MID WEST PORTS

TECHNICAL GUIDELINE

MWPA403 – GUIDELINES FOR HD GALVANISING

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APPENDICES

1. PREFACE

This documents has been compiled for the Mid West Ports Authority (MWPA) to provide developers, designers, contractors and inspectors guidance on the corrosion protection by hot dip galvanising (HDG) of MWPA's steel assets. It does not replace bespoke project bases of design, design criteria or specifications but it is intended to provide developers, designers, contractors and inspectors with a benchmark for the minimum technical requirements for corrosion protection of new construction, refurbishment and repair projects containing HDG assets.

The chapters of this guide include methods and guidance on the statutory requirements; MWPA health; safety, environment, quality and operational policies and procedures; site exposure classifications; port assets; protective coating materials, surface preparation, coating application and inspection and testing information to undertake a project at MWPA containing HDG assets.

This document will be used as a basis for identifying any shortcomings in the technical content and ultimately accepting or rejecting proposed, underway or complete projects including HDG assets.

2. SCOPE

2.1. GENERAL

This document provides information on hot-dip galvanising selection, application and inspection guidelines for new construction and refurbishment projects at MWPA and forms part of the MWPA Technical Guidelines Series.

It includes the guidance on the technical requirements for design, surface preparation, galvanising and testing of coatings for steel assets within the port area. The assets are exposed to a wide range of environments, from benign to very aggressive exposures. In addition, a range of atmospheric exposures occur inside and external to the various buildings, bulk handling facilities and structures on the site.

2.2. EXCLUSIONS

This guideline does not cover thermal metal spray coatings, including zinc coatings and zinc alloy coatings (which are the subject of AS/NZS 2312.3), nor does it include concrete repair, galvanised concrete reinforcement, cathodic protection, petrolatum tape and HDPE jacket wrapping systems, architectural finishes, fire proofing or insulation requirements.

3. GLOSSARY

For the purposes of this Guideline the following particular definitions apply:

Table 1: Glossary of Terms

Term	Definition
Abrasive Blast	Surface preparation of substrate as described in AS 1627.4
Acceptable	Shall mean acceptable to MWPA (the Owner) or the owner's Engineer
Atmospheric Corrosion	Corrosion with the earth's atmosphere at ambient temperature as the corrosion environment.
Approved/ Approval	Approved by MWPA (the Owner) or Owner's Engineer in writing
Contract	The agreement between MWPA (the Owner) and the Contractor
Design Life	Period of time the protective coating or lining must perform its intended function before first major maintenance. Coating Works must be specified and applied to minimise capital, operating and maintenance costs throughout the service life of the asset.
Elevated Temperatures	Temperatures between +60^{o}C and +200^{o}C
Exceptional Exposure	Special Cases, such as exposure that substantially intensifies the corrosive exposure and/or places increased demands on the corrosion protection system
Hot Dip Galvanised Coating	Coating obtain by hot dip galvanising. NOTE: The term 'hot dip galvanised coating' is subsequently referred to as the coating.
Hot Dip Galvanising	Formation of a coating of zinc and /or zinc/iron alloys on iron and steel products by dipping prepared steel or cast iron in a zinc melt.
Life to first maintenance	The time interval that can elapse after initial coating before coating deterioration reaches the point when maintenance is necessary to restore protection to of the base metal
Duplex Coating	A coating system where an element is galvanised and then a second polymeric top coating is applied to the element.
Manufacturer	The supplier or manufacturer of the coating system or materials.
Multi-component	Coatings supplied in two or more separate packs that require mixing and combining together to complete the product prior to application.
Owner	Means the owner of the project or asset.

Table 2: Abbreviations

Abbreviation	Meaning
ACA	Australasian Corrosion Association
AINDT	Australian Institute for Non-Destructive Testing
ANSI	American National Standards Institute
AS	Australian Standard
AS/NZS	Australian-New Zealand Standard
BOD	Basis of Design
ASTM	American Standard of Testing and Materials
BS	British Standards
DFT	Dry Film Thickness
EMP	Environment Management Plan
EPA	Environment Protection Authority
MWPA	Mid West Ports
HDG	Hot Dip Galvanising
HFO	Heavy Fuel Oil
HSEC	Health, Safety, Environment and Community
ISO	International Standards Organization
ITP	Inspection and Testing Plan
MS	Mild Steel
MSDS	Material Safety Data Sheet
µm	Micron (0.001 mm)
MRWA	Main Roads Western Australia
NACE	National Association of Corrosion Engineers
NATA	National Association of Testing Authorities
NDT	Non-Destructive Testing
O&M	Operations and Maintenance
PIANC	Permanent International Association of Navigational Congresses
ppm	Parts per million
PTDS	Product Technical Data Sheet
QA / QC	Quality Assurance / Quality Control

4. RELEVANT DOCUMENTATION

4.1. GUIDELINE SERIES

This guideline should be read in conjunction with other parts of the MWPA Technical Guideline series, where relevant, and these are listed below:

- MWPA 000 Series – Port Development Guidelines
- MWPA 100 Series – Technical Guidelines - General
- MWPA 200 Series – Drafting Guidelines and AutoCAD Standards
- MWPA 300 Series – Mechanical Guidelines
- MWPA 400 Series – Guidelines for Maritime Structures
- MWPA 500 Series – Civil Engineering Guidelines
- MWPA 600 Series – Buildings and Structures Guidelines
- MWPA 700 Series – Electrical and Instrumentation
- MWPA 800 Series – Guidelines for Rail Infrastructure
- MWPA 900 Series – Additional Guidelines

4.2. MID WEST PORTS POLICIES AND PROCEDURES

All parties developing, designing, specifying, preparing, applying and inspecting any aspect of a MWPA coating project should be aware and abide with MWPA policies and procedures. A full list of MWPA's policies and procedures can be found in MWPA 100 and obtained either from the MWPA website (https://www.MWPA.wa.gov.au) or requested from the MWPA Project Coordinator or Owner's Engineer.

4.3. LOCAL, STATE AND FEDERAL STATUTORY REQUIREMENTS

In addition to the requirements of this part of the MWPA Technical Guidelines, all protective coating works shall meet the requirements of Local, State and Federal statutory, health, safety and environmental requirements and regulations and include, but not be limited to the following:

- Western Australian Environmental Protection
- Western Australian Occupational Safety and Health Act (1984) and Regulations (1996)
- Western Australian Occupational Safety and Health Legislation Amendment Act (1984)
- Western Australian (Certificates of Competency and Safety Manning) Regulations (1983)
- Transport Operation (Marine Safety) Act
- Western Australian Mines Safety and Inspection Act 2005 and Regulations (2005)
- Dangerous Goods Safety Act (2004)
- Port Authorities Act (1999)
- Maritime Transport and Offshore Facilities Security Act (MTOFSA) (2003)
- Environmental Protection Act and Regulations (1986)

4.4. AUSTRALIAN STANDARDS AND DESIGN CODES

The latest version of the following standards and documents shall be adopted for Works covered by this Guideline:

4.4.1. AUSTRALIAN STANDARDS AND DESIGN CODES

Table 3: Australian Standards and Codes

No.	Title
AS 1074	Steel tubes and tubulars for ordinary service
AS 1214	Hot-dip galvanised coatings on threaded fasteners
AS 1397	Continuous Hot-Dip Metallic Coated Steel Sheet
AS 1442	Carbon Steels and carbon-manganese steels – Hot rolled bars and semi-finished products
AS 1447	Hot-rolled spring steels
AS 1627	Metal Finishing – Preparation and Pre-treatment of Surfaces
AS 1657	Fixed Platforms, Walkways, Stairways and Ladders – Design, Construct and Installation
AS 1897	Electroplated coatings on threaded components (metric coarse series)
AS 2159	Piling – Design and Installation
AS 2309	Durability of Galvanised and Electro-galvanised Zinc Coatings for the Protection of Steel in Structural Application – Atmospheric
AS/NZS 2312.1	Guide to the Protection of Structural Steel against Atmospheric Corrosion by use of Protective Coatings Part 1: Paint Coatings, including Amendment 1: 2004.
AS/NZS 2312.2	Guide to the Protection of Structural Steel against Atmospheric Corrosion by use of Protective Coatings Part 2: Hot Dipped Galvanising, including Amendment 1: 2004.
AS 2331	Methods of Test for Metallic and Related Coatings
AS 3750	Paints for Steel Structures
AS 3894 Parts 1-14	Site Testing of Protective Coatings
AS 4036	Corrosion of metals – Dissimilar metals in contact in seawater
AS 4100	Steel Structures
AS 4291	Mechanical properties of fasteners made from carbon steel and alloy steel
AS 4291.1	Part 1: Bolts, screws and studs
AS 4312	Atmospheric Corrosivity Zones in Australia
AS 4506	Metal finishing – Thermoset powder coatings
AS/NZS 4534	Zinc and zinc/aluminium-alloy coatings on steel wire
AS/NZS 4680	Hot-Dip Galvanised (zinc) Coatings on Fabricated Ferrous Articles

No.	Title
AS/NZS 4750	Electro-galvanised (zinc) coatings on ferrous hollow and open sections
AS/NZS 4791	Hot-dip galvanised (zinc) coatings on ferrous open sections, applied by an in-line process
AS/NZS 4792	Hot-dip galvanised (zinc) coatings on ferrous hollow sections, applied by a continuous or a specialized process
AS/NZS ISO 9001	Quality Management Systems
AS/NZS ISO 14001	Environmental Management Systems
APAS	Australia Paint Approval Scheme **Note:** All coatings applied in Australia shall be APAS approved unless specifically otherwise approved by MWPA.
Code of Practice	Government of Western Australia - Prevention of Falls in the Workplace

4.5. INTERNATIONAL STANDARDS

In the absence of suitable Australian Standards and where items are to be coated overseas, the latest version of the following International Standards may be referenced.

4.5.1. INTERNATIONAL STANDARDS AND DESIGN CODES

Table 4: International Standards and Codes

No.	Title
ISO 1461	Hot dip galvanised coatings on fabricated iron and steel articles
ISO 2063	Thermal Spraying - Metallic And Other Inorganic Coatings - Zinc, Aluminium And Their Alloys
ISO 8044	Corrosion of Metals and Alloys – Basic Terms and Definitions
ISO 8501-1 (AS 1627 Part 9)	Pictorial standards for protection of steel surfaces
ISO 8503	Preparation of steel substrates before application of paints and related products
ISO 9001	Quality Management System
ISO 9223	Corrosion of metals and alloys, corrosivity of atmospheric classifications
ISO 9224	Corrosion of metals and alloys, corrosivity of atmospheres – Guiding values for the corrosivity categories
ISO 12944	Paints and varnishes - Corrosion protection of steel structures by protective paint systems
ISO 14713	Protection against corrosion of iron and steel structures
NACE SP 05 08	Methods of Validating Equivalence to ISO 8502-9 on Measurement of the Levels of Soluble Salts

No.	Title
NACE Report 6A192/ SSPC-TR 3	Dehumidification and Temperature Control During Surface Preparation, Application, and Curing for Coatings/Linings of Steel Tanks, Vessels, and Other Enclosed Spaces
SSPC-SP WJ-2/ NACE WJ-2	Waterjet Cleaning of Metals—Very Thorough Cleaning (WJ-2)
SSPC VIS 4 / NACE VIS 7	Guide and reference, photographs for steel surfaces prepared by water jetting
SSPC VIS 5 / NACE VIS 9	Guide and reference, photographs for steel surfaces prepared by wet abrasive blast blasting
ASTM – A36	Specification for structural steel
ASTM – A123	Specification for zinc (hot-dip galvanised) coatings on iron and steel products
ASTM – A153	Specification for zinc coating (hot –dip) on iron and steel hardware
ASTM – A384	Practice for safeguarding against warpage and distortion during hot-dip galvanising of steel assemblies
ASTM – A385	Practice for providing high quality zinc coatings (hot-dip)
ASTM – A767	Specification for zinc coated (hot-dip galvanised) steel bars for concrete reinforcement
ASTM – D6386	Practice for preparation of zinc (hot-dip galvanised) coated iron and steel products and hardware surfaces for painting
ASTM – E376	Practice for measuring coating thickness by magnetic-field or eddy current (electromagnetic) test method.

4.6. ADDITIONAL REFERENCES

The following references have been used in the production of this guideline:

Table 5: Additional References

References	
i.	www.midwestports.wa.gov.au
ii.	Contractor and Worker Requirements (Contractor Handbook) – A summary of the OSH, Environmental and Security Requirements at Geraldton Port (May 2013)
iii.	Industrial Galvanisers Manual (INGAL Manual) available from Industrial Galvanisers Corporation Pty Ltd - http://manual.ingal.com.au/index.php

4.7. PRECEDENCE

As a general guide, where particular aspects are not covered in the MWPA Technical Guidelines or where conflict between documents exists, the following precedence for standards applies:

1. Statutory Regulations
2. Design Codes and Standards
3. Project Specific Specification
4. MWPA Technical Guidelines
5. Other References (e.g. Recognised Industry Best Practice)

Regardless of the general order of precedence, if there is a conflict between documents, the clause presenting the more conservative and pragmatic guidance will govern. If in doubt, or in all cases where noncompliance is anticipated, clarification shall be sought from the MWPA.

5. ASSETS

5.1. GENERAL

The MWPA assets applicable to this guideline are summarised below:

- Navigational aids
- Berth structures
- Jetty structures
- Pens
- Shiploaders
- Materials handling structures
- Train/truck unloaders
- Buildings
- Fencing
- Buried Services
- Signage and lighting
- Access structures

A specific list including parent assets/sub-assets/components which are galvanised has been provided in Appendix C.

6. EXPOSURE ENVIRONMENT

6.1. GENERAL

In general, atmospheric corrosivity in Australia falls under six varied categories (C1 to CX). Each corrosivity category is governed by an expected corrosion rate range of various steel elements in each exposure environment. These atmospheric corrosivity categories are clearly defined in Table 6.1, Section 6 of AS/NZS 2312.2. In addition to these generic corrosivity categories, there are specific cases where the expected corrosion rate can vary significantly based on the micro-environment. For example, areas of continued wetting and drying cycles, those in contact with corrosive mineral ores, salts or chemical fumes need to be dealt with on a case by case basis. If there is any doubt in assigning a corrosivity category, professional advice should always be consulted. Section 6.2 aims to provide examples of specific micro environments in which Port Assets are exposed to.

6.2. MICRO ENVIRONMENTS

Table 6 provides a summary of the anticipated micro-environments at the Port sites. Estimated corrosion rate ranges have been provided base on the assigned steel corrosivity category. The steel corrosivity categories will later be used in the determination and selection of the appropriate hot dip galvanising coating thickness. A comparison has also been provided for expected corrosion rates according to the piling code AS 2159.

Table 6: Classification of Micro Environmental Exposures at the Port

Exposure Environment	Steel Corrosivity Category	Estimated Zinc Corrosion Rate (µm/year)	Estimated Mild Steel Corrosion Rate (µm/year)
Atmospheric	AS/NZS 2312.2 HDG Coatings	AS/NZS 2312.1 Paint Coatings	Source: AS/NZS 2312.2 Table 6.1
Bund Area General	CX	CX	8.4 – 25
External (All building and structures)	CX	C5-Marine	8.4 – 25
Internal (BHF Structures, Train Unloader, Truck Unloader, Dust Extraction Equipment, Chemical Stores)	CX	C5-Industrial	8.4 – 25
Internal (Ship loaders, Workshops)	C4	C4	4.2 – 8.4
Internal (Inside Administration building, Operations & Control rooms)	C1	C1	≤ 0.1
Tidal/Splash		AS 2159	
Tidal - splash, immersion seawater (Wharf Substructure, Fenders, Dolphins, Navigational Aids, Slipway, Ramp)		Very severe	N/A

Exposure Environment	Steel Corrosivity Category	Estimated Zinc Corrosion Rate (µm/year)	Estimated Mild Steel Corrosion Rate (µm/year)
Submerged		AS 2159	
Fresh water, seawater, chemical (Pipes, Tanks, Wharf Substructure, Fenders, Dolphins, Navigational Aids, Slipway, Ramp)		Moderate – very severe	N/A
Buried		AS 2159	
Fill, soil, industrial or mine waste (Piles, Pipes, Footings , Slabs)		Non-aggressive – very severe	N/A

7. COATING SELECTION

7.1. GENERAL

This section aims to assist in the selection of an appropriate galvanising coating thickness based on the exposure environment and durability requirements of a zinc coating.

7.2. SELECTION OF GALVANISING FOR THE EXPOSURE ENVIRONMENT

Selection of the appropriate galvanising thickness for the exposure environment can be simplified using the data summarised in the following tables. The governing factor in most cases for the choice of galvanising thickness will be the exposure environment in which the galvanised element will be exposed to and the thickness of the component requiring coating application. As presented previously in Table 6, the exposure environment will directly relate to a corrosivity category. Other considerations to be made are the durability of the galvanising and the desired coating life / time to first maintenance. Table 7 provides a summary of the how the corrosivity category relates to expected corrosion rates of zinc in the galvanising coating.

Table 7: Corrosivity Category and Respective Corrosion Rate of Zinc

Corrosivity Category	Corrosion Rate of Zinc Galvanising Coating (µm /year)*	Corrosion Level
C1	< 0.1	Very Low
C2	0.1 - 0.7	Low
C3	0.7 - 2.1	Medium
C4	2.1 - 4.2	High
C5	4.2 - 8.4	Very High
CX	8.4 - 25.0	Extreme

**Zinc corrosion rates obtained from Table 6.1 AS/NZS 2312.2-2014*

Table 8 provides a summary of the coating durability classification versus coating life expectancy / time to first coating maintenance.

Table 8: Durability Classification and Time to First Maintenance of Coating

Durability Classification	Time to First Maintenance (years)*
Very short term (VS)	0 - 2
Short term (S)	2 - 5
Medium term (M)	5 - 10
Long term (L)	10 - 15
Very long term (VL)	15 - 25
Extra-long term (EL)	> 25

**Time to first maintenance obtained from Section 6.3 Life to first maintenance of coatings AS/NZS 2312.2-2014*

Generally it is assumed that the life of most hot dip galvanised coatings is approximately proportional to coating mass or thickness, using the corrosion rate ranges for zinc presented in Table 7, the minimum and maximum coating design life and durability classification can be determined.

Given the theoretical maximum achievable HDG galvanising coating thickness is directly proportional to the thickness of steel being galvanised, Table 9 below provides a comparison of steel thickness being galvanised to the standard HDG designations.

Table 9: Steel Thickness vs Achievable HDG Coating Thickness

Steel Thickness (mm)	Standard Coating Designation	Minimum Coating Mass/ Thickness*	
		g/m²	µm
> 1.5 to < 3.0	HDG390	390	55
> 3.0 to < 6.0	HDG500	500	70
> 6.0	HDG600	600	85
> 6.0	HDG900	900	125

**Minimum zinc coating thicknesses obtained from Table 6.2 AS/NZS 2312.2-2014*

Table 10 is an abbreviated section from Table 6.2 in AS/NZS 2312.2 which summarises the relationship between coating thickness, corrosivity category and expected coating life. This table can then be used as a guide for choosing an appropriate coating thickness for a steel element for a given exposure classification.

Table 10: Expected of Life to First Maintenance for a series of Hot Dip Galvanised Coating Thicknesses according to Corrosivity Category and Durability Classification

HDG Coating System	Standard Coating Designation	Minimum coating mass/ thickness		Corrosivity Category according to ISO 9223 Expected min – max coating life (years) & Durability Rating							
		g/m²	µm	C3		C4		C5		CX	
Hot Dip Galvanising AS/NZS 4680	HDG390	390	55	26 - 78	EL	13 - 26	VL	2 - 6	M	2 - 6	S
	HDG500	500	70	33 - 100	EL	16 - 33	VL	2 - 8	L	2 - 8	M
	HDG600	600	85	40 > 100	EL	20 - 40	EL	3 - 10	VL	3 - 10	M
	HDG900	900	125	60 > 100	EL	30 - 60	EL	5 - 15	VL	5 - 15	H

The full table including hot dip galvanised steel sheets and tubes and other elements is available in Table 6.2 AS/NZS 2312.2. It should also be noted that the expected coating life assumes uniform corrosion is occurring. Other forms of aggressive corrosion such as crevice and pitting corrosion will significantly change these design lives accordingly. Appendix H in AS 4680 and Appendix B in AS/NZS 2312.2 discusses in depth the specific mechanisms and effects of the local / micro environment on the corrosion rates of galvanising and steel. Recommendations for standard coating thickness designations for specific MWPA asset types are provided in Appendix C.

8. GUIDELINES TO DESIGNERS

8.1. SAFETY IN DESIGN

Designers should ensure that all designs and documentation are in accordance with current Safety in Design best practice and legislation, and that the relevant reviews and audits have been carried out during the design development phases. Designs should demonstrate and document how safety has been considered in the final product, during construction and ongoing maintenance of the assets.

8.2. STEEL DESIGN / DETAILING FOR GALVANISING

As per AS/NZS 4680 items to be galvanised shall be designed to suit galvanising. In particular the following must be taken into consideration:

- Vent and drain holes – these must be provided in the items to allow hot air to vent during the hot dip process, and for excess zinc to drain from the piece.
- Lifting points – points should be provided to allow the galvaniser to suspend and lower the piece into the galvanising bath.
- Maximum size and weight for dipping – the size of available baths should be confirmed and pieces sized appropriately. Progressive dipping may be an option, but should be discussed in advance with the galvaniser. Consideration must also be given to the weight of pieces and the capacity of lifting equipment.
- Warping – due to the heat involved in the hot dip galvanising process residual stresses in the piece may cause warping, therefore measures such as alternating welds, balancing design, and annealing/stress relieving may be required.
- Galvanising thickness – the total amount of zinc deposited by hot dip galvanising has a bearing on the time to first maintenance. This is related to the steel composition, surface condition, through thickness, and time in bath.
- Hydrogen embrittlement – care should be taken when using high-tensile steels that may be susceptible to embrittlement from hydrogen evolved during the pickling process.
- Overlapping and contacting surfaces – the design should avoid narrow gaps. Where gaps of less than 2.5 mm are unavoidable they should be sealed by welding prior to galvanising.
- Dimensional tolerances – parts will increase in size during galvanising, and this must be taken into account, particularly for tight tolerance parts.
- The presence of vent and drain holes can allow highly corrosive micro-environment to occur, these can be sealed or capped to prevent this.
- Excessive galvanised thickness – when selecting the steel, care should be taken with regards to the silicon and phosphorus content, as these may cause excessive galvanising thickness that is susceptible to flaking. Generally the following guidelines are applicable:
  - Phosphorus < 0.04%
  - Silicon < 0.04%, or 0.15% < Silicon < 0.22%

Where possible, it is recommended that discussions between the designer, fabricator and galvaniser are undertaken early in the design process to ensure that the quality required is achieved.

8.3. DUPLEX COATINGS

Duplex coatings refer to protective coatings applied over galvanised steel. This practice can provide long durability in severe exposures, and may compensate for reduced galvanised thickness with thin sections. Galvanised steel is generally suitable in the pH range of 6 – 12, duplex coatings may be required where portions of galvanised steelwork are locally exposed to corrosive environments outside this range. Duplex coatings may also be employed to add colour for signage and safety reasons.

8.3.1. TOP COAT SELECTION

Guidance on suitable duplex coatings is provided in AS/NZS 2312.2 Section 7.5, and Table 7.1. It is recommended that the coatings with the longest durability are preferred, although care should be taken to specify a coating with an appropriate life for the underlying asset.

Generally galvanising provides a good surface for coating, although the following issues should be considered by the designer:

- In corrosive exposures (C3 to C5) thin porous coatings can actually accelerate the corrosion of the galvanising.
- Certain paints are susceptible to saponification when applied to alkaline surfaces such as galvanised steel, it should be confirmed with the paint supplier that the proposed system will be compatible with the substrate.
- Surface preparation of galvanised steel produces a lower surface profile for the coating to adhere to when compared to steel. To avoid delamination, coatings that will shrink considerably during curing should be avoided, and suitable coating thicknesses should be confirmed by the coating manufacturer to ensure coating warranty cover.
- For externally exposed items subject to UV exposure a system with a polyurethane topcoat should be used, e.g. system 5D.

Table 11: Compatibility of Duplex Coating Systems for various Exposure Environments

Exposure Environment	Steel Corrosivity Category		Preferred Duplex System	Durability – Years to 1st maintenance
Atmospheric	AS/NZS 2312.2 HDG Coatings	AS/NZS 2312.1 Paint Coatings	Source: AS/NZS 2312.2 Table 7.1	
External (All building and structures)	CX	C5 - Marine	5D	10 - 15
Internal (BHF Structures, Train Unloader, Truck Unloader, Dust Extraction Equipment, Chemical Stores)	CX	C5 - Industrial	5I	10 - 15
Internal (Ship loaders, Workshops)	C4	C4	5I	> 15

Exposure Environment	Steel Corrosivity Category		Preferred Duplex System	Durability – Years to 1st maintenance
Internal (Inside Administration building, Operations & Control rooms)	C1	C1	1D*	N/A
Tidal/Splash		AS 2159		
Tidal – splash, immersion seawater (Wharf Substructure, Fenders, Dolphins, Navigational Aids, Slipway, Ramp)		Very severe	Not recommended	N/A
Submerged		AS 2159		
Fresh water, seawater, chemical (Pipes, Tanks, Wharf Substructure, Fenders, Dolphins, Navigational Aids, Slipway, Ramp)		Moderate - very severe	Not recommended	N/A
Buried		AS 2159		
Fill, soil, industrial or mine waste (Piles, Pipes, Footings, Slabs)		Non-aggressive – very severe	5I	N/A

***NOTE:** *Within C1 exposure environments coatings are not regarded as necessary to achieve durability, however they may be employed to provide colour for safety or signage reasons. Above data obtained from AS/NZS 2312.2 Table 7.1*

8.3.2. SURFACE PREPARATION

All contaminants on the galvanised surface shall be removed as follows:

1. Non-oily deposits shall be removed by detergent washing, followed by thorough clean water rinsing. Detergent is to be non-ionic type.
2. Grease and oily deposits shall be removed using an alkaline oil emulsifying detergent. Solvents for this purpose are not to be used.
3. Dry thoroughly.

Abrasive blast clean all galvanized surfaces to be painted by sweep blasting using garnet or ilmenite with an abrasive size capable of passing a test sieve of 150 to 180 microns.

Abrasive blast pressure 275 kPa (40 psi) maximum.

Blast nozzle distance from surface 350 to 400 mm, at an angle no greater than 45°.

Surface profile 30 to 40 µm, or as recommended by the Paint Manufacturer with regard to the galvanising thickness.

All spent abrasive shall be removed from the site on completion and disposed of appropriately in accordance to the local regulations.

In the event abrasive blasting exposes "Kirkendall Voids" within the galvanizing, the following procedure shall apply:

- All affected areas shall be power tooled to remove all loose and flaking Hot Dip galvanising. Care should be exercised not to remove the material back to bare metal.
- Apply two coats zinc rich epoxy @ 75 µm each for a minimum total DFT 150 µm.

Where peeling or other defects in the galvanised layer are extensive, this shall be grounds for rejection.

8.4. DISSIMILAR METALS

Connection of dissimilar metals that can form a galvanic couple should be avoided. Specifically with regards to galvanised steel, the most common couples encountered are connections to bare carbon and stainless steel. In the presence of an electrolyte these will cause accelerated corrosion of the zinc. This situation is typically undesirable and needs to be designed out, e.g., through substitution of materials, electrical isolation, or exclusion of the electrolyte.

The use of dissimilar metals that may result in galvanic corrosion is not permissible without the prior approval of the MWPA Project Coordinator or the Owner's Engineer.

Where the use of galvanic couples is unavoidable, design guidance in AS 4036 should be used to mitigate the risks of corrosion.

8.5. SERVICE LIFE REQUIREMENTS

The service life requirement shall be defined as the period to first major maintenance. Major maintenance will be required once the galvanising or duplex system has deteriorated beyond the condition stipulated in Clause 10.2.

All galvanising works must be designed to minimise capital, operating and maintenance costs throughout the service life of the asset. This should be factored into the asset management plan for the asset.

8.6. ACCESS

Consideration should be given to access for maintenance and inspection, and where possible access should be designed in. Where it is not feasible to provide access for maintenance and inspection the designer should select a more durable solution that would otherwise be required.

9. GUIDELINES TO CONTRACTORS

9.1. PRE-CONTRACT MEETING

As early as possible the galvaniser should be invited to provide feedback on the design, conduct a constructability review and identify issues that may impact the quality and durability of the galvanised steel. If duplex coatings are to be applied a clear line of communication between the galvaniser and coating contractor is to be established, and agreement made regarding responsibilities and timing of operations.

The coating contractor should refer to **MWPA401 Guidelines for Protective Coatings**.

Agreement should be made regarding the transport and storage of items prior to erection or installation. Proper transport and storage guidance is provided in AS/NZS 4680, Appendix F.

10. REPAIRS

10.1. REPAIRS AFTER GALVANISING

All galvanised pieces shall be checked prior to transport, and repairs made as follows:

- Where damaged or uncoated areas exceed 0.5% or 250 cm^2, whichever is the lesser, the piece shall be repaired by removing defects and re-dipping the piece.
- Where damaged or uncoated areas do not exceed 0.5% or 250 cm^2, they may be repaired using one of the following coatings:
  - Organic zinc rich epoxy paint complying with AS/NZS 3750.9. This shall be applied in two coats, each coat shall have a minimum dry film thickness of 50 µm.
  - Inorganic zinc silicate paint complying with AS/NZS 3750.15, this shall have a minimum dry film thickness of 100 µm.
  - Zinc metal spray to ISO 2063 or AS/NZS 2312.2.
  - Zinc alloy solder stick.

10.2. PROCEDURES FOR IN-SERVICE REPAIRS

10.2.1. GALVANISED STEEL

For repairs to galvanising the following procedure shall be followed:

1. Check environmental conditions Environmental conditions must be within the coating manufacturer's recommended parameters before preparation & coating proceeds, which should at a minimum, be to the following.
   a. Do not proceed if the surface is wet or likely to become wet after blasting or before prime coating or top coating.
   b. Do not proceed if the surface temperature is within 3°C of the dew point.
   c. Do not proceed if the surface temperature is less than 10°C.
   d. Do not proceed if the substrate temperature is greater than 45°C.
   e. Do not proceed if the relative humidity is greater than 85%.
   f. Do not proceed if the weather is clearly deteriorating or unfavourable for application or curing.
   g. Do not proceed in high wind conditions.
   h. Do not stand the coating in direct sunlight before mixing or adding the converter (catalyst).
2. Surface preparation:
   a. Thoroughly remove oil and grease from the surface (as per AS 1627.1), apply the degreaser as per the supplier's recommendations. It is important that this occurs prior to blasting. If grease or oil is present on the surface it will appear to be removed by the blasting process, but this is not the case. Although not visible, the contamination will still be present as a thin layer, and will affect the adhesion of subsequent coatings, refer Industrial Galvanisers Specifiers Manual (INGAL Manual).
   b. Select the most appropriate abrasive blasting method from AS 1627.4.

c. Spot blast corrosion defects in the galvanising back to near white metal (Class Sa 2½), following the appropriate procedure in AS 1627.4.

d. Back off the blast nozzle away from the surface a further distance of approximately 1 m and blast the feathered edge at an oblique angle to the surface.

e. Sweep blast the coating surrounding the repair at a similar distance and angle to that used in step 2(d).

f. Test for surface contaminants and soluble salts to AS 3894.6 methods A, C, and D. Where surface contaminants and/or soluble salts are found to be above the coating manufacturer's specified limits, the surface shall be high pressure washed with fresh water until surface contaminants and/or soluble salts are found to be below the specified limits. Where high pressure washing has taken place, re blasting of the area will be necessary to remove any flash rusting.

Note 1: Alternatively, for small areas, replace steps 2(a) to 2€: power tool clean to AS 1627.2 Class PSt 3. However, tightly adhering mill scale and rust in deep pits will not normally be removed by this method of cleaning. Care should be taken not to polish the metal surface as this may reduce the key for subsequent coating.

Note 2: Bolt areas will require stripe coating by brush prior to general application.

3. Paint the Surface

a. Apply a minimum of two coats of organic zinc rich epoxy paint complying with AS/NZS 3750.9, and which for optimum performance should contain not less than 92% zinc in the dried paint film, to a total minimum DFT of 150 µm. Application should comply with the requirements of AS/NZS 2312. Coating is to be prepared and applied strictly in accordance with the manufacturer's instructions.

b. If a close colour match is essential and the asset item is not top coated apply a light coat of aluminium paint over repair area after drying. Rub over aluminium paint with a soft rag before drying to blend the repair into the surrounding galvanised coating appearance. (INGAL Specifiers Manual) Where an additional protective coating system is required over the galvanised surface apply the same protective coating system as originally specified.

c. Undertake testing to determine the compliance of the repair referring to AS 3894.3. If necessary remediate as per preceding steps.

4. Report

a. All activities undertaken, the area(s) repaired, and the results of the compliance testing shall typically be reported as per the conformance report given in Appendix A. Include photographic records of works.

10.2.2. DUPLEX COATINGS

For repairs to duplex coatings the following procedure shall be followed:

1. Check environmental conditions. Environmental conditions must be within the coating manufacturer's recommended parameters before preparation & coating proceeds, which should at a minimum, be to the following.

a. Do not proceed if the surface is wet or likely to become wet after blasting or before prime coating or top coating.

b. Do not proceed if the surface temperature is within 3°C of the dew point.
c. Do not proceed if the surface temperature is less than 10°C.
d. Do not proceed if the substrate temperature is greater than 45°C.
e. Do not proceed if the relative humidity is greater than 85%.
f. Do not proceed if the weather is clearly deteriorating or unfavourable for application or curing.
g. Do not proceed in high wind conditions.
h. Do not stand the coating in direct sunlight before mixing or adding the converter (catalyst).

2. Surface preparation:
   a. Thoroughly remove oil and grease from the surface (as per AS 1627.1), apply the degreaser as per the supplier's recommendations.
   b. High pressure wash with fresh water at 6.9 MPa (1,000 p.s.i.).
   c. Using very fine abrasive (60 to 80 mesh) brush blast non-compliant coating to AS 1627.4 Appendix D.
   d. Back off the blast nozzle away from the surface a further distance of approximately one metre and blast the feathered edge at an oblique angle to the surface.
   e. Sweep blast the coating surrounding the repair at a similar distance and angle to that used in step 2(d).
   f. Confirm surface cleanliness has been achieved as per AS 1627.9 before proceeding.
   g. Test for surface contaminants and soluble salts to AS 3894.6 methods A, C, and D. Where surface contaminants and/or soluble salts are found to be above the coating manufacturer's specified limits, steps 2(a) and 2(b) are to be repeated, i.e. the surface shall be high pressure washed with fresh water again until surface contaminants and/or soluble salts are found to be below the specified limits. Where high pressure washing has taken place, re-blasting of the area will be necessary to remove any flash rusting.
   h. Dry thoroughly without contaminating the surface (i.e. using forced heated air)
3. Paint the surface:
   a. Apply the same top-coats as originally specified.
4. Test repair for compliance:
   a. Check DFT to AS 3894.3 – rectify if required.
   b. 100 % surface area test for continuity to AS 3894.1 or AS 3894.2, test voltages to be confirmed by the paint supplier. Coatings are to be 100% continuous.
   c. Cure coating to AS 3894.4, coatings are to be cured before being placed back into service.
5. Report:
   a. Report all activities undertaken, the area(s) repaired, and the results of the compliance testing. Include photographic record of works.

      NOTE: Coating shall proceed as soon as practicable after surface preparation and the following procedure completed within one (1) day and step 4(a) should be completed within four (4) hours of step 3(a).

11. QUALITY CONTROL AND QUALITY ASSURANCE

11.1. GENERAL REQUIREMENTS

All aspects of the protective coating work under the contract shall be adequately inspected and documented. This responsibility lies primarily with the contractor, and the contractor is therefore required to critically inspect and test their own work for compliance with the specification.

Only (independently) verified documentation of as-constructed details, relevant correspondence, test reports and inspection details can provide evidence that the works comply with the specification and the MWPA Project Coordinator or the Owner's Engineer reserve the right to witness, audit or duplicate any inspection or testing that is carried out by the contractor.

The absence of the MWPA Project Coordinator or the Owner's Engineer does not absolve the contractor from carrying out the tasks and the required quality inspection and documentation in accordance with the specification.

All coating contractors should be accredited to the Painting Contractor Certification Program (PCCP). All Galvanisers should have an accredited Quality Management / Quality Assurance System certified to ISO 9001 or other approved quality management system to control quality of the galvanising process.

11.2. INSPECTION AND TESTING PLAN

The contractor shall prepare an Inspection and Testing Plan (ITP) that reflects how each individual task is to be inspected and tested and how the results are to be documented. The ITP shall include:

- Each aspect of the work that shall be inspected and tested as per the requirements of the specification;
- Party responsible for inspection or test;
- Method of test and relevant test standard;
- Timing and frequency of test;
- Acceptance criteria for inspection or test;
- Nomination of the document in which the test result is to be recorded; and
- Name of person conducting inspection or test.

The ITP shall nominate the following minimum hold and witness points:

- For galvanisers:
  - Upon receipt of fabricated steel work to check for surface defects that require remediation.
  - To check that all required masking is completed.
  - To check that lifting and scheduling is achievable with equipment.
  - Prior to handover of the coated items, check coating thickness and record the visual condition at handover.

- For coating contractors:
  - Upon receipt of galvanised steel work to check for all surface defects, including bare or damaged galvanising. These shall be repaired prior to the preparation of the surface to be coated;
  - Carry out a visual surface check for oil and other contamination and degreasing as necessary prior to surface preparation;
  - Confirm residual soluble salt concentration prior to first coat i.e., less than 50 mg/m^2;
  - Confirm climatic conditions are acceptable i.e., less than 85% relative humidity and dew point great 3°C;
  - After surface preparation confirm substrate is as required in the specification;
  - After the application of each coat of paint to determine thickness, quality and any repairs needed;
  - Prior to handover of the coated items to record the visual condition at handover.

11.3. IDENTIFICATION AND TRACEABILITY

All work shall be subdivided into distinct work lots. Each work lot and item to be treated shall be assigned a unique identification number, and the contractor shall maintain a register of all allocated work lot numbers and the item numbers that are contained in each work lot.

The contractor shall follow the approved ITP's for each work lot based on the various tasks to be conducted.

The contractor shall ensure that traceability is maintained throughout all documented records under the contract. All test results where applicable under the contract shall be positively identified with their respective work lot number.

11.4. COMPLIANCE INSPECTIONS AND TESTING

All work under the contract shall be inspected and documented by the contractor to ensure compliance with the specification. For this purpose, the coating contractor shall subdivide all areas to be treated into distinct work lots or work items (refer clause 11.3).

All compliance inspections and tests shall be based on work lots. The costs for all such inspections, tests and documentation shall be borne by the contractor and shall be allowed for in any submitted tender. The contractor shall document all equipment used in the project and all inspection and testing results in a Coating Inspection Report. For The documentation may be the contractor's own standard QA documentation design, but for duplex coatings shall satisfy the requirements of AS 3894 Parts 10 to 14, as a minimum and accommodate the documentation of all items listed in the approved ITP.

The contractor shall nominate a QA/QC representative. The QA/QC representative shall have current qualifications recognized by ACA, NACE. The QA/QC representative's qualifications and experience shall meet the requirements of NACE Coating Inspector Level 2

The contractor shall conduct sufficient inspection and testing work (and subsequent repair work where necessary) in order to satisfy that each work lot complies with the specification. The contractor shall ensure that all aspects of the specification have been met prior to notifying the Owner's Engineer or any other QA/QC auditors to test and verify that the work conforms to the specification.

The contractor shall supply a complete set of QA records during handover of the works.

The QA record shall contain as a minimum:

- For duplex coatings all completed Coating Inspection Reports (refer to AS 3894 Part 10 to 14).
- For non-duplex coatings, all completed Coating Inspection Reports (refer AS 4680 Appendix B / AS/NZS ISO HB18.28 Conformity Assessment)
- All non-compliance reports.
- All records of corrective action (may be recorded in “Coating Inspection Report” or on “Non-Compliance Report” as appropriate).
- Any correspondence related to the works conducted in each individual work lot.

11.5. THIRD PARTY (INDEPENDENT) INSPECTION

The contractor shall advise the inspector in sufficient time to enable attendance at the work site without causing unnecessary delay or hindrance to the progress of work.

12. GUIDELINES TO INSPECTORS

The required acceptance inspection and testing remains essentially the same for factory (shop & yard) and site applied coatings.

12.1. AUTHORITY OF THE INSPECTOR

The Inspector shall conduct all aspects of their work in accordance with the ACA code of professional conduct. The Inspector shall be minimum NACE certified coating inspector Level 1. The Inspector should be employed directly by MWPA to provide QA/QC services in an unbiased manner.

The Inspector shall be the sole judge of whether compliance with the specification, relevant Australian or International Standards or good painting practices in general is being adhered to. Issues of non-compliance shall be addressed with the contractor upon detection. The coating contractor shall be given an opportunity to conduct rework within twenty four (24) hours in order to meet the specified criteria.

The Inspector shall immediately notify the MWPA Project Coordinator or the Owner's Engineer of any non-conformance issues and keep the MWPA Project Coordinator or the Owner's Engineer informed of the progress of rectification work. If rectification of the detected non-compliance is not carried out to the satisfaction of the Inspector, MWPA Project Coordinator or the Owner's Engineer, the Inspector shall submit a written non-conformance report to the MWPA Project Coordinator or the Owner's Engineer and the contractor.

In case of doubt about any aspects of the contractor's work or in the absence of relevant guidance in the Specification, the Inspector shall nominate a suitable Australian or International Standard in consultation with the MWPA Project Coordinator or the Owner's Engineer, the coating manufacturer and the contractor in order to create clarity on any such matters.

The contractor shall provide the MWPA Project Coordinator or the Owner's Engineer and the Inspector with safe access to all treated areas and all QA/QC documentation at any time for the duration of the project.

No party conducting inspections or audits shall produce non-conformance reports without notifying the contractor that a non-conformance has been detected.

12.1.1. EXCLUSIONS

The Inspector shall not undertake the following roles or activities:

- Make changes to the scope of work or specification without written consent of the MWPA Project Coordinator or the Owner's Engineer and the coating manufacturer.
- Give instructions to the applicator to perform works outside of the Specification or the scope of work.
- Tell the applicator how to do their job. The Inspector's role is to point out requirements the applicator achieve in order to meet the Specification.
- Report non-conformances to the MWPA Project Coordinator or the Owner's Engineer or the coating manufacturer without notifying the applicator that a non-conformance has been detected.

12.2. INSPECTION OF SUBSTRATE AND COATINGS

Inspection of the substrate, coated areas and items shall include but not be limited to the following:

- Surface contaminant tests to AS/NZS 3894.6 Method C;
- Coating thickness tests (DFT) to AS 3894.3; and
- Tests for cure of coatings to AS 3894.4.

The results of all paint coating tests shall be recorded on an approved Coating Inspection Report. This documentation may be the coating contractor's own standard QA documentation template but shall satisfy the requirements of AS 3894 Part 10 to 14, (and be modified to suit other specific project requirements) as a minimum and accommodate the documentation of all items listed in the approved ITP.

All equipment to be used for inspection purposes shall be calibrated in accordance with equipment manufacturer's instruction and the relevant Australian or International Standards.

12.3. CONTRACTOR'S ITP

The contractor shall prepare and submit an ITP for the coating systems specified as per Clause 11.2. The MWPA Project Coordinator or the Owner's Engineer shall approve the ITP before any work is commenced.

13. MAINTENANCE AND INSPECTION

13.1. MAINTENANCE AND INSPECTION RECORDS

The contractor shall maintain proper records as required by the Specification in accordance with Australian Standards AS/NZS 4680, AS 3894 Parts 10, 11, 12, 13 and 14 and any additional records as required by the MWPA Project Coordinator or the Owner's Engineer. Such records shall be available for inspection at any time by the MWPA Project Coordinator or the Owner's Engineer and become the property of the MWPA Project Coordinator upon completion of the contractor's contract.

14. DOCUMENTS TO BE SUBMITTED

14.1. GENERAL

The contractor shall submit all coating information to the MWPA Project Coordinator or the Owner's Engineer for approval prior to the commencement of work.

Examples of typically required tender and project documentation are listed below and shall include as a minimum: a description of the proposed galvanising process, paint system and materials, manufacturer's data, application, drying, over-coating times and any other information necessary for the MWPA Project Coordinator or the Owner's Engineer to properly assess the proposed coating system. Documentation covering the work procedures, inspection, tests, methods of surface preparation, coating materials and their application on the project shall also be provided.

14.2. TENDER DOCUMENTS

Table 12 provides a summary of the recommended tender documents required for both HDG and Duplex coatings systems.

Table 12: Tender Documents Required for Coating System

Item Description	HDG Coating	Duplex Coating
Scope of work	✓	✓
Nominated Surface Preparation Method	✓	✓
Nominate selected approved coating supplier and materials	✓	✓
Product Technical Data Sheets (PTDS) for proposed coating materials	✓	✓
Cathodic Protection confirmation re coating materials – if applicable	✓	✓
MSDS for approved coating materials	✓	✓
PCCP Certification Certificate	✓	✓
Evidence of adherence to AS 4680	✓	✓
Insurance (where applicable)	✓	✓
Environmental Operating Licence, if applicable	✓	✓
Approved HDG Coating / Duplex Coating Inspector	✓	✓
Evidence of Quality Assurance System conforming to ISO 9000	✓	✓

14.3. PROJECT DOCUMENTS

- Updated scope of work
- Safe Work Method Statement (SWMS) details of Work Method, Containment Process and Environmental Controls
- Site Health and Safety Plan
- Coating Inspection Report Form
- ITP (Inspection and Test Plan) for review

- Work lot identification
- Copy Daily Work Report
- List of inspection instruments and equipment
- Guarantee Format for evaluation
- Defect Liability Expectations
- Use of site paint gauges / other hand held test equipment and calibration
- Slinging of loads to prevent damage
- Other storage issues
- Plugging of bleed hole

Note: The above list is a guide only and not necessarily exhaustive or complete for a specific project.

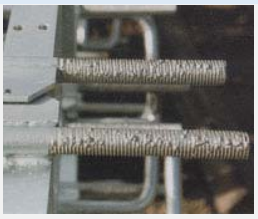
APPENDIX A

EXAMPLE ITP FORM

EXAMPLE ITP FORM					
STRUCTURE		INSPECTOR			
WORK ORDER NO.		DATE			
ASSET ITEM		LAST INSPECTION DATE			
AREA		DATE OF FABRICATION			
SUBSTRATE		DATE OF INSTALLATION			
SPECIFIED COATING		SPECIFIED DFT (µm)			
CALIBRATION					
INSTRUMENT USED		CALIBRATION BLOCK		CALIBRATED STANDARD THICKNESS	
RESULTS					
	1ST	2ND	3RD	4TH	5TH
LOCATION					
MIN DFT (µm)					
MAX DFT (µm)					
AVERAGE DFT (µm)					
# READINGS TAKEN					
SIGNATURE OF INSPECTOR					
SIGNATURE OF O&M REPRESENTATIVE					

APPENDIX B

EXAMPLE DEFECT PHOTOS

Common Post-Galvanising Defects*		
Defect	**Description**	**Representative Image**
Ash Staining	Zinc ash (by-product of galvanising process) can be trapped on inaccessible areas and sticks to the outside of the coating as the item is removed from the bath. It can leave a dull surface appearance and in some cases a light brown stain. It does not affect the durability of the galvanising coating.	
Chain and Wire Marks	Lifting aids can leave un-galvanised sections on the surface that will need to be repaired. Ensure lifting does not affect galvanising process.	
Clogged Holes	Liquid zinc metal will not easily drain from holes less than 8mm in diameter due to its high surface tension. This can be minimised by making holes as large as possible and by carefully shaking or blowing compressed air across the substrate after removing from the kettle.	
Clogged Threads	Occurs from poor drainage when item is removed from galvanising kettle. Must be cleaned before part can be accepted. Various methods can be used to clean threads including heating with a torch and using a wire brush to remove excess zinc.	
Dark staining adjacent to welds	Caused by surface contamination preventing galvanising from occurring. Surfaces should be cleaned thoroughly before galvanising.	
Delamination	Thick galvanised coatings (>250 microns) can be brittle and delaminate from the surface under impact. Thus these items require careful handling in transport and erection. Thin, cold rolled items with very smooth surface finishes and manufactured from reactive steel may also give rise to coating delamination.	

Common Post-Galvanising Defects*		
Defect	**Description**	**Representative Image**
Distortion	Buckling of thin flat plate can occur during galvanising. Can be avoided by using thicker plate, adding ribs or corrugations to stiffen section.	
Dross Pimples/ Inclusions	Caused by iron inclusions reacting with zinc during galvanising process, may lead to surface looking rough and gritty. This will not affect the durability of the galvanising coating.	
Dull Grey Coating	Usually occurs with steels containing a high silicon content. Dependent on silicon content of steel substrate which is highly reactive to zinc. Can also occur around welds where high silicon content steel filler rods have been used. Does not affect durability of coating.	
Runs, Drainage Spikes and Puddling	Runs occur on the surface of a sample when zinc freezes as the item is removed from the zinc bath. Adjustment to the angle of the item during drainage can help prevent this from occurring.	
Rust Stains (bleeding)	Can be caused by surface contaminants penetrating the galvanised surface forming a crystalline product that reacts with water. Bleeding can be removed by cleaning the affected area.	
Un-galvanised Welded Areas	Coating missed on weld areas caused by excess weld slag, slag should be removed by fabricator prior to galvanising	
Wet Storage Stain (Bulky white deposit)	Caused by galvanised items being stored in moist environments. Can be prevented by storing in dry places. Heavy deposits can be removed carefully by brushing using a solution of sodium or potassium dichromate in 0.1% by volume sulphuric acid, ensuring surface is then washed thoroughly with water to remove any contamination.	

*Contents and information in this table was summarised from these online resources available from:

1. American Galvanisers - www.galvanizeit.org
2. Industrial Galvanisers - www.ingal.com.au
   Galvanisers Association of Australia – www.gaa.com.au

APPENDIX C

MWPA'S GALVANISED STEEL ASSETS

Asset	Sub Asset	Sub Asset - Material	Sub Asset – Colour	Coating System Designation
Access Structures	Pedestrian overpass, Walkways, Stairs and Landings	HDG steel grid mesh	N/A	HDG 600;
	Handrails/Kickplates	HDG steel	Y14 Golden Yellow	HDG 600 + EPSt 125 + ACR/PU 75;
	Ladders	HDG Steel / GRP	Y14 Golden Yellow	HDG 600 + EPSt 125 + ACR/PU 75
Berths/Jetties – above water	Deck Type 1	HDG steel grid mesh;	N/A	HDG 600;
	Deck Type 2	Reinforced concrete/ HDG grid mesh drain cover;		HDG 600;
	Deck Type 3	HDG Steel grid mesh	N35 Light Grey	HDG 600
Berths/Jetties – Submerged	Piles	N/A	N/A	N/A
Fencing	Gates	HDG steel;	N/A	HDG 600
	Fences	HDG steel / HDG steel + PVC;	N/A	HDG 20 / HDG 20 + PVC 100
	Posts	HDG steel / Aluminium	N/A	HDG 600
Sign and lighting	Signs	HDG steel/Aluminium;	N/A	Max achievable HDG thickness depended on steel element thickness. Refer Table 9 Section 7.2 of this guideline for HDG designations;
	Posts	HDG steel/Aluminium	N/A	HDG 600