2006 Volume 3 Issue 2

HOT DIP GALVANIZING TODAY

HOT DIP GALVANIZERS ASSOCIATION Southern Africa

27

Featuring:

Tube, Pipe and Accessories; Water Storage Systems; Education and Training

Duplex Coatings

Hot Dip Galvanized Pump Station Platforms – Coating Report

Corrosion of Hot Dip Galvanized Piping – Corrosion Report

ZINC

SOUTHERN AFRICAN INSTITUTE OF STEEL CONSTRUCTION

HOT DIP GALVANIZING TODAY

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27

CONTENTS

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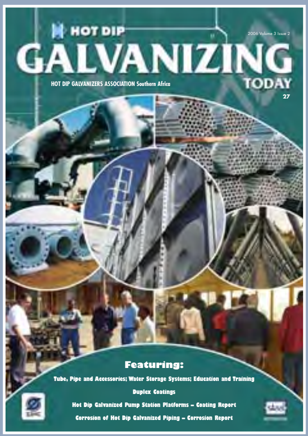
Front Cover: *A kaleidoscope of photos depicting this issue's features – Tube and Pipe, Water Storage and Education and Training*

Hot Dip Galvanizing – Adding value to Steel



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

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Executive Director's Comment

In the immediate past issue of our journal (2006 Volume 3 Issue 1) I reviewed how the price of zinc is derived. It was further stressed, and I quote, "there is a great need for caution relating to realities when pricing hot dip galvanizing".

As indicated, our industry is subject to the international zinc price, quoted on the London Metal Exchange (LME) in US dollars. My estimates of where the price of zinc was headed was that it would remain at a level of between $2100 and $2400 per ton, with an average price for 2006 at approximately $2200. Well, I was totally off the mark.

The International price of zinc is continuing to hit new record highs. As I write these comments, the price has exceeded $2900 per ton. In Rand terms, the price is in the order of R18000 per ton. Part of the reasons given for these exceptionally high zinc prices is the issue of supply and demand. International stocks of zinc have fallen to under half of the levels considered necessary to maintain a stable market. However, an additional factor has now entered the zinc market, viz, the asset speculators, who are generating profits from the volatility of base metal prices.

As zinc constitutes a major cost input in the hot dip galvanizing process, where does this leave our industry? Hot dip galvanizers must remain vigilant of the daily price of zinc and adjust accordingly. In addition, they should apprise their customers of the current situation and provide for adjustments in their respective hot dip galvanizing prices.

As the Hot Dip Galvanizers Association we monitor the changes to the international price of zinc. Should members or their customers wish to update themselves, they can visit our web site where they will find a link to the base metal prices, including the international stock holding situation. Alternatively they may contact our office for the latest situation report.

PS: Updated zinc prices (15 May) have risen to US$3900 per ton having touched a high of US$4000 per ton on 11 May.

Bob Wilmot

Note from the Editor

Despite the undeniable success in many instances where hot dip galvanizing on its own and sometimes in combination with a paint system has stood the test of time, there are a number of industrial and public companies that operate in moderately corrosive environments that continually specify corrosion control coating systems that are often based on initial costs only and do not consider the corrosive and environmental conditions. Relatively short coating performance warranties are frequently required of the paint manufacturer or paint contractor, suggesting that ongoing and expensive maintenance is necessary and an acceptable evil, to be carried out by contracted maintenance paint contractors.
In aggressive environments, coating maintenance will always be required, however, the frequency of this maintenance can be considerably lengthened, merely by selecting the most appropriate corrosion control coating system. Instead of merely specifying the use of the current coating system for an extension of an existing project without evaluating its performance over the original desirable life of the original coating, without taking into account the exorbitant cost of ongoing maintenance, is in my opinion irresponsible. A hot dip galvanized coating can most often be found on articles at, or adjacent to an existing site and because the thickness of residual coating can be easily measured and the coating visually evaluated and often its performance is surprisingly good, in spite of the corrosive conditions at hand.

The now regular duplex coating section discusses "Warranties and Guarantees" and "Recycling of Garnet" an ideal abrasive used for sweep blasting, whereas the special features in this edition, include "Education and Training," which amongst other things addresses the HDGASA's primary education and training objectives including two papers on the subject, given at the last Hot Dip Galvanizing Conference in Johannesburg in February. "Tube, Pipe and Accessories and Water Storage Systems" are the other two features.

Feedback from Saskia Salvatori, the Association's office manager and organiser of the Eskom Hot Dip Galvanizers Awards Event to be held in August, relating to the Awards Event.

We show a pictorial view of the fun had at the Association's recent golf day.

The "Corrosion Report" includes a hot dip galvanized pipe failure due to the aggressiveness of the conveyance water, whereas the "Coating Report", addresses coating issues with regards to some pump station platforms, where the primary problem was lack of proper communication prior to the coating of the components.

Our personality profile is Sue Clark a talented architect and the winning designer of the "Freedom Tower" who amongst other things loves sketching, painting, metal construction and ceramic work.

Our guest writer discusses "The Brain", whereas "Miss Conception" addresses "Hot dip galvanizing of reinforcing steel for concrete, only works if you don't need it"
In Walter's Corner, Walter discusses "A good looking coating is not necessarily a good coating."

This issue's Case History looks at the corrosion performance of a 76-year-old "Braithwaite" type pressed steel water tank at the old Johannesburg fort.

Trust you enjoyed using the product information CD, issued with the previous magazine? If you had any problems relating to the disc or wish to air your views on any aspect of this magazine and the information it contains, kindly contact me.

Terry Smith

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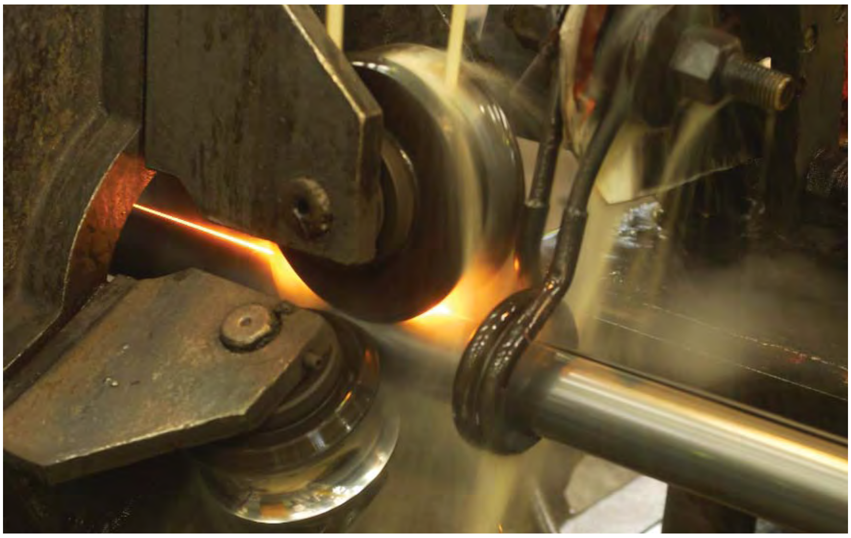
High frequency welding or electric resistance welding of tube and pipe

The vast majority of tube and pipe used in South Africa is manufactured using the High Frequency or Electrical Resistance Welding (ERW) process. One of the advantages of the ERW process is that no filler material is used. Chemistry is therefore not affected by the welding process. Another advantage of the ERW process is that it's a very competitive as the process is ideally suited to a mass production environment.

ERW welding evolved from low to medium frequency techniques which were developed around the turn of the century. The current used to heat the edges of the strip was first introduced by a rotating contact wheel, known as ERW. While making a good weld, the process was limited in speed and tended to heat a much greater mass of metal than was needed to make a good weld. As high frequency oscillators were developed for radar applications during World War II, their advantage for use in welding became apparent. ERW welding permitted much greater speeds and the heating of a small mass of metal due to the shallow penetration of the High Frequency current. In essence the strip edges are fused together by means of high frequency induction welding. This is done by inducing a current along the open seam using an alternating and variable magnetic field, which creates sufficient temperature to enable fusion of the two edges.

Research into improving the process is on-going. The aim of the research is to improve the efficiency of the process and the weld consistency.



The above photo shows the ERW welding process. The coil on the right of the welding rolls induces a magnetic field that is concentrated on the open seam by the impeder inside the tube (not seen) resulting a flow of electrons on the edges of the strip. This flow generates heat along the seam to fusion temperature. The weld rolls then fuse the open seam to complete the "welding" process and the welded tube can be seen on the left hand side of the photo. Tube travelling right to left

Competitiveness of Tube and Pipe

The inherent strength of steel makes tube and pipe very competitive. This applies to both conveyance pipe and structural tube. The chemical composition requirements of the steel used to make tube and pipe has, over the years, changed so that the end product is more suited to its applications. The introduction of tube made from graded steel has significantly improved its competitiveness.

Most international and local specifications have taken into account galvanizing requirements so that end users receive a better quality product. This is typically achieved by limiting the amount of Silicon and Phosphorus in the steel to ensure that it falls within the preferred parts of the Sandlin curve.

Structural tube offers Engineers, Developers and Architects added benefits. These include structural benefits which translate into lighter and more efficient structures, reduced wind load for exposed structures, better design against corrosion and last but not least, more aesthetically pleasing structures.

For further information contact the Association of Steel Tube and Pipe Manufacturers of South Africa on (011) 823-2377 *or e-mail* astpm@astpm.com.

Automatic hot dip galvanizing plants for tubes and pipes

Mass production of hot dip galvanized steel pipes and tubes are processed in plants set up specifically for the automatic or semi-automatic zinc coating of tubular products. While pipe galvanizing plants usually form part of the pipes and tubes manufacture operations, certain other tubular products with specially treated ends and fittings, are galvanized in batches in plants that provide custom galvanizing services. We refer to these two types of hot dip galvanizing operations as (1) automatic pipe galvanizing plants, which provide zinc coatings in terms of the SANS 32 (En 10240) specification, and (2) batch type plants, controlled by SANS 121 (ISO 1461) specification.

Hot dip galvanizing is a universally tried and tested surface finishing operation used to protect steel products from the ravages of corrosion. Large scale galvanizing of pipe is a semi-continuous operation, which uses specially designed equipment to automatically transport chemically cleaned pipes through molten zinc and obtain a controlled zinc coating of uniform thickness. Following a controlled immersion period in the molten zinc, the pipes or tubes are automatically withdrawn and immediately treated to remove excess molten zinc and ash inclusions from the external as well as internal surfaces of the pipe or tube. This is achieved by first passing the pipe or tube through an "air-blowing ring" that wipes excess zinc off the external surfaces. This is immediately followed by high-pressure compressed air or alternatively, superheated steam being blown through the inside of the product to remove excess molten zinc and any other entrained contaminants.

While pipe galvanizing equipment has evolved and processes have changed over the years, the corrosion control objectives remains the same, clean the steel and metallurgically bond a zinc coating of specified thickness to the pipe surfaces (inside and outside).

There are two widely used designs of pipe galvanizing machinery. The main difference between them is the way pipes are submerged into the molten

Hot dip galvanized pipes being conveyed to be quenched and passivated in order to prevent white rust also referred to as wet storage stain.

Pipes being immersed "screwed" into the molten zinc using a series of screw conveyors or augers. Immersion times are determined by the rotational speed of the augers.

A hot dip galvanized pipe passing through the air blowing ring and being wiped.

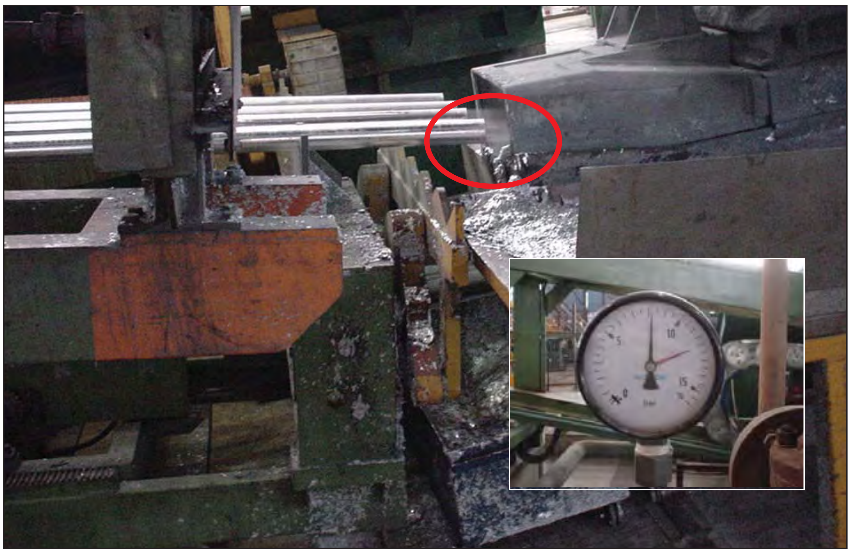
zinc. Chemically cleaned and fluxed pipes enter the zinc bath from the side or from an end. In both cases the pipes are forced into the molten zinc at a slight angle to allow air and any trapped steam to escape freely. Besides being an important safety feature, the immersion of the pipes at an angle improves the quality of the hot dip galvanized coating on the inside of the pipes.

Side entry system

Typically, several pipes are allowed to roll from a loading table into the bath at any one time, often with manual assistance. Once in the bath, a mechanism lowers the pipes at a pre-determined rate. This mechanism can be a pusher-rod type or a notched wheel. After being immersed in the molten zinc for a prescribed period, the pipes are individually and automatically extracted from the molten zinc, transported through the "air blowing ring" and onto a supporting conveyor where compressed air or superheated steam is blown through the inside of the pipe. As an alternative, an air lance has been successfully used on larger diameter pipes.

End entry system

After drying, the fluxed pipes are transported on a roller conveyor system located at the end of the zinc bath. This conveyor carries the individual pipes and deposits them onto a series of screw conveyors or augers, located within the molten zinc, which rotate and thereby draw the pipes into the molten zinc. The rotational speed of these conveyor screws (augers) determines the time of immersion and hence zinc coating thickness. Extraction is achieved by a process of "lifting hooks" that raise the galvanized pipes out of the molten zinc engaging magnetic rolls that transport the pipe through the blowing ring and onto the steam blowing equipment.



Superheated steam being blown through the inside of two pipes. Pressures of 9 to 10 bars are used at temperatures of 930°C.

Blowing ring and steam blowing

As the hot dip galvanized pipes leave the molten zinc they pass through the air-blowing ring to facilitate wiping of the external surface. The air pressure and "angle of attack" of air onto the pipe will control the amount of molten zinc removed and hence set the final coating thickness. This process has no effect on the formation or thickness of the zinc iron alloy layer, which was determined by metallurgical laws.

Following the air-ring wipe and internal blow, the pipes are transported to the quench and passivation tank. The quench and passivation process is included so as to prevent white rust or wet storage stain.

Specification for blown hot dip galvanized pipes

As indicated above, the specification applicable to pipes processed on automatic or semi-automatic equipment employing air wiping and internal blowing is SANS 32 also known as EN 10240. Coating thickness requirements called for in terms of this specification are briefly summarised in table 1 on page 7. Apart from coating thickness measurements, there are requirements relating to the chemical analysis of the coating, refer to the full specification for details.

Minimum local coating thickness (blown pipes)

Minimum local coating thickness on the inside surface except at the weld bead = 55μm.

Minimum local coating thickness on the inside surface at the weld bead = 28μm.

Testing adhesion on hot dip galvanized pipes

MINIMUM COATING THICKNESS ON STEEL TUBES TO EN 10240				
COATING QUALITY		A1	A2	A3
Mandatory	Minimum local coating thickness on the inside surface except at the weld bead	55µm	55µm	45µm
	Minimum local coating thickness on the inside surface at the weld bead	28µm	1)	1)
Options	Minimum local coating thickness on the outside surface	2)	2)	2)
COATING QUALITY		B1	B2	B3
Mandatory	Minimum local coating thickness on the outside surface	55µm 3)	40µm	25µm
1)	This requirement does not apply			
2)	This requirement applies when the purchaser specifies Option 1			
3)	Option 3 specified (if >55µm required, purchaser to specify according to ISO 1461)			

Coating qualities 'A' and 'B' refer to end application with quality 'A' being for gas and water installations and 'B' for other applications. The number following the quality letter refers to specific requirements in terms of coating thickness.

NOTE: In South Africa, **EN 10240** to quality A1 replaces the previous **SABS 763,** B4 coating.

Table 1.

DEGREE OF FLATTENING FOR TESTING COATING ADHERENCE FOR TUBES	
Tube type	**Distance between platens**
Square	75% of side
Rectangular tube	75% of shorter side
Round ≤ 21.3mm	85% of outside diameter
Round > 21.3 ≤ 48.3mm	80% of outside diameter
Round > 48.3 ≤ 76.1mm	75% of outside diameter
Round > 76.1 ≤ 114.3mm	70% of outside diameter
Round > 114.3mm	65% of outside diameter

Table 2.

Testing for adhesion is not necessarily a true measure of the adhesive strength of the metallurgical bond between the hot dip galvanized coating and the base steel, but it does serve as an indicator of the adhesion properties of the coating.

Cold Flattening Test (*Hot Dip Galvanized Tube*)

For compliance with EN 10240, the most popular test is cold flattening in accordance with EN 10233. Test pieces not less than 40mm in length are flattened between parallel flat platens as shown in table 22. No cracking or flaking of the coating shall occur on the surface away from the cut surface.

Bend Test (*Hot Dip Galvanized Tube*)

The bend test shall be carried out using a tube bending machine, and the test piece shall be bent through 90° round a former having a radius at the bottom of the groove equal to eight times the outside diameter of the tube.

Note: *Should the above requirement of bending be implemented for the fabrication of gates, etc. after hot dip galvanizing, the maximum coating thickness should be no greater than 40% more than the minimum required in table 1.*

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

Why vent holes are extremely important when closed tubular components are to be hot dip galvanized!

The question of why vent holes are important often arises when a customer is reluctant to add holes to his component.

The photos indicate a recent incident of what happens when vent holes are not added.

Photo 1 shows the component of which there were two that were processed, the first, this one, was successfully hot dip galvanized, in spite of the lack of vent and fill holes in the central section. The second component was left in the flux solution prior to the galvanizing operation and due to some porosity in the welds accumulated a small quantity of moisture, which when dipped into the molten zinc immediately changed into superheated steam (a volume expansion of about 1 700 times). This lead to the immediate removal of about 50 tons of molten zinc, the untimely death of two galvanizers and the plant being out of action for about eight months.

Photo 2 shows the ruptured side wall of the elbow of the component and photo 3 shows the damage to the galvanizing bath.

Because the distorted bath contacted onto the furnace wall, it had to be switched off, leading to the solidification of the zinc in the bath. The bath as it was could not be removed as it was too heavy and the furnace had to be rebuilt around the bath in order to re-melt and pump out the molten zinc.

A catastrophe of note!!

Therefore, when next designing a structure, which is to be hot dip galvanized, bear in mind that articles are immersed into and withdrawn from a bath of molten zinc heated to a temperature of 450°C, should these articles be closed tubular in design, it is imperative that appropriately sized and positioned holes for venting, filling and draining are added. Holes will ensure that all internal surfaces are hot dip galvanized eliminating hidden corrosion while in service, increase the coating quality and more importantly, ELIMINATE THE POSSIBILITY OF AN EXPLOSION DURING PROCESSING.

Photo 1.

Photo 2.

Photo 3.

Trucking and Engineering (T&E)

Established in 1982 Trucking & Engineering based on the West Rand (T&E) (a division of Inmins Trading (Pty) Ltd) has been a major supplier of pipe and related products to the gold, platinum and diamond mining industry.

T&E has a range of locally designed and patented products which have been successfully introduced into the industry that result in ease of installation and cost savings. T&E have also been successful in exporting these products into other Africa and overseas countries, these include compact flanges, hydraulic sealing pipe couplings, abrasive steel piping for backfill/slurry applications, to mention a few.

Recent secured contracts where some of these products have been supplied:-

- Impala Platinum No. 20 shaft
- Anglogold Ashanti's Moab Khotsong Mine

These contracts required hot dip galvanizing throughout and pipe sizes ranged from 50 to 400NB and used the patented T&E "Hi-Press" Self Energizing Pipe Couplings in the vertical, these allow for expansion and contraction and form a perfect seal without having to machine the pipe ends.

Contact information:

Brian de Kok

Godfrey Bousfield

Standard flanged hot dip galvanized pipes being loaded onto a transport facility.

Pressed steel sectional water tanks

The concept of liquid storage in tanks constructed by means of a series of modular steel panels bolted together on site was originally developed and patented in 1901 by Braithwaite in the United Kingdom, an organisation which has continued to be active to this day.

There are many beneficial features associated with the pressed steel sectional tank concept. It facilitates construction in an infinite range of sizes and configurations. The profile panel sections provide excellent strength properties while tanks mounted on steel towers above ground level have an aesthetically pleasing appearance.

A major advantage of the sectional tank design is that it facilitates easy handling and transportation over long distances to remote areas, regardless of the final dimensions of the assembled unit. Assembly on site is quickly achieved without the need for sophisticated tooling. In this way pre-manufactured storage facilities having a capacity even in excess of 15 000 cubic meters, can be provided for a vast variety of applications regardless of the location of the site.

Reservoirs constructed from pressed steel sections are used extensively by the mining industry and municipal authorities. Large storage tanks to this design which are mounted on steel towers can also be seen at many of Eskoms power stations.

Pressed steel sectional water tanks are normally hot dip galvanized for corrosion control in accordance with the requirements of the SANS 121 (ISO 1461) galvanizing standard. The thickness of the hot dip galvanized coating applied is within a range of 80 to 100µm. This is more than five times the thickness of zinc on pre-galvanized corrugated steel cylindrical tanks.

An old "Braithwaite" pressed steel tank (see Case History), supported by a painted steel structure.

Hot dip galvanizing has achieved an impressive record over many years by providing protection from corrosion for tanks constructed from pressed steel sections. Hot dip galvanizing alone provides adequate corrosion control in most applications. Meanwhile, investigations into the feasibility of providing added protection by way of an additional internal lining are presently in progress. The purpose is to ensure extended maintenance free life in situations where water with aggressively corrosive properties is required to be stored. Practical test results obtained to date by applying a duplex coating consisting of hot dip galvanizing and an epoxy based organic coating on internal surfaces are extremely promising.

■ *Walter Barnett*

Roundabout playpumps

A visitor to many rural areas in South Africa might be greeted by the sight of children laughing and playing on a brightly coloured roundabout, with a large elevated water tank standing nearby.

While the children are playing, their roundabout is busy pumping water from an underground aquifer and piping it up to the storage tank from where it can be collected by means of a communal tap. These PlayPumps are the brainchild of Roundabout Outdoor, who entered into a public-private partnership with the Department of Water Affairs and Forestry at the end of 1999 with the intention of delivering quality water to all South Africans by 2008. Eskom has also joined the partnership by providing funding for some of the pumps.

The PlayPumps are installed at sites where there are large gatherings of children, such as school playgrounds, clinics and community centres. To prolong their lifespan to about 20 years, they are first hot dip galvanised before being painted in bright colours. Approximately 700 of these roundabout pumps have been installed in South Africa to date.

This project is part of the United Nations Millennium Development Goals and has brought many advantages to the communities where the PlayPump is installed. These include easy access to clean drinking water, increasing the health benefits for children by allowing them to stay properly hydrated and reducing the terrible burden that rural women and girls face daily, hauling water often from long distances. From an environmental aspect, the PlayPump helps in reducing evaporation, contamination and wastage through effective storage and plumbing mechanisms. Billboards on the sides of the storage tanks are used to carry HIV/AIDS awareness campaigns, as well as advertising which helps to pay for pump maintenance.

Billboards on the sides of the storage tanks are used to carry advertising which helps to pay for pump maintenance.

For more on this special project, go to www.playpumps.org.

Bulk water storage

Johannesburg-based Abeco Tanks has been in operation for 23 years and can boast several thousand successful installations in many countries, including South Africa.

The company specialises in the design, manufacture and installation of sectional steel water storage tanks as well as support towers for elevated tanks. All their steel components are hot dip galvanized to internationally accepted standards.

Hot dip galvanized pressed steel tanks provide safe, hygienic water storage facilities with a long life span. Thanks to their modular design, Abeco's tanks offer versatile and cost effective solutions for liquid storage. The modular design has been refined to the extent that all tanks regardless of size or configuration use a common set of standard components. The components are mass-produced, resulting in savings in cost and delivery lead times. The components are also easy to transport, manhandle and install.

Pipe connections are welded to tank panels at positions specified by customers. Connection points can be fitted at virtually any point on a panel. There is virtually no limit to the capacity that can be accommodated but the tank depth is limited to 4 panels (4.88m) for standard tanks and 5 panels (6.1m) in special applications.

1 million litre pressed steel tank.

Abeco's pressed steel tanks are largely used for potable water storage, but can be used for the storage of many other liquids.

As an alternative to the pressed steel tank design circular water tanks constructed from continuously hot dip galvanized sheeting, provide safe hygienic long lasting water storage at ground level. A self-supporting domed roof made of cold rolled profile steel sheeting covers the tank. This offers a more durable and permanent cover than alternative fabric covers.

Abeco has developed a design that offers significant cost savings over other types of sectional tanks. For example, minimal site preparation is required and in many instances concrete foundations can be eliminated.

A full bag liner is not needed to contain the water. The shell seams are sealed by special profile rubber gaskets. A vinyl liner supported on a bed of sand forms the tank floor. To avoid damage the liner is fitted after the whole tank has been assembled. The seal between the liner and the shell is created by a unique bolted clamping arrangement.

Abeco's support towers for elevated tanks are of an all bolted design. The towers are designed to internationally accepted standards using design criteria critical to specific regions. For maintenance-free, long life, hot dip galvanizing is recommended as the standard finish for support towers.

520Kl tank (9x8x4 panels) on 18m tower – Orange Walk, Belize, Central America.

ABECO TANKS – THE NAME THAT HOLDS WATER

Several thousand tanks successfully installed in Africa and South America

Established in 1983, Abeco Tanks is a leading innovator in the development of water storage solutions. Abeco Tanks is committed to developing cost effective solutions for water storage needs in communities with limited resources.

Products:

- Galvanized pressed steel tanks;
- Support towers for elevated tanks;
- Circular bolted tanks.

Features:

- Rugged, simple modular design.
- Guarantees safe, hygienic and durable water supplies.
- Sectional steel water tanks are easy and quick to install.
- Transportable to remote locations.
- Minimal site preparation for circular bolted tanks.

Applications:

- Mainly potable water, but also
- Hot water; effluent; fuels; corrosive liquids.

Abeco
TANKS

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www.abecotanks.com

The primary marketing objective of the HDGASA

The primary role of The Hot Dip Galvanizers Association Southern Africa (HDGASA) is to promote a higher level of acceptance of, and confidence in, hot dip galvanized products and offerings on a national basis, in order to increase the demand from potential customers to use hot dip galvanizing as a coating for effective corrosion control. The HDGASA is also the vehicle that provides its galvanizing members with technical know-how and marketing support in order to increase the quality and acceptability of hot dip galvanizing in the marketplace – creating a fertile marketplace for members to market and serve the need for effective, economic and quality coatings for corrosion control in existing and new market segments.

Discussions with specifiers at the hot dip galvanizing bath at a recent plant tour in Durban.

The HDGASA is simultaneously an advisory body and independent authority, representing end-users, consumers and specifiers of hot dip galvanized steel products in the corrosion control industry, ensuring quality standards and customer satisfaction with the hot dip galvanized coatings supplied by all galvanizers in Southern Africa. This simultaneously includes duplex systems.

To this end a number of priority activities have been implemented:

- Plant tours and presentations.
- Office presentations.
- Individual visits to specifiers and architects offices.

Discussions with specifiers in the finished product yard at a recent plant tour in Cape Town.

Plant tours and presentations

Plant tours are usually arranged in member galvanizers areas, when required, where amongst other things, discussions on the process can take place. The plant tours are usually followed up by a short presentation on the many benefits as well as the working characteristics of hot dip galvanizing and duplex systems (hot dip galvanizing plus an appropriate paint system). In most instances a plant tour and presentation will take about two hours.

Office presentations

In the event of limited available time from the specifiers perspective, in office presentations can be arranged. These presentations are usually between 45 minutes and an hour long and will provide the specifier with an indepth understanding and insight into the benefits and working characteristics of hot dip galvanizing and duplex coatings.

Individual visits to specifiers and architects offices

Knowing that most specifiers and architects are busy and that the possibility of formal presentations and/or plant tours is not always feasible, individual visits to specifiers and architects offices are undertaken. Association staff regularly visit member galvanizer's areas and undertake to call on specifiers and architects to enlighten them about the benefits and working characteristic of the coatings.

Should a reader wish to broaden his or her knowledge of hot dip galvanizing and/or duplex systems via one or more of the above activities, kindly contact Saskia at the HDGASA.

Coating 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 Coating 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 will be run from the Hot Dip Galvanizer's Association Offices in St. Andrews, Bedfordview. Bookings are limited (maximum 20 people) and will be treated on a first-come-first-serve basis.

COURSE CONTENT

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

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, on the following dates: June 6 & 7; September 5 & 6 and November 28 & 29. Lunch and refreshments will be provided. Comprehensive course notes can be collected from our offices two weeks before the course.

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.

Update on Merseta and skills development

During 2005, we attended and participated in the development workshop aimed at the compilation of the National Qualifications for Metal Processing. This National Qualification encompasses the requirements for our industries' skills development.

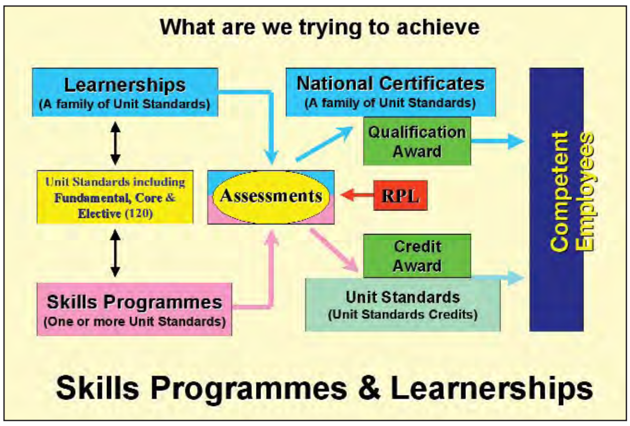
The work of the workshop was completed at the end of October 2005 and the qualification proposals were submitted to the NQF before the end of 2005. It is understood that our submission has been accepted and has been forwarded to the necessary authorities for finalisation and publication in the Government Gazette.

At the time of writing, we are waiting publication and formal recognition of the National Qualification. Our follow up enquiries have not been able to establish when such finalisation will take place.

What has emerged from the exercise is that the Association will not be able to undertake the actual skills development training, due to the lack of educational facilities. Such training will need to be acquired through an approved training (service) provider. It is envisaged that the Association will provide the training and instructional material to the selected service provider, who in turn would then be in a position to offer skills development to the hot dip galvanizing industry.

The actual training material has been developed and consists of thirteen separate modules, each of which covers a specific aspect of the galvanizing process. In should be noted that these modules pertain to hot dip galvanizing and only form one of the unit standards that comprise the National Qualification. Competence in a number of other unit standards, e.g. crane and forklift driving, health & safety, control of chemicals and numerous other unit standards need to be completed in order to achieve the full qualification.

Should any of our readers have enquiries relating to the subject of Skills Development and Training, kindly refer such to the Association's office and we will explain the requirements of the full Metal Processing National Qualification.



Hot dip galvanizing: the steps required to ensure a good product

At the Hot Dip Galvanizing Conference held on the 6th and 7th February 2006 the writer, in addition to other issues, covered the points in the article below i.e. How to ensure a good hot dip galvanized product.

If one chats to steelwork fabricators about hot dip galvanizing and the galvanizers we typically get a litany of negative comments such as:

- "They" are never on time
- "They" loose and damage my steel
- If "they" give it back to me it is twisted and looks terrible with black streaks and dross on the surface
- They put in drain holes with a cutting torch that looks like nothing on earth.

Some of these comments might even have some truth in them… but it is necessary to look into just what is the actual cause of failure of the process resulting in a "poor product"

The fact that galvanizers are apparently often not on time has 3 main causes:

- o Poor or no communication between the fabricator and the galvanizer thus not allowing the galvanizer to adequately plan for the work.
- o Greedy galvanizers who take on too much work
- o Poor management and planning by the galvanizers

The fact that steel gets damaged and lost in the process can be attributed to poor management controls at the galvanizers.

But the last points are very often the result of the fabricator not paying attention to the basics that are required to ensure that a good product. What are these basics?

"Hot dip galvanizing is the classic split responsibility process"

In order to achieve a good hot dip galvanized product the following 3 groups of actions are required:

1. *A good set of detailed drawings which need to:*
   - o Be dimensionally correct (no post galvanizing rework)
   - o Call up continuous welding
   - o Indicate suitable fill, drain and vent holes
   - o Have over all piece sizes suitable to the available hot dip galvanizing bath sizes

2. *High quality fabrication including:*
   - o Dimensionally correct (no post galvanizing rework)
   - o Continuously welded without pin holes and cracks
   - o Insertion of suitable fill, drain and vent holes
   - o Good cleaning including removal of:
     - Paint marks (both at mills and fabricators)
     - Boilermakers wax crayons (do not use them rather than having to remove the marks)
     - Welding slag (both from stick welding and the silicon like glaze of the mig/mag process)
     - Burrs
     - Sharp edges
   - o Clear permanent marking, one mark per assembly (modern 3-D packages give each sub component its own mark and a different mark for the assembly)
   - o Good loading, supporting and transport to the galvanizer
   - o Good management controls and paperwork
   - o Good selection of materials for architecturally important finishes (so-called silicon killed steels)
   - o Selection of compatible ancillary items (hot dip galvanized bolts etc)

3. *Good hot dip galvanizing*
   - o Careful pre-inspection
     - Why not do this at the galvanizers works?
   - o Careful jigging (supporting for dipping)
   - o Good post galvanizing inspection
   - o Good repairs to poor coating
   - o Straightening where required
   - o Good management controls and paperwork to return all the bits and pieces
   - o Quick turn around times
     - Hot dip galvanizing will always be on the critical path of the programme
     - But never short change yourself – allow sufficient time to do the process properly
     - Remember more haste usually results in less speed….

From the above 3 subjects it is clear to see why I referred to the whole process as being a "split responsibility" process because it is the fabricator who is responsible for 1 and 2 above and the hot dip galvanizer who is responsible for 3.

But without all 3 actions being competently executed it is unlikely that we will end up with a good galvanized product.

- To achieve this good product then pre-supposes a serious commitment from all the players

Is there a way forward to greater commitment by the players and hence ensuring a good hot dip galvanized product?

We believe there are several ways that the whole process can be improved. These would include:

- Education and training for all the players but especially at draughtsperson level
- Communication between the parties before during and after the process
  - o To discuss timetable requirements
  - o To review the technical issues on the drawing board to ensure a good set of detailed drawings
  - o To ensure adequate pre-galvanizing inspection.
  - o To keep an open dialogue going between the players to ensure a smooth relationship between the players to the technical benefit of the project.
  - o Post project post mortem discussions to ensure generally improved future performance by the various parties.

Editorial comment:

The Association wishes to thank Spencer Erling – Technical Education Director of SAISC for this valuable contribution.

The Association realises that in the past there have been many instances where all parties including our members and non-member galvanizers have acted irresponsibly to the detriment of the project at hand. We are of the opinion that many of these issues are solvable and to this end and in co-operation with the South African Institute of Steel Construction (SAISC) will shortly be arranging a round table discussion with a number of SAISC member steel fabricators.

Furthermore to add to points 1 and 2 above, the Association has a number of good design tools, including a wall chart on "Design for Hot Dip Galvanizing". Reference can also be made to IS0 14713. The Association's ongoing commitment to strive for good quality coatings and successful hot dip galvanized steel projects is borne out by the Association's staff availability to become involved at the commencement of the project.

From decision by the end-user/specifier to use hot dip galvanizing as the preferred corrosion control coating to receipt of the finished components – site and overall experience

The role of the Hot Dip Galvanizers Association Southern Africa (HDGASA)

Primary goal – promoting hot dip galvanizing and duplex systems, where applicable.

The HDGASA has built a tremendous credibility with specifiers that have interfaced with the organisation since its inception in the early sixties.

Other background information:

- Represent 75% by volume of the general galvanizers in SA.
- Technical advice to members in plant control.
- Members comprise the full spectrum: General; Tube; Spin; Sheet and Wire. This also includes support members and companies that have a vested interest in the Industry.
- Publish literature including our quarterly magazine, "Hot Dip Galvanizing Today".

Coating 50 years old and still plenty of maintenance free life.

Although the HDGASA has many strategic objectives and activities, the three activities that are applicable to this paper are:

- General promotion of hot dip galvanizing and duplex systems, where applicable.
- Getting involved in the design stages of major development projects on behalf of end-users.
- Assisting members and end-users with quality assurance, particularly with coating miss-perceptions.

Introduction

What are the process steps to be followed by specifiers and galvanizers when selecting hot dip galvanizing as a means of corrosion control for a new major project:

Based on recommendations from other end-users / specifiers or past successful project experience, the decision to specify hot dip galvanizing for structural and other steel components for new projects, can be a rewarding one for a number of reasons.

One of the major benefits of hot dip galvanizing is the long-term maintenance free service life that is available to the client, saving enormous sums of money, normally spent on coating maintenance over the prescribed life of the project.

Hot dip galvanized coatings perform very well in most atmospheres and imperfections in the coating, such as lumps, runs; minor protuberances, excessive dross, etc. will not necessary reduce the coating's corrosion control performance. However, in order to avoid these aesthetically unacceptable imperfections, there are a number of steps that must be taken by the specifier and the galvanizer to ensure a greater degree of quality control and all round client satisfaction at the completion of the project.

Two examples of projects that have had above average success from a project management perspective:

- Bofakeng Rasimoni Platinum Mine – *Bob Andrew, Anglo Platinum*
- MTN Head Office - Phase 2 – *Tomme Katranas, Africon*

Decision by end-user or specifier can be based on:

- Acceptance from past project experience.
- Referral by colleague or other authorities.
- Proper value analysis of environmental conditions.
- Proper value analysis of service life requirements.
- Discussion with HDGASA and / or Galvanizer.
- **CORROSION CONTROL SHOULD NOT BE AN AFTERTHOUGHT!**

Next step – (*see explanation under remarks*)

1. *Check Environment*

   Appropriate (A)

   Look at web site; discuss with HDGASA; assess thickness and appearance of residual hot dip galvanizing on components on site adjacent to the new project and evaluate its performance in terms of coating life.

Less appropriate (B)

Assume that hot dip galvanizing will perform in most applications, including all marine conditions, concentrated SO2 environments, acidic waters (immersed), in acidic soils (buried).

2. *Provide correct specifications*

Appropriate (A)

HDGASA Specification: HDGASA 2006-03.

SANS 121 (ISO 1461) – General Hot Dip Galvanizing – Industrial (or Architectural – see HDGASA checklist)

SANS 32 (EN 10240) – Tube Hot Dip Galvanizing.

SANS 3575/4998 – Sheet, specify class of coating.

SANS 675 / 935 – Wire, specify class of coating (SANS 935).

Less appropriate (B)

All items to be "Galvanized" or SABS 763 or SANS 763.

"Electro-galvanized"

"Cold Galvanized"

"Pre-galvanized"

3. *Compile Project Specification (PS) and Quality Plan (QP)*

Appropriate (A)

SANS 121 – Annex A.

- Specify steel composition.
- Identify significant surfaces.
- A sample or other means of showing the required finish.
- Any special pre-treatments.
- Any special coating thickness.
- Any after treatments.
- Inspection requirements.
- Whether a certificate of compliance is required.
- Required method of repair if necessary.
- Specify selected site repair material and maximum size of repair allowable.
- If architectural – specify packaging if necessary.

Less appropriate (B)

No reference.

4. *Negotiate galvanizing price for project*

Appropriate (A)

- Ensure galvanizer is member of HDGASA.
- Ensure that galvanizer is aware of requirements in both 2 & 3.
- Discuss max sizes of components that can be processed.

Less appropriate (B)

Get price from one or two galvanizers who are friends or are conveniently situated.

Accept lowest price.

5. *Secure order for contract*

Appropriate (A)

- Inform selected galvanizer.
- Galvanizer to assist with correct design, including drainage & vent holes, etc, in conformance with Association wall chart or SANS 14713.
- If necessary involve HDGASA.
- Discuss roll out of project and delivery programme. Size of project.
- Re-visit project specification requirements.

Less appropriate (B)

Start fabricating, disregarding the design requirements of hot dip galvanizing or after quickly glancing at the HDGASA website.

6. *Send components*

Appropriate (A)

Programme receipt and return of hot dip galvanized material to ensure project roll-out and optimum use of transport facility.

Incoming pre-galvanizing inspection.

Less appropriate (B)

Delays experienced by the fabricator and not keeping the galvanizer informed.

Non-conformance on receipt of goods by the galvanizer, due to insufficient drainage, vent or filling holes; also weld slag and weld porosity; etc.

Components held in quarantine.

Expect delays in project.

7. *Galvanizer experiences delays due to technical problems*

Appropriate (A)

Inform customer promptly, renegotiate delivery programme

Less appropriate (B)

No prompt communication by galvanizer. When customer phones or arrives on due date he is informed of the delay.

8. *Coating inspection and certification*

Appropriate (A)

Galvanizer informs customer when coating inspection will be carried out and if acceptable, certification will be completed.

Less appropriate (B)

No plant inspection is arranged, galvanizer arranges transport and delivery.

Certification often requested some time after delivery of components to the site.

9. *Components loaded on transporter*

Appropriate (A)

Particularly for distant deliveries:

- Ensure packaging is complete – see Project Specification.
- Ensure components have adequate and efficient dunage material so as not to rub against one another, partic-ularly at flange / pipe interfaces.
- Ensure the components are securely strapped down using soft ropes.

Less appropriate (B)

- No packaging in spite of architectural requirement.
- Inappropriate dunnage.
- Components secured using unprotected chain, etc.

10. *Arrival of finished components and offloading on site.*

Appropriate (A)

- Dedicated space prepared.
- Sufficient space available for easy offloading.
- Correct stacking on dunage – not on damp soil.
- Components angled to the plane of the ground when stacking to ensure reduced rainwater retention and therefore reduce the incidence of wet storage staining in moist atmospheres.

Less appropriate (B)

- Very little site space.
- Components have to be stacked on top of one another.
- Wet trades are active adjacent to, and general site dirt may affect appearance of hot dip galvanized coating.
- Potential for coating damage - huge.
- Coating inspection is conducted resulting in non-conformance of coating.
- Galvanizers QA personnel is requested to inspect coatings on site.
- Galvanizers QA personnel invites Association staff to assist.

11. *Acceptance / dispute between galvanizer, fabricator and end-user*

Appropriate (A)

- Clearance certificate received from galvanizer.
- Project on schedule.
- No payment delays.
- SERVICE AND DELIVERY BY GALVANIZER AND FABRICATOR APPLAUDED!

Less appropriate (B)

- Dispute regarding coating damage and defects.
- Late delivery.
- Project completion delayed (penalties).
- Payment withheld.

Very little site space.

Wet trades are active adjacent to, and general site dirt may affect appearance of hot dip galvanized coating.

- THE HOT DIP GALVANIZING INDUSTRY RECEIVES A BAD REPUTATION!

12. *Summary*

Appropriate (A)

- Understand environment – Discuss with HDGASA or similar organisations.
- Quote correct specifications, compile project specification / quality plan, use architectural checklist.
- Discuss with galvanizer when negotiating price and again when order is secured.
- Programme receipt and return of material.
- Communicate progress in both directions.
- Conduct coating inspection at plant / coating inspector should be qualified – (HDGASA coating inspectors course) Certificate of conformance is to

be issued.

- Packaging (Architectural)
- Correct dunage when transporting.
- Appropriate site stacking.

Remarks

1A If the evaluation of the hot dip galvanizing in terms of the environment and required service life, proves disappointing due to the environment at hand, consider the use of a duplex coating for the new project.

1B The corrosion rate of hot dip galvanizing is directly related to the thickness of the coating and the environment at hand. The coating performs as a slowly corroding barrier and although it will corrode faster in a more acidic environment, the coating will not fail catastrophically but the rate of corrosion will increase. eg. if the corrosion rate of hot dip galvanizing is about 1 to 2μm in 90% of South Africa, in more corrosive environments it will possibly increase to about 2 to 10μm per year. At 10μm per year with a desirable service free life of 20 years for structural elements, hot dip galvanizing maybe painted (duplex coating). Duplex coatings provide a synergistic effect in that if the hot dip galvanizing provides say 10 years of life plus the paint which say provides 5 years of life the combined effect is 10 + 5 = 15 (at least) x 1.5 = 22.5 years of life. For atmospheric corrosion rates on zinc coatings see also ISO 9223.

2A When general hot dip galvanizing is required, specify its conformance with SANS 121 (ISO 1461). In addition to the basic specification and if it entails a project, specify HDGASA 03 – 2006. This specification amongst other things includes, QC, coating repairs, handling & storage, loading and unloading, covering and stacking. Furthermore, the end-user should specify the component's end use, ie. Industrial or architectural. For an architectural finish, refer to the Association's Architectural Check List, for both the designer and the galvanizer.

Should the application be for plain-ended tube of up to ø114mm and less than 6m in length, required for water conveyance, etc, specify SANS 32 (EN 10240). (This is not applicable if carbon steel tube is purchased and requires hot dip galvanizing in areas not accessible to a tube hot dip galvanizing plant.)

For Continuous Hot Dip Galvanizing of sheeting, specify SANS 4998 (Structural grade of material) or SANS 3575 (Deep draw and commercial grade of material). Both specifications include a range of coating classes, providing varying degrees of corrosion protection – specify coating class, ie. Z275, etc.

For Continuous Hot Dip Galvanizing of wire, specify SANS 675. This specification is primarily for fencing and gabions and includes a single class of coating, mainly for corrosion protection, depending on the wire diameter. The alternative specification is SANS 935, which includes three classes of coating, viz, heavy, medium and light. Should no reference be made as to the coating class, the coating thickness on the delivered wire may be inappropriate for its expected life.

2B All items to be "galvanized", "MSG" for "mild steel galvanized" or use of the incorrect specifications such as SABS 763 (which was superseded in May 2000) or even SANS 763 (which doesn't exist) can be misconstrued, particularly when fasteners are required, the "galvanized" may be interpreted as electro-galvanized or electroplated, which will provide less protection in a corrosive environment, than required.

"Cold galvanized" is a term often used for repair of hot dip galvanized coatings, when a zinc rich paint or epoxy is required. "Cold galvanizing" has been misinterpreted as the cold process equivalent to the "Hot process".

"Pre-galvanized" is a generic term used for continuously hot dip galvanized sheeting. Although the process of application is similar to the general hot dip galvanizing process, the coating excludes the presence of iron/zinc alloys, which make up about 50 to 85% of the general hot dip galvanized coating. These iron/zinc alloys provide an additional 30% increase in corrosion performance. When using pre-galvanized material, the specification of class of coating is important in terms of corrosion protection.

3A Specify steel composition:

- The greatest influence on coating thickness and appearance in hot dip galvanizing is the chemical composition of the steel, with Silicon (Si) and Phosphorus (P) playing the major roles.
- Inform steel suppliers of the intention to hot dip galvanize the finished components.
- For architectural use, specify Si – 0.03% max & P – 0.01% max or Si - 0.15% to 0.25% max & P – 0.02% max.
- For industrial or mining use, specify Si – 0.15% to 0.3% max & P – 0.03% max.

"Cold galv" encompasses many products, only some blend in with the final zinc patina, once formed.

Identify significant surfaces:

A significant surface can be defined as a surface that impacts on the performance of that article.

A sample or other means of showing the required finish:

Should the specifier require a number of significant surfaces, it is recommended that a sample be manufactured and following discussion with the galvanizer, a suitable compromise be achieved. The sample can then be used as the basis for future acceptance or rejection.

Any special pre-treatment:

Pre-treatment includes, the application of a mask or other applicable requirement, to prevent the formation of the coating, when dipped. Although it is preferable that the fabricator do this prior to delivery to the galvanizer, provided the galvanizer is aware of the requirements, this can be negotiated.

Coating inspection of the components is recommended at the galvanizer prior to delivery to site.

Specify packaging if deemed necessary.

Any special coating thickness:

The specified coating thickness is generally determined by a law of metallurgy, addressed in table 1 & 2 of SANS 121. Variance in coating thickness – a requirement for a thicker coating (25% greater than the standard, can be requested for components not centrifuged, without affecting specification conformity.

Note: *Where steel composition does not induce moderate to high reactivity, such as in aluminium killed steel, thicker coatings are not always easily achieved.*

Any after treatments:

After treatments may include the exclusion or increased concentration of sodium di-chromate passivation. The former may be required for immediate subsequent painting and the latter for the prevention of white rust during arduous and lengthy transport conditions.

Inspection requirements:

Should the end-user require additional inspection requirements, these should be conducted at the galvanizer. Here questions can be raised and answered quickly, inspection speeded up and the time saved will benefit the overall project.

Whether a certificate of conformance in terms of the specification, is required:

While the galvanizer is conducting his own inspection of the components, it is generally easy to complete a certificate of conformance, for issue to the client.

Required method of repair at the galvanizer:

The specification requires that coating repairs be carried out using a choice of specific materials, should the choice not be made known to the galvanizer and if necessary discussed, the galvanizer will make use of the most convenient method at hand, often to the detriment of the end use of the component.

Specify selected site coating repair material and maximum size of allowable repair:

- Where practical, maximise the acceptable repair area. Although the specification calls for a maximum size of repair area to be individually less than 10cm² and a total of coating repairs on one component to be no greater than 0.5% of the surface area, the HDGASA recommendations differently. "All surfaces that are to be cut and/or welded must be repaired and areas no greater than the size of a R5 coin may be repaired". Should there be damaged or altered areas greater than this, the component should be sent for stripping and regalvanizing. This view may be waived if the component plays a critical role in the construction process, in which case the engineer in charge of the project may decide as to what may be acceptable by the client.
- Specify the coating repair material. The specification requires a specific coating thickness where repair is warranted, this, for structural applications is about 120µm. Unless this can be achieved in one application, specify the number of coats necessary for achieving this requirement in terms of the material selected (often impractical). Furthermore, for aesthetics ensure that the colour of the applied repair material roughly resembles the colour of an oxidised hot dip galvanized coating, the appearance of which should take several months of exposure, to achieve.

If architectural – specify packaging if deemed necessary:

Hot dip galvanizing for industrial use may be acceptable if components lie on site before erection and gather site dirt.

However, if the application is architectural, components are likely to be delivered to site when wet trades are still present and the likelihood of site contamination is high. When seen to be necessary, components may be covered or wrapped until wet trades move off site.

Further requirements, such as QC, handling, loading and offloading, covering and stacking are addressed in HDGASA 03-2006.

This paper was presented by Terry Smith at the Hot Dip Galvanizing Conference held in Johannesburg – 6 & 7 February 2006.

Warranties and guarantees

Consultants and their Clients may be heading for disaster by relying on long term guarantees for protection against failed coating applications. There is a tendency to value a written guarantee above a proper design and material evaluation and/or the experience of the applicator.

One too often hears "I have a guarantee so I am okay".

The need to engineer the design, choose an appropriate coating material and assess the applicators ability to execute the work must never be allowed to be over weighed by a piece of paper which makes very limited promises and which is seldomly read.

A further problem is that the facilities are not always used in the way they were initially intended. A change in the operating conditions can seriously affect the performance on the coating and negate the guarantee. Typical changes would be the chemical composition of the immediate atmosphere or temperature changes within the structures that are coated.

There is a responsibility on the part of all concerned to ensure that the product selected and design details are entirely suited to the application.

A failure on one count will be a failure nevertheless.

Let us accept at this stage that a guarantee is not a reliable assurance of the performance of the product. The market needs to know that a solution will not fail – not what recourse it has in the event of a failure. I have not seen a guarantee, which covers the consequences of a product failure.

So we need to concentrate on avoiding failure by design.

This is only possible when the market realises that it is immoral to buy on price alone.

Yet we hear all too frequently that an alternative will not be considered unless its cost is lower than the previously used system.

Surely at least from a moral point of view, price must be regulated to a lower priority than performance. So real assurance of product performance is only available to the market when solutions are properly engineered.

Guarantees

From time to time, we are asked by Clients or their Consultants to provide a long term guarantee for the supply and application of coatings. The wish to hold a guarantee, which says that the material and the contractor workman-ship is guaranteed for a given period of time under specified conditions.

Reluctance on the part of the supplier to provide long term guarantees is generally seen as a lack of confidence in his product/service. So let us consider a few points on the value of guarantees.

Obligations of parties

When the supplier provides a guarantee and the Client accepts it, obligations come into force with both parties. The supplier will be committing himself to react in specified ways in the event of specified events. For example, to investigate complaints of a defect within a limited period of time, and to carry out repairs to, or replace, defective areas as he finds necessary.

The Client undertakes to operate the facility, as defined in the warranty, and to protect the coating against mechanical damage. When a defect seems to have occurred he will also be responsible for providing free/ unimpeded access to the work area and if necessary, remove any material covering the coating to permit proper inspection of repair to take place.

Limitation of liabilities

By accepting a guarantee, the Client also accepts that there will be limit on the value of repairs, or to the compensation, he may claim for material which has failed prematurely. The maximum value will almost certainly be limited to the contract value.

Reducing liabilities

Most, if not all, long term warranties today are reducing warranties. This means that a ten-year reducing guarantee, for example, is worth 10% of the original contract value per year of guarantee remaining in force. Therefore the tenth year the warranty is worth a maximum of 10% of the original contract value – i.e. if the total installation fails.

Allowances for escalating costs

While the value of the guarantee is reducing each year, the cost of replacing the coating is rising and is not catered for in the guarantee.

Owners responsibilities

Owners help to determine the final quality of coating applications by deciding whether to specify performance, fund inspection and deciding whether to use qualified, full-time inspection. Inspection is an additional cost beyond specification development. Owners may choose to not spend money for inspection, believing the specifications to be sufficient to achieve quality. Depending upon the project size, owners may require the architect, engineer or general contractor to inspect surfacing applications, as part of the general inspection process.

Knowledgeable third party inspectors who work for the owner, having no affiliation with the material supplier or applicator, generally serve the owner well.

Appropriately qualified inspectors who are responsible in their duties to enforce specification compliance can often provide high value and return on investment.

Owners sometimes think coating manufacturer's representatives can provide no-cost inspection. They can. However, value received generally has a direct relationship to the dollars spent. Although the representative is concerned about proper surface preparation and application of the provided, one should not expect that the representative will stay on the job, from beginning to end, 8 hours per day checking preparation, mixes and application. They will not likely document details, nor should they be expected to come forward on the owner's behalf to indicate a problem with the coating material or the application unless, of course, they are in the process of looking for another job.

If specifications require manufacturers to inspect the work, manufacturer's representative have been known to breeze in and out a few times while the work is in progress, bringing donuts and coffee for the contractor's personnel. Remember, it is the contractor who is paying them for their materials. Unless the work is drastically and obviously wrong, most representatives many not be aware of inconsistencies in the specifications and the way the work is being performed, or worse yet, they may see a problem and not say anything.

Effects of specifications un-enforcement

"Too often, owners and facility operators are driven by price in their search for contractors. Unfortunately, there are facility owners who regard industrial painting as little more than a commodity and who are unwilling to pay reasonable premiums to hire accomplished workers. This approach is unfair to legitimate contractors because it encourages unqualified firms to offer lower bids for jobs that are beyond their technical capabilities. It also exposes the facility owner to protracted field problems associated with poor quality control extended de-livery schedules and premature failures leading to more costly repairs later."

Unless contractors work is required to conform to carefully written performance specifications, standards and manufacture's requirements, they simply assume their work is acceptable. Contractors often refer to their methods and workmanship as meeting "standards of the industry." In fact, in their minds they are correct. However, standards are not industry standards unless they are written, definable and reproducible.

Contractors benefit by inspection, because their goal is to execute the work properly, safely, profitably and to the satisfaction of the owner. Inspectors assist conscientious contractors by helping to discover and remedy noncompliant application issues before they turn into problems. Contractors correct deficient work while in progress, than after completion from oversight rather than intended non-compliance.

Furthermore, contractors who produce marginal quality may be more likely than others to not include enough money in their estimates to comply with specifications. Should these contractors work be inspected with regularity, their quality would improve or they would go out of business. Installations would last longer. Plant down-time as a result of surfacings failures would be reduced. Warranties could function as a safety net after the application, rather than as a hopeful means to engender quality.

Manufacturers participate in warranties with the understanding their materials have been applied according to specifications and their written requirements. Their formulations and testing are based on certain parameters of surface conditions during application, correct mixing and application requirements. If the foregoing pre-requisites are not met, the manufacturer's warranty obligation is usually voided.

Disputes can result between contractor and manufacturer while the owner is caught in the middle, waiting for repairs to happen. After the fact, manufacturers become very active in testing and investigation when they may become obligated to participate in coatings replacement. With their laboratory and testing resources, manufacturers generally have the advantage to determine if their requirements had been met.

Conclusion

A guarantee time is usually shorter than the durable life expectancy of a coating system, and there are no rules that link the two periods of time i.e.

A guarantee is a legal document drawn up by legal experts, which outlines what will happen should a failure occur, but offers no substance to the success or failure of the specification performance.

The durability range of a specification is not a guarantee time, but a tool used at the planning and design stage to assess the level of coating failure before the first major maintenance.

It is critical at the beginning of the project for the asset owner, project managers, suppliers, consultants and contractors to agree that the specification will meet the designed durable life expectancy of the system.

Warranties are meaningful when design and application are harmonious.

■ *Mike Book, Affiliate Member of the* HDGASA.

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Recycling garnet in the shop and field

Alex J. Schuster, Regional Sales Manager – Barton Mines Company, L.L.C., Lake George, NY U.S.A.

The benefits of recycling garnet abrasives are undeniable. As disposal and transportation costs continue to rise, recycling is an efficient, environmentally friendly and proven method of reducing costs. Over the last seven years, recycling garnet in the field and shop has increased sharply.

Garnet recycling is conducted daily in a wide range of blast room applications. For fieldwork, recycling garnet is increasingly popular though these projects face additional challenges not encountered in a shop environment. Important field related considerations include how to keep the abrasive dry and how to ensure a continuous supply of quality, recycled abrasive. Portable recycling units utilising existing separation technology, have been specially designed to facilitate high efficiency garnet recycling in the field.

This paper will explain what a garnet abrasive is and how to recycle it properly. It will identify several fundamental recycling principles as well as some important factors to consider when evaluating whether or not to recycle in the field.

What is a garnet abrasive?

Garnet is a natural mineral typically mined from or near a river or ocean. Garnet is used for a variety of industrial applications such as sandpaper, water jet cutting and, naturally, abrasive blasting.

There are eight different varieties of garnet. The variety most commonly used for blasting is an "almandite" garnet, which is an iron-based mineral. It is very heavy (140lbs/ft^3) with a specific gravity of 4.1, very hard (7.5 on Moh's hardness scale) and durable. Specific gravity and durability are critical factors affecting both blasting and recycling performance. Because of these physical properties, garnet is capable of very high performance when used as a single pass (i.e. disposable) or recycled abrasive.

Much of the garnet used for abrasive blasting is uncrushed and alluvial, meaning that it was formed on a water source. The resulting garnet particles are sub-rounded to sub-angular in shape. Because alluvial particles are uncrushed, they contain few stress fractures and resist rapid breakdown during blasting.

Values vs. cost per ton

Increasingly, organisations now realise that the abrasive cost per ton is only one component of the total surface preparation cost. A high performance abrasive costing triple that of a less efficient abrasive can actually provide more "value" and reduce total surface preparation costs. This is a simple concept but to the uninitiated the abrasive with the lowest cost per ton is often perceived as the "best buy".

In reality, the relationship between abrasive performance and abrasive related costs is linear. These costs include abrasive disposal, collection, dust control and labour. All of the project costs affected by the abrasive should be factored into any evaluation as to which product represents the best value for a specific job.

Benefits of blasting garnet abrasives

Based on hundreds, if not thousands, of production jobs and countless side-by-side field tests, the typical benefits of blasting and almandite garnet include:

1. Reduced consumption/reduced disposal (typically by 50-75% compared to coal slag or sand);
2. Fast cutting (typically 20-35% faster compared to coal slag);
3. Low dusting (as much as 75% less than coal slag or silica sand depending on application);
4. Reduced cleanup (due to less abrasive consumed and less ricochet);
5. Recyclable (depending on application and source of garnet – typically 3-5 uses are possible);
6. Health & Safety – no detectable amounts of heavy metals and low free silica (less than 0.5%);
7. Non-Metallic/non-rusting/non-conductive. Suitable for steel and aluminium substrates.

Recycling Garnet

Most abrasives are classified as either single pass or recyclable. Rarely is a ferrous abrasive disposed of after one use intentionally. At the other end of the spectrum, abrasives that breakdown excessively, say 45% per blast, are not typically recycled. Somewhere in the middle is garnet.

Garnet abrasives are unique among mineral abrasives because they can be profitably blasted as a single pass, or, if conditions allow, a recycled abrasive. While recycling in general is appealing, recycling a garnet abrasive is especially attractive due to the dramatic cost savings it provides. About half of all garnet users recycle either in the shop or in the field. The other 50% have determined that blasting garnet as a single pass abrasive is economically effective and provides other valuable benefits unavailable from lower cost, lower performance abrasives.

In stationary blast rooms, recycling is straightforward Most of the time, recycling equipment is already in place. For field applications, equipment setup and layout, project containment, the weather and other situational factors can make recycling more involved.

Recycling is not "free". In the shop, purchasing, operating and maintaining the recycling equipment are primary costs. In the field, making sure the abrasive stays dry and is collected in a timely fashion for processing are additional costs.

When to recycle garnet

One can be very analytical when evaluating the cost and benefit of recycling in the field as illustrated by the following cost formula.

Unit Cost = (Abrasive + Labour + Equipment + Abrasive Collection + Disposal Costs) / Area Blasted. Other costs, such as dust control, medical monitoring, etc., can also be factored in as needed.

This formula, however, provides only part of the answer. Given that garnet is durable enough to be recycled and that efficient recycling equipment is available, the on-site conditions of each project are the primary factors determining whether recycling makes sense. Is the project big enough to justify the fixed equipment expenses associated with recycling? How will the abrasive be collected dry? What additional equipment, if any, is needed to charge the blast post with recycled garnet?

Garnet recycling equipment

There are a wide variety of recycling systems available on the market capable of recycling garnet. The goal is to select a unit that is easy to operate and one that produces a clean, productive finished material.

Effective recycling equipment for blast rooms has been around for decades. The major components of one popular design include a rotary drum, a gravity-fed air-wash separator, a dust collector, a bucket elevator and a recycled abrasive storage bin. Over the last ten years, a family of highly efficient portable garnet recycling systems have been developed which are capable of producing exceptionally clean recycled garnet.

Overview – recycled garnet

The blasted, dirty garnet is fed into the inlet hopper, travels up the bucket elevator and is gravity fed into the rotary drum. Here the oversized contaminants are extracted and useable garnet particles laden with undesirable fines pass through the air wash. In the air-wash, the unwanted fines are removed and the clean garnet falls into the recycled abrasive storage bin below. This process is straightforward and is not difficult to conduct in the field with the right equipment and a little training.

How the blasted garnet is cleaned

The rotary drum is the first stage of the cleaning process. No adjustment is required and the result is the same every time – any contaminant larger than 3/16" (paint chips, flake rust, etc.) will be automatically extracted.

The two major components of the air wash separator are a counter weighted swinging baffle and a lower separator lip. The dust collector extracts fine unusable garnet and pulverised paint fines as the blasted abrasive is cycled through the air wash. The lower separator lip scalps off any contaminants that are too heavy to be pulled into the dust collector, but are not quite as heavy as the usable garnet particles. Specialised garnet recycling units also include a very useful vibratory screen positioned below the air-wash that remove all particles that are similar in weight to garnet but that are slightly larger in size. The mesh size of the vibratory screen must be carefully chosen based on the grade of garnet recycled.

The dust collector provides a constant flow of clean air that is drawn through the blasted garnet effectively "washing" away the unwanted fines. Adjusting the airflow through the separator determines how many fines will be extracted. Unwanted fines are the "enemy" of productive blasting because they produce extra dust which cause profile to vary and productivity to slow. Removing undesirable fines is perhaps the most critical step in recycling.

Key concepts of recycling

When recycling, adding virgin or "make-up" abrasive at the rate of attrition is critical. Attrition means how much an abrasive breaks down each time it is blasted. Given that particle break down does occur, the only way to maintain the needed working mix is by adding virgin abrasive.

A working mix that is too fine for the coating or contaminant removed will cut unnecessarily slow and produce extra dust. A working mix that is too coarse will cut slower and create too much profile, causing primer consumption to increase.

A proper working mix is not that difficult to create and maintain when recycling but it does take an understanding of the process. In order to determine a suitable working mix range, the type and thickness of the contaminant or coating to be removed and the desired profile must be known. These two items determine the size of abrasive particles needed. Choose an abrasive that is as fine as possible provided it removes the coating quickly and creates the needed profile. The thicker the coating, the coarser the abrasive needed to remove it quickly. The coarser the abrasive, the deeper the profile produced.

When Recycling Garnet...

Recycling garnet can yield dramatic savings, especially when conducted properly. Though the actual process of recycling is the same in the field and in the shop, recycling in the field requires extra steps and closer management.

Wet Garnet:

Avoid this at all costs. Wet garnet will not flow and might damage the recycling equipment. It can be dried in the sun manually or via gas fired dryer. Generally if garnet gets wet, save it for batch (i.e. bulk) drying later or dispose of it. Proper containment and a flexible abrasive collection program are the best ways to avoid the difficulties associated with wet abrasive.

Centralised Recycling:

It makes sense to establish a Centralised recycling area, preferably inside a shed or building. This eliminates the problems associated with inclement weather when recycling.

Batch Recycling:

If the recycling operation is under cover or the garnet is collected in watertight bibs, it can be stockpiled for recycling. A typical recycling unit will recycle 4-6 tons per hour. Recycling in batches of 20-25 tons over an eight-hour shift is preferable to recycling five tons at a time over several shifts.

Adequate abrasive supply:

Given the goal of recycling in larger batches, additional garnet will be needed throughout the various stages of the blasting and recycling operation. The blast pots will need to be full, abrasive will need to be stockpiled for recycling and enough abrasive to operate one or two shifts should be held in reserve in case of equipment problems, etc.

Recycling garnet typically reduces the total amount of abrasive needed to complete the job by approximately 75-85% as compared to single pass garnet blasting. If high operating losses are anticipated due to wet or unrecoverable material, take this into account as well.

Abrasive collection:

This can be accomplished in a variety of ways depending on application. In a blast room, an auger or other automatic recovery system is typically used. In the field, often the abrasive is shovelled or vacuumed up. If a manual collection method is used, consider having one man collecting abrasive throughout the shift for every two blasters operating. In a simple blast shed, a bobcat or modified forklift is very effective.

Dust collection:

Adequate dust collection is very important. However, to the extent that the garnet is recycled properly and most of the fines have been removed, minimal dust collection can be used for the first two or three blast cycles.

Make-up abrasive:

Adding virgin abrasive regularly to the abrasive being recycled is usually where organisations have the most trouble. These make-up abrasive additions can be added continuously during recycling or at the end of every shift. For every 250 litre drum of fines (about 450kg.) extracted by the separator, add back in about 450kg. of virgin garnet.

Recycling equals savings

Recycling can reduce the total abrasive requirement of a project by as much as 75-85% as compared to single pass garnet blasting.

Garnet typically reduces abrasive consumption by at least 50% without recycling, compared to lower cost disposable abrasives such as coal slag and silica sand.

When recycling a quality almandite garnet, at least 2-4 additional uses are typically possible after the initial blast.

Summary: savings by the numbers

Garnet is a versatile, high performance mineral abrasive that can be recycled or used as a single pass abrasive with high efficiency. Garnet has found worldwide acceptance as a premium blasting abrasive that offers a full range of benefits to all users, from worker health and safety to fast cutting; from reduced environmental impact to reduced total project cost.

A properly recycled garnet abrasive can produce blasting performance equal to virgin garnet. In terms of productivity, dust generation, profile and level of cleanliness, the end result is the same – a high quality blast produced by a fast cutting, low dusting abrasive. The payoff of recycling is that the surface preparation costs could be reduced by as much as 50%.

2006 Eskom Hot Dip Galvanizing Awards

For those wishing to enter this year's prestigious Eskom Hot Dip Galvanizing Awards Event, the deadline for entry (31st May) is just around the corner.

These awards recognize and promote the development, application and use of hot dip galvanizing and duplex coating technology for corrosion control purposes.

The Eskom Hot Dip Galvanizing Awards is regarded throughout the industry as giving great exposure to every participant, not to mention the esteem of being a category winner or an overall winner. The competition has been running since 2000 and every year both the quality of the projects and the evening itself, has improved.

The event, which will again be held at The Castle, Kyalami, on Friday the 11th of August promises to be everything as good as the previous year and more.

A number of exciting entries have already been received and more are expected based on our feedback from the market.

Should you have a project, which has been hot dip galvanized and / or duplex coated (hot dip galvanizing plus paint), and still wish to participate, kindly get your entries in.

In order to simplify the process of entry, we have included 5 easy steps for you on our website, www.hdgasa.org.za. Alternatively, contact Saskia Salvatori on (011) 456 7960.

Thank you to Eskom for sponsoring this year's event and for supporting the event since 2000!

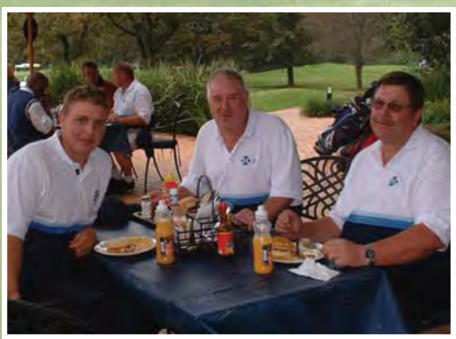
The Association held its annual Golf Day on the 23rd March 2006 at the Royal Johannesburg Golf Club. Despite the fact that the golf course was water logged, the players arrived to battle it out in the drizzle and the mud.

We would like to thank all the golfers and the following sponsors who made the event possible:

• ABB South Africa • Armco Galvanizers • Barloworld Galvanizers • Chemserve Orlik • Darren Millington Pro Shop • Duplex Coatings • Lianru Galvanisers • Off the Edge Marketing • Tempest Fire • Zincor Ltd

CONGRATULATIONS TO ALL THE WINNERS!

For more photos of the day, kindly visit the HDGASA website – www.hdgasa.org.za



Corrosion of hot dip galvanized piping used for re-circulating mine water

We report, following a number of visits underground to investigate conditions encountered where hot dip galvanized re-circulating cooling water pipes were failing due to corrosion, after approximately 12 to 18 months of service life.

During the inspection visits, it became obvious that the corrosion in question, originated from within the pipes, i.e. the waterside of the pipe. Where external corrosion was encountered, it could be ascribed to water leaking from the pipe being examined. The following photographs support this position and illustrate the performances of other (air piping) viz, hot dip galvanized pipes that were subjected to the similar "external" environmental conditions existing within the shaft.

Having established that the circulating cooling water was carrying the source of the corrosive elements, various water samples were taken. Water samples were taken from the actual corroding water pipe as well as from the returning water to the settling dam and a sample from the water exiting from the settling dam.

All water samples taken, exhibit an extremely high chloride content as indicated below:

- Circulating water (taken from the corroding pipe):
  Chloride = 1 120ppm
- Return water to the settling dam:
  Chloride = 16 400ppm
- Water exiting from the settling dam and returning to the surface:
  Chloride = 1 480ppm
- Comparison with sea water:
  Chloride = 20 000 – 30 000ppm
- Recommended levels of chlorides:
  < 500ppm

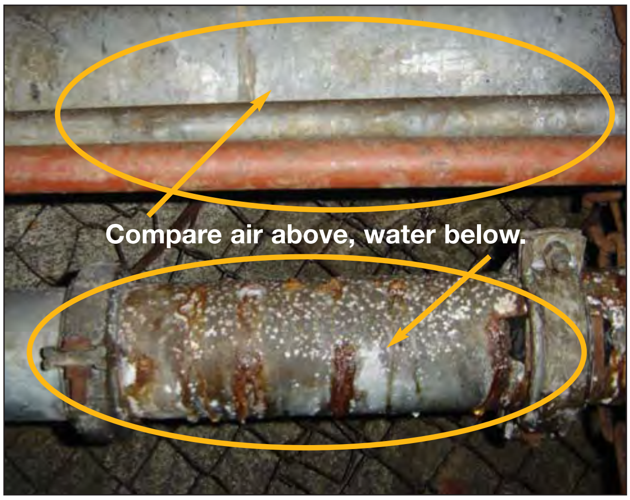
Conclusions and recommendations

Considering all the evidence, the primary cause of corrosion of the hot dip galvanized pipes is the result of the high chloride content within the cooling water.

It was recommended that the water treatment process be investigated to establish the possible source of the chloride contamination. It was further recommended that the water treatment process be extended to include the control of chlorides, sulphates and nitrates. In addition, a process of routine "bleeding off" to waste, of the circulating water, should be conducted in order to prevent accumulation of salts within the system. Such waste water to be replaced by clean make-up potable water.

In addition, consideration should be given to the lining of the pipes with an epoxy type coating to provide additional "barrier protection". To this end it was proposed that 3 or 4 sample pipes be prepared using a

Hot dip galvanized coating, external surfaces, performing very well except where internal corrosion has resulted in the perforation of the pipe. The cooling water has started to "leach out" and commence corroding the external surface of the pipe. Where no perforation has occurred, little or no external corrosion has resulted.



Two hot dip galvanized pipes, within the same shaft. The cooling water pipe exhibiting corrosion, while the air pipe above it is performing satisfactorily. It was reported that the larger air pipe had been in service longer than the water pipe in question.

duplex coating system, i.e. hot dip galvanized and internally coated with a suitable system. The sample pipes should be installed and performance monitored over period of 6 months. Should this recommendation be found to be successful, an economical review of the costs relating to water treatment versus the epoxy coating system would be conducted in order to establish the most cost effective solution to the corrosion problem encountered.

Figure 1: Section of underground pipe as received. Note the white (zinc) corrosion product and red rust emanating from the longitudinal perforations associated with the weld seam.

Figure 2: Corroded internal condition of the pipe section.

In addition to our findings and report, the matter was referred to an independent materials consultant, who submitted the following findings.

Evaluation of Corroded Piping

Introduction

Following the premature leakage of an underground piping system that had been installed between twelve and eighteen months prior to the investigation, water samples and a pipe section from the affected piping system were submitted for evaluation.

It was reported that the piping employed had been hot dip galvanized in order to provide longevity against the ravages of corrosion. The water passing through the system was also stated to be treated and regularly monitored with feedback control.

Evaluation

The pipe sample submitted (*figure* 1) was noticed to have a galvanized surface skin on the outside of the pipe. However, it was evident that the internal surface of the pipe was corroded and eroded (*figure* 2) with large longitudinal perforations through the wall that followed the weldment seam (*figure* 3). Shallow pitting was also evident within an arc of the internal surface perimeter that was associated with a waterline effect (*figure* 4).

On the outer surface of the pipe sample, white rust of the coating and red rust stains (from the substrate material) extending from the perforations was evident.

Figure 3: Pitting perforation along the weld seam.

Figure 4: Pitting attack along the edge of the 'waterline' marking.

The composition of the pipe was to the AISI 1010 steel grade, which is commonly employed for piping of this nature and application.

A section through the pipe revealed a core structure consisting predominantly of equi-axed ferrite. No significant population of manganese sulphide stringers or deleterious inclusions was evident (*figure* 5). The outer surface of the pipe had a ‘normal’ galvanized skin in which all the constituent ferro-zinc alloy layers could be discerned (*figure* 6). The thickness of the external galvanized layer was microscopically measured and found to be 77-80µm in depth. On the corroded internal surface of the pipe, intergranular penetration of the oxide along the ferrite grain boundaries was noted. The weld zone had a coarse acicular ferrite structure (*figure* 7).

The water analysis of samples taken in the underground settling dam, after the settling dam and water supplied to the working face of the mine revealed high total dissolved contents and extremely high concentrations of chloride (approaching that of sea water 20 000-30 000ppm).

Discussion

The zinc layer applied via galvanizing to the surface of the pipe protects the steel substrate via sacrificial corrosion. Initially the as-galvanized state of the pipe offers a silvery bright and reflective surface due the extreme outer surface skin of pure zinc metal that is deposited on the pipe surfaces as it is withdrawn from the galvanizing tank. However, this aesthetically pleasing surface state is soon lost due to the formation of a dull zinc carbonate surface film, which is the mechanism by which zinc attempts to protect itself from corrosion. Zinc ‘rusts’ to form a friable, voluminous corrosion product that is white in colour, as was evident on the outer surface of the pipe sample).

It should be noted that the steel composition could on occasion, result in a dulled galvanized zinc surface. This is due to the steel composition forcing the zinc-iron reaction to continue (which produces the microscopic layered structure noted) even after the pipe has been fully withdrawn from the galvanizing tank. This produces a harder surface without the desired aesthetic quality. The corrosion characteristics however, are not affected.

Providing that the water conditions at the galvanized surface of the pipe remain such that the zinc carbonate film is maintained in a stable state, the anticipated full sacrificial life of the zinc layer will be achieved. In cold/chilled water systems, the stability of the zinc carbonate film is largely controlled by the pH state of the water. The minimum corrosion rate is achieved at a relatively high pH level (7.5-12), whilst acidic pH levels (≤6) will result in destabilisation of the zinc carbonate film.

Destabilisation of the zinc carbonate film results in its dissolution into the aqueous environment and this is further accelerated by water flowing over the surface. As the zinc attempts to re-protect itself in the areas of destabilisation, the galvanized zinc skin is thinned and this foreshortens the predicted service life achievable. In the instance where the environment conditions are not controlled and the undesirable state is maintained for a significant period, the loss of the zinc coating will expose the steel substrate of the pipe.

Scaling tendencies (protecting the pipe surface) are indicated by the calcium carbonate levels and high levels (hard waters) generally serve to assist and protect the zinc surface from high chloride levels present in the water. Chlorides adsorb onto the zinc surface where they occupy sites that should be taken up by the larger compound carbonate ions. Their presence serves to assist in the surface destabilisation and stripping off of the zinc. Normally, the large carbonate ion would protect the surface from chlorides, even at high ionic concentrations of the latter. In this instance though, the pH imbalance would offset the ability of the adsorbed carbonate ion layer to protect the zinc coated surface.

Once the zinc layer has been removed from the internal surface of the pipe via the mechanism discussed, the steel substrate is left bare and thus highly susceptible to the flowing high chloride ion containing environment. The corrosion mechanisms noted on the exposed steel internal surface of the pipe are typical of general corrosion (normal wasting of the steel) overlaid with localised corrosion of specific sites – in particular the weld seam. The 'waterline' effect arises from stagnant conditions and slow drainage conditions out of the pipe. This effect arises due to differential aeration.

Figure 5: Cross section through the corroded region (125X). Note the clean ferrite structure.

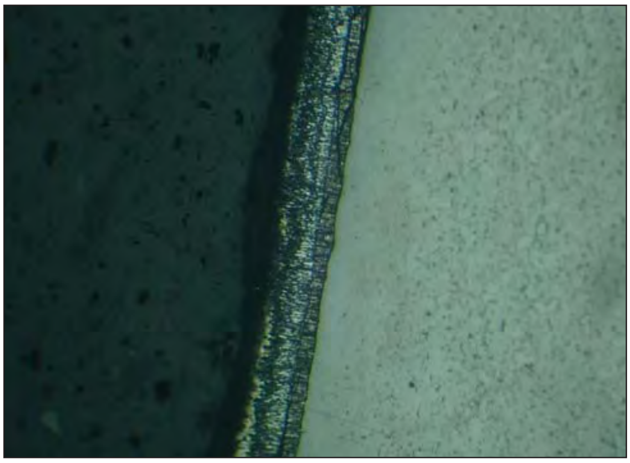


Figure 6: Cross section through the external surface galvanized zinc skin (125X). Note the various zinc-iron alloy layers present in the coating.

Figure 7: Cross section through the weld and heat affected zone (125X). Note the coarse acicular grain structure.

The perforation of the pipe along the pipe weld seam is a 'normal' likelihood. The general structure of the pipe consisted of fine grained equi-axed ferrite. At the weld and adjacent heat affected zone, the grain structure was coarsened. This metallurgical anomaly (the weldment) creates a high strain energy site relative to the remainder of the pipe material. Under corrosive conditions, the weldment becomes the anode and due to its small size in relation to the large pipe diameter and associated internal surface area, the corrosion current is concentrated on the former site and thus produces a locally accelerated rate of pitting corrosion.

Pitting corrosion is also associated with 'dirty' steel, which has a large population of manganese sulphide stringers (these inclusions form local anode sites and their dissolution generates intense acidic cells that produce similar rapid pits and perforations). However, as was observed, the steel cleanliness was not of a contributory nature – to whit – the steel was clear of these detrimental anomalies.

The shallow pitting attack noted away from the weld seam was associated with external factors (re: the waterline effect). Differential aeration occurs due to the difference in oxygen potential between the surface and bulk regions of a stagnant or slow moving aqueous volume and causes pits to form immediately below the liquid surface, with the formation of a nodule-like skeletal oxide spinodal structure at the surface (iron oxide has a larger volume (≈11%) than the steel from which it is generated).

The water analyses carried out concurrently with the pipe sample submission, as well as those previously undertaken all highlight severe variances from the conditions that are intended to prevail. The variances were not minor and were up to two orders of magnitude wayward of the desired controlled conditions. The reported pH range required was $9^1/_2$-$10^1/_2$ (in keeping with the ideal operational range for a galvanized coating). The measured pH's varied down to roughly $5^1/_4$. Ideally chloride levels should not exceed 200ppm, but were found to be approximately 20 000ppm.

The water results were undertaken by several laboratories and although each returned varying values, all results indicated excesses of a significant level, which outweighs the anticipated differences that might arise due to sampling.

The corroboration of the water analysis results obtained to date, coupled with the extensive corrosion damage to the piping internal surfaces and the nature thereof, over the reported service period, indicated that the water treatment had not been controlled nor accurately monitored.

It should be noted that the visible corrosion failure of the piping via the appearance of the longitudinal weld seam perforations and leakages, represent the weak link in the system. For the period that the water control has been wayward, the pumps and equipment attached to and fed from the water system will also have suffered in terms of accelerated corrosion via the non-optimum state of the water.

Conclusions

The premature corrosion failure of the underground piping system was due to the loss of the internal protective galvanized zinc layer applied to the pipes, which resulted in exposure of the steel pipe substrate and the accelerated pitting corrosion attack to the weld seam.

The corrosion-erosion loss of the internal protective galvanized zinc layer was the result of destabilisation of the protective zinc layer via inadequate water control and the development of severely aggressive and corrosive aqueous environment conditions.

The grade of material employed for the pipe, the structure of the steel and the external zinc coating characteristics were found to be satisfactory. No un-anticipated metallurgical anomalies (re: the steel cleanliness) were evident that might have contributed to the accelerated corrosion attack of the pipe. The weld seam, being a metallurgical anomaly, is an inherent manufacturing feature within the pipe.

Water sample analyses (current and prior) returned conditions that were significantly variable from the indicated and reported control ranges.

In summary, the failure of the piping system was the consequence of inadequate water control. Measurements of the water conditions were inaccurate and this resulted in failure to implement the necessary minor (usually) adjustments required and the sustained period of poor control has ultimately resulted in the large discrepancies now present and the associated damage experienced.

Corrosion damage is not forgiving and is not recoverable.

Recommendations

The residual life on the piping may be considered in terms of weeks rather than years – even without considering the local accelerated pitting failures that will increasingly develop in numeracy, severity and extent. The pipe damage is extensive and advanced.

In-situ relining of the pipe using a fibre-hardening resin composite might be considered. This technique is routinely carried out on older urban water systems and has the advantage of structurally bridging all the perforations currently present (pipe-within-a-pipe). In-situ applied polymer coatings (unfilled paints) will protect the internal surface, although they may have difficulties in maintaining their integrity over the wider and longer weld perforations. They also do not offer any sacrificial protection at local damage sites – unless they contain a zinc filler.

Replacement of the galvanized piping can be undertaken providing that the water conditions are returned to the desired operational ranges.

Third party independent water analysis should be undertaken with the results being submitted to the user and transmitted to the facility carrying out the water control function. Routine analysis becomes routine and should be guarded against.

■ *Bob Wilmot, Russel Thompson (Physmet) & Walter Barnett*

Hot dip galvanized pump station platforms

As part of the Association's effort to educate and improve the frequent ineffective communication between the end client 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 coating report by the Association. We further include a comment from the galvanizer following the debacle.

For obvious reasons names of all parties have been withheld but the article might be invaluable to others in order to avoid similar situations in future.

The Hot Dip Galvanizers Association was asked to comment on the hot dip galvanized coating used to protect certain structural steel Pump Station Platforms. This was done at the galvanizer's premises.

The specification for these platforms require hot dip galvanizing to SANS 121 (ISO 1461) followed up by three coats of paint, i.e. a duplex system. It appears that the duplex coating is required for enhanced corrosion protection, as the platforms are to be installed close to the sea or in the splash zone.

Following an inspection of the coating, I report as follows:

Hot dip galvanizing

When designing a structure which is to be hot dip galvanized, it must be borne in mind that articles are immersed into and withdrawn from a bath of molten zinc heated to a temperature of about 450°C. Design and fabrication is required to conform to acceptable standards which apply, regardless of whether a hot dip galvanized or a painted coating is to be applied. In the case of hot dip galvanizing, some additional requirements, which aid access and drainage of molten zinc, will reduce costs and immensely improve coating quality, particularly with steel that is ***reactive to molten zinc***. (See "Reactions between iron and zinc", available on request).

With certain fabrications, holes, which are present for other purposes, may fulfil the requirements of venting of air and draining of zinc; in other cases, such as this, it is necessary to provide additional holes for this purpose. Furthermore:

- Holes for venting and draining should be as large as possible.
- These holes should be diagonally opposite one another but also as near to the corners as possible, to prevent air traps.
- In the case of huge components such as these, it is always wise to ensure that the design of the component has been thoroughly discussed with the galvanizer ideally prior to fabrication but certainly before it leaves the fabricators premises.
- The client has specified that the components be duplex coated and for preparation, sweep blasting has been selected. The Association has a Code of Practice for preparation including sweep blasting, which is freely available in electronic form. ISO 12944 also has a part dedicated to preparation prior to painting over hot dip galvanizing. Non-compliance with either of these standards can lead to excessive blast pressure and inappropriate blast media being used, both of which may lead to the partial or full destruction of the metallic coating.

In the majority of cases, particularly for mining and industrial purposes, hot dip galvanizing is specified for corrosion protection. For this reason, the two most important inspection criteria of hot dip galvanizing are coating thickness and coating continuity.

Coating Thickness

A number of coating thickness readings were taken on all four of the pump station platforms. Coating thickness readings ranged from 220 to 469 with a mean of 322µm. Coating thickness conforms to the

Figure 1: Lumps and runs leading to excessive coating thickness.

requirements of SANS 121, which requires that for steel thickness 6mm and greater the mean coating thickness is 85µm with a minimum local coating thickness of 70µm.

As life of a zinc coating, no matter how applied is more or less proportional to its thickness in a given environment, the thicker coating will provide a substantially longer life than a thinner coating.

SANS 121 does not specify a maximum coating thickness. A thick hot dip galvanized coating does; however, tend to be brittle and may be easily damaged.

Coating Continuity

The coating is relatively continuous, except for a few mechanically damaged areas ranging from the size of a R2 coin to about 5x that size, caused by inappropriate sweep blasting or mechanical handling during transport and repeated on or off loading.

Observations

Lumps and runs leading to excessive coating thickness (figure 1):

The principle of good hot dip galvanizing is rapid immersion and slow withdrawal. Molten zinc has a density of 6.8 in molten form and steel 7.84, without sufficient fill holes, the component will tend to float in the molten zinc increasing the time that is normally required to submerge the component into the zinc bath. Coupled to this is the normal boil off time which is the time it takes for solidified zinc, caused by the immersion of a relatively cold object entering the molten zinc, to return to molten zinc. This additional time, coupled with moderately reactive steel will have a marked incremental effect on the coating thickness.

It follows therefore that "The more simple the component the greater the hot dip galvanized coating quality, the more complex the component, the greater the requirements for appropriately sized and positioned fill and drainage holes, the absence of which will cause excessive zinc runs

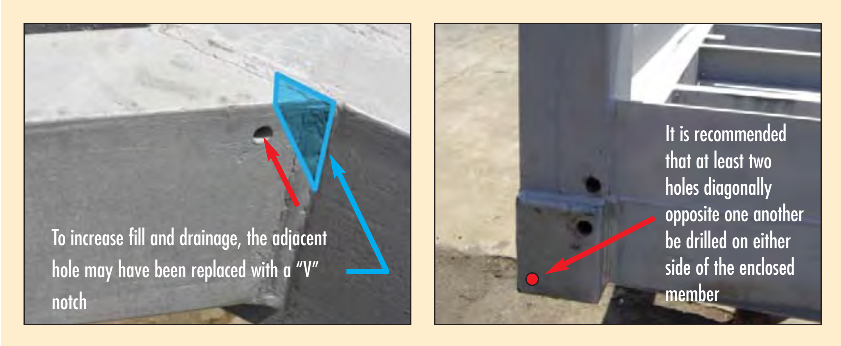


Figure 2: Fill and drainage holes.

(thick coatings), the deposition of superficial surface ash, etc".

Due to the possibilities of excessive cleaning, which when dealing with the relatively low skills base employed at the galvanizer or on site, leading to uncoated areas, the galvanizer will usually limit mechanical cleaning dependent upon the application and customer requirement. As can be seen the coating thickness in both instances has not been compromised and in our opinion is not compromising any mating surfaces. Coating roughness may lead to an aesthetically unacceptable coating appearance if the application was architectural but for this purpose, the surface, from a corrosion resistance perspective is deemed to be acceptable.

Fill and drainage holes (figure 2):

Depending on the orientation of the component when supported on the flight bar, the fill/drainage holes shown in this photo could be inappropriately positioned, with the one below being too small. To increase fill and drainage, the latter hole may have been replaced with at "V" notch (*see figure 2 above left*). Short of discussion with the galvanizer it is recommended that at least two holes diagonally opposite one another be drilled on either side of the enclosed member (*see figure 2 above right*).

Mechanical damage:

In order to close the drainage holes, carbon steel plugs have been hammered into the component and this hammering onto a thick coating has caused excessive coating damage alongside most of the drainage holes (*figure 3*).

Inappropriate blasting pressure / media particularly with the thick coating on these components (see heading overleaf) or just frequent handling (in the absence of lifting lugs, various other methods of lifting may have been used). These collectively could have caused the coating damage shown in *figure 4*.

Notice the inappropriately sized fill and drainage holes and also the mechanical damage resulting from the hammering of the mild steel lugs (*figure 4 - bottom left*). The recorded residual iron/zinc alloy layer (*bottom right – figure 4*) is 18.7µm. This residual Fe/Zn alloy layer is normally indicative of a silicon-killed steel.

Figure 3: Mechanical damage caused by hammering steel plugs at most drainage holes.

Figure 4: Mechanical damage.

Excessive blast pressure and / or inappropriate blast media:

The following photos show the extent of the coating damage caused by incorrect blast pressure and / or inappropriate blasting media. Blast pressure required for creating a substrate key for subsequent painting onto plain steel usually requires at least 700kPa but with sweep blasting the pressure must be reduced to no more than 250 to 300kPa. Appropriate controls such as needle valves adjacent to the operator are necessary to ensure the reduced blast pressure is maintained and controlled.

Figure 5 (*top left*) shows the entire surface coating that has been reduced to a mean coating thickness of 29µm, with a maximum of 110 and a minimum of 11.1µm. 23 coating thickness readings were taken on this surface. *Figure* 5 (*top right*) shows one of the readings (18.9µm).

Fill and drainage hole closure plugs:

These plugs seem to have been made from uncoated carbon steel. Carbon steel is electro-positive to zinc and due to the contact with the hot dip galvanized coating particularly fully immersed in water, would lead to a rapid attack of the surrounding metallic coating. The top paint coating would provide a measurable amount of protection but this would be short lived. It is recommended that all plugs be manufactured from some form of industrial plastic or lead. Furthermore, in order to minimise the damage to the hot dip galvanized coating when installing the plugs, the shape should be able to take a hammering without affecting the hot dip galvanized coating. See proposal in *figure* 6.

Crevice (*potential corrosion area*):

Lack of sealing of crevices (*see figure* 7) can lead to premature corrosion, particularly when the component is fully immersed in seawater.

Recommendations:

Due to extensive coating damage sustained by inappropriate sweep blasting, the platform marked "hold" should be stripped off and re-galvanized.

In terms of the Association's Code of Practice, it is recommended that immediately after sweep blasting, painting must take place. Immediate painting is necessary to ensure that the substrate remains free of contaminants.

Subsequent handling of the platform bases will to a greater degree have resulted in surface contamination such as transport oil and grease, fingerprints from handling, being deposited on the surfaces, which must be comprehensively removed.
As the platforms are expected to perform in accordance with the end-users specifications and the environment at hand, it is therefore recommended that all platforms be stripped off and re-galvanized.

A secondary option to save immediate costs but this would have to be discussed with the client, would be to repair coating damage in accordance with the coating repair procedure attached, using a product such as "Zincfix".

The crevice highlighted above should be comprehensively sealed before painting takes place.

Although comment was not sought in terms of the paint coating system, which we understand is an epoxy primer, followed by 1 coat of high build epoxy, finished off with a polyurethane topcoat. No DFT's have been given and it is understood that these would be in accordance with the respective data sheets.

Making use of two coats of epoxy tar or two coats of a product such as "Galvanox", with the DFT's in accordance with the respective data sheets, as a substitute paint coating system over the initial epoxy primer, would in our opinion be more resistant to sea water, either at the splash zone or fully submerged in the sea.

Finally, having been involved in the promotion of the hot dip galvanizing industry for more than 10 years,

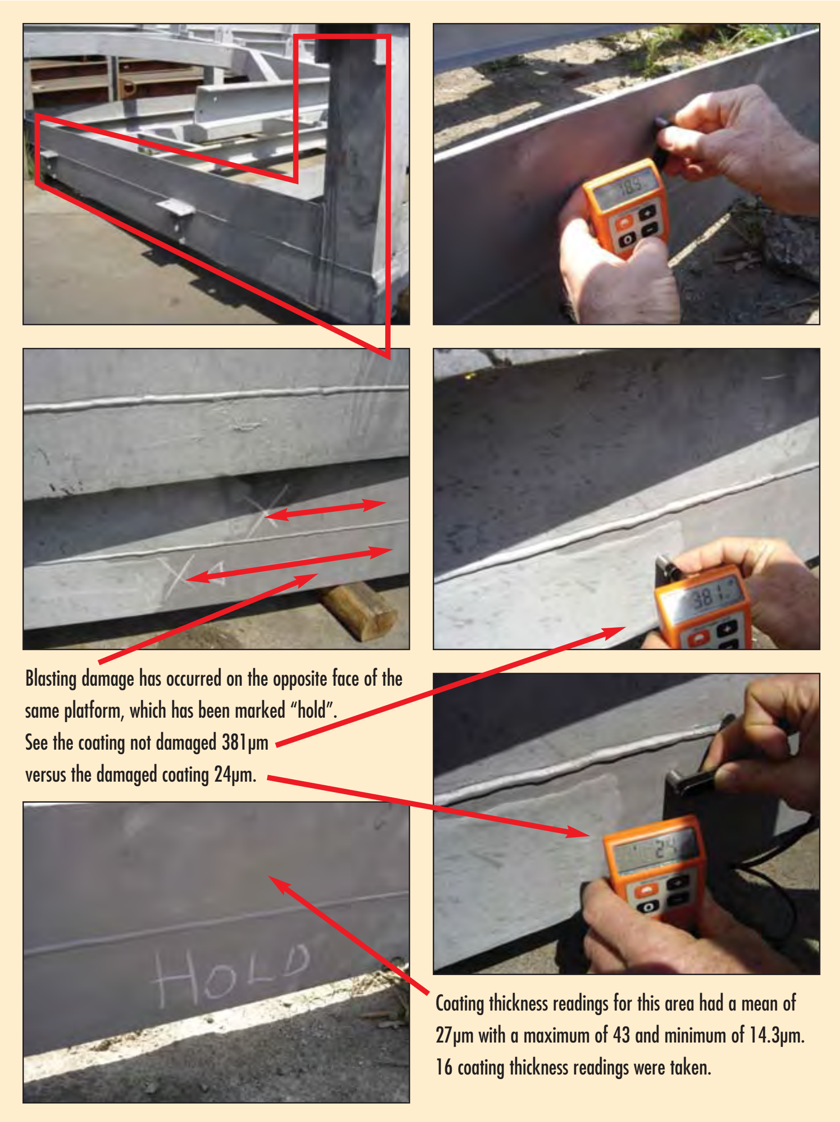


Figure 5: Excessive blast pressure and/or inappropriate blast media.

passionately seeking opportunities to promote and overcome design and process difficulties, with design engineers and end-users, I am always amazed that there always seems to be time to redo the products at an immense cost versus initial involvement of the HDGASA and / or its members to optimise planning of the coating of these platform bases.

For your further reading, I have attached the comments of the galvanizer.

■ *Terry Smith*

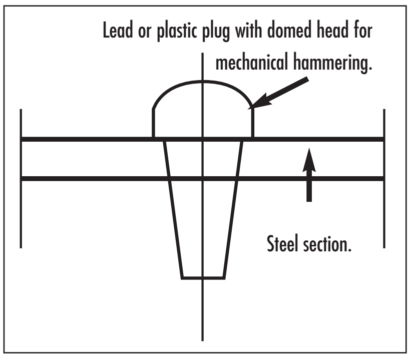


Figure 6: Fill and drainage hole closure plugs.

Figure 7: Crevice (potential corrosion area).

THE GALVANIZER'S COMMENT ABOUT THIS JOB

At no stage was the galvanizer involved with the design of the product or involved during manufacturing. It was only after the product was fabricated that the galvanizer was involved to have it urgently hot dip galvanized, however no provision had been made for venting or drainage. At this stage unfortunately it is too late to make proper alterations for venting and drainage and inadequate size holes had to be drilled afterwards.

Be the time that the holes had been complete we were requested to galvanize this as a matter of urgency. A special weekend shift had been arranged to do this job. As can be expected the coating thickness was far greater than necessary, a direct result of the design.

This unfortunately contributes to unnecessary costs for the galvanizer and the customer, in fact with the amount of zinc on the product and the overtime, we most probably made a loss on this job.

To compound the situation mild steel studs had been used subsequently to plug the holes with disastrous results as can be expected with such a thick coating. To expect the galvanizer in this instance to strip and re-galvanize, will contribute to unnecessary costs for the customer and the galvanizer as it is, in my opinion, possible to repair the product, either with zinc metal spraying or with a zinc rich epoxy. We recommend the zinc rich epoxy in this instance.

This once again proves the importance for the design engineer or the fabricator to involve the galvanizer up front, prior to galvanizing to avoid this type of situation. The amount of management time that is subsequently spent to debate this and write reports is totally unnecessary as it adds to more cost and loss of productivity.

This unfortunately is the sad story in the galvanizer's life, as this happens all the time despite constant efforts to educate our customers regarding the importance of the design for galvanizing.

Kind regards
The galvanizer

Personality Profile

Sue Clark

Sue Clark is an architect with Equilibrium Studio, Tshwane.

Sue grew up in Tshwane and soon after high school, travelled to The USA and Namibia. Sue returned and studied Architecture at the University of Cape Town. After graduating as an Architect, she moved to the UK to join an architectural practice. Work later relocated her temporarily to Malaga in Spain, and later to Jakarta in Indonesia. After some years abroad, during which Sue gained much useful and varied experience, she returned to South Africa to join the Pretoria branch of Stauch Vorster, Architects. She later moved to AUB Projects, after which she joined Jens Juterbock in their own architectural practice in Pretoria under the name, Equilibrium Studios (Pty) Ltd.

Sue and Jens have been responsible for a number of award-winning projects. These have included the up-grading and additions of Daimler-Chrysler's head office buildings at Zwartkops, the erection of the Wesleyville school and Community centre at Chalumna, and building the Chatsworth Community Centre in Durban. The Daimler Chrysler extensions and the Chatsworth Community both received South African Institute of Steel Construction Steel Awards.

They won the recent international competition for a design, to be used for the Long Walk to Freedom Statue, to be erected at the Port Elizabeth harbour entrance. What will be a particular design challenge will be corrosion protection in the form of a duplex coating, for the 40-plus metre steel pinnacle to the tower.

Sue and Jens's hobbies studio has been constructed largely from recycled material that was salvaged from demolition sites, and the design has received worldwide attention and recognition as well as a South African Institute of Steel Construction Steel Award.

Jens Juterbock (Architect), Judge Albie Sachs and Sue Clark (right) admire the winning entry for the Port Elizabeth "Freedom Tower" which was submitted by Sue Clark.
Photo supplied with thanks by "Die Burger".

One of Sue's special interests is light steel construction, and the South African Institute of Steel Construction sponsored her attendance of a workshop in Australia on the subject, where she enjoyed the privilege of exchanging ideas with some of the most respected world experts in this field.

Sue feels that corrosion control of steel structures, especially at coastal locations, as was the case with the Chatsworth project, needs to be thoroughly addressed by the project team at the inaugural stage of each project.

Sue's numerous hobbies are allied to, and augment her architectural interests. She loves sketching, painting, metal construction and ceramic work. The Studio invested in a laser cutter, which was used to create a stunning 1:100 scale model of the "Ten Years of Freedom" monument, required for the competition, and now travelling the country as an exhibit. Sue and Jens recently entered the Carrol Boyes candle-holder design competition, and reached the finalist list. Sue and Jens believe that involvement in challenges of this kind helps to broaden views and prevent the mind from slipping into stale approaches to the profession.

Equilibrium Studio is currently involved in the Tiger, Pygmy Hippos and Reptile Enclosures at the Johannesburg Zoo. These projects require special attention to steel detailing, and particularly the treatment of the mild steel structure and mesh for long-term durability and low maintenance. Structures need to be attractive, without detracting from the animals, or creating an impression of a prison.

Sue and Jens prefer simple designs and structures with perfect detailing. They also prefer low maintenance and natural materials that have a recyclable value, hot dip galvanized mild steel being the favoured structural material.

Walter's Corner

A good looking coating is not necessarily a good coating.

The most attractive and physically appealing young ladies don't necessarily make the best wives and mothers. This is a fact, which is substantiated by unofficial divorce statistics, hence the saying beauty is only skin deep. But what has this got to do with hot dip galvanizing you might ask. There is of course a distinct parallel between the two.

Protective coatings are provided primarily to control the degree of inevitable corrosion attack, which varies from one environment to another. While durability is the prime requirement for any protective system, a pleasing aesthetic appearance is in many instances also an essential requirement. On the other hand, an initially attractive surface finish does not necessarily indicate that a durable coating has been applied. In the case of organic coating systems, the best of two worlds is normally achieved by applying a heavy duty paint system which is overcoated by means of an attractive top coat in an appropriate colour.

When considering a zinc metal coating applied by the hot dip galvanizing process, we are concerned with a different protective concept in that the formation and durability of the coating is largely governed by metallurgical laws of nature. Molten zinc, at the galvanizing temperature, reacts with the iron in steel to produce the well-known series of iron / zinc alloys, which are overcoated by relatively pure zinc as the item is withdrawn from the galvanizing bath. The final coating thickness achieved is to a large extent governed by the steel composition with silicon, phosphorus and to a lesser degree, the carbon content, playing the major role.

The protective mechanism provided by zinc is somewhat different from that available by means of an organic coating. Apart from cathodic protection, which precludes the possibility of corrosion creeping underneath the coating at discontinuities, the coating also provides essential barrier protection.

There is no such thing as total corrosion prevention by any coating but corrosion control is of course possible. In this respect, zinc is somewhat of an enigma in that it is a reactive metal, which readily combines with other elements in

the environment. The fact that zinc reacts with both oxygen and carbon dioxide (which are ever present in the atmosphere) is beneficial in that a stable surface film of zinc carbonate is thus formed on the coating surface. Other substances such as chlorides, sulphates and acids result in undesirably aggressive reactions with zinc.

A hot dip galvanized coating is aptly described as a wasting protector, the thickness of which is reduced to a lesser or greater degree, over a period of time, depending on environmental conditions. For this reason, the protective life of the coating is more or less proportional to its thickness in a given environment. This is because the coating weathers away fairly uniformly while it is not prone to pitting or localised corrosion.

It follows therefore that the thicker the hot dip galvanized coating, the longer its protective life. But herein lies what is sometimes conceived to be a problem. Thicker, more durable hot dip galvanized coatings lack the initial glossy silver lustrous appearance of the thinner coatings while at the same time, the surface finish is inclined to be discoloured and somewhat rougher. I hasten to add that this is no excuse for a galvanizer to provide a coating with gross imperfections such as excessive surface roughness and protuberances, which can be prevented by good galvanizing practice. Meanwhile, the galvanizer achieves optimum results if he is made aware of the chemical analysis of the steel that is to be hot dip galvanized but this unfortunately is rarely the case.

While substantially thicker hot dip galvanized coatings will provide long term protection, surface appearance may well deteriorate as the protective film weathers away with time. Discolouration and surface rust staining can become evident even when many years of protective life still remains. This is due to the thick iron / zinc alloy structure of the protective film which, when exposed, is dark grey in colour while the rust stains emanate from iron in the coating and not from the steel substrate.

This can be misleading and frequently results in the erroneous assumption that the coating has failed. Thickness measurements with a correctly calibrated instrument will invariably indicate that a protective barrier still remains, bearing in mind that the iron / zinc alloy layers in a hot dip galvanized coating are if anything, more resistant to corrosion than pure zinc.

An interesting example can be observed on the high-rise lighting masts at the Gillooly's Interchange on the N3 highway in Bedfordview, east of Johannesburg. The original hot dip galvanized coating was extremely thick and now more than 30 years later still averages 260μm. See individual coating thickness readings taken on the matt grey and black coating. The original coating had dark grey patches which were evident where the iron / zinc alloys had grown through to the coating surface during galvanizing. A passing motorist today can well be forgiven for assuming that the coating has failed whereas a significant protective barrier still remains. Meanwhile, corrosion at busy interchanges such as this one is relatively severe, due to the presence of high levels of exhaust fumes.

It has to be conceded that aesthetically, the high-rise lighting masts at Gillooly's are somewhat of a disaster despite the extremely effective corrosion control attributes provided by hot dip galvanizing in this case. Unfortunately, no-one has been able to develop a coloured zinc nor is this ever likely to happen. To misquote Henry Ford, "you can have any colour galvanizing you like as long as it is grey".

This is not to say that the neutral grey appearance of most galvanized coatings does not have its attributes in many applications, both architecturally and for other reasons. The Armco guardrails installed on the sides of motor roads are hot dip galvanized as a matter of routine. Gone are the days when these rails were painted white. The reason given by road safety authorities is that the neutral grey appearance of zinc is less likely to distract motorist's attention from the road ahead.

But how can a more glamourous appearance be provided for galvanizing when this is necessary? The answer is of course obvious; apply a decorative

The general appearance of the matt grey and black weathered iron/zinc alloy hot dip galvanized coating.

The matt grey weathered coating thickness measured 302μm.

The matt black weathered coating thickness measured 278μm.

surface paint coating. Contrary to a general misconception, a suitably cleaned galvanized coating provides the ideal surface on which to apply a compatible paint coating. This concept of duplex coating is synergistic from a durability aspect, but it also ensures that beauty is no longer only skin deep.

MISCONCEPTIONS

Miss Conception puts it "straight"

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

Hot dip galvanizing of reinforcing steel for concrete only works if you don't need it.

True or false?

This statement was repeated to me by an eminent consultant and friend of many years who resides in the Western Cape.

The fact is that hot dip galvanizing of rebar is no substitute for good quality concrete, correct structural design and competent construction procedures.

Provided that cured concrete is to the required density, cover over the rebar is adequate and no voids or pockets are present in the poured mix, additional corrosion protection of the reinforcing steel is generally unnecessary. Unfortunately we do not live in a perfect world where all these essential requirements can always be guaranteed.

For this reason, the provision of a protective coating on rebar must be regarded as additional insurance "cover" (no pun intended) aimed at preventing unforeseen premature failure and the substantial extension of the service life of reinforced concrete structures.

In corrosive environments where, for example, chloride levels in the atmosphere are aggressively high, corrosion inducing substances, including carbonation, permeate through the concrete cover to the rebar where corrosion is initiated. At the same time, the pH level of the concrete is reduced, thus increasing the propensity for steel corrosion.

The condition of exposed hot dip galvanized reinforcement found during the demolition of the 40 year old bridge. With isolated exceptions, the hot dip galvanized reinforcing shown, in this photograph, is typical of 98% of that inspected.

A potential problem frequently remains undetected until such time that steel corrosion products build up sufficient pressure to cause spalling and cracking of the concrete cover. This inevitably results in an accelerated degree of steel corrosion and potential structural failure.

Repairs to damaged concrete structures are costly and in many cases only moderately successful, hence measures that can prevent premature failure should always be considered. Spalling of concrete is not necessarily confined to aggressive environments. The problem can be observed at several freeway bridges in the Gauteng region where repairs are currently taking place.

Galvanized reinforcing steel is by no means a new concept and its successful use in many countries including South Africa is well documented.

The slender pre-cast concrete panels that were used on the Civic Centre in Braamfontein were hot dip galvanized due to cover restrictions and to prevent spalling and rust staining. To date after some 30 odd years the panels are performing as expected.

Phoenix Galvanizing is accredited with ISO 14001 and OHSAS 18001

Phoenix Galvanizing's ISO 14001:2004 and OHSAS 18001 journey started in 2004, when management took the decision to boldly attempt implementing the standards as an integrated system. Certification would mean that Phoenix Galvanizing would be acting more responsibly towards its employees, clients and suppliers. The fact that Phoenix Industrial Park is situated on the outskirts of a vast residential area, the implementation of ISO 14001:2004 would also have a positive impact on the local community and environment in general.

Implementation and certification of these systems required a thorough understanding of health, safety and environmental legislation, a review of the company's culture, an upgrade of policies and procedures, training of the entire workforce and capital investment in appropriate areas.

A lot of hard work and dedication went into closing out findings by SABS during the 1st and 2nd stage audits, which were cleared in October 2005. The certification process by SABS then followed and has culminated in the 7 December 2005 certification ceremony of both ISO 14001 and OHSAS18001.

From left to right: Yashica Ramkisson - Chairperson of the SHE Committee; Roy and Yashada Ramkisson - Directors; Shuvendra Nagasar - VC of SHE Committee; Latha and Anni Ramkisson - Directors; and Frank Mokamo - Regional Director SABS KZN.

Phoenix Galvanizing is the first Hot Dip Galvanizer in the country to achieve both marks! Phoenix Galvanizing is one of only 5 companies in KZN with all three marks: SABS ISO 9001:2000, ISO 14001:2004 and OHSAS 18001.

"Braithwaite" type pressed steel water storage tank

The application

The concept of liquid storage in tanks constructed by means of a series of modular steel panels bolted together on site was originally developed and patented in 1901 by "Braithwaite" in the United Kingdom, an organisation which has continued to be active to this day.

Large storage tanks constructed to this design from pressed steel sections such as the one in this case history are generally mounted on steel towers and used extensively as in this case by municipal authorities.

Environmental conditions

South Africa is known for its many atmospheric conditions from relatively benign to extremely corrosive. Although Johannesburg has no doubt suffered from pollution from numerous sources, one such source being the old Orlando and Kelvin Power Stations (*see article in magazine* No. 26), where huge amounts of coal were burnt monthly, the atmosphere is currently relatively benign. The area of Johannesburg currently falls into corrosion category (C1 or C2 in accordance with ISO 9223) and therefore has a zinc corrosion rate of less than 1mm per year. (*See Corrosion Category table in magazine* No. 23, *page* 62).

Our findings

The "Braithwaite" water tank and stand is situated on the eastern rampart of the Johannesburg Fort. The water tank steel panels have the same pressed steel form that is used to manufacture present day Braithwaite tanks. Braithwaite commenced business in 1901.

Although the coating on the fasteners has failed and are now discolouring the remaining hot dip galvanized coating on the pressed steel panels, they are still structurally sound but would shortly require over coating or replacement.

The coating on the pressed steel panels ranges from 2.7 mils (68µm) to 3.6 mils (91µm), which in terms of the life of the water tank, is impressive to say the least.

General view of water tanks.

Close-up of panels and bolts.

View on the roof looking north.

Should the water tank have been ordered prior to 1937 the British specification BS 729 would not have been in existence as it was first published in that year.

However, BS 729 requires that for steel thickness less than 5mm but greater and equal to 2mm a coating mass of 460 grams/m^2 (coating thickness – 64µm) and for steel thickness greater than 5mm a coating mass of 610 grams/m^2 (coating thickness – 85µm), be deposited on the steel.

As it was difficult to assess the steel thickness of these panels, we must assume that they were most probably 5 to 6mm thick, as per the local equivalents.

Conclusion

In order to establish when the water tank and structure was installed, we discussed the history of the fort with Mr Herbert Prins a Heritage Architect, who was kind enough to share some facts in trying to establish the age of the water tank. The following sequence of events is known:

- The Prison within the Rampart was built in 1893.
- The rampart (the embankment on two sides of the Fort) was built in 1896.
- Boer war commenced in 1899 and ended in 1902.
- Paul Kruger built several forts in the Johannesburg / Pretoria area at much the same time as the one in Johannesburg.
- Johannesburg surrendered in May 1900 and the Boer garrison moved out at the same time the British garrison moved in.
- After the Boer war the British garrison moved out (sometime between 1902 and 1907 when the Transvaal received responsible government).
- In 1909 the women's goal was built.
- In 1928 the Awaiting Trial prisoner block was built.

It would seem that there was a strong possibility that the Braithwaite water tanks were ordered from the United Kingdom to accommodate water for the entire goal including the Awaiting Trial prisoner block and that suggests that the tanks may have been in existence since about 1930.

Should this be correct, then the hot dip galvanizing has performed considerably well over the 76 odd years. Several coating thickness readings were taken at between 2.7 to 3.6 mils (about 68 to 91µm) *see photos*.

On one bolt the coating thickness read as 0.99 mils (25µm), but generally the fasteners were starting to corrode and are discolouring the hot dip galvanized surface of the plates. This makes sense, as they

Maximum coating thickness, 3.6mils (91µm) on panel.

Minimum coating thickness, 2.7mils (68µm) on panel.

would have had an original coating thickness of about 45 to 70µm and with a zinc corrosion rate of less than a micron a year, would be 70 to 80 years old.

No surface inspection was done on the inside of the tank.

The structure holding up the water tanks is fairly corroded but could, if required, be restored. The components could be abrasively blasted and hot dip galvanized and if the tanks were also re-galvanized, the tank and tank stand would provide a further 70 odd years of service free life at the site.

HDGASA 03-2006 has just recently been launched

The sequence follows two existing coating specifications, being **HDGASA 01-1990 – Code of Practice for Surface Preparation and Application of Organic Coatings** applied to New Unweathered Hot Dip Galvanized Steel (Sheet and Section) excluding In-line Coil Coating (Duplex Systems) and **HDGASA 02-1990 Specification for the Performance Requirements of Coating Systems** applied to New Unweathered Hot Dip Galvanized Steel (Sheet and Section) excluding In-line Coil Coating (Duplex Systems).

Over and above SANS 121 (ISO 1461), which addresses the hot dip galvanized coating, **HDGASA 03-2006**, briefly incorporates, Approval of the galvanizer; Quality Standards, such as Quality Control and Coating Repairs; Quality Surveillance; Data Book; Handling and Storage, which addresses Handling; Loading; Unloading; Cover and Stacking. Site coating repairs are also addressed as well as Duplex Coatings; Selection of Paint Coatings for Duplex Coatings; Quality Control and Surveillance as well as Related Documents are also incorporated.

The specification is available from the Association or the website – www.hdgasa.org.za and can easily be incorporated into specific project specifications, where necessary.

Guest Writer

Bob Andrew, our guest writer, is a consulting value engineer and Honourary Life Member of this Association.

Enhanced brain power can lead to greater willpower

MIND OVER MATTER MAY NOT BE SO FAR FETCHED

Why is it that most successful people continue to succeed, while others continue to fail? Is this just because of the random or chaotic nature of life: some succeed and others don't?

Surveys have shown that successful people really think they are successful while unsuccessful people firmly believe they are not. Its almost as if a belief in success is a prerequisite for success; there must be a will or an intention to succeed.

In 1934, J.B. Rhine, a lecturer in the psychology department of Duke University, North Carolina, began to investigate physical motion which could be produced by the mind: he called the phenomenon "psycho-kinesis" (lit. mind movement). Although the scientific community remained sceptical, Rhine did appear to prove that the mood of the subject played an all-important role. Those subjects who wanted the tests to work produced statistically better results than those who were ambivalent about them. Subjects who competed against one another also produced better results than individuals tested alone. Subjects who were asked to repeat the tests of others were unable to match the results of the original subjects. Positive feelings about the tests and a sense of challenge seemed to produce the will to get good results.

The brain is probably the last frontier where the boundaries of scientific knowledge are not yet in sight. Perhaps the next century will reveal more clearly how the brain works and what its effects are on human action and development. It may also reveal how the brain becomes the non-dimensional 'mind'. What is known is that when the brain is stimulated it produces some kind of a will or an intention, which sets off a chain of events to make our muscles move.

The memory of the brain is awesome: 10 billion cells with an information capacity of 10 trillion bytes, or 10 terabytes. Compared to current technology, the brain is equal to about 50 000 average sized computer hard drives. In these terms, a single human brain is worth about R100 million. One wonders if there would be any talk of laying off staff if organisations placed this sort of value on their employees?

There is no doubt that the challenge for the future is how to unleash and maximise human brain power. Unlike computers, the brain converts raw information into knowledge. As the brain retains and processes knowledge, blending it with experience, wisdom is acquired. Wisdom allows one to see things more clearly, to act prudently and effectively, to anticipate and avoid potential problems and to be compassionate. Wisdom also involves a deep understanding of the human and cosmic situation. This is obviously a very desirable condition and may probably be the key to the survival of our planet.

J.B. Rhine, and many after him, including Uri Geller, have given some indication that a person may be able to directly affect their environment simply by intending to do so. If this is true, the next level of technological development may be some form of an extension of the mind; some are already calling this the 'noetic (mind) age'. To get to this level, present-day humankind must better recognise and appreciate the value of the individual. People must also be encouraged to learn to attain knowledge and convert it into wisdom. To do this, people need space, time and opportunity to practice their knowledge in order to accumulate their own experiences.

In the corporate environment, managers must realise that they are working with individuals, each of whom needs to be nurtured so as to develop their powerful brain potential. Managers also need to be aware of the synergy that exists between individuals in a group and need to foster the delicate conversion of conflict into co-operation. Perhaps, in the future, managers will adopt the role of a developer of wisdom, rather than a developer of processes and systems.

HOT DIP GALVANIZING MEMBERS

GALVANIZER	LOCATION	TEL. NO	SPIN	NO. OF LINES	BATH SIZES (L x W x D) (m)
GAUTENG					
ABB Powerlines	Nigel	011 739-8200		1	12.0m x 1.4m x 1.8m
Armco Galvanizers	Isando	011 974-8511		1	13.2 m x 1.5m x 2.0m
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
Barloworld Galvanizers (Pty) Ltd	Germiston	011 876-2900		2 Tube	14m x 1.35m x 2.5m 10.0m x 2.0m x 4.0m Dia 42mm to 114mm max tube length 6.7m
Barloworld Robor Tube	Elandsfontein	011 971-1600		1	Pipe plant
Cape Gate (Pty) Ltd	Vanderbijlpark	016 980-2270		#	Wire galvanizer
DB Thermal SA (Pty) Ltd	Nigel	011 814-6460		#	In-line galvanizer
Galvadip (Pty) Ltd	Waltloo	012 803-5168		1	7.2m x 1.5m x 1.8m
GEA Air Cooled Systems	Germiston	011 861-1571		#	In-line galvanizer
Mittal Steel SA	Vereeniging	016 889-8816		#	Sheet galvanizer
Lianru Galvanisers cc	Nigel	011 814-8658		2	7.2m x 1.3m x 1.6m 1.95m x 0.83m x 1.2m
Pro-Tech Galvanizers (Pty) Ltd	Nigel	011-814-4292	●	2	3.0m x 1.1m x 1.2m 3.2m x 1.1m x 1.5m
Supergalv	Alrode	011-908-3411		1	6.0m x 1.2m x 1.8m
MPUMALANGA					
Chevron Engineering (Pty) Ltd	Barberton	013 712-3131		1	Dia 0.7 x 1.2d
NORTH WEST					
Andrag Agrico	Lichtenburg	018 632-7260		#	In-line galvanizer
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
South Cape Galvanizing (Pty) Ltd	George Industria	044 884-0882		1	5.5m x 1.0m x 2.6m
Zincgrip Galvanizers & Coatings	Stikland	021 949-7630		1	4.5m x 1.0m x 2.5m
EASTERN CAPE					
Galvanising Techniques cc	Port Elizabeth	041 486-1432		1	12.4m x 1.4m x 2.6m
Galvaspin (Pty) Ltd	Port Elizabeth	041 451-1947	●	1	1.8m x 1.2m x 1.4m
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 0.95m 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	● ●	3	14.0m x 1.4m x 2.5m 7.0m x 1.2m x 3m 2.5m x 0.9m x 1.2m
Voigt & Willecke (Pty) Ltd	Durban	031 902-2248		1	9.0m x 1.2m x 2.5m
ZIMBABWE					
Tube & Pipe Industries Ltd	Harare	092634-611721		1	7.0m x 1.2m x 1.2m

The bath dimensions provided in this schedule are actual dimensions. Please check with your galvanizer the actual component size that can be accomodated, either in a single dip or by double end dipping.

 # Sheet, Wire, Tube and In-line galvanizing members dedicate their plants to the galvanizing of their own products.

For specific contact names (eg. sales or production personnel) and mobile telephone numbers, kindly contact the company receptionist.