

# Advanced Inspection and Acceptance Procedure for Steel Structure Galvanization in Transmission Projects

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**Abstract:** *Dubai Electricity & Water Authority (DEWA) uses tubular monopoles and steel lattice towers for the transmission and distribution of 400kV and 132kV voltages for overhead lines. Transmission towers are an essential part of DEWA's power grid construction work and plays a vital role in the power transmission process. Transmission towers are exposed to external environment and easily affected by environmental pollution. Due to rapid shifts in relative humidity and higher airborne salinity levels corrosion may easily occur. This affects the service life of the tower and its performance. In order to prevent corrosion, anti - corrosion treatment must be carried out in the process of manufacturing the tower. Galvanization of tower parts using hot dip process is carried out to protect the steel from corrosion. The tower parts used in DEWA power grid systems are galvanized in accordance with DEWA technical specification requirements. Hot dip galvanizing of tower parts ensures many years of zero maintenance there by lowering the life cycle costs. Galvanization process shall comply with requirements laid on international standards ASTM A123 and A153 and procedure to avoid material embrittlement as per ASTM143. Galvanized tower parts are tested to ensure DEWA OHL specification requirements as per the guidelines given in ISO1461. DEWA ensures strict quality control by scrutinizing tower fabricator's manufacturing quality plan and by conducting quality assessment tests at tower fabrication factory before giving dispatch clearance to tower supplier for delivery of materials at site. Tower fabricator has to obtain DEWA approval for material suppliers of steel and bolt, nut accessories and the inspection test plan. The different stages involved in the galvanization process, Inspection procedure and acceptance criteria on galvanization of finished goods are addressed in this article.*

**Keywords:** Galvanization, steel Structure, steel lattice towers

## 1. Introduction

### Galvanization Process

Galvanization is type of anodic coating. On the base metal, a metal that is anodic (more active) to base metal is coated. In the case of possibility of corrosion, the coating metal corrodes because it is anodic to the base metal, while the base metal is protected that is being cathodic. The process of coating zinc on iron or steel is called galvanization. A zinc is above the iron in the electrochemical series, zinc is anodic to iron. So in the galvanized iron, zinc (anode) protects iron (cathode).

Galvanization process involves different steps. The fabricated steel member are dipped into an alkaline solution to remove the grease or organic matters. Later the steel member is rinsed in water bath. In the next step, to remove rust or scales, the steel member is dipped in dilute hydrochloric acid. That is steel member is subjected to acid pickling to remove the oxide layers or the scales present over the surface of steel member. Then it is followed by washing with water. The cleaned steel member is now dipped in  $ZnCl_2$  and  $NH_4Cl$  flux to ensure proper coating of zinc on it. The steel member with flux coating is dried before it is taken to galvanizing bath containing hot zinc (98% Zn) at about  $450^\circ C$ . As a result zinc coating take place on fabricated steel member. The hot dipped coating consists of nearly pure zinc on outer part and the portion next to steel base is composed of zinc - iron alloys. After this the member is subjected to quenching process by dipping into water. After cooling the properly galvanized items are taken out.

### Routine Tests on Galvanized Tower Parts

Tower fabricator has to carry out the inspection of finished goods in presence of DEWA inspection team/engineers. Contractor to raise inspection request for DEWA and provide the packing list of fabricated items for the selection of test samples.

Sampling is the first activity in any finished goods inspection of tower parts. The sampling starts with selecting samples from offered lot on random basis for different tests. From the packing list of materials which has distinct mark number for different items and the summary of all sections corresponding to the particular mark number, samples are selected. Usually one sample on every 50MT is selected from the tower steel offered lot for inspection for performing galvanization tests.

In order to mitigate the problems related to corrosion of tower parts and connections during service life of the towers in DEWA network, the following tests are conducted to ensure that the zinc coating is being furnished in line with DEWA technical specification requirements. Visual inspection of the coating and adhesion tests are performed for compliance with the requirements. The thickness of the coating is determined by two methods namely magnetic thickness measurement test using Elcometer and by stripping test. Uniformity of zinc coating is verified by conducting the Preece test.

### Visual Inspection

The galvanized items are examined for bare spouts, roughness, drips and runs, flux, ash and dross inclusion

surface defect etc. The specimens are rejected under the following situations;

- When the sizes of the bare spots are not small and which cannot be rectified by patching treatments.
- Incase of heavy roughness caused by high galvanizing temperature or long time immersion time.
- Heavy drips and runs caused by cold galvanizing bath, high withdrawal speed, articles in contact during withdrawal etc.
- Flux stains after removal of flux.
- If dross contaminations is heavy caused by the entrapped dross particles.
- Heavy pitting due to galvanizing of rusted materials.

#### Adhesion Test

This test is conducted to verify the adhesion of the coating. The test is applicable to flat surfaces by pivoted hammer and for round and curved surfaces by knife. Pivoted hammer test is used to determine the adhesion of Zinc coating on fabricated tower parts from angles and plates. Fix the horizontal base on a firm surface and allow the hammer head to swing freely through an arc from the vertical position to strike the horizontal surface. Form parallel impression with 6mm spacing along a common axis on the specimen by allowing 3 - 4 standard blows. Coating can be considered adherent if the coating between the areas between the impressions does not peel off.

#### Magnetic thickness Measurement

This non - destructive test is conducted to determine the coating thickness by Elcometer. The basic principle is variation in the force of attraction between two ferromagnetic bodies as a function of the distance between them. The non -ferromagnetic Zinc resists the force of attraction between steel and the elcometer probe.

To conduct the test, the elcometer probe is allowed to contact with the coated surface, then steady reverse force is applied to break the magnetic bond with the coated surface. The required (reverse) force to break the magnetic bond is measured. More the Zinc coating less (reverse) force is required to break the magnetic bond. *The minimum average of zinc coating thickness shall be 127 microns for fabricated tower steel sections as per DEWA standard specifications.* The thicker the zinc coating, the longer the coating is going to survive. However the coating thickness is controlled to maximum 300 microns to avoid flaking of coating.

#### Stripping Test

This test is used to determine the Zinc coating on galvanized tower parts. Select the sample from the given lot having same sections with same steel composition. Determine the weight of the Zinc coating on the specimen in accordance with Test method A90/A 90M.

If the test results fail to conform to the DEWA requirements, the test is repeated with two more samples selected from the same lot. If any one of these two test results fails the lot shall be rejected. *In order to mitigate the problems related to*

*corrosion of tower parts and connections during service life of the towers in DEWA network, a zinc coating of 900 g/m<sup>2</sup> of surface is required as per DEWA OHL technical specification.*

#### Preece Test

Preece test is an inspection or acceptance test conducted on galvanized sections to determine the uniformity of Zinc coating. The test is carried out in accordance with ASTM A239. To qualify the test, there should not be any formation of red deposit of copper Sulphate on the specimen.

#### Test on Fasteners and Accessories

Galvanization tests on the bought - out items like bolts, nuts and accessories (BNA) are performed as per relevant ASTM standardson a random basis to ensure compliance with DEWA specification requirements. Minimum average zinc coating thickness shall be 43microns (305g/m<sup>2</sup>). Fasteners that is susceptible to embrittlement are tested in accordance with ASTM A143.