Quality - Inspection Before & After Hot Dip Galvanizing

11.1 INSPECTION BEFORE HOT DIP GALVANIZING

Good quality hot dip galvanized coatings on fabricated articles are more likely to be achieved if correct fabrication techniques have been adhered to. Inspection of fabricated assemblies, castings and other components for hot dip galvanizing, should be carried out before despatch to the galvanizer *(table 21)* in order to ensure conformity to the design requirements detailed in *Chapter 9*. This may avoid costly rectification and unnecessary delays at the galvanizers premises.

11.2 INSPECTION AFTER HOT DIP GALVANIZING

As a final step in the process, the hot dip galvanized coating is inspected for compliance with relevant specifications. Interpretation of inspection results should be made with a clear knowledge of the causes of various conditions which may be encountered and their potential influence on the ultimate objective of providing long term corrosion protection.

Inspectors should remember that the ***purpose of hot dip galvanizing is to protect steel from corrosion.*** The length of time that this protection can be expected to last, is called its "service life or time to first maintenance". This is defined as the time taken for the appearance on an article of 5% surface rust. **The service life of a hot dip galvanized coating is directly related to the thickness of the protective zinc coating. Corrosion protection is greatest when the coating is thickest. Thus coating thickness is the single most important quality check.**

Coating thickness is only one inspection aspect. Other checks must include continuity, coating adhesion and appearance. Embrittlement and defects, which arise from specific materials, design and fabrication, must also be considered when inspecting susceptible items.

While minimum standards must be satisfied in all these considerations, their relative importance varies according to the end use of the finished product. For example, the aesthetic appearance of hot dip galvanized structural steel in an industrial application is less important than when a structure is destined for use in a decorative application. Understanding of the specific requirements as well as the limits to what can be achieved by hot dip galvanizing is essential for effective inspection.

11.3 THICKNESS TESTING

Several methods are used to determine the thickness of the zinc coating on a hot dip galvanized article. The size, shape and number of pieces to be tested, will dictate the method to be used. Specified test methods are either destructive or non-destructive. These are detailed in **SANS 121/ISO 1461** and in **SANS 32/EN 10240**. The most practical test is the non-destructive method utilising the electromagnetic principle for determining coating thickness *(figure 84)*.

Threaded articles must fit their mating parts and, in the case of assemblies that contain both externally and internally threaded articles, it shall be possible to screw mating parts together by hand.

For small items, particularly those with complex geometries, **ISO 1460** provides for gravimetric measurements aimed at determining mass of coating per unit area as opposed to thickness. This is a destructive test method.

11.4 APPEARANCE

The ability of a hot dip galvanized coating to meet its primary objective which is to provide corrosion protection, should be the chief criterion when evaluating coating acceptability.

The specified requirements for a hot dip galvanized coating are that it be:

- continuous,
- relatively smooth,
- free from gross imperfections,
- free from sharp points (that can cause injury), and
- free from uncoated areas

To be essentially free from uncoated areas was best described in **SABS 763** 4.3.2 b. This reads as follows:

"The area of an individual bare spot or thin area shall not exceed 5mm². The combined area of bare spots or thin areas shall not exceed 25mm² per metre of length or per square metre of surface of an article.".

It is recommended that the above clause is retained for the guidance of inspectors.

The above requirements are of particular importance when a subsequent organic paint coating is to be applied onto a galvanized surface. Smoothness and absence of roughness achieved on mechanically wiped products, such as continuously galvanized sheeting or wire, are not to be used as the criteria for accessing surface finish on general hot dip galvanized products. Roughness and smoothness are relative terms. The end use of the product must be the determining factor in setting standards.

In order to provide optimum corrosion protection, the hot dip galvanized coating should be continuous. Handling techniques for hot dip galvanized articles may entail the use of chain slings or other holding devices if suitable lifting fixtures are not attached to the item. In exceptional circumstances, chains and special jigs may leave a contact touch mark on the hot dip galvanized item. These marks are not always detrimental and a reason for rejection. Should these marks, be greater than 5mm² with bare steel exposed, suitable repairs should be carried out using the method described in **SANS 121/ISO 1461.** *Refer to Chapter 15 - Reconditioning Damaged or Site Modified Hot Dip Galvanized Coatings.*

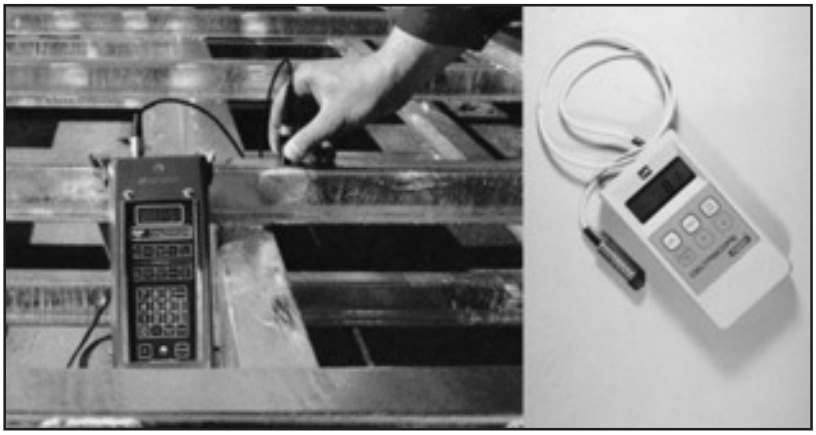

Figure 84. Using a digital instrument to measure zinc coating thickness.

Size and Shape
Check that work is suitably sized and if necessary, lugs have been provided for the handling and galvanizing facilities of the selected galvanizer. It may be too late to make changes to the design, but it is costly to despatch work which the galvanizer cannot process.

Structural Steel
Check that bending, punching and shearing have been carried out in conformity with the recommendations in Chapter 9.

Satisfactory Hot Dip Galvanizing
Observance of the points listed below and described in more detail in Chapter 9 will ensure optimum galvanized product quality and minimise extra costs or delays.

1. Check that closed vessels and hollow structures are adequately vented for safety and optimal fill and drain holes have been provided to ensure satisfactory hot dip galvanizing.
2. Check that all welding slag has been adequately removed.
3. Check that assemblies comprising castings and steels of widely differing surface conditions have been abrasive blast cleaned to minimise differences in galvanized finish.
4. Check that castings are abrasive blast cleaned before despatch unless otherwise arranged. Check that large grey iron castings have been normalised.
5. Check that appropriate temporary or permanent markings are provided.

Table 21.

Differences in the lustre and colour of hot dip galvanized coatings do not affect corrosion resistance and the presence or absence of spangle has no effect on coating performance. The well-known spangle effect found on some hot dip galvanized surfaces is a factor of primary crystallisation. It is chiefly dependant upon the zinc bath chemistry, the rate of cooling, the method of pickling, the steel chemistry, and the thickness of the coating. In fact, dull grey or patchy matte grey hot dip galvanized coatings give service lives equal to or greater than bright or spangled coatings. Variations in coating appearance or finish are important only to the extent that they will affect corrosion performance or the intended use of the article. The primary function of a hot dip galvanized coating is corrosion protection. Specific requirements beyond the standard set out in **SANS 121/ISO 1461**, (eg. aesthetic appearance) should be communicated to the galvanizer in writing or negotiated at the contract review stage.

In order to comply with additional requirements, the following information may be requested by the galvanizer:-

a) Steel composition.
b) Identification of significant surfaces which require special care.

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

c) A visual standard should be established if a special finish is required.
d) Any particular treatments that are required or not required before or after galvanizing.
e) Deviation from standard coating thickness. See information below *table 2.*
f) Acceptable method of repair, if required *– refer to Chapter 15 - Reconditioning Damaged or Site Modified Hot Dip Galvanized Coatings.*

For ensuring optimum appearance of the hot dip galvanized coating after installation, *refer to Installation Do's and Don'ts on page 46.*

11.5 ADHESION OF THE COATING

Acceptable adhesion is related to the practical conditions pertaining during transportation, erection and service. Hot dip galvanized coatings should be sufficiently adherent to withstand normal handling without peeling or flaking regardless of the nature and thickness of the coating. Bending or forming, other than straightening by the galvanizer after hot dip galvanizing, is not considered to be normal handling.

When reactive grades of steel or very thick sections are hot dip galvanized, coatings which are thicker than usual may occur. The galvanizer has limited control over the formation of thicker coatings, since this is a function of the chemical composition of the steel. Extended immersion time also plays a role. Heavy hot dip galvanized coatings greater than 250µm thick, may have brittle tendencies. Interpretation of the standard adhesion tests must take this into consideration. The requirements for careful transportation, handling and erection should be evaluated against the additional corrosion protection afforded by these thicker coatings.

11.6 TESTING FOR ADHESION

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.

Paring Test
This simple but effective test is conducted by cutting or prying the hot dip galvanized coating with a sharp knife. Considerable pressure is exerted in a manner tending to remove a portion of the coating. Adherence is considered satisfactory when it is possible to remove only small particles of the coating. It should not be possible to peel any portion of the coating in the form of a layer so as to expose the underlying iron or steel in advance of the knife. Although not mentioned in **SANS 121/ISO 1461**, this test has shown practical significance as a test for adhesion.

Cold Flattening Test (Galvanized Tube)
For compliance with **SANS 32/EN 10240**, the most popular test is cold flattening in accordance with **SANS 8492/ISO 8492.** 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 (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 23.*

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 22.

MINIMUM COATING THICKNESS ON STEEL TUBES TO SANS 32/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 SANS121/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, **SANS 32/EN 10240** to quality A1 replaces the previous **SABS 763,** B4 coating.				

Table 23.