Case History
No. 14/2007

Evaluation of the hot dip galvanized coating at Pentrich Sub-Station, Mkondeni, Pietermaritzburg

The application

Eskom has for many years relied on hot dip galvanizing to protect their assets amongst other things such as the steelwork required for power stations, pylon structures and sub-station steelwork that are exposed to the many environmental conditions throughout South Africa.

This substation is clearly one of these assets. The sub-station was built around 1967 and exposed to the atmosphere of Mkondeni, Pietermaritzburg. Believing that the steelwork had to be painted as it was showing signs of discolouration in certain areas, Eskom requested a paint contractor to quote on refurbishing the coating. The cost of R1.2 million to paint over the residual hot dip galvanized coating made staff at Eskom take a indepth view of the situation. The Association was requested to evaluate the condition of the existing coating and found some very interesting results.

The 132/88kV terminal tower on the Georgedale / Pentrich line.

A typical 132/88kV isolator support.

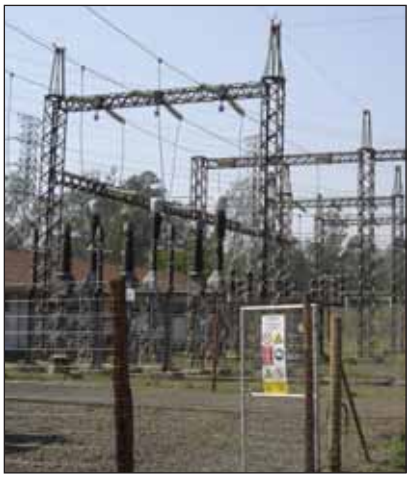
Environmental conditions

According to ISO 9223 – Corrosion of Metals and Alloys – Corrosivity of Atmospheres – Classification and the slow rate of corrosion achieved, *(see table at end of case history)*, suggests this part of Pietermaritzburg is likely to be a C2 or at worse a C3 environment. A modified table of corrosion rates taken from ISO 9223 has been included at the tail end of this report.

Hot dip galvanizing is normally specified primarily for corrosion protection. For this reason, the two most important inspection criteria of the coating taken at any time during the life of the coating are coating thickness and coating continuity.

The hot dip galvanized coating thickness on several components within the sub-station was scrapped clean of atmospheric contaminants, measured using a calibrated electromagnetic coating thickness gauge and results tabulated below.

Although SABS 763 was the hot dip galvanizing specification at the time of installation, coating thickness

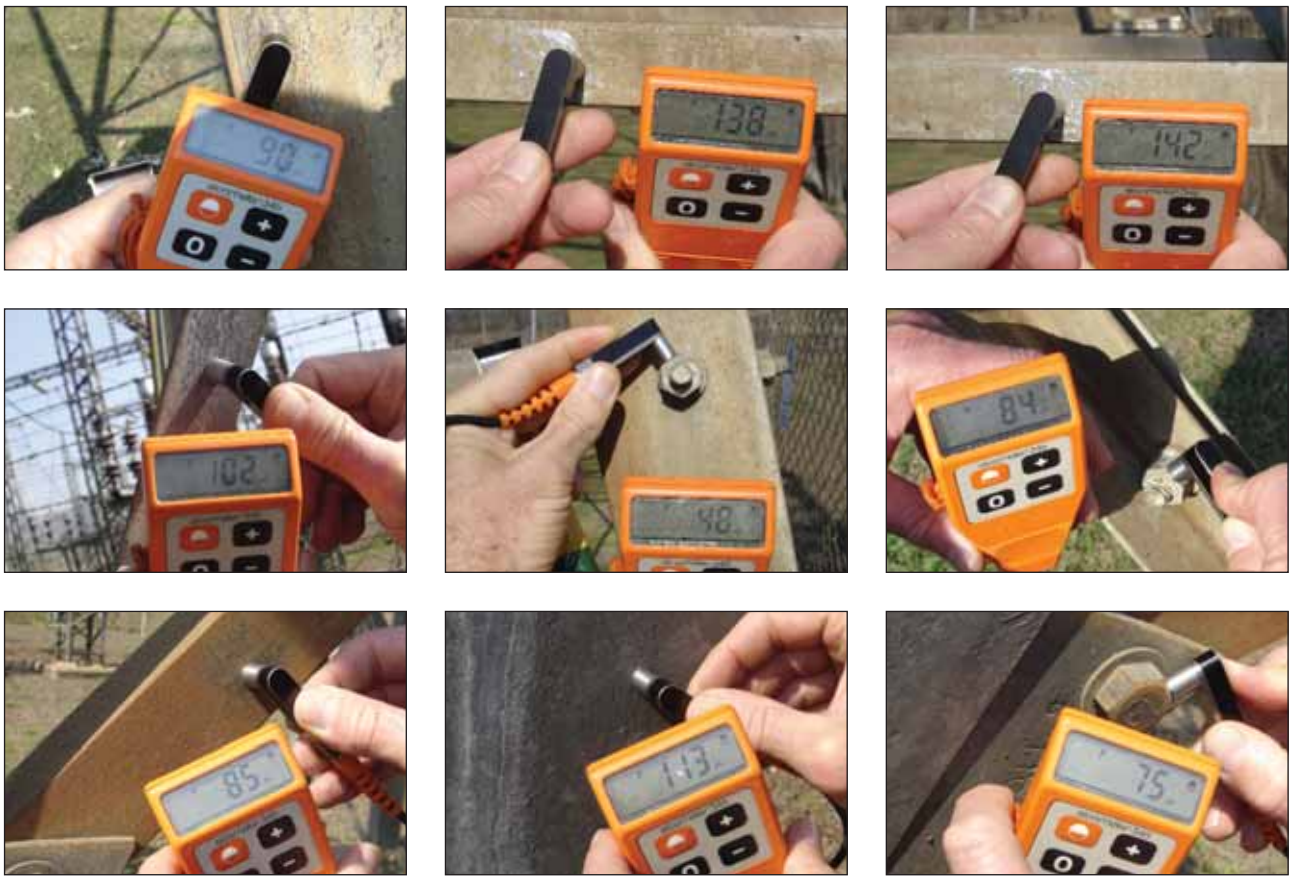


General photo of Pentrich Sub-Station.

COATING THICKNESS (µm)				
Georgedale / Pentrich 3 – 132/88kV Terminal Tower				
	Mean	Max	Min	No. of readings
90 x 90 x 8mm L	95	114	83	9
30 x 30 x 3mm L	134	161	114	11
M12 Hex Nut	78	141	55	10
M12 hex Bolt	97	132	65	12
132/88kV Isolator Support				
50 x 50 x 6mm L	88	109	61	22
150 x 75 Channel	123	179	89	18
70 x 70 x 12 L	155	162	145	14
M16 Hex Nut	73	88	59	4

Hot dip galvanized coating thickness readings taken on various exposed components at Pentrich Sub-Station.

Hot Dip Galvanizers Association Southern Africa
Unit U4 (Upper Level), Quality House, St. Christopher Road, St. Andrews, Bedfordview
P.O. Box 2212, Edenvale, 1610 • Website: www.hdgasa.org.za • E-Mail: hdgasa@icon.co.za



Photos above starting top left in each row show residual coating thickness readings of 90; 138; 142; 102; 48; 84; 85; 113 and 75µm, taken on the 132/88kV terminal tower and one of isolator supports.

requirements are similar to SANS 121 (ISO 1461), the current specification. SANS 121 requires that for steel thickness equal to and greater than 6mm the local coating thickness shall be a minimum of 70µm with a mean of at least 85µm. Steel equal to and greater than 3mm but less than 6mm shall have a local coating thickness of 55µm with a mean of 70µm. *See also table 2 and 3 from SANS 121 (ISO 1461).*

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.

In spite of the atmospheric conditions the hot dip galvanized coating has corroded very little in the 40 years of exposure.

Photo right shows Mr Rob Maitland-Stuart of Eskom Distribution looking very satisfied at the thought of not having to refurbish the coating due to its substantial residual coating, see photo above left (162µm).

The paint support barrier over the HD nuts was easily removed and the residual zinc electroplated coating measured between 7.1 and 16.4µm.

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The holding down nuts and bolts of all the structures from the coating thickness readings taken, seemed to have been originally zinc electroplated and are breaking down. The holding down bolts have subsequently been over coated using some zinc rich paint, which was scrapped off to measure the residual metallic zinc coating thickness. Although because of their size and the local atmospheric corrosion conditions, corrosion of these bolts in the medium term would never really compromise the life of the structure, they however should be repaired using an appropriate zinc rich epoxy.

"Zincfix" due to its convenient size, easy achievement of the required coating thickness in a single application and durable performance, is recommended as the preferred coating repair material. See the Association's Coating Repair Procedure.

Conclusion and recommendation:

One of the major benefits of using a metallic zinc coating no matter how it is applied is its predictable life performance. This is calculated by measuring the mean hot dip galvanized coating thickness and comparing that with the corrosion rate figures given in the ISO 9223 specification.

Bear in mind that coating life is proportional to its thickness and for this reason the thinner zinc electroplated coatings on the holding down nuts in spite of the interim support provided by the paint, is far less durable when compared to the superior, thicker hot dip galvanized coating on the structural steel components, covered in the case history.

The uncoated holding down bolts and zinc electroplated nuts, should be suitably cleaned and comprehensively over coated with an approved paint coating. One such approved coating system is "Zincfix". Zincfix was introduced into the market about 8 years ago and because of convenience, easy application, predictable coating thickness applied in a single coat and known performance, is extremely popular in the market.

The residual hot dip galvanized coating on the structural steel after 40 years of exposure to the atmosphere of Mkondeni, Pietermaritzburg, is in a sound condition and will not require any refurbishment for another 40 years.

TABLE 2: MINIMUM COATING THICKNESS ON ARTICLES THAT ARE NOT CENTRIFUGED – SANS 121 (ISO 1461)		
Profiles	**Local coating thickness, min. µm***	**Mean coating thickness, min. µm***
Steel ≥ 6mm	70	85
Steel ≥ 3mm to < 6mm	55	70
Steel ≥1.5mm to <3mm	45	55
Steel < 1.5mm	35	45
TABLE 3. MINIMUM COATING THICKNESS ON ARTICLES THAT ARE CENTRIFUGED TO SANS 121 (ISO 1461)		
Diameter of the article	**Local coating thickness, min. um***	**Mean coating thickness, min. um***
20mm diameter	45	55
6mm to < 20mm diameter	35	45
< 6mm diameter	20	25

NOTE 1: Hot dip galvanizing specifications state the minimum acceptable coating thickness and not average coating thicknesses. The thickness actually achieved, varies with steel composition and this can range from the minimum up to at least 50% greater. As life expectancy predictions are normally based on the minimum coating thickness, they are usually conservative.

1	2	3	4	5	6	7
				MAINTENANCE FREE LIFE OF THE COATING		
Corrosion category	**Description of environment**	**Corrosion rate (av. loss of steel in µm / yr.)**	**Corrosion rate (ave. loss of zinc in µm / yr.)**	**Continuously hot dip galvanized sheeting Coating class – Z275 (±20µm)**	**Hot dip galvanized coating (85µm) Steel thickness ≥ 6mm**	**DUPLEX COATING SYSTEM Hot dip galvanizing + an appropriate paint system**
C1	Interior: dry	≤1.3	≤0.1	>50	>50 #1	Not required for corrosion protection #2
C2	Interior: occasional condensation Exterior: exposed rural inland	>1.3 to 25	0.1 to 0.7	>40	>50 #1	Not required for corrosion protection #2
C3	Interior: high humidity, some air pollution Exterior: urban inland or mild coastal	>25 to 50	0.7 to 2.1	10 to 40	>40	Not required for corrosion protection #2
C4	Interior: swimming pools, chemical plant, etc. Exterior: industrial inland or urban coastal	>50 to 80	2.1 to 4.2	5 to 10	20 to 40	Coating life in columns 5 & 6, plus the paint life multiplied by a factor of at least 50%
C5-I or C5-M	Exterior: industrial with high humidity or high salinity coastal	>80 to 200	4.2 to 8.4	2 to 5	10 to 20	Coating life in columns 5 & 6, plus the paint life multiplied by a factor of at least 50%

Modified from Table 5 – ISO 9223.

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