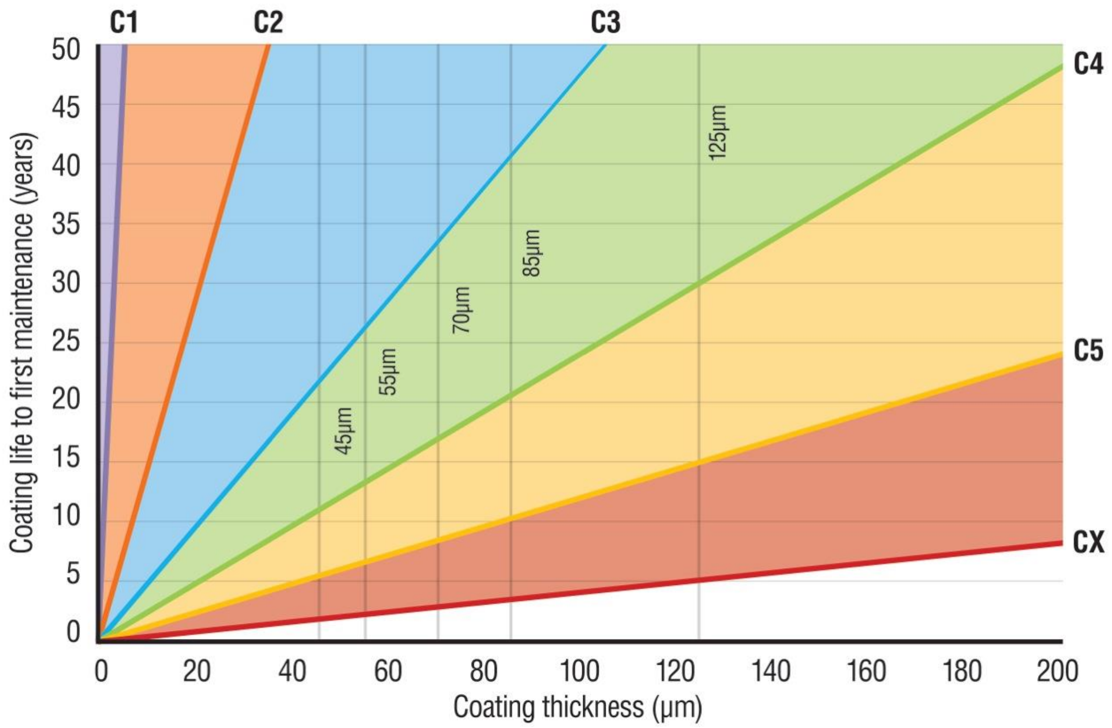

Figure 8: Life to first maintenance for galvanized coatings

To use the chart, let's say you have a hot dip galvanized structure using steel thicker than 6 mm and located in a C4 environment, as described in Table 2. According to AS/NZS 4680, a piece of steel greater than 6 mm thick must have a minimum average of 85 µm zinc thickness (see Table 4). If you follow the 85 µm marker on the chart up to the green C4 line and across to the "coating life to first maintenance" axis, you'll see you have, in the worst case, approximately 20 years until first maintenance (or 5% rust of the substrate steel). In other words, 95% of your coating is still intact, so the structural integrity is not threatened. In the best case, the durability of the coating will be up to 40 years (following the line up to next zone).

DURABILITY OF COMMONLY AVAILABLE GALVANIZED COATINGS

There are many different hot dip galvanized coatings available in Australia and Table 6 shows the common structural grades and their relative performance in various environments [10]. It is important to recognise that the durability of all galvanized coatings is generally directly proportional to the coating thickness, which is defined in each manufacturing Standard.

After-fabrication hot dip galvanizing manufactured to AS/NZS 4680 produces the maximum thickness possible relative to steel thickness, which means it will always provide a longer life to first maintenance than any other hot dip galvanized coating. This contrasts with continuously or specialised coated products, which are produced by different processes. For continuous coated products, the zinc thickness is accurately controlled, regardless of steel thickness, so that it remains smooth and ductile to allow for later cold forming and for varying manufacturing and end usage and therefore the corrosion protection is necessarily less because of the lower zinc thickness.

Table 6: Expected life to first maintenance for commonly available hot dip galvanized products

System	Reference Standard		Steel thickness	Coating thickness		Selected corrosivity category & Calculated life (min-max, years)				
			mm	g/m^2	µm	C2	C3	C4	C5	CX
Batch HDG	AS/NZS 4680	HDG390	>1.5-≤3.0	390	55	78->100	26-78	13-26	6-13	2-6
		HDG500	>3.0-≤6.0	500	70		33-100	16-33	8-16	2-8
		HDG600	>6.0	600	85	>100	40->100	20-40	10-20	3-10
		HDG900[1]	>>6.0	900	125		60->100	30-60	15-30	5-15
		Centrifuged	< 8.0	250	35	50->100	17-50	8-17	4-8	1-4
			≥ 8.0	390	55	78->100	26-78	13-26	6-13	2-6
	AS/NZS 1214	All	All	360	50	71->100	24-71	12-24	6-12	2-6
HDG purlins	AS 1397	Z350[2]	≥1.0-≤3.2	140	20	29->100	10-29	5-10	2-5	1-2
		Z450[2]	≥1.5-≤3.2	180	25	36->100	12-36	6-12	3-6	1-3
HDG tube	AS/NZS 4792	ZB100/100[3]	≥1.6-≤6.0	100	14	20->100	7-20	3-7	2-3	0-1
		HDG300[4]	≥2.0-≤5.9	300	42	60->100	20-60	10-20	5-10	1-5
	AS 4750	ZE50[5]	≥2.0-≤5.9	50	7	10-70	3-10	2-3	1-2	0-1

Notes:

1. Hot dip galvanized coatings thicker than 85 µm are not specified in AS/NZS 4680 but the general provisions of that Standard apply and, together with specific thickness figures, may form a specification capable of third-party verification. It is essential to know the composition of the steel to be used and the galvanizer should be consulted before specifying, as these thicker coatings may not be available for all types of steel. Where the steel is suitable, thick coatings may be specified.
2. AS 1397 [14] C350 and C450 are typically supplied as purlins (See for example, Lysaght, Stramit, Fielders, etc.). The base steel thicknesses quoted here is the usual range used for these products. Other thicknesses may be available; however the coating thickness supplied is independent of the base steel thickness.
3. AS/NZS 4792 ZB100/100 [15] is the usual specification of the coating supplied by Australian Tube Mills for their DuraGal^{PLUS} range of tubular products. Thicker coatings (ZB 135/135) are available in a limited range of specific tubular building products.
4. AS/NZS 4792 HDG300 [15] is the typical Australian Tube Mills and Orrcon specification for specialised HDG coatings applied to circular hollow sections.
5. AS 4750 ZE50 [16] is the usual specification of the coating supplied by Orrcon for their ALLGAL range of tubular products.

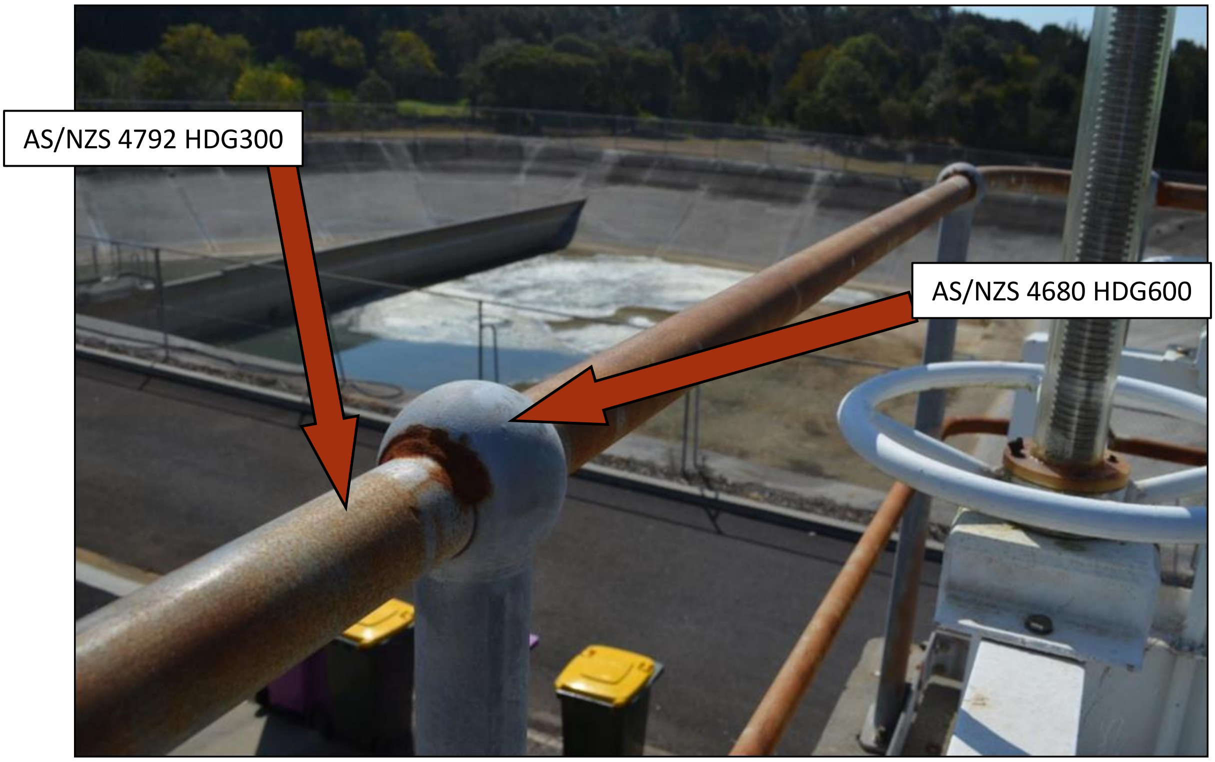

Figure 9: The handrail above was about 7 years old in a C5 waste water treatment and marine environment when the photo was taken. The post was hot dip galvanized to AS/NZS 4680, while the rail was produced to AS/NZS 4792 HDG300 – or about half the nominal coating thickness of the post. The weld joining the rails was never repaired. Clearly, the after fabrication galvanized post to AS/NZS 4680, with at least double the original coating thickness of the continuously galvanized rail to AS/NZS 4792, has provided superior corrosion protection of the base steel.

Figure 10: This galvanized security fence is about 5 years old and in a C3 environment. It has a galvanized wire mesh of an unknown original thickness added for extra security.

Figure 11: The same fence as Figure 10 from another angle, showing the galvanizing on the wire mesh has broken down and rust has stained the entire structure, while the tubular after-fabrication galvanized fence is still rust free.

THE LIFE OF HOT DIP GALVANIZING IN WATER

Except for some very hard waters, the corrosion of hot dip galvanizing in water is considerably greater than most conditions of atmospheric service; however hot dip galvanizing can be appropriate in many water immersion situations. Typical corrosion rates for zinc in water are shown in Table 7.

Table 7: Typical Corrosion Rate for Zinc in Waters [17]

Water Type	Corrosion Rate (μm/y)
Sea Water	15 – 25
Hard Fresh Water	2.5 – 5
Soft Fresh Water	5 – 10
Distilled Water	50 – 200

In freshwater, the corrosion rate depends on the ability of the coating to develop a protective layer. The formation of this layer is dictated by the pH, hardness, alkalinity and total dissolved solids of the water. The pH has a profound effect, with zinc being vulnerable outside the pH range 6 – 12 (Figure 12).

Salt water at depth, with lower oxygen levels will tend to be less corrosive, whereas at the splash zone where the water is oxygen rich and more turbulent the corrosion rate is much higher and therefore hot dip galvanizing alone is not recommended.

Water temperature is also important [18], increasing markedly in corrosivity with increasing temperature up to 70°C when it falls away (Figure 13). For this reason hot dip galvanized steel should not be used for hot soft or condensate water applications.

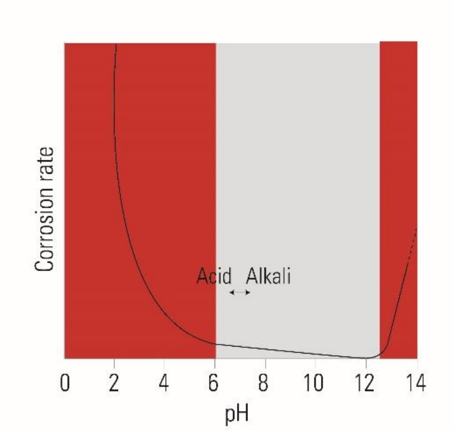

Figure 12: Corrosion of zinc with variations of pH

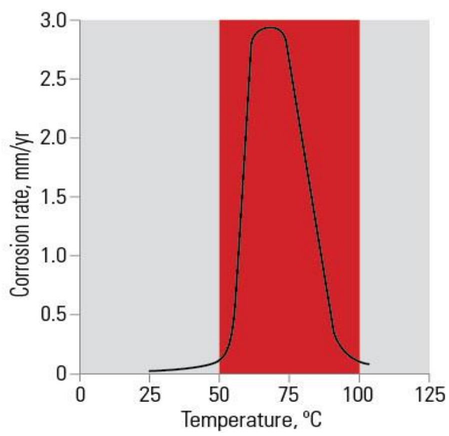

Figure 13: Effect of temperature on zinc immersed in distilled water

THE LIFE OF HOT DIP GALVANIZING IN SOIL

The corrosion of zinc in soil has been extensively studied [19] and Australian Standards exist for design of specific products (for example, AS/NZS 2041.1 (20)).

Figure 14: The Grand Arbour in Brisbane is an excellent example of hot dip galvanizing in free draining soil.

The corrosion of zinc in soil is on average considerably greater than in the atmosphere, but can vary greatly, even over short distances. This is essentially because of the varying moisture content and its heterogeneity, particularly along a vertical profile. In general terms, coarse open textures are less corrosive than fine ones, such as clays, which tend to hold water. Soil mineral content, pH and oxygen content are also important indicators. Mineral content is easily appraised by measurement of soil resistivity; the lower the resistivity the greater the corrosion rate. If the moisture content of the soil is less than 17.5% then there will be no accelerated corrosion and the soil chloride ion concentration is reported to not have a significant effect on the corrosion rate of the hot dip galvanizing.

The service life of hot dip galvanized culverts can be effectively predicted from soil resistivity and pH, while hot dip galvanizing is used extensively by the rammed earth industry and was, for many years, used in the Australian domestic water supply industry.

However, where long term service is required and the soil conditions are uncertain it is often prudent to consider additional surface protection including appropriate paint coatings, bituminous compounds, tape wraps or concrete encasement.

DISSIMILAR METALS

Stainless steel and aluminium are commonly used in contact with hot dip galvanized steel, notably as fasteners and are mostly satisfactory. This is due to the small surface area of the stainless steel or aluminium fastener compared to the relatively larger area of the hot dip galvanized article. Best practice includes the use of insulating washers which will electrically isolate the two metals. In very corrosive locations, alternative solutions should be considered. Conversely, hot dip galvanized fasteners should not be used to join stainless steel or aluminium articles. More information is available in Appendix B8 of AS/NZS 2312.2.

In corrosive situations and when in direct electrical contact, copper and its alloys can accelerate the rate of corrosion of hot dip galvanized steel. Corrosion products of copper and its alloys can also accelerate the corrosion of galvanized surfaces.

CHEMICALS

A wide range of organic and inorganic chemicals and solvents are compatible with hot dip galvanized steel [(1) (18)]. However, hot dip galvanized steel should not be used in contact with strong acids or strong alkalis (below pH 6 and above pH 12 respectively) or, if it is, the galvanized surface will need to be top-coated with appropriate chemically resistant coatings.

Compatibility of galvanized coatings with various media		
Aerosol propellants		excellent
Acid solutions	weak, cold quiescent strong	fair not recommended
Alcohols	anhydrous water mixtures beverages	good not recommended not recommended
Alkaline solutions	up to pH 12.5 strong	fair not recommended
Carbon tetrachloride		excellent
Cleaning solvents	chlorofluorocarbon	excellent
Detergents	inhibited	good
Diesel oil	sulphur free	excellent
Fuel oil	sulphur free	excellent
Gas*	towns, natural, propane, butane	excellent
Glycerine		excellent
Inks	printing aqueous writing	excellent not recommended
Insecticides	dry in solution	excellent not recommended
Lubricants	mineral, acid free organic	excellent not recommended
Paraffin		excellent
Perchlorethylene		excellent
Refrigerants	chlorofluorocarbon	excellent
Sewage		excellent
Soaps		good
Timber preservatives (Copper-chromium-arsenic, Boron)	Freshly treated After drying is completed	poor excellent
Trichlorethylene		excellent

*Chromate passivation is recommended because moisture may be present.

Galvanized coatings perform extremely well when compared to other protective coatings for steel in the severely corrosive conditions prevailing in most sewage treatment operations. As a result galvanized steel is used extensively in sewage treatment plants throughout the world.

CONTACT WITH BUILDING MATERIALS

Hot dip galvanized coatings give invaluable protection to steel used in all sections of the building industry. Care should be taken that the hot dip galvanized products are stored and transported under dry ventilated conditions, but no additional protection is required. When in contact with fresh mortar, concrete or plaster, which may occur during the building process, the slight etching action on hot dip galvanized steel ceases after curing.

Figure 15: The interface of hot dip galvanized steel and concrete can be protected with a non-conductive paint to slow corrosion

IN CONCRETE

In corrosive environments it is good practice to separate the interface of concrete and hot dip galvanized steel with a coat of non-conductive paint. This assists with keeping any moisture that is pulled into small gaps by capillary action away from the hot dip galvanized coating and can be used on posts and base plates alike.

HOT DIP GALVANIZED REINFORCEMENT

Hot dip galvanized steel reinforcement and other fittings including bolts, ties, anchors, dowel bars and piping, have been extensively used in a wide range of reinforced concrete structures and elements in many different exposure conditions. All types of reinforcing steels can be hot dip galvanized, including the newer high strength grades. Over the years, extensive testing has confirmed that hot dip galvanizing does not adversely affect the tensile mechanical properties of conventional reinforcing steels.

For hot dip galvanized reinforcement in concrete, the extension of life to the onset of corrosion has been reported to be some 4-5 times longer than that for the corrosion of black steel in equivalent exposure conditions. More information on the use of hot dip galvanized reinforcement is available from the GAA.

IN CONTACT WITH TIMBER

When hot dip galvanized steel products and fasteners are installed in direct contact with unseasoned timber it may be necessary to protect them with an application of suitable paint. Timbers freshly treated with acidic preservatives of copper-chromium-arsenic type, such as Celcure, Copas and Tanalith, can be severely corrosive to metallic building materials, including galvanized coatings. However, once the timber has dried out the preservatives become fixed, and the performance of hot dip galvanized coatings in contact is excellent, even when the timber is again wetted. Hot dip galvanized coatings also perform well in contact with boron-treated timbers.

EFFECT OF TEMPERATURE

Hot dip galvanized coatings will withstand continuous exposure to temperatures of approximately 200°C and occasional excursions up to 275°C without any effect on the coating. Above these temperatures there is a tendency for the outer zinc layer to separate, but the alloy-layer, which comprises the majority of the coating, remains. Adequate protection may often, therefore, be provided up to the melting point of the alloy layer (around 650°C).

DUPLEX SYSTEMS – PAINT OVER GALVANIZING

Figure 16: Queanbeyan pool in the ACT has shown excellent long-term performance of the duplex coatings, both outside and inside the pool structure

In service conditions where the life of the hot dip galvanized steel may be limited, the addition of a paint finish, (a duplex coating system) can extend the service life of the steel. Indeed, if the paint system is maintained by appropriate reinstatement from time to time, so as to preserve the galvanized surface and the paint, the service life of the structure should be unlimited.

There are three main reasons for painting hot dip galvanized steel. These are:

1) Decorative – to create an aesthetic colour and gloss or provide an identifying or camouflaging colour
2) Enhanced durability – to increase the service life in corrosive locations
3) Increased chemical resistance – in a situation where hot dip galvanizing alone may be vulnerable, such as outside the pH range of 6 to 12

In corrosive locations, such as severe coastal or industrial service, an appropriately maintained duplex system will provide a synergistic improvement over and above the separate contributions of each coating. Research has shown the increase in service life can be 1.5 – 2.3 times over the individual coatings service life alone [(10) (12)].

The type of paint selected and the surface preparation will vary depending upon the environment and the aesthetic demands. Detailed advice is contained in the Guide to Paint over Galvanizing available direct from the GAA [(21)].

Figure 17: "The Moment" by Damian Vick from fabrication, galvanizing, painting, and the final product.

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