2009 Volume 6 Issue 1

HOT DIP GALVANIZING TODAY

HOT DIP GALVANIZERS ASSOCIATION Southern Africa

38

Featuring:

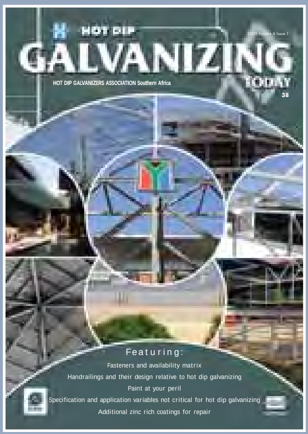
Fasteners and availability matrix

Handrailings and their design relative to hot dip galvanizing

Paint at your peril

Specification and application variables not critical for hot dip galvanizing

Additional zinc rich coatings for repair



The Association is a technical information centre established for the benefit of specifiers, consultants, end users and its members

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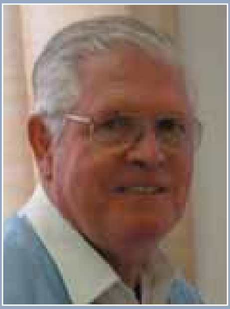
Front Cover: *A kaleidoscope of photographs showing some hot dip galvanized structural steel buildings and discoloration of some galvanized sheeting (see also Wamosha).*

Hot Dip Galvanizing – Adding value to Steel

Executive Director's Comment



As the Hot Dip Galvanizers Association Southern Africa we have been directed, by our members, to maintain a centre from which we disseminate technical skills (training) and knowhow within the corrosion industry in general and more specifically to ensure the correct and appropriate application and employment of hot dip galvanizing and duplex coating systems.

We fulfill this objective in a number of ways, including presentations at conferences and seminars, various presentations to interested parties, skills development training, for example our plant operator training and inspector's courses, together with various publications, CD Information disc, quarterly journal and our web site.

We have recently revamped the web site, hopefully to make it more user friendly and provide complete answers to corrosion control issues.

Visiting our web site, www.hdgasa.org.za, you will find a wealth of technical and detailed information. The web site has been developed on the basis of addressing typical queries, but more importantly to open up the economical and exciting potential of products with regards to corrosion control of carbon steel structures.

Visit the specific sub-heading of Technical. After applying a "click" to this word, you will find a further five headings that will direct you a long list of technical information and detail that has been developed over time that includes actual field experiences. The case studies and information sheets have been specifically designed to be practical, but without too much technical detail. These sub-headings are complemented by three other sub-headings of "Misconceptions, Technical Papers and FAQs.

When you visit our web site, feel free to comment on the information in terms of relevance to your specific technical requirements. Should you have any technical questions that are not addressed within the overall structure of the web site, we would welcome your critic

Bob Wilmot

Note from the Editor

In support of Bob's comment on education, I wish to emphasise that while Association staff involved on a promotional level are relatively few in number, we decided in spite of these constraints, several years ago to maximise member benefits in the area of promotion. The proposal was that these staff members would (according to a formula) proactively call on Consulting Engineers and Architects in and surrounding member areas, in order to educate and explain the characteristics of hot dip galvanizing and duplex coatings, by discussion and/or a presentation. This initial contact is then followed up with the delivery of the quarterly magazine and subsequent visits.

At certain intervals therefore, other than the areas where we currently reside i.e Johannesburg and Cape Town, we regularly travel to other areas, such as Durban, Richards Bay, Pietermaritzburg, East London, Port Elizabeth, George, Bloemfontein, Nelspruit and Polokwane. Should a reader wish to be visited for a discussion and/or a presentation to staff to enhance their technical knowledge on the use of the coatings and thereby claim CPD points, kindly contact us.

At the Association we pride ourselves in providing cost effective advice in the use of our coatings and are always happy to be involved in the evaluation and inspection of previously exposed and weathered hot dip galvanized or duplex coated components.

Should a reader require this evaluation and inspection service, kindly contact Bob or myself.

Our feature for this first issue in 2009 includes strength designations of fasteners, with additional participation from a fastener supplier in Cape Town.

Also a pictorial view of what to consider when designing and fabricating handrails together with an example of the sacrificial properties of hot dip galvanizing on a handrail.

Under Duplex Coatings, we publish an interesting article on the "Choice of rust prevention" together with a paper published in Corrosion and Coatings in 1986, called "Paint at your Peril"

Education and Training, expands on our certificated coating inspectors course, an essential requirement in any coating inspectors portfolio. This year in addition to the courses in Johannesburg, we have planned two in Cape Town.

In Misconceptions, Miss asks the question "Smooth and polished surfaces are a standard feature of all hot dip galvanized surfaces" – True of False?

The Coating Report expands on our already comprehensive comparison of Zinc Metal Spraying versus Hot Dip Galvanizing using a particular project.

Other regular articles include, Bob's Banter, where Bob Andrew chats about "Chaos".

"On the Couch" includes an interview with Architect Yvonne Onderweegs.

"Members news" includes an Exxarro article on nickel/zinc; the Phoenix Elephant visits Cape Town enroute to Europe; Installation of a new plant at Excell Galvanizing in Harrismith; Voigt & Willecke increase their bath size from 9 to 14m.

Taking coating thickness readings with a calibrated instrument, is important for all coatings. We include the third article in the series that covers, "What is important when taking coating thickness readings?"

Should a reader wish to express an opinion or provide us with an article, or comment on our articles, positively or negatively, kindly contact me.

Even though they say that come February the year is almost over, we take this opportunity to wish all our readers good business in 2009.

Case History and other regular articles will resume in the next issue.

Enjoy the "magazinc".

Terry Smith

2009 HOT DIP GALVANIZING AWARDS




Each accepted nomination must comply with the following:

- Each winning project should have the potential to be used as a case study in the future
- Every accepted submission should add to market development
- Awards are specifically aimed at market development

The submission process for 2009 is as follows:

1. Call for nominations (closing date is 31 March 2009).

   Please complete the nomination form and submit, together with photos and an overview of the project, to the Association via e-mail or by hand.
2. Screen possible projects for consideration
3. Nominated projects to be visited by an Association staff member and nominator. The project team owner/fabricator (i.e. the customer of the hot dip galvanizer) will be asked to complete an evaluation form.
4. The nominator/project team owner will be responsible for the completion of the submission. The Association staff will be on hand to assist.
5. The completed project submission deadline is 30 May 2009. However, you may submit earlier.
6. The submission will be made available on the website for peer review and comment.
7. Assessment of final entries: the various categories will be agreed on.

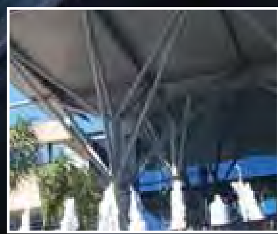
The conditions of entry are as follows:

- All nominations to be submitted to the HDGASA by 31 March 2009.
- All submissions to be submitted to the HDGASA by 30 May 2009.
- The Judge's decision is final and no correspondence will be entered into.
- By submission of an entry, the nominator assumes responsibility for the accuracy of all information and provides the HDGASA with assurance that permission has been obtained and that the information and photos may be used in the magazine, on the Association's website and for promotional purposes.
- Submissions to be completed according to template (available on website or on request).
- Only new submissions will be accepted, other than previous projects now qualifying as a Vintage submission.
- The project or product must be complete before the deadline date for submissions – 30 May 2009. However, if it is not complete by nomination deadline, it may be submitted for consideration.

Material to be submitted:

- A motivation as to why your project should be chosen as a winner is essential. Does it have the WOW factor? Will it have an impact on the market by aiding development of the hot dip galvanizing industry? Is it a new application or normally difficult to galvanize?
- Technical information is extremely important. Motivation, numbers and facts will assist with the adjudication.
- The professional standard of the submission forms an integral part of the judging criteria.
- Submissions should include a minimum of 5 full colour photographs. All digital photographs are to be at least 300dpi for reproduction purposes.
- Kindly ensure that electronic copies of the digital photographs are supplied with entry.





The objective of the Hot Dip Galvanizing Awards is to recognise and promote the development, application and use of hot dip galvanizing and related technology as a corrosion protection system.

Kindly contact the Association for further details on (011) 456-7960 or hdgasa@icon.co.za

Confessions of an 'Awards Junkie'

The beginning of the year signals my favourite time of the working calendar – Hot Dip Galvanizing AWARDS time! I have been called names by my peers (all in good fun) – fiercely competitive; compulsively spirited, but my favourite and the one that has stuck is awards junkie. I've tried to pinpoint my obsession for the awards scheme and I reckon that an unhealthy addiction to watching beauty pageants in my teens has played a (small) role. I know that I am treading on dangerous ground now; what with comparing shiny pieces of metal to shapely leggy beauties, but I don't care. To me a piece of galvanized steel is perfection.

My adventure starts with the selection process. Weighing up projects based on their merit, uniqueness and aesthetics and eliminating them one by one until I have the final selection (yes it sounds alarmingly like a beauty pageant doesn't it?) My top candidates become like children. I strive to intimately know every minute detail of them. I ponder over their weights, their measurements, their characteristics (weight, bust, waist, hips….see where I'm going with this?). Their project partners are harassed (I mean this in the nicest possible way because let's face it, people are busy) for information and projects are photographed extensively from every possible angle (I rest my case on the beauty pageant thing already). A handy hint here to my future co-competitors, hot dip galvanizing photographs well against an "interesting sky". The spectacular blue African sky is, well spectacular, but I feel hot dip galvanizing is far more attractive when juxtaposed against a mix of cumuli nimbus and bright blue sky. The coating is meant to 'shine', as she is the star of the show (did I say SHE?) and her true beauty certainly is not done justice in overcast weather.

The next round is preparing the entry according to the HDGASA template. A colourful play of words ensues and the fun escalates into a 'mini novel' which the judges should enjoy reading, filled with interesting details about the project, in addition to the required template information.

People ask about the time I spend on entries and yes, I must confess, I do spend time; probably more than most (to the utter dismay of my bosses). But the key is to eye the projects out early. I start hunting for my top contestants months in advance and as a result, the awards have become part of my job all year through. I am constantly gathering information and snapping pictures. The beginning of the year is simply a culmination of gathered data and dressing up for the gala evening (and here I'm not referring to the awards evening, I'm talking about 'dressing my entries up for the judges').

There is no winning recipe in the HDGASA Awards. Criteria change all the time, but what has remained constant is my enthusiasm for the event and the excitement the scheme stirs in the industry. One of my guests at a HDGASA awards ceremony a few years ago commented; "When you invited me to this function I was quite sceptical, I mean you said that a couple of engineers are getting together in Germiston. I must say I have been pleasantly surprised. This is great!" Yes it was quite late in the evening, yes the bottles on the table were empty, and yes, the guest did walk away with an award, but – this scheme generates energy and galvanizes the industry as a whole for one evening (pun intended). It is a great initiative which deserves 100% passionate support from all the role players in the Industry. And yes, I shall be there again, I'm a JUNKIE remember!

Author wishes to remain anonymous

Strength designations, metric bolts

The strength of metric structural bolts is specified in terms of the tensile strength of the threaded fastener and defined according to the ISO* strength grade system which consists of two numbers separated by a point, for example 4.6. The first number of the designation represents one hundredth of the normal tensile strength (MPa)* and the number following the point represents the ratio between nominal yield stress and nominal tensile strength.

* *In South Africa the specification is according to SANS 1700 Part 5, Section 1*

* *MPa = megapascals and is the force measurement, newtons per square millimetre*

For example a Property Class 4.6 bolt has:

Tensile strength of 4 x 100 = 400 MPa, minimum

Yield stress of 0.6 x 400 = 240 MPa, minimum

Mild steel bolts fall into the range, 4.6; 4.8; 5.6; 5.8 and 6.8.

Hi tensile bolts fall into the range 8.8, 10.9, 12.9

Tensile strength

Tensile strength is the maximum tension applied load a fastener can support prior to, or coincident with, it fracture. (Force or tension required to break the part when pulled in straight tension)

Yield strength

Yield strength is the tension-applied load at which a fastener experiences a specified amount of permanent deformation. In other words, the material has entered its plastic zone and will begin to elongate or lengthen.

Proof load

Proof load is a tension-applied load that the fastener must support without evidence of permanent deformation. Proof load is an absolute value, not a maximum or minimum. Proof loads are established at approximately 90 to 93 percent of the expected minimum yield strength of the fastener material.

Important note

It is important to note that cold forged mild steel grade 4.6 and 5.6 fasteners with higher elongation capability (designated by the ".6") require to be tempered to achieve this property. Should your specification require this, it is important to specify 'tempered to grade .6' as in South Africa many fasteners are sold with this grading when they have not been tempered. Mild steel yield grades, 4.8 and 6.8, do not have to be tempered and will cost less than 4.6 and 5.6 grades however the design engineers must be happy with the fact that elongation will be lower. The higher elongation of 4.6 and 5.6 allows the steel structure to withstand higher shock stresses than 4.8 where shocks could result in bolts breaking. Longer lengths (200mm) and larger diameter (30mm) 4.6 and 5.6 bolts which are hot forged do not have to be tempered.

R. Pietersma, CBC Fasteners

Fastener availability matrix and participating fastener suppliers

From experience it has been shown that on many occasions at building sites, alternatives such as zinc electroplated fasteners are mistakingly used. In order to provide a similar service life to that of the hot dip galvanized structure, it is important to specify and use hot dip galvanized fasteners. To this end we provide the following "Fastener Availability Matrix", indicating the feasibility and availability of a range of hot dip galvanized fasteners, etc. Should a particular fastener that you require not be listed, kindly contact one of the participating fastener suppliers at the end of this matrix or the Association.

TYPE OF FASTENER	COMPANY	STEEL GRADE	SPECIFICATION	SPECIFICATION	AVAILABLE SIZES	HOT DIP GALVANIZED TO ORDER	HOT DIP GALVANIZED EX STOCK
LOCKING NUTS							
Half Lock Nuts	Bolt Fast	MS			M6 – M30	Yes	
	Tel-Screw Products	MS/HT			M8 – M48	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS/HT			M8 – M36	Yes	Yes
Hard Lock Nuts	Bolt Fast	Gr: 8			M6 – M30	Yes	
Castle Nuts	Bolt Fast	MS/Gr:8			M6 – M30	Yes	
	Tel-Screw Products	MS/Gr: 8			M6 – M100	Yes	
Steel Hex Lock Nuts	Bolt Fast	MS			M6 – M100	Yes	
	Tel-Screw Products	MS/HT			M6 – M100	Yes	
	WLS Fastener Manufacturing Co. cc	MS				Yes	
Crimped Nuts	Bolt Fast					Yes	
	Impala Bolt & Nut	MS				Yes	
	Tel-Screw Products	MS			M8 – M48	Yes	
Flanged Crimped Nuts	Bolt Fast					Yes	
	Impala Bolt & Nut					Yes	
Locking Washers	Bolt Fast	MS			M6 – M52		
	WLS Fastener Manufacturing Co. cc					Yes	
Nyloc Nuts	Most suppliers	Most smaller size Nyloc nuts are imported and are only available as electroplated					
	Bolt Fast	Gr: 8					
	Impala Bolt & Nut		DIN 985				Yes
Cleeve Lock Nuts	Bolt Fast	Gr: 8			M6 – M30		
Prevailing Torque Hex Lock Nuts	Bolt Fast					Yes	
	Tel-Screw Products	Gr: 8 & 10	DIN 980V			Yes	
NORMAL NUTS							
Hex OS Nuts	Bolt Fast	MS/Gr: 8 & 10			M6 – M64		Yes
	CBC Fasteners	Gr: 8	DIN 934	ISO 4032	M6 – M30	Yes	Yes
	Impala Bolt & Nut	Gr: 8	DIN 934		M8 – M30		Yes
	Tel-Screw Products	Gr: 8,10 & 12	DIN 934		M16 – M36	Yes	
	Tel-Screw Products – HS Friction Grip	Gr: 8 & 10	DIN 6915		M8 – M64	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS/HT			M8 – M64		Yes
Hex Long OS Nuts	Bolt Fast	MS			M6 – M20	Yes	
	Rawlplug South Africa	MS			M6 – M16	Yes	
	Tel-Screw Products	MS/HT	TSP		M8 – M48	Yes	
	WLS Fastener Manufacturing Co. cc	MS			M8 – M36		Yes
Shear Nuts or Anti-vandal Nuts	Bolt Fast	MS			M6 – M20	Yes	
	Impala Bolt & Nut	MS					Yes
	Rawlplug South Africa	MS			M8 – M16	Yes	Yes
	Tel-Screw Products	MS/HT			M8 – M48	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS			M8 – M24	Yes	
Flanged Nuts	Bolt Fast	MS			M6 – M10	Yes	
	Tel-Screw Products	HT/MS			M8 – M36		
	WLS Fastener Manufacturing Co. cc	MS			M8 – M16		Yes
WASHERS							
Thru Hardened Washers	Bolt Fast	Gr: 8			M6 – M48	Yes	
	Tel-Screw Products		DIN 6916		M10 – M64	Yes	
	WLS Fastener Manufacturing Co. cc	MS			M8 – M36		Yes
Flat Washers	Bolt Fast	MS			M6 – M64		Yes
	Impala Bolt & Nut		DIN 120/125		M8 – M30		Yes
	Tel-Screw Products	MS	DIN 120/125		M8 – M76		Yes
	WLS Fastener Manufacturing Co. cc	MS			M8 – M76		Yes
Square Flat Washers	Bolt Fast	MS			M12	Yes	
	Tel-Screw Products	Specially manufactured to order			M6 – M76	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS			M8 – M30		Yes
Square Curved Washers	Bolt Fast					Yes	
	Tel-Screw Products	Specially manufactured to order			M6 – M76	Yes	Yes
Spring Washers	Bolt Fast	MS			M6 – M52		Yes
	Impala Bolt & Nut		DIN 127		M8 – M30		Yes
	Tel-Screw Products		DIN 127		M8 – M64		Yes
	WLS Fastener Manufacturing Co. cc				M8 – M36		Yes

continued on page 8...

Impala Bolt & Nut S.A. (Pty) Limited is a manufacturer of mild steel and hi-tensile bolts and nuts, ranging from M6 right up to M30 in diameter.

We have established ourselves over the years as a reliable and quality conscious manufacturer who strives for customer satisfaction with every order.
We specialise in hot dip galvanized bolts and nuts and have a very large stockholding of these items.

Impala Bolt also has a specialised fastener division which manufactures for the motor industry and any specials that you, the client, might have.
We are available at any time to be of assistance and offer sound advice as to what product best suits your application.

All items manufactured are also available in zinc plated / hot dipped / CAD and trivalent coating as per the motor industry standards.

Our dedicated sales team will gladly assist you with all your requirements.

IMPALA BOLT & NUT S.A. (PTY) LIMITED

Manufacturers of Industrial Fasteners

48 Nagington Road, Wadeville, Germiston
P.O. Box 14766 Wadeville 1422
Tel.: (011) 824-3925 • Fax: (011) 824-3803

TYPE OF FASTENER	COMPANY	STEEL GRADE	SPECIFICATION	SPECIFICATION	AVAILABLE SIZES	HOT DIP GALVANIZED TO ORDER	HOT DIP GALVANIZED EX STOCK
BOLTS AND SCREWS							
Hex Head Screws	Bolt Fast	MS/Gr: 8 & 10			M6 – M42		Yes
	CBC Fasteners	MS	DIN 933	ISO 4017	M18 – M30	Yes	Yes
	CBC Fasteners	Gr: 8.8	DIN 933	ISO 4017	M8 – M30	Yes	Yes
	Impala Bolt & Nut	MS	DIN 658		M8 – M24		Yes
	Impala Bolt & Nut	Gr: 8.8	DIN 933		M8 – M30		Yes
	Rawlplug South Africa	MS	DIN 933		M6 – M12	Yes	
	Tel-Screw Products	Gr: 8.8/MS			M6 – M39	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS/HT			M8 – M36		Yes
Hex Head Bolts and OS Nuts	Bolt Fast	MS			M6 – M36		Yes
	CBC Fasteners	MS	DIN 601	SABS 135	M8 – M30	Yes	Yes
	Impala Bolt & Nut	MS			M8 – M30	Yes	
	Tel-Screw Products	MS/HT	DIN 601	Lay – 520	M8 – M39	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS			M8 – M36		Yes
Hex Head Bolts and OS Nuts (High tensile)	Bolt Fast	MS/Gr: 8 & 10			M6 – M52		Yes
	CBC Fasteners	Gr: 8.8	DIN 931	ISO 4014	M8 – M30	Yes	Yes
	Impala Bolt & Nut	Gr: 8.8	DIN 931		M8 – M30		Yes
	Tel-Screw Products	Gr: 8.8/MS	DIN 931		M8 – M56	Yes	Yes
	WLS Fastener Manufacturing Co. cc	HT			M8 – M36		Yes
Large Dia Bolts & OS Nuts	Bolt Fast	Gr: 8			M30 – M76	Yes	
	Tel-Screw Products	Gr: MS/8.8			M36 – M76	Yes	
	WLS Fastener Manufacturing Co. cc	MS/HT			M39 – M76	Yes	
Cup Head Square Neck Bolts & OS Nuts	Bolt Fast	MS			M6 – M30	Yes	
	CBC Fasteners	MS	SABS 1143		M8 – M20	Yes	Selected
	Impala Bolt & Nut	MS	DIN 603		M8 – M16	Yes	
	Rawlplug South Africa	MS	DIN 603		M8 – M12	Yes	
	Tel-Screw Products	MS	SABS1143 / DIN 603		M8 – M30	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS			M8 – M20	Yes	
C/Sunk Square Neck Bolts & OS Nuts	Bolt Fast	MS			M10 – M24	Yes	
	CBC Fasteners	MS	SABS 1143		M10 – M20	Yes	
	Impala Bolt & Nut	MS	DIN 605		M10 – M16	Yes	
	Tel-Screw Products	MS/HT	SABS 1143		M8 – M30	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS			M10 – M20	Yes	
C/Sunk Nib Bolts & OS Nuts	Bolt Fast	MS			M10 – M24	Yes	
	CBC Fasteners	MS	SABS 1143		M12 – M24	Yes	
	Impala Bolt & Nut	MS	DIN 604		M10 – M20	Yes	
	Tel-Screw Products	MS	SABS 1143		M8 – M24	Yes	
	WLS Fastener Manufacturing Co. cc	MS			M12 – M24	Yes	
Friction Grip Bolts & Nuts	Bolt Fast	MS			M16 – M30	Yes	
	CBC Fasteners	Gr: 8.8S/10.9S	SABS 1282	ISO 7411	M12 – M30	Yes	
	S.A. Bolt Manufacturers	Gr: 8.8/10.9S			M12 – M30	Yes	
	Tel-Screw Products	MS/HT					
	WLS Fastener Manufacturing Co. cc	HT			M12 – M30	Yes	
Hex Socket C/Sunk Head Screws	Bolt Fast	MS			M6 – M39	Yes	
	S.A. Bolt Manufacturers	Gr: 10.9/12.9			M6 – M48	Yes	
	Tel-Screw Products	HT					
	WLS Fastener Manufacturing Co. cc	HT			M8 – M24	Yes	
Lockbolts	Avlock International (Pty) Ltd	Gr: 8.8	ASTM A325		5mm–28mm	Yes	
	Bolt Fast					Yes	
	S.A. Bolt Manufacturers Pins & Collars	Gr: 6.8/8.8			M12 – M24	Yes	
Pigtails – 1 & 1 1/2 Turn	Bascol (Pty) Ltd	MS/EN8			M8 – M12	Yes	Yes
	Bolt Fast					Yes	
	Tel-Screw Products	MS/SS/HT			M6 – M76	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS			M8 – M24	Yes	
3m – Threaded Rod	Bascol (Pty) Ltd	MS/EN8			M6 – M72	Yes	
	Bolt Fast	MS/Gr: 8			M6 – M30		Yes
	Impala Bolt & Nut	MS/HT	DIN 975		M8 – M24	Yes	
	Tel-Screw Products	MS/HT			M8 – M76	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS			M8 – M36		Yes
1m – Threaded Rod	Bascol (Pty) Ltd	MS/EN8			M6 – M72	Yes	Yes
	Bolt Fast	MS/Gr: 8 & 10			M6 – M52		Yes
	Impala Bolt & Nut	MS/HT	DIN 975		M8 – M24	Yes	
	Rawlplug South Africa	HT			M6 –M30	Yes	
	Tel-Screw Products	MS/HT			M8 – M36	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS			M8 – M36		Yes

TYPE OF FASTENER	COMPANY	STEEL GRADE	SPECIFICATION	SPECIFICATION	AVAILABLE SIZES	HOT DIP GALVANIZED TO ORDER	HOT DIP GALVANIZED EX STOCK
BOLTS AND SCREWS continued							
HD Bolts (Foundation Bolts) & OS Nuts	Bascol (Pty) Ltd	MS/EN8			M6 – M72	Yes	Yes
	Bolt Fast	MS/EN8			M6 – M72		Yes
	Rawlplug South Africa	MS/HT			M8 – M36	Yes	
	Tel-Screw Products	MS/HT			M8 – M72	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS			M8 – M72	Yes	
CONCRETE ANCHOR BOLTS							
Rawlbolts	Bolt Fast	MS			M6 – M24		
	Rawlplug South Africa	5.8	BBA	All International	M6 – M24	Yes	
SPT Construction Anchors	Bolt Fast				Various		
	Rawlplug South Africa		EU	All International	M6 – M24	Yes	
R-KEM Chemical Bolts	Bolt Fast				Various		
	Rawlplug South Africa	5.8/HT	BBA		M8 – M30	Yes	Yes
R-KEX Chemical Bolts	Bolt Fast				Various		
	Rawlplug South Africa	5.8/HT	BBA		M8 – M30	Yes	Yes
R-CAS Chemical Bolts	Bolt Fast				Various		
	Rawlplug South Africa	5.8/HT	BBA		M8 – M30	Yes	Yes
R-HAC Chemical Bolts	Bolt Fast				Various		
	Rawlplug South Africa	5.8/HT	BBA		M8 – M30	Yes	Yes
Express Anchor Bolts	Bolt Fast						
	Rawlplug South Africa				M6 – M24	Yes	Yes
Chemical Anchors & Threaded Studs	Bascol (Pty) Ltd	MS/EN8			M6 – M72	Yes	Yes
	Bolt Fast				Various		
	Rawlplug South Africa	MS/HT			M8 – M30	Yes	Yes
	Tel-Screw Products	MS/HT			M8 – M36	Yes	Yes
	Tel-Screw Products	MS/HT			M16 – M76	Yes	
	WLS Fastener Manufacturing Co. cc	EN8			M8 – M30	Yes	Yes

continued on page 10...

TYPE OF FASTENER	COMPANY	STEEL GRADE	SPECIFICATION	SPECIFICATION	AVAILABLE SIZES	HOT DIP GALVANIZED TO ORDER	HOT DIP GALVANIZED EX STOCK
CONCRETE ANCHOR BOLTS continued							
Kalm Chemical Anchor Bolt	Bolt Fast				Various		
	WLS Fastener Manufacturing Co. cc	EN8			M8 – M30	Yes	
Trugrip Anchor Bolt	WLS Fastener Manufacturing Co. cc	EN8			M10 – M30		Yes
Rawl Kemfix Chemical Anchor Studs – for use with all chemical anchoring (capsule and/or cartridge systems)	Bolt Fast				Various		
	Rawlplug South Africa	Gr: 5.8	Imported	Imported	M8 – M30 Various lengths		Yes
Through Bolts / Stud Anchors / Wedge Anchors	Bolt Fast				Various		
	Rawlplug South Africa	Gr: 5.8	Imported	Imported	M8 – M24 Various lengths		Yes
MISCELLANEOUS							
Self Drilling Screws	Bolt Fast	MS			Various		
	Rawlplug South Africa				Various	Yes	
	WLS Fastener Manufacturing Co. cc					Yes	
Cast-In Lifting Sockets	Bolt Fast	EN8			M8 – M36		
	Tel-Screw Products	EN8			M8 – M36		
	WLS Fastener Manufacturing Co. cc	EN8			M8 – M36	Yes	
SPECIAL FASTENERS							
Countersunk Machine Screws	Bolt Fast	MS			M6 – M24	Yes	
	Tel-Screw Products	MS/HT	DIN 963 & 965		M6 – M36	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS/HT			M8 – M36	Yes	
Round U-Bolts	Bascol (Pty) Ltd	MS			M8 – M36	Yes	Yes
	Bolt Fast	MS			M6 – M72	Yes	
	Tel-Screw Products	MS/HT			M8 – M76	Yes	Yes
	Tel-Screw Products	HT			M8 – M76	Yes	

TYPE OF FASTENER	COMPANY	STEEL GRADE	SPECIFICATION	SPECIFICATION	AVAILABLE SIZES	HOT DIP GALVANIZED TO ORDER	HOT DIP GALVANIZED EX STOCK
SPECIAL FASTENERS continued							
Square U-Bolts	Bolt Fast	MS			M8 – M76	Yes	
	Bascol (Pty) Ltd	MS			M8 – M48	Yes	
	Tel-Screw Products	MS/HT			M8 – M76	Yes	
	WLS Fastener Manufacturing Co. cc	MS/HT			M8 – M36	Yes	
TV U- Bolts	Bolt Fast	MS			M8 – M76	Yes	
	Bascol (Pty) Ltd	MS			M8 – M16	Yes	Yes
	Tel-Screw Products	MS/HT			M8 – M76	Yes	Yes
Hook Bolts	Bascol (Pty) Ltd	MS			M8 – M20	Yes	
	Bolt Fast	MS			M8 – M76	Yes	
	Rawlplug South Africa	MS			M6 – M12	Yes	
	Tel-Screw Products	MS/HT			M8 – M76	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS/HT			M8 – M76	Yes	
Channel Bolts	Bascol (Pty) Ltd	MS			M8 – M10	Yes	
	Bolt Fast	MS			M8 – M76	Yes	
	Tel-Screw Products	MS/HT			M8 – M76	Yes	
	WLS Fastener Manufacturing Co. cc	MS/HT			M8 – M76	Yes	
J-Bolts	Bascol (Pty) Ltd	MS			M8 – M36	Yes	
	Bolt Fast	MS			M8 – M76	Yes	
	Rawlplug South Africa	MS			M6 – M12	Yes	
	Tel-Screw Products	MS/HT			M8 – M76	Yes	
	WLS Fastener Manufacturing Co. cc	MS/HT			M8 – M76	Yes	
Eye-Bolts	Bascol (Pty) Ltd	MS			M8 – M16	Yes	
	Bolt Fast	MS			M6 – M42		
	Rawlplug South Africa	MS			M6 – M12	Yes	
	Tel-Screw Products	MS/HT			M8 – M76	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS			M6 – M76	Yes	

continued on page 12...

TYPE OF FASTENER	COMPANY	STEEL GRADE	SPECIFICATION	SPECIFICATION	AVAILABLE SIZES	HOT DIP GALVANIZED TO ORDER	HOT DIP GALVANIZED EX STOCK
SPECIAL FASTENERS continued							
Straining Eye-Bolts	Bascol (Pty) Ltd	MS			M8 – M16	Yes	
	Bolt Fast	MS			M8 – M76	Yes	
	Tel-Screw Products	MS/HT			M6 – M76	Yes	Yes
	WLS Fastener Manufacturing Co. cc	MS			M8 – M24	Yes	
Linked Eye Bolts	Bolt Fast	MS/HT			M6 – M76	Yes	
Linked Eye Nuts	Bolt Fast	MS/HT			M6 – M76	Yes	
	Rawlplug South Africa				M6 – M16	Yes	
Linked Eye Rods	Bolt Fast	MS/HT			M6 – M76	Yes	
	Tel-Screw Products	MS/HT			M8 – M76	Yes	
Forged Eyebolts	Bolt Fast	MS/HT			M6 – M30	Yes	
	Rawlplug South Africa				M6 – M16	Yes	
	Tel-Screw Products	MS/HT			M8 – M30	Yes	
Welded Eyebolts	Bolt Fast	MS			M8 – M16	Yes	
	Rawlplug South Africa	MS			M8 – M16	Yes	
Scaffold Rings	Bolt Fast	MS			M8 – M16	Yes	
	Rawlplug South Africa	MS			M8 – M16	Yes	
Threaded Studs	Bascol (Pty) Ltd	MS/EN8			M8 – M64	Yes	
	Bolt Fast	MS/EN8			M8 – M76	Yes	
	Rawlplug South Africa	MS/HT			M6 – M30	Yes	
	Tel-Screw Products	MS/HT			M8 – M76	Yes	
	WLS Fastener Manufacturing Co. cc	MS/HT			M8 – M76	Yes	Yes
Tie Rods	Bascol (Pty) Ltd	MS/EN8			M6 – M72	Yes	
	Bolt Fast	MS/EN8			M8 – M76	Yes	
	Tel-Screw Products	MS/HT			M8 – M76	Yes	
	WLS Fastener Manufacturing Co. cc	MS/HT			M8 – M76	Yes	

TYPE OF FASTENER	COMPANY	STEEL GRADE	SPECIFICATION	SPECIFICATION	AVAILABLE SIZES	HOT DIP GALVANIZED TO ORDER	HOT DIP GALVANIZED EX STOCK
SPECIAL FASTENERS continued							
Other specials	Bascol (Pty) Ltd	MS/EN8	Threading & bending to customers specification				
	Bolt Fast	Any special manufacturing					
	Rawlplug South Africa	Special application chemical and/or mechanical anchor bolts as required					
	Tel-Screw Products	Specials manufactured to order			M8 – M76	Yes	
	WLS Fastener Manufacturing Co. cc	MS/HT			M8 – M76	Yes	
Domed Head or Cap Nuts	Bolt Fast	NP			M6 – M76	Yes	
	Tel-Screw Products	MS/HT	DIN 1587		M6 – M76	Yes	
	WLS Fastener Manufacturing Co. cc	MS/HT			M8 – M36	Yes	
Hex Coach Screws	Bolt Fast	MS			M6 – M20	Yes	
	Rawlplug South Africa		DIN 7976		M5 – M12	Yes	
	Tel-Screw Products	MS	DIN 7976		M6 – M12	Yes	Yes

OS – Over Sized / MS – Mild Steel / HT – High Tensile

THE ABOVE MATRIX IS NOT NECESSARILY COMPREHENSIVE AND TOTALLY REPRESENTATIVE OF THE INDUSTRY BUT INCLUDES PARTICIPATING FASTENER MANUFACTURERS AND STOCKISTS.

PARTICIPATING FASTENER SUPPLIERS CONTACT DETAILS

COMPANY	TELEPHONE	EMAIL	WEBSITE
Avlock International (Pty) Ltd	011 917 2110	query@avlock.co.za	www.avlock.co.za
Bascol	011 493 8160	michael@bascol.net	www.bascol.co.za
Bolt Fast	021 505 1000	ShaunD@boltfast.co.za	www.boltfast.co.za
CBC Fasteners	011 955 4485	tech@cbc.co.za	www.cbc.co.za
Impala Bolt & Nut	011 824 3925	adiamond@impalasa.co.za	–
Rawlplug	011 894 7147	rmuller@infodoor.co.za	www.rawlplug.co.za
SA Bolt Manufacturers	011 814 2240	info@sabolt.co.za	www.sabolt.co.za
Tel-Screw Products (Pty) Ltd	011 898 3200	info@telscrew.co.za	www.telscrew.co.za
WLS Fasteners	011 882 1150	wlsandrew@telkomsa.net	www.kalm.de

Failure of High Tensile Fasteners (Grade 10.9)

NOTICE

Following a recent failing of certain hot dip galvanized grade 10.9 bolts, a meeting was attended by representatives of the bolt manufacturer's, a leading local steel fabricator, the SAISC and the Hot Dip Galvanizers Association. The meeting addressed a number of issues, and possible combination of reasons that may contribute to a high tensile bolt failure.

The meeting agreed that a review of current practice would be undertaken. Such review would include material specifications, manufacturing requirements, including heat treatment, and of course hot dip galvanizing controls when processing high strength fasteners.

Once this review process has been completed a formal technical review paper, on the subject, will be published and circulated as widely as possible.

Should you require further information on this, kindly contact the Association.

MISCONCEPTIONS

Miss Conception puts it "straight"

"Miss Conception" rectifies incorrect impressions concerning hot dip galvanizing.

Smooth and polished surfaces are a standard feature of all hot dip galvanized surfaces.

True or false?

The service life of hot dip galvanized steel, as a material of construction, is provided in two ways. Firstly, by a barrier protective layer of zinc carbonate ($ZnCO_3$) and secondly by cathodic protection, which we often refer to as sacrificial protection.

In the case of hot dip galvanizing steel, barrier protection is provided by a continuous protective film of a matt grey surface layer of zinc carbonate. The formation of this barrier protection ($ZnCO_3$) is dependent on the corrosion inducing substances present in a particular environment. The ultimate service life of a hot dip galvanized steel structure is a function of the zinc coating thickness and the environment in which it is required to operate.

Zinc is electronegative in relation to carbon steel, hence when it is in electrical contact with the steel substrate, it is sacrificed preferentially in the presence of an electrolyte, being atmospheric, water or soil. The steel remains protected even at smaller uncoated surfaces as long as the surrounding zinc coating is present. It is for this reason that zinc anodes are attached to the hulls of boats in order to provide cathodic protection.

Initially smooth, bright and shiny zinc surfaces are invariably associated with extremely thin coatings achieved, for example by zinc electroplating. Such coatings are however, inadequate and do not provide extended corrosion control in any but the mildest environments. The life of a zinc coating in a given environment is more or less proportional to its thickness, thus the thicker the coating, the longer the service life. In the case of continuously galvanized sheet, the coating is bright and smooth due to the production process used to galvanize and also the presence of a small quantity of aluminium which is added to the molten zinc in the galvanizing bath. The resultant zinc coatings applied by this process are also relatively thin with virtually no Fe/Zn alloys, which are present in a hot dip galvanized batch type coating.

As far as the initial bright shinny surface finish is concerned, this will inevitably disappear in time in all but the most benign environments. This is desirable in that the natural formation of a durable protective surface film of basic zinc carbonate provides extended protective life to the zinc coating, the overall dissolution of which is considerably less than that of a coating where no zinc carbonate surface film has formed.

While an aesthetically pleasing appearance is desirable, it must be borne in mind that the prime purpose of a hot dip galvanized coating is to provide corrosion protection for extended periods of time and to this end the zinc coating thickness is essential. At the same time, an extremely thin coating will provide limited cathodic protection (large cathode - steel and small anode - zinc).

A competent hot dip galvanizer will employ well trained inspectors who will be granted the authority to accept or reject steel that has been galvanized by the production department. The inspectors' responsibility is to ensure that the coating applied conforms to the requirements of the relevant specification. This includes coating thickness, coating continuity and coating adhesion to the underlying steel. The process of forming a hot dip galvanized coating is governed by metallurgical laws and depends on the steel components being thoroughly cleaned and fluxed before being immersed into molten zinc.

Fe/Zn alloys are produced which influence ultimate coating thickness and surface appearance. Steels containing reactive levels of silicon, phosphorous and to a much lesser degree carbon and manganese, provide thicker coatings with longer service lives providing more resistance to the ravages of corrosive attack. Normally such coatings do not display bright and shiny surface finishes since Fe / Zn alloy layers are predominant and dull grey in appearance. From a protection aspect, the thicker coatings are preferred provided that excessive brittleness does not result in coating damage during handling and the installation of structures. While the overall appearance of the coating is important, most important is its ability to withstand corrosion attack in a cost effective manner.

Therefore a surface finish of hot dip galvanized steel can be described as relatively smooth and certainly not polished.

FEATURES FOR 2009

May/June (No 39):
Tubes, pipes, scaffolding; Masts and poles; Water storage; Heat exchangers and cooling fans; Sustainability of the industry – including the regeneration of acid.

August/September (No. 40):
Awards; Cable ladders and trays.

November/December (No. 41):
Safety and security; Continuous sheet and wire galvanizing; The world of hot dip galvanizing around us.

NOTE: FEATURES MAY BE SUBJECT TO CHANGE

"Although understandably not always practical, minimizing galvanizing coating repair is a function of proper design and good fabrication techniques!"

There are many specifiers and steelwork fabricators who through the Association and/or its members have developed a good understanding of the process of hot dip galvanizing. This entails dipping a pre-cleaned fabricated steel component into a bath of molten zinc where a metallurgical reaction takes place producing a series of iron/zinc alloys, normally over coated with a layer of pure zinc. This dipping process ensures that all cleaned and accessible surfaces will react, leading to an impervious envelope that according to atmospheric corrosion conditions will provide a known predictable service life.

SANS 121 (ISO 1461), the general hot dip galvanizing specification does, for practicality allow coating repairs to be carried out, provided they are limited to a maximum single repair area of


Photo 1.


Photo 2.

continued on page 16...


Photo 3.


Photo 4.






Sliding and specialised joints eliminate or minimise the need for coating repairs.

10cm² with a total of 0.5% of the surface area. Both zinc metal spraying and zinc rich paint or epoxy are recommended as repair materials, however, even if they are applied correctly, the latter method of repair which may be seen as the most convenient, will not necessary provide the same life as the hot dip galvanizing.

If the area is not repaired, zinc will because of its nature, sacrifice itself in preference to the steel substrate and while some discoloration may take place at the post cut or welded area making the surrounding coating work a bit harder, *(see top photos on page 17)*. Should the area not be repaired, surface discoloration is possible but corrosion creep is impossible.

Many specifiers make use of this allowance in terms of the specification and/or the characteristic of zinc and still achieve cost effective service lives.

However, some specifiers pay more attention to their design and fabrication techniques so that areas of repair are significantly minimized or not necessary at all.
The following set of photos have been taken of handrails that fit this category of good design and fabrication, including sliding joints, site bolting, specialized sockets and no welding, eliminating the need for coating repair, with its differential colouring, etc. resulting in an aesthetically pleasing finish and a predictably long and maintenance free service life!


Specialised sockets eliminate or minimise the need for coating repair.

The Association would like to acknowledge the advertisers and thank them for their support

Zinc's second defense mechanism – cathodic or sacrificial protection!


Photo 1.


Photo 2.


Photo 3.

Hot dip galvanizing has two natural defense mechanisms, first, providing a slowly corroding barrier and second, sacrificial protection of the surrounding uncoated steel when the coating has been damaged or altered by cutting and/or welding. *Photos 1 - 3* show this defense mechanism on a handrail in excess of 10 years old that obviously was cut and welded and not repaired.

The screwed and socketed handrailing *(photo 4)*, a popular handrail configuration, is now discolouring at the threaded section. This may be because of excessive thread length and limited throwing power of the zinc coating.


Photo 4.


Photo 5.

Note: Most pipe manufacturers who hot dip galvanize their pipes according to SANS 32 (EN 10240) thread the pipes after hot dip galvanizing according to specifications such as BS 21:1985. This specification recommends a standard thread length in ratio with a standard internal socket thread length, thus accommodating the natural sacrificial protection of the zinc coating.

Photo 5 shows the effects of the collapse of a typical barrier coat (paint), leading to extensive under creep corrosion and rust formation.

Patterns and trends are more important than detail and data

Is your business chaotic? Is there disorder and apparent lack of control? Don't worry, this may not be a bad thing. Mathematicians and scientists are proving that chaotic systems usually have some underlying order in them. Very few systems are entirely random.

What is a chaotic system? It can be defined as a dynamic system which is too rich and varied for us to understand in simple mechanistic or linear ways. Chaotic systems are non-linear, i.e. a change in input will not necessarily produce a proportional change in output. Hi-fi owners are used to dealing with non-linear systems: an uncontrolled feedback to an amplifier will cause a severe distortion in the output signal. Non-linear systems are also exponential: a small change to the initial conditions can produce a massive change in the end result. Think of what the El Nino effect does: a change of 3-5 degrees in the temperature of the Pacific Ocean causes irregular turbulent weather conditions all over the globe!

Scientists, being scientists, go a bit further: they distinguish between chaotic systems and complicated systems. They define a chaotic system as one where neither the details of the system nor any general patterns or trends are discernible. In complicated systems, on the other hand, details may be understood but again no patterns. Just to confuse us even more, they define complex systems as being ones where patterns may be apparent, even though the details are unknown. Fortunately, chaos theory, as the study of seemingly unpredictable dynamic non-linear systems is called, can be applied to all three.

How can chaos theory be applied to business? Businesses are dynamic and non-linear systems. If there is any doubt, think of how unpredictably people interact and communicate with one another. Think too, how frustrated managers become when an increase in machine operators does not produce the expected proportional increase in production. The globalisation of markets; economic deregulation; the computing and communication revolution; and the increasing importance of green environmental issues is also causing non-linear turbulence in business environments. Many people believe that most businesses today are complex systems on the knife edge of chaos.

The sensitive dependence on initial conditions in chaotic systems implies that strategic planning may be a futile exercise, rather like the difficulty in accurately predicting weather. Instead of predicting the future, perhaps it would be better to adapt to the future as it evolves around us. We must be prepared to react to unexpected and unanticipated events. A competitive advantage will be gained by effectively adapting to novel and unpredictable situations faster than the competition. Chaos theory tells us to be adaptive rather than manipulative.

In nature, predators and prey must continuously co-evolve by adjusting to the adaptation of their opponents. Some species will reach a local optimum in their 'survival fitness' but each species must be able to adapt very rapidly if the environment changes in such a way as to make their behaviour sub-optimal. A change in the environment may cause an evolutionary spurt until a local optimum is again reached.

Chaos theory provides metaphors that can change the way managers think about problems they face. Instead of competing in a game or a war, they should be trying to find their way in an ever changing, ever turbulent landscape. The company's goals, who its competitors are and the course of action it wants to take are factors which will affect the shape of the landscape. The objective is to reach and climb a 'peak' and these peaks may be very different from the competitors'. Just as important is to get out of, and away from, any 'troughs' that will also form part of the landscape.

Chaos theory has allowed scientists to deal more confidently with non-linear dynamic systems, such as the effect of friction on a moving body, turbulence in fluids and biological growth. Now chaos theory invites managers to explore the 95% of the organisational world that has been avoided because it is too dark, murky and intimidating, e.g. the dynamic evolution of new technology and markets, the complex interaction of market forces and the dynamics and interaction of people.

By understanding chaos and complexity, managers can get an insight into how seemingly unpredictable situations can manifest themselves in predictable patterns. Managers can improve their decision making and their search for innovative solutions by looking at patterns rather than details.

The Association wishes to thank Bob Andrew who is a consulting value engineer and honourary member of the Association for his article. He can be contacted on anneve@iafrica.com or boband@mweb.co.za

Paint at your peril!

This paper published in Corrosion & Coatings in 1986, examines four extremely important application variables, namely ambient temperature, relative humidity, surface temperature and using the known ambient temperature and relative humidity, the dew point. The paper where applicable has been shortened for convenience purposes.

That the environmental conditions under which any paint is applied can exert a considerable influence on the performance of that paint, is a fact well known to everybody involved in specifying, manufacture, supply and application of anti-corrosion coatings.

The data sheets of any reputable coating supplier give guidance as to the limits of temperature and humidity, outside of which the material should not be used.

Unfortunately many anti-corrosion specifications are not written by knowledgeable specialists, but by workers in other disciplines. They may be excellent practioners in their own specialisations, but tend to regard anti-corrosion precautions as a nuisance. They seem to work on the assumption that the painter will know what to do when the time comes. But since the specification does not spell out the environment limits, the tender price is calculated without considering time.

When the work comes to be done there is nothing to say that "thou shalt not" apply paint under certain conditions. Therefore paint is applied when conditions are wrong and the penalty has to be paid in the form of job failures.

Everything that needs to be known on the subject of "paint and the environment" has to be said, and in one place or another been published.

This paper therefore does not set out to report research work or to present any new knowledge. Its sole object is to consolidate in one document what needs to be known about the effect of temperature and humidity upon the application of a protective paint coating.

What is the environment?

In its glossary of corrosion terms, NACE defines Environment as "The surroundings or conditions (physical, chemical or mechanical) in which a material exists". In the context of this paper this definition could be

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adopted to “The surroundings or conditions (physical or atmospheric) prevailing when the coating is applied”. This environment is not necessarily the same as that environment in which the fully cured coating will perform its protective function.

This operating environment is scope for a complete study in its own right.

While several atmospheric conditions must be considered before applying a coating, there are two major ones which need to be taken into account at this stage. These are the ambient temperature and relative humidity.

Along with these two parameters, two others need to be known. The latter are just as important as the former for obtaining good paint application.

The first is the surface temperature of the substrate being coated. Due to the fact that different materials have different specific heats, and therefore that two substrates in the same ambient temperature may have totally different surface temperatures, this parameter must be measured whatever temperature can exert an influence on a coating application.

The second is a number read from a table, using the ambient temperature and humidity as input, namely the dew point.

Ambient Temperature

Temperature affects the rate of all physical and chemical reactions. It influences viscosity, making a paint coating more difficult to apply when the temperature is low. It also influences drying times of coatings, since volatiles, whether solvents or water, evaporate faster when temperatures are high.

One of the most marked effects of temperature variation is on the performance of chemically cured materials such as epoxies. High temperature shortens pot life and speeds up the cure of the film. Low temperatures slows the reaction – at below 10°C it virtually ceases! Such situations produce their own problems, to be examined later in this paper.

Relative humidity

Just as water will dissolve up to a certain amount of given chemical at a given water temperature, and once having dissolved this maximum amount, known as the saturation level, will dissolve no more. So air at a given temperature, has the ability to contain a certain amount of water vapour or moisture. The mass of moisture held in a given volume of air is known as the absolute humidity.

The *relative humidity* is the actual amount of moisture in the air, expressed as a percentage of that amount of moisture that would be required to saturate the air, *at a given temperature*. Obviously if the actual amount of moisture held is the same as the amount that would be required to saturate the air at that temperature, then the relative humidity is 100%.

Given the situation that the moisture content of the air remains constant, then as temperature falls and the air is able to contain only a lesser quantity of moisture, some temperatures will be reached at which excess moisture starts to precipitate. This temperature is known as the dew point. This is highly relevant to the subject and will be dealt with in detail below.

Surface temperature

It is perfectly feasible for the surface temperature of a substrate to differ markedly from the ambient temperature in which it exists.

This is largely due to the ability of most substrates to absorb heat when exposed to a heat source, such as the sun. The colour of the substrate plays an important part since the darker its colour the more heat it will absorb.

Some actual case histories are of interest in comparing ambient and surface temperatures.

1. On a roof coating job the following temperatures were measured. The site was some 50km NW of Pretoria, the time 11h00 in late October. Exposure was full sunlight. Ambient temperature – 34°C. Galvanized (only) roof sheeting – 50°C. Factory coated (white) galvanized roof sheeting – 48°C. Galvanized (only) gutter – 50°C.
2. In mid-summer in the Karoo, galvanized roof sheeting temperatures, taken in the early afternoon have exceeded 75°C, when the ambient temperature was in the high 30’s.

Dew point

Dew point is defined as that temperature at which a mixture of air and water vapour is saturated with moisture and will deposit dew.

To be able to determine the dew point of prevailing conditions both *ambient temperature* and *relative humidity* need to be known. Given this input (methods of determination are described below) the dew point can be read directly from a table *(not included in this artice)*.

Where the input data is in the form of wet and dry bulb thermometer readings, the dew point can be read from hygrometric tables or from a psychrometric chart.

The important fact to remember is that while the dew point is calculated from the ambient temperature of the air, moisture will deposit as dew on any surface that is at, or cooler than, the dew point. Therefore the painter must know the surface temperature on which he is working, as well as the ambient temperature in which he is working.

In order to shorten the paper slightly, METHODS OF DETERMINING THE VARIOUS PARAMETERS, has been omitted.

Effects of the environment on coating application

Temperature

A good coating specification or a complete technical data sheet will cite two temperature figures that are very important during coating application.

These are the *minimum application temperature* and the *maximum application temperature*.

The effect of LOW temperature

Temperatures at or below the permissible minimum may:

1. Make the paint difficult to apply, because of its increasing viscosity.
2. Retard evaporation of volatiles, thus slowing up the drying rate. This can lead to solvent retention problems. Under these conditions it is essential to make sure that volatiles have in fact escaped from the film before applying a subsequent coat, otherwise the entrapment problem is compounded.
3. Slow the reaction rate between the components of a chemical cured coating, to a point where curing ceases.

Should the substrate have been exposed to very low night temperatures and remain shaded in the morning, it will certainly not have warmed to above the permitted minimum application temperature by the time site work normally commences. Good site control should opt for loss of production by delaying commencement of work until the substrate warms above the minimum.

The effect of HIGH temperature

Temperature at or above the permissible maximum may:

1. Lower the viscosity of the paint sufficiently to increase the incidence of runs.
2. Cause rapid evaporation of volatiles from the applied film or during atomisation in the spraying process. This may lead to poor wetting of the substrate with resulting adhesion problems.
3. Speed up the reaction rate between components of a chemically cured coating, making up for difficult handling because of reduced pot life.

Temperature: Its effect on chemically cured coatings

Extreme of temperature have undesirable effects on chemically cured coatings. The property must noticeably affected is the pot life. The pot life of a coating is defined as that time during which the material, after

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mixing, remains usable in the can. This definition applies to both solvent borne and solvent free twin packs.

It does not however apply directly to water borne epoxies. Here the stated pot life must never be exceeded. Epoxy emulsions have the shortcoming that because of the presence of the water carrier they appear useable. After the expiration of the stated pot life in the in-can reaction, has proceeded to a point where film coalescence on the substrate will be complete.

Temperature affects pot life and curing time by a factor of two, for every 10°C variation in temperature. Most data sheets publish these properties as determined at 25°C. If the temperature rises by 10°C the values will shorten to half the published figure. If the temperature falls by 10°C the values will double.

As an example: a material with a pot life of 60 minutes at 25°C will have a pot life of 30 minutes at 35°C and 2 hours at 15°C.

It must be noted that at 5°C the pot life will not be 4 hours but an indefinable time, due to the fact that the reaction will have virtually ceased when the temperature falls below about 10°C.

A similar effect occurs with curing time of the applied film. A factor of two per 10°C variation again applies. When the temperature falls below 10°C the curing reaction virtually ceases and the curing time becomes indefinably long. If a temperature rise occurs later, the reaction will resume and ultimately the material can reach a state of full cure.

Humidity

Just as the specification or data sheet limits the range of application temperatures, so too should a humidity limit be specified.

The effect of high humidity

1. Working in high humidity means that application is being carried out so close to dew point. A few degrees drop in surface temperature and dew formation occurs. The resulting moisture layer will upset adhesion. Specifications and data sheets lay down 85% as the maximum humidity at which coating may take place. However, at 80% RH dew point is within 3°C of ambient temperature. Thus work is still being carried out in the danger zone.
2. A drop in surface temperature is possible where painting is being done in conditions of fitful sun and shade. Sudden shading may be sufficient to lower the temperature sufficiently to allow moisture to deposit.
3. High humidity allied to low temperature will cause water based coating to dry slowly, since the evaporation rate will be low. On the other hand when allied to a high temperature, rapid evaporation of solvents can produce a cooling effect at the substrate, sufficient to cause moisture to condense on the still wet paint film. Surface blushing occurs and is noticeable on clear films.
4. High humidity will also allow a reaction of moisture with certain curing agents, such as primary amines, in chemically cured epoxy coatings. This reaction, known as bloom, if not detected and dealt with, can lead to intercoat delamination of a subsequent coat.
5. When humidity is high, air-lines should be regularly checked for condensation which may have escaped the moisture traps.

The effect of low humidity.

1. Low humidity cause problems with the curing of ethylene silicate zinc-rich coatings. During application under conditions of high humidity the coating absorbs moisture from the air and cures rapidly to a water soluble film. However, under conditions of low humidity, and more particularly if the temperature is high, hardening will be retarded and friable film will result. At a humidity below 40%, some manufacturer's data sheets recommend assisting cure by means of water spray.
2. One-pack urethanes which also rely on a reaction with atmospheric moisture will fail to cure fully under conditions of low humidity.
3. Low humidity coupled with high temperature may lead to a rapid loss of volatile from water based coatings. This will result in adhesion problems because of poor wetting of the substrate.

Other environmental conditions

The environmental conditions that have been examined so far, are those whose Extreme can be specified in terms of measurable numbers. Other conditions may be encountered which cannot be specified.

Rain, thunderstorm, frost and snow are really extensions of the parameters that have been discussed, but wind is a condition that cannot be turned into a number. The effect that wind can have on the application of paint cannot be assessed in terms of wind speed or its direction. A light breeze may do more damage on one site than half-a-gale, on another. It depends on the sites capacity for producing dust. If painting has to be carried out on site, dust rather than wind must be controlled, for a satisfactory result to be achieved.

Controlling the environment

Control of environmental conditions will only be achieved by site ingenuity. In the dust and wind example discussed above, tarpaulins rigged as a screen could be effective on one site whereas regular watering of the surroundings , possibly with the addition of a dust palliative to the water, may be effective on another. Trial and error is the way to solve this problem, with the ultimate solution being only to paint when the wind is not blowing. What such a solution would do to costs does not bear contemplation.

Controlling temperature and humidity problems during site application of protective coatings is not easy. One obvious answer is to coat in a controlled atmosphere shop instead of on site. This can be feasible, but there are fabrications that can only be coated on site, due to size or because the assembly requires welding followed by coating. Handling damage during transport of shop coated components is another hazard that must be faced.

Low temperatures can be raised by constructing covers and using space heaters. This approach would also help to obviate dew problems. These same covers can reduce high surface temperatures by shading the work area.

It is easy to see that controlling the environment is something that is simpler to talk about in theory than it is to achieve in practice.

Conclusion

This paper set out to examine those conditions of the environment that can affect the satisfactory application of a protective coating – ambient temperature, relative humidity, surface temperature and dew point temperature. It has shown how these parameters may affect the actual application of the coating as well as its performance during drying and curing. Various ways of measuring these parameters have been discussed. As stated in the introduction nothing new has been populated, but an attempt has been made to make information easily available in one document.

For the bibliography, as well as the section omitted on *Methods of Determining the Various Parameters*, contact the Association.

We wish to thank Peter Marples in association with the late Eric Duligal for allowing us to publish this paper.

Specification and application variables – not critical for successful hot dip galvanizing

In light of the possible problems relating to the application of paint, with respect to these four highlighted and important application variables discussed in the previous article, we present to you the reliability and simplicity of hot dip galvanizing where these variables and others of equal importance have no effect on successful hot dip galvanizing!

When choosing a rust prevention method for a steel component or structure, there are many technical issues to be addressed. The environment in which the steel component or structure is to work must be analysed carefully. The need for handling, transport, fabrication and final erection require careful consideration.

The reliability factor of a coating may be defined as the extent to which its physical, chemical and mechanical characteristics can be consistently realised during and after application.

The reliability factor determines the overall cost-effectiveness of a coating in an environment.

There are numerous paint systems for steel and a wide range of possible specification and application variables. These variables can substantially reduce the performance of a given system and therefore its economics. By contrast, the hot dip galvanizing process is simple, standardised and virtually self-controlling, governed mainly by the laws of metallurgy. As a result it is inherently reliable and predictable.

The table summarises some of the application conditions including temperature, humidity and air pollution, determining the reliability of a typical paint system for steel and for hot dip galvanizing.

The reliability factor for hot dip galvanizing is shown to be superior, mainly because it is not influenced by these and other variables which can reduce the ultimate performance of a typical paint system.

Factor	Paint System	Hot Dip Galvanizing
Application Conditions		
1. Temperature	Good results are difficult to obtain if the air temperature is below +10°C. Surfaces exposed to direct sunlight can easily become too hot.	Not affected by the air temperature or normal variations in the process temperature.
2. Humidity	Dew and surface condensation delay painting, which should not be carried out if relative humidity exceeds 80%.	Not affected.
3. Air pollution	Steam, fumes, gases, dust, wind and other pollutants have an adverse effect on the quality of the paint coating.	Not affected.

Extracted from "Steel Protection by Hot Dip Galvanizing and Duplex Systems", available from the Association.

On the couch with

Yvonne Onderweegs

I have to admit an addiction to décor magazines, which seldom satisfies a hot dip galvanizing fanatic like me, in terms of residential projects featuring the coating. However an unexpected gem revealed itself to me one Sunday afternoon in the pages of a leading South Africa décor magazine – a stunning beach house, situated in Boggomsbaai, with duplex coated sunscreens! The architect behind the design is *Yvonne Onderweegs of SLEE & Co*, based in Stellenbosch. Yvonne is one of two female architects at the company and laughs at my suggestion that a female architect is perhaps more practical than a male, saying: "I don't know about practical! Women are generally more sensitive to the 'small print' of people's needs. Residential architecture is so personal, it is always a design challenge to incorporate and respect the diverse aspirations, lifestyles and heritages of clients."

I got into this business unexpectedly! I was 15 years old, an exchange student to Germany when I visited the Energy Forum Building in Bad Oeynhausen, designed by Frank Gehry. I consciously experienced the relation between space, light and detailed construction for the first time – and I was completely fascinated by it.

True South African architecture to me is when designers and contractors acknowledge South Africa's natural envelope, embrace the people; knowing their skills, capabilities and improving craftsmanship, and show remembrance to historically significant built landscapes. Unfortunately this does not happen often.

I find inspiration in creative activities in different cultures that make people come alive! – anything from hand crafts, literature, culinary arts, to music and dance.

Our company SLEE specialises in high-end residential, holiday homes, lodges and selective commercial work that falls into our design philosophy.

Challenges a woman faces in this industry are to gain respect from all parties and to lead a project with authority. This one achieves by voicing design decisions with confidence and setting inter-relational boundaries.

The professional achievement that I am most proud of is most likely a project I'm currently busy with in Nature's Valley – purely for the wonderful synergy between client, site, design and execution. Another Slee & Co project that does me proud is the Stone House, in Mooikloof Pretoria. This project has won the 'Best Building in South Africa' voted by respondents in a recent on-line survey conducted by SAIA and VISI magazine and also an Award of Merit from SAIA.

Hot dip galvanizing to me means using galvanized steel at the coast, which is versatile, durable and low-maintenance – material qualities that fit into our design philosophy: being frugal in detailing and the application of building materials.

I use this coating often because we work in harsh coastal conditions where any sculptural extrusion requires strength of steel and resistance to corrosion.

A prime example of the application of hot dip galvanizing in one of my designs is the sunscreens at a holiday home in Boggomsbaai. Heat reflective glass and galvanized fish-bone beam structures protect the openings, allowing light and views of the skies into the spaces without the heat, their moving shadows the only reminder of time when relaxing here.

I choose to live in South Africa because this is honestly home! I value the country for how much it gives rather than what crime steals. I grew up in a home with strong European influence (Dutch parents) but my parents imparted to us a consciousness and appreciation for South Africa's dynamic complexity in culture and contrasting landscapes.

When I leave the office I go long distance race-walking to clear my head and keep me fit. I enjoy most of my evenings with family and friends – from relationships grow love, great wisdom, ability and expertise.

Also see www.slee.co.za

The Association wishes to thank Desere Strydom for this contribution.

The consistancy and uniformity of hot dip galvanizing versus zinc metal spraying or spray paint

Ensuring that hot dip galvanizing will stand up to its reputation for long term corrosion protection, Association staff will passionately pursue any opportunity to eliminate unnecessary misconceptions and disputes but at the same time highlight unacceptable coating quality.

As part of the Association's effort to educate and improve communication between end clients and the galvanizer, often via a number of contracting parties, the specifiers finish expectations and the manufacturer and galvanizer's commitment to the quality of the final product, etc. we include for your reading, this report by the Association.

The Hot Dip Galvanizers Association Southern Africa, Cape Town was requested to undertake the coating inspection of the zinc metal sprayed coating on 8 tubular toberone shaped trusses and one tubular centre piece for a swimming pool. The coating inspection took place at a galvanizer who is also a reputable zinc metal and paint spray applicator. The beams were inspected and re-inspected on 8, 23, 26 and 29 September respectively and again on 3 October. Unfortunately, due to travel commitments, the last two trusses were inspected by a third party. I report as follows:

Preamble

The specification originally called for hot dip galvanizing of the toberone trusses and accessories but owing to the finished component size being too large wrt the relative bath size, the component would have had to be triple dipped into molten zinc for optimum coating coverage. Triple dipping of a tubular item such as this would have been more costly when compared to normal galvanizing due to a longer processing time and extremely difficult with vent and drainage holes likely to have been incorrectly positioned, leading to

Photo 1: Toberone trusses 1, 2 & 3 were inspected on 8 September.

continued on page 26...

Photo 2: In order to minimise coating damage, only soft slings were used for loading/unloading for the duration of this project.

Photos 3 (left) and 4 (right) show the degree of difficulty in ensuring a uniform spread of zinc metal spraying to the specified coating thickness.

potential explosions, air pockets and reduced coating quality.

It was therefore, decided that all components that could fit the galvanizing bath would be hot dip galvanized and others such as the toberone shaped tubular trusses and centre connecting section be zinc metal sprayed.

A specification was compiled by the consulting engineers, requiring a minimum coating thickness of 100µm with a mean of 120µm but it was felt that this should be read in conjunction with SANS 2063 – Metallic and other inorganic coatings – Thermal spraying – Zinc, aluminium and their alloys.

Photo 5.

Photo 6.

SANS 2063 requires the following when taking coating thickness readings on components with a surface area of greater than 2m^2:

- All parties identify and agree on the areas where coatings are likely to be at their lowest and these areas be inspected for conformity.
- Take 10 readings evenly spread out over a surface area of 1dm^2 (10cm x 10cm) at these identified areas.

Photo 7.

Photo 8.

Photo 9.

Photo 10.

Due to the size and shape of the tubular toberone truss, the degree of spraying difficulty and as there was no identification in the specification as to where the required coating thickness was more important, it was decided to increase the required number of coating thickness readings to the following, in order to exceed specification conformity.

Take one reading approximately every 300 to 400mm along the length of each tube, with one line of readings approximately within each 90° quadrant of the tube. For this reason at one inspection, up to 652 readings on the tubular truss were taken.

General coating thickness readings for toberone trusses 1, 2 and 3 inspected 8 September

Owing to a misunderstanding at the galvanizer, coating inspection was only carried out after the zinc metal


Photo 11.


Photo 12.


Photo 13.

1st Toberone truss	Mean	Max	Min	No. of readings
Main tubes	187	283	80 #	64
Secondary tubes	144 #	269	68 #	84
Gusset plates	146 #	298	41 #	70
End plates	161 #	286	48 #	74
2nd & 3rd Toberone trusses	**Mean**	**Max**	**Min**	**No. of readings**
All tubes	170	345	67 #	188
All tubes	185	285	71 #	205

Table 1.

Photo 14.

spraying and first coat of paint (epoxy primer DFT 50µm) was completed.

Photos 5 and 6 show coating thickness readings (122 & 73µm) where the combined coating of zinc metal spraying plus epoxy primer was under thickness. A second coat of epoxy primer (at least 50µm DFT) was added to increase the final coating thickness and therefore align the overall coating thickness with that required in the specification.

Photos 7 - 10 show acceptable coating thickness readings i.e. 100 + 50µm. (255, 246, 217 and 203µm, respectively).

Coating defects and thin coatings

Photos 11 and 12 highlight scuff marks showing a coating thickness at the scuff marks of 192µm. *Photo 13* shows an edge coating thickness, all edges were re-stripe coated, *see Photo 14*.

Coating thickness readings for toberone trusses 1, 2 & 3 (Zinc metal spraying plus epoxy primer)

(See table 1)

Coating thickness with respect to zinc metal spraying is applicator dependent and not chemical reaction dependent such as hot dip galvanizing, so metal thickness has no real bearing on the resultant coating thickness. Therefore, coating thickness readings for the 2nd and 3rd toberone trusses in this instance were taken on all the tubes, irrespective of metal thickness.

All areas that were considered under coated i.e. less than 150µm, see # (Zinc metal spray 100 plus epoxy primer 50µm) were highlighted on the truss to be over coated with a further coating of an additional epoxy primer of 50µm DFT to ensure overall coating thickness conformity.

Re-inspection of general coating thickness of toberone trusses 1,2 & 3 inspected 23 September

Photos 15 and 16 show a general view of two of the toberone trusses. Owing to excessive demand on the spray painting facility the trusses had to be temporarily moved to limit potential coating damage. *Photo 17* shows the third truss still in the spray painting shop.

Other than some surface scuff marks found on two of the trusses (*photos 18 and 19*), the overall coating thickness of toberone trusses 1, 2 & 3 conformed with the specification and were acceptable.

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Photo 15.


Photo 16.


Photo 17.


Photo 18.


Photo 19.


Photo 20.

Photo 21.

Photo 22.

General coating thickness readings for toberone 4, 5 & 6

(See photos 20 - 22) The trusses in *photos 21 and 22* were incorrectly marked as 2 and 3 and should have been 5 and 6.

Coating defects and thin coatings

Photos 23 - 25 show highlighted areas that were under coated.

Coating thickness readings for toberone trusses 4, 5 and 6, taken 23 September (first inspection) – (Zinc metal spraying only)

(See table 2)

All areas that were considered under coated i.e. less than 100µm, see #1 (Zinc metal spray 100µm minimum) were highlighted to be over coated with additional zinc metal spraying to achieve the specified coating thickness.

Coating thickness readings for toberone trusses 4, 5 and 6, taken 26 September – second inspection (zinc metal spraying only)

(See table 3)

8 undercoated spots were identified and marked.

Coating thickness readings for toberone trusses 4 and 5, taken 29 September – third inspection (zinc metal spraying only).

(See table 4)

Four undercoated spots were identified and marked on the 4th toberone truss and two undercoated spots were identified and marked on the 5th toberone truss.

Toberone trusses 7, 8 and centre connecting piece

Owing to my absence due to a business trip following the initial coating inspection of the centre piece on Friday 3 October, trusses 7 and 8 were inspected and reported by another

4th Toberone truss	Mean	Max	Min	No. of readings
Main tubes	97	223	37 #1	197
Secondary tubes	115	224	52 #1	161
Tertiary tubes	126	230	63 #1	33
Gusset & end plates	106	302	21 #1	159
5th Toberone truss	**Mean**	**Max**	**Min**	**No. of readings**
Main tubes	123	300	41 #1	261
Secondary tubes	133	280	50 #1	213
Tertiary tubes	168	269	72 #1	47
Gusset & end plates	143	319	45 #1	131
6th Toberone truss	**Mean**	**Max**	**Min**	**No. of readings**
Main tubes	122	340	31 #1	393
Secondary tubes	105	345	37 #1	260
Tertiary tubes	171	319	96	34
Gusset & end plates	162	387	23 #1	103

Table 2.


Photo 23.


Photo 24.


Photo 25.

party. See table 5 for initial coating thickness readings on the centre piece.

Photos 26 and 27 show the centre toberone truss connection piece at the initial coating inspection carried out on Friday 3 October.

Coating defects and undercoated areas

Photos 28 - 31 show undercoated areas, coating thickness achieved (208µm) and a further highlighted undercoated area (72µm).


Photo 26.


Photo 27.

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General comments

In addition to our fact sheet on the difference between zinc metal spraying and hot dip galvanizing, a copy of which is available from our web site *www.hdgasa.org.za* there is one further extremely important difference, that became evident to me during the coating inspection period.

This factor should be taken into account every time, before repeating the above exercise. The factor is also applicable to painting by spraying or brushing.

The factor is obviously coating thickness assurance and consistency.

In spite of the difficulty of hot dip galvanizing big and awkward shapes, leading to multiple dipping and higher costs, the assurance and consistency of a metallurgically applied coating versus the possible inconsistency of a mechanically applied coating such as zinc metal spraying or painting, is considerable.

To overcome double or triple dipping it is recommended that the hot dip galvanizing method applied to the Athlone Stadium Roof supporting arch, where the individual tubes were prepared for welding, masked with "Galvastop" and then hot dip galvanized before welding took place. The fully welded up sections were then zinc metal sprayed and painted to finalise the coating of the structure.

Hot dip galvanizing ensures that due to the metallurgical reaction that takes place between molten zinc and hot steel, that assurance and consistency of the coating thickness is easy to achieve and can be easily monitored by taking a few coating thickness readings on each of the different metal thicknesses.

Where in comparison, to achieve a consistent zinc metal or paint sprayed coating, takes a number of inspections and many coating thickness readings, if coating success is to be met.

Terry Smith

4th Toberone truss	Mean	Max	Min	No. of readings
Main tubes	167	371	69 #1	121
Secondary tubes	126	217	52 #1	167
Tertiary tubes	142	360	75 #1	37
Gusset & end plates	191	345	43 #1	80
5th Toberone truss	**Mean**	**Max**	**Min**	**No. of readings**
Main tubes	175	352	85 #1	133
Secondary tubes	133	236	72 #1	179
Tertiary tubes	151	254	87 #1	43
Gusset & end plates	197	316	63 #1	73
6th Toberone truss	**Mean**	**Max**	**Min**	**No. of readings**
All tubes	185	470	83 #1	558

Table 3.

4th Toberone truss	Mean	Max	Min	No. of readings
All tubes	211	454	87#	482
5th Toberone truss	**Mean**	**Max**	**Min**	**No. of readings**
All tubes	239	487	86#	334

Table 4.

Centre piece	Mean	Max	Min	No. of readings
All tubes	147	345	27 #	363

Table 5.

Photo 28.

Photo 29.

Photo 30.

Photo 31.

Zinc rich coatings for repair purposes

Introduction

Three zinc-filled paints, whose envisaged application was as a primer base coat and/or as a repair coating in instances where galvanized or similar applied coatings had been locally damaged were submitted for evaluation. For purposes of this comparative evaluation, localised damages to a galvanized skin due to welding were considered. The coatings were identified as:

(1) Galvo Bond (manufactured by Sprayflo) zinc-based, containing aluminium

(2) Cramolin Zink (imported ex Germany) zinc-based

(3) Trowelable, zinc containing, two-part resin system (supplied by Sprayflo).

Sample preparation

The sample batch consisted of a quantity of 150 x 150mm panels, 2mm thick that were hot dip galvanized. The one long edge of each panel was roughly chamfered. Two samples each per applied coating were prepared.

Welding of the panels was undertaken using the shielded arc process (SAW) using the commonly available ER7024 filler material. The rods were 2.5mm diameter and the welding settings were 110 amperes at 30 volts (DC+). Outgassing of the zinc resulted in numerous pore sites and craters within the weld bead. The slag coating was chipped away and the weld bead brushed to remove traces of slag from localised pinhole defects. Final degreasing employed a water-30% methanol mixture.

Two of the candidate coatings were supplied in aerosol packages with the third as a two-part trowelable medium. Spray application observed the peculiar instructions offered on the individual cans. Four coats were applied each sprayed at 45° orientation to the panel and each run progressively orientated at 90° to the longitudinal axis of the weldments. The spray speed was 30mm/s and the start/stop position was off the sample. No delay or partial dry period was permitted between spray passes to prevent layering effects within the coating. The trowelable medium was mixed in the provided ratio and brushed over the weldments.

Evaluation

The coated samples were rested for twenty-fours at ambient temperature (22°C) and humidity (62%) prior to salt spray evaluation. The salt spray evaluation was carried out in accordance with the ASTM B117:03 specification. The total duration of exposure was 42 days, (1008 hours). Details of the average fog exposure conditions were:

Salt:	*reagent grade NaCl*
Water:	*Rand Water Board*
Solution Concentration:	*5% NaCl*
Test Temperature:	*35-36°C*
Fog Volume:	*1.84 millilitres per hour (for 80 cm^2 collection area)*
Solution pH:	*7.0*
Solution SG:	*1.028*

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Figure 1: Coated samples prior to evaluation.

Results

A record of the sample condition prior to (*figure 1*), during (*figure 2*) and following the exposure period (*figure 3*) was made.

It was noted that the zinc-aluminium spray-applied coating collapsed after 317 hours of fog exposure, with red rust appearing within the coated zone. At the termination of the test period, both sample panels had extensive red rust damages. White rust was noted on the parent panels. No similar white (or black) rust formation was noted on the coated regions.

The imported spray applied zinc coating survived for 688 hours before red rust damages were evident within the repair zone. At the termination of the exposure, only one sample had an isolated instance of red rust damage. No white rust formation preceded the red rust appearance.

The trowelable coating did not deteriorate during the exposure period.

Comments

The inclusion of aluminium into the formulation of the Galvo Bond product provided a better colour match to the bright zinc of a newly galvanized surface. The Cramolin Zink product offered a flat dark grey appearance that would better colour matched to weathered and/or reactive galvanized coatings.

The Cramolin Zink offered a better wet film build behaviour than the Galvo Bond. Neither however, matched the trowelable method of application in this regard.

The appearance of red rust on the three affected samples would have taken place at holiday sites within the coating where the steel substrate – burnt of any galvanized zinc by the localised heat of the arc welding – was exposed. This exposure can be ascribed to failure of the spray-applied coatings to fully cover the weld bead surfaces and thus leave some occluded areas susceptible to corrosion attack. The heavier coating applied in the instance of the Cramolin Zink product, relative to the Galvo Bond, would result in fewer exposed substrate surface sites available for attack.

In all instances, none of the coatings demonstrated any prior white corrosion damages, whilst the parent galvanized surfaces developed a heavy white rust layer with no red rust on these zinc coated parent surfaces. The absence of such white rust products on the coatings would intimate that although the coatings contain zinc-based pigments, these organo-zinc or metallic zinc components were not physically exposed to the salt-rich fog. The zinc component has been effectively encapsulated within the resin matrix of the paint medium and permeation and diffusion of moisture and ionic species through the resin base was not effected during the exposure period. In particular, the two-part trowelable medium would offer substantial advantages over the solvent-based spray coatings in terms of resin matrix stability.

With the absence of prior white rust formation in the vicinity of the red rust damage sites, the macroscopic sacrificial protection of the zinc (that contained within the coating) offered to the steel substrate to which it was in intimate contact, did not evolve. To wit, no electrochemical or galvanic degradation of the zinc contained within the coatings was evident.

In the instance of the spray-applied films, the zinc pigment is inherently applied with a film of encapsulating resin that effectively insulates it from the steel substrate and any adjacent zinc ‘particle’. Shrinkage of the resin due to cross linking and solvent loss is likely to expose the zinc component and thus bring about the necessary intimate contact required to produce the galvanic coupling behaviour. In this regard, thick wet films have prolonged evaporation and slower cross-linking rates and thus the inter-particle separation between zinc and at the zinc-substrate interface is enhanced. Thin film application (single pass spraying) will increase the likelihood of galvanic coupling of the pigment component due to rapid volatility and perforation of the resin film.

Thin film application is readily realised on flat featureless surfaces. In instances where multi-angle surfaces

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Figure 2: Coated samples after 744 hours (31 days).

occur – such as the weld beads – shadow zones will arise, necessitating multi pass applications of the coating.

The instructions provided with the Galvo Bond product required a spray application separation distance of 50 - 80mm and that of the Cramolin Zink, 300mm. Considering the spray cone base diameters at these distances, the former product offers tighter coverage control whilst the latter is better suited to large area coverage. Coating thicknesses have to be continuously adjudged, taking the residual can internal pressure, nozzle velocity and pass traverse speed into consideration.

The two-part trowelable coating employs resins that cross-link via chemical catalysis. Contamination of the resin matrix via residual traces of the carrier solvent is eliminated and the matrix is – generally – stable in respect of latent moisture diffusion. Furthermore, the manual brush application of the coating ensures that the wet film thickness is substantially greater than that which could be practically realised via the spray

Figure 3: Coated samples after 1 008 hours (42 days).

application method. The latter aspect inherently increases the path length required for aggressive species to penetrate through to the substrate. Under these peculiar conditions, the inclusion of sacrificial zinc compounds into the resin matrix might be considered to be principally beneficial in terms of a filler or extender with the corrosion aspect being of a secondary role. The resin film also offers superior scratch and abrasion tolerance, specifically in terms of the relatively thicker coating layer. The ability to locally control the coating thickness by manner of the method of application offers additional aesthetic qualities that are not detrimental to the performance of the coating. The pinholes and unsightly blemishes associated with poor quality weldments can be improved. This practice however, should only be considered on non-critical weldments that have no structural or strength requirements.

The resin contraction that occurs during the polymerisation reaction is reduced relative to those coatings that have volume loss due to solvent volatility. Consequently, the zinc-based pigment becomes tightly encapsulated and the likelihood of any galvanic contact between the coating zinc component and the substrate becomes increasingly remote.

Conclusions

Of the two spray applied coatings, it was found that red rust damages occurred on the Galvo Bond protected panels prior to that of the Cramolin Zink coated panels. Neither of the spray-applied coatings could match the performance of the two-part troweled coating for the month-long exposure salt fog exposure period.

No white rust was evident upon or through any of the coatings, although the adjacent galvanized parent panel coatings had extensive white rust formation.

The specific and localised nature of the red rust damages that had occurred indicated that the corrosion attack had taken place at locations associated with sites that had not received sufficient coverage owing to their peculiar geometry. This also implied that the zinc contained within the applied films had not offered any macroscopic sacrificial benefit to the substrate.

The noted failure of the coatings to invoke either white rust formation or effect sacrificial galvanic protection, should be viewed in terms of the satisfactory behaviour of the resins employed in these products, rather than as influenced by the nature and content of the zinc additions.

Recommendations

It would be unfair to compare and rate the products superior/inferior to one another. The information provided by each manufacturer infers to the nature of their intended application.

The Cramolin Zink product is intended for area coverage and is marketed as a primer. Its role as a zinc film touch-up medium can be incorporated into that description. In the latter role, its dark colouration favours its use with reactive galvanized zinc coatings or weathered zinc surfaces.

The Galvo Bond product is marketed as a touch-up medium for galvanized coatings with the large area (primer) role not being specifically advanced. The inclusion of aluminium into the formulation results in preferred colour matching to newly galvanized and bright zinc coatings

Considering the performance of the coatings upon the weld repair, it is recommended that the weldments be mechanically dressed in order minimise the risk of coating holidays stemming from weld bead geometry features.

RS Thompson, Physmet

Evaluation of roof sheet discolouration

"Wamosha" which in Zulu means inappropriate use, misuse or messing about, has replaced the words, "Galvanizing Failures". This column will feature articles where we find hot dip galvanizing or where other zinc coatings that are often inappropriately specified when general hot dip galvanizing is preferred, have been inappropriately used.


Photo shows discoloration of the galvanized sheeting immediately below the polymer roof sheeting.

A sample section of discoloured polymer roof sheeting (*figure 1*) was submitted for assessment. It was reported that the section had been installed into an application in Bloemfontein. The discolouration was reportedly associated with rust stains emanating from the galvanized hold down fasteners.

By examination of the section it was revealed that the roofing tile had been manufactured by laying down a layer of resin into which chopped glass fibres had been embedded. The fibres were noticed to be loose and were readily frayed from the resin layer. The smooth resin rich surface of the sample was contaminated with iron hydroxide (red rust). Numerous 'crazy cracks' were evident (*figure 2*). Infra red analysis of the resin indicated that it was a polyester. A sample section of roofing material was immersed in distilled water for 220 hours (nine days). The pH level of the distilled water volume with the immersed sample therein was monitored, along with the pH of a similar volume of the same distilled water batch (control sample). The pH level on the distilled water volume with the immersed panel section was noticed to progressively reduce over the course of the exposure period (*graph 1*).

In the manufacture of the resin, various anhydrides, polybasic acids, glycols and styrene are produced by reaction processes from benzene, propylene and ethylene, which the resin manufacturer 'mixes' together and 'cooks' in reactor vessels. The 'cooking' process is stopped short before full hardening is achieved and the mix is then thinned with styrene. Manufacturers will vary the ratios and make additions to suit peculiar requirements. In the pre-polymerised condition, accelerators (napthanates) and catalysts (methyl ethyl ketone peroxide - MEKP) will need to be added to take the polymerisation reaction to completion. Polyester has the ability to absorb moisture, which in the partially cured state will react with the acid components within the resin and subsequently leach out. This partially accounts for the observed inability of the glass strands to be satisfactorily bound into the resin as well as the reduction in the pH level upon sustained immersion in a closed volume of neutral fluid.

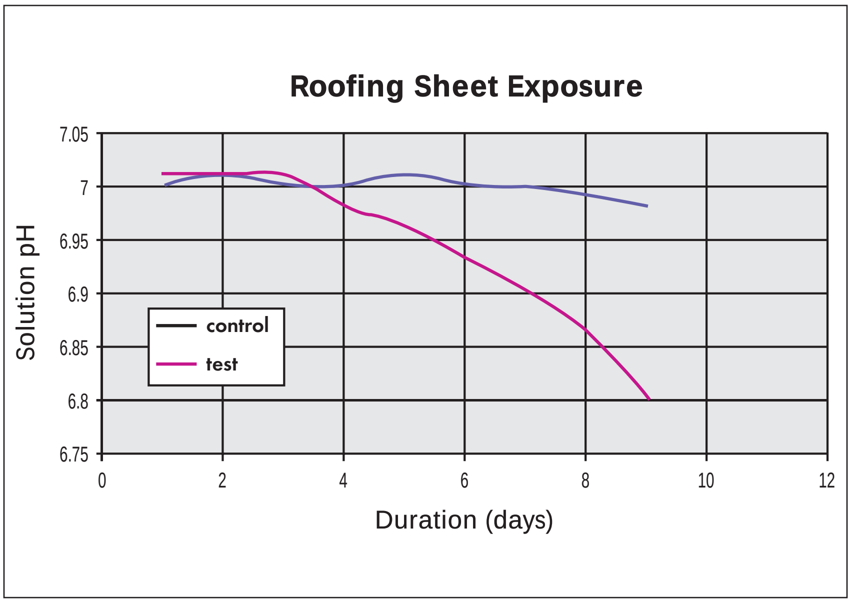
With the roof sheeting being installed and having galvanized fasteners passing through the resin, the slow release of acidified


Figure 1: Glass reinforced polymer roofing section as received.


Figure 2: Rust stains on the resin face (left) with the chopped glass strands on the reverse face.

moisture from the resin will, within the confined volume beneath the screw head, produce local attack to the zinc film. The anodic line at the sheet-screw interface will be narrow and the resultant high corrosion current density will result in rapid consumption of the zinc, as well as further attack to the steel screw substrate material. The latter attack generates the iron hydroxide that gets washed down the roofing gradient by conventional rainwater flow and gives rise to the reported staining effect.

There are numerous variables that interact with one another during the manufacture of the resin. Raw ingredient ratios, pre-polymerisation temperatures and durations all interplay with one another to result in a resin – available for manufacture – at varying possible degrees of cure.



Graph 1.

Furthermore, storage times and conditions of the bulk resin also have an influential role upon the final behaviour of the resin during manufacture of the sheets.

The roofing panels are essentially a glass fibre covering, with the resin component carrying out the function of holding the fibres

continued on page 38...

together in a thin sheet form whilst simultaneously offering a smooth water resistant surface. The fibre disbondment was an indication that the manufacture of the roofing panels had not been adequately controlled with insufficient 'wetting out' of the fibres, in addition to the aforementioned cure state of the resin.

The polyester family of resins are noted for their low ductility and the cracking experienced is a manifestation of this inherent behaviour. Due to thermal expansion of the sheets and constraint imposed upon the panels by the holding fasteners, cracking might be anticipated. The cracking would again, be enhanced by the resin condition.

In summary, the apparent state of the roofing panels suggests that their manufacture has not been optimal. This has resulted in fibre loss, corrosion attack to the holding fasteners and cracking damages. The likely cause of the noted deterioration might be linked to the state of the resin employed and the methods employed during manufacture (failure to fully wet out the fibre component).

The state of this roof should be subjected to continuous monitoring from both functional, as well as structural aspects. The short-term removal of the red rust stain might be addressed by treating with a diammonium citrate solution (which does not attack steel) or a proprietary cleaner. However, the steel substrate on the fasteners has been exposed and the stain is likely to return. Sealing off the fasteners by using a flexible penetrating sealer might also offer some temporary relief. In essence though, the current roofing system below the polymer roof sheet has failed and consideration should be given to its replacement.

RS Thompson, Physmet

NOW WITH CPD POINTS

Galvanizers Inspectors Course

Hot dip galvanizing is one of the most widely used methods of protecting steel from corrosion. As a final step in the process, the hot dip galvanized coating is inspected for compliance with the appropriate specifications.

This Galvanizers Inspectors Course has been designed to provide delegates with sufficient knowledge to test, inspect and interpret test results.

Following the course and successful result in a three-part exam, the delegate will be issued with a certificate, and if required, registered as an approved HDGASA inspector. Registration will be confirmed on an annual basis. Successful inspectors will become Individual members of the Association for the year.

The course is usually run from the Hot Dip Galvanizers Association in St Andrews, Bedfordview but from 2009 it will be available in Cape Town. Bookings are limited to 10 people on a first-come-first-serve basis.

COURSE CONTENT

- Introduction to corrosion
- Inspection before hot dip galvanizing
- Quality assurance in coating applications.
- Understanding zinc coatings
- Inspection after hot dip galvanizing

COURSE DURATION

This is a 2-Day Course comprising lectures on the first day, a Plant Tour in the morning of the second day, and the qualifying examination in the afternoon.

DATE AND TIME

Courses commence at 08h00 sharp and end at 16h30. Lunch and refreshments will be provided. Comprehensive course notes can be collected from our offices two weeks before the course.

Johannesburg:
February 17 - 18; April 7 - 8; June 9 - 10; August 4 - 5; October 6 - 7 and Nov 24 - 25.

Cape Town:
May 20 - 21; September 9 - 10

COURSE COST AND PAYMENT TERMS

R2 394.00 per person inclusive of VAT. Should you have 2 or more delegates from the same company, course costs will be R2 166.00 per person inclusive of VAT. Please note that payment is due on the first day of training. Cheques to be made payable to "Hot Dip Galvanizers Association SA". Members qualify for a discount.

SHOULD YOU BE INTERESTED, KINDLY CONTACT SASKIA SALVATORI AT THE ASSOCIATION.

NOTE: All professional Engineers, Technologists, Technicians and Certificated Engineers are required to achieve a certain number of points for Continuous Professional Development (CPD). By attending the Association's two day Coating Inspection Course, you will obtain 2 points (accredited by ECSA).

Measuring coatings on metal substrates (Part 3)

The metal under the coating is called the substrate and it is important to know what it is before we try to measure the thickness of the coating.

The choice of probe depends on both the coating and the substrate and many combinations can be measured with Elcometer probes, but not every one. Here are some popular examples:

Zinc or galvanizing on steel	*F*
Anodising on aluminium or magnesium	*N*
Lacquer on brass	*N*
Paint or enamel on steel	*F*
Hard chrome on high tensile steel	*F*
Electroplated nickel on steel	*Cannot be measured with F or N probe*
Tin on brass	*Cannot be measured with F or N probe*
Decorative chrome on zinc	*Cannot be measured with F or N probe*
Silver on copper	*Cannot be measured with F or N probe*
Chrome on plastic	*Cannot be measured with F or N probe*

Shape

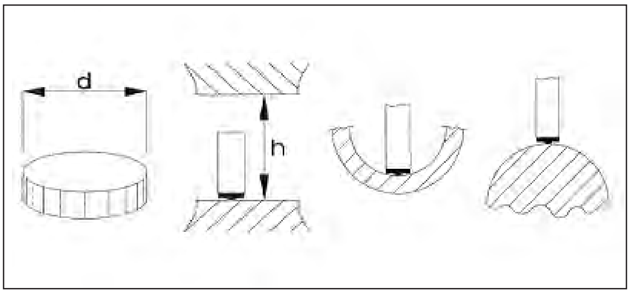
The size and shape of the location to be measured can be big or small, wide or narrow and flat or round. It is very important to know about the shape before deciding which is the best probe to use.

Probes cannot measure on every surface; they are designed for specific tasks based on demand from users. You should compare the probe parameters with the shape and size of the item to be measured.

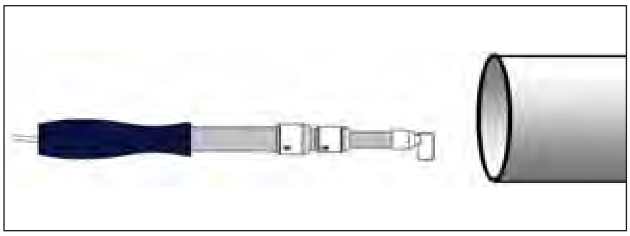
Elcometer 456 Integral Gauge.

Big things and large spaces are usually measured with the *Standard* probes, which are straight with a spring-loaded sleeve. But where there is little surface or the required measurement is in a confined space, use *Right Angle* probes or *Miniature* probes *(see picture below)*.

For coatings inside cylinders, a *Telescopic* probe can reach over 1 metre – more if you can put your arm inside. Remember to calibrate on a similar curved surface with no coating before you measure the coated parts.



Check the probe fits the space available.



Telescopic Probe for pipes and tubes.

New galvanizing alloy available in South Africa

Exxaro Base Metals Zincor is able to offer a new galvanizing alloy product to the galvanizing industry.

The alloy is called BritePlus Nickel and is manufactured by Teck Cominco in Canada. Teck Cominco are one of the largest zinc mining and smelting companies in the world and are world leaders in the research and development into the application of zinc coating in the galvanizing industry.

BritePlus Nickel has been specifically developed for the hot dip galvanizing industry and is used widely in North and South America, Europe and the east. Exxaro Base Metals Zincor has been awarded the rights to procure and sell the alloy in South Africa on behalf of Teck Cominco in Canada.

After an initial trial, Robor Galvanizing, are currently the only general galvanizer using the alloy on an ongoing basis. The alloy contains nickel, bismuth and aluminium additions and is added to the galvanizing kettle in conjunction with normal zinc additions.

The addition of BritePlus Nickel has a number of important advantages, which are:

- There is improved control of the zinc coating when galvanizing fabricated steel structures.
- The quality of galvanized product is improved.
- The visual appearance of the products is improved with a "brighter" galvanized product.

If there are galvanizers who would like to undertake a trial of the BritePlus Nickel alloy at their plants or require any additional information, they should contact Owen Tennant at Exxaro Base Metals Zincor on 011 812 9544.

New galvanizing plant gets top of the range heating and control equipment

KZN-based Excell Galvanizers (part of Harrismith Galvanizers) commissioned a leading heating elements company to design, manufacture and install the heating and control equipment for their new plant built last year.

Hi-Tech Elements supplied a new 500kW heating structure complete with steel modular sections insulated with high-density fibre modules. Ni/Cr heating elements were fitted to these structures, forming the complete furnace around a new galvanizing tank.

All the cleaning tanks were also fitted with Hi-Tech Elements' HotRod® immersion heaters in various types, namely St/Steel 316, Vitrosol glass as well as Teflon heaters for the flux tanks.

The thermo-couples for the zinc, the heating cavity around the tank and all the cleaning tanks were also supplied and fitted by the company. In addition, full Thyristor control panels to manage the kettle as well as all the heated cleaning tanks were designed, built, installed and commissioned by Hi-Tech Elements in a very efficient time.

Commented Andre Goosen, MD of Hi-Tech Elements, "As with their larger system which we installed about three years ago, our efficiency and expertise was again used by Excell to expedite the work quickly and cost effectively".

For more information on Hi-Tech Elements' capabilities, contact 011 894 3937 or email sales@hi-techelements.co.za.

Phoenix Elephant comes to Cape Town en route to Europe

Last year's judges Commendation Recipient at the 2008 HDGASA Awards – Andries Botha Sculpture, is in the news again. The piece went on show at Durban's prestigious KZNSA Gallery. The sculpture called Lux Themba (Lux-light and Themba-Elephant) is perhaps better known in the hot dip galvanizing fraternity as "The Phoenix Elephant" (after Phoenix Galvanizing, where she was hot dip galvanized).

The sculpture, measuring 3.5m x 1.3m x 2.1m was constructed from a hot dip galvanized frame, 120 kg of galvanized hook bolts, washers and nuts and clad in iron and lead wood. All wood was recycled from naturally fallen trees. The sculpture weighs 1.5 tons in total. The sculpture was commissioned by Bert van der Kampf as a memorial for his deceased wife Annemarie.

Lux Themba will also be on display in Cape Town briefly, at the launch of Andries Botha's Human Elephant Foundation, before her final voyage to her owner in Brabant, Netherlands.

Voigt & Willecke 2009, bigger and better...

After careful planning and precision execution, Voigt & Willecke Galvanizing in Durban successfully launched their new 14m line at the end of January 2009. Jay Reddy, CEO of Voigt & Willecke Galvanizing cites market demand, in terms of fabricated lengths, as the main contributing factor for the expansion of the plant.

"Voigt & Willecke will continue to supply and deliver quality products that clients have become accustomed to as well as offering clients the benefit of accommodating longer lengths in a single immersion."

HOT DIP GALVANIZING MEMBERS

GALVANIZER	LOCATION	TEL. NO	SPIN	NO. OF LINES	BATH SIZES (L x W x D) (m)
GAUTENG					
Armco Galvanizers	Isando	011 974-8511		1	13.2m x 1.5m x 2.2m
Armco Galvanizers – Dunswart	Dunswart	011 914-3512	●	3	5.2m x 1.2m x 2.0m 3.0m x 1.0m x 1.5m 2.0m x 1.0m x 1.5m
Babcock Nthuthuko Powerlines (Pty) Ltd	Nigel	011 739-8200		1	12.0m x 1.4m x 1.8m
Cape Gate (Pty) Ltd	Vanderbijlpark	016 980-2270		#	Wire galvanizer
DB Thermal SA (Pty) Ltd	Nigel	011 814-6460		In-line	16.0m x 1.0m x 1.0m
Galvadip (Pty) Ltd	Waltloo	012 803-5168		1	7.2m x 1.5m x 1.8m
Galvrite Galvanising (Pty) Ltd	Randfontein	011 693-5825		1	6.5m x 1.3m x 2.0m
Galvspin Galvanizers cc	Boksburg North	011 894-1426	●	2	2.0m x 1.2m x 1.5m 1.5m x 1.0 x 1.5m
GEA Air Cooled Systems	Germiston	011 861-1571		In-line	11.5m x 1.0m x 1.0m
Lianru Galvanisers cc	Nigel	011 814-8658		2	7.2m x 1.3m x 1.6m 4.5m x 1.3m x 1.6m
Macsteel Tube & Pipe	Boksburg	011 897-2194		In-line	13.5m x 1.6m x 2.4m
Mittal Steel SA	Vereeniging	016 889-8816		#	Sheet galvanizer
Pro-Tech Galvanizers (Pty) Ltd	Nigel	011-814-4292	●	2	3.2m x 1.1m x 1.5m 3.0m x 1.1m x 1.2m
Robor Galvanizers (Pty) Ltd	Germiston	011 876-2900		3 Tube	14.0m x 1.35m x 2.5m 10.0m x 2.0m x 4.0m Dia 42mm to 114mm max tube length 6.7m
Robor Tube	Elandsfontein	011 971-1600		1	Tube & pipe galvanizer
Supergalv	Alrode	011-908-3411		1	6.0m x 1.2m x 1.8m
NORTH WEST					
Andrag Agrico	Lichtenburg	018 632-7260		#	In-line galvanizer
FREE STATE					
Harrismith Galvanizing & Steel Profile	Harrismith	058 623-2765		1	12.0m x 1.2m x 2.5m
WESTERN CAPE					
Advanced Galvanising Corp.	Bellville	021 951-6242		1	8.0m x 1.5m x 3.0m
Cape Galvanising (Pty) Ltd	Parowvalley	021 931-7224		1	14.0m x 1.6m x 2.6m
Galvatech (Pty) Ltd	Bellville	021 951-1211		1	7.5m x 1.5m x 2.6m
Helderberg Galvanizing	Strand	021 845-4500		1	5.5m x 0.8m x 2.4m
Pro-Galv cc	Stikland	021 945-1803		1	7.2m x 1.3m x 2.6m
South Cape Galvanizing (Pty) Ltd	George Industria	044 884-0882		1	3.7m x 0.94m x 2.3m
EASTERN CAPE					
Galvanising Techniques cc	Port Elizabeth	041 486-1432		1	12.0m x 1.3m x 2.3m
Galvaspin (Pty) Ltd	Port Elizabeth	041 451-1947	●	1	3.0m x 1.2m x 1.8m
Morhot (Pty) Ltd	East London	043 763-1143		1	6.0m x 1.2m x 2.5m
KWAZULU/NATAL					
A&A Galvanisers	Pietermaritzburg	033 387-5783	●	1	3.3m x 0.9m x 1.9m
Bay Galvanisers	Richards Bay	035 751-1942		1	5.0m x 1.2m x 2.5m
Phoenix Galvanizing (Pty) Ltd	Phoenix	031 500-1607	●	2	14.0m x 1.4m x 2.5m 3.0m x 1.2m x 1.2m
Pinetown Galvanizing	Pinetown	031 700-5599		1	9.0m x 1.2m x 3.0m
Voigt & Willecke (Pty) Ltd	Durban	031 902-2248		1	14.0m x 1.3m x 2.5m

\# *Sheet, wire, pipe and other in-line galvanizing members dedicate their plants to the galvanizing of their own products.*

Note:

- *Where more than one galvanizing line is available, the number of lines and the significant bath dimensions are listed, ie. widest, longest and deepest.*
- *For specific contact names (e.g. sales or production personnel) and mobile telephone numbers, contact company receptionist.*
- *The bath sizes are inside dimensions and not maximum component size (length, width and depth). Kindly take note of the expansion of the component when dipped into molten zinc, or discuss with relevant galvanizer.*