BGF-01. Rev 1

PROCESS CONTROL
Of
HOT-DIP GALVANIZING

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PROCESS CONTROL OF THE HOT DIP GALVANIZING PROCESS

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PROCESS CONTROL OF THE HOT DIP GALVANIZING PROCESS

1.0 SCOPE& PURPOSE

This procedure covers the process control steps during the hot dip galvanizing and the testing of the galvanized unit to ensure the quality. A metal (particularly steel) is galvanized by immersing it fully in the molten zinc metal at temperature ranging from 445-460 degrees Celsius. This coating will protect the steel (which is having a considerable rate of corrosion) from oxidation.

2.0 REFERENCES

ASTM A123 (2009) - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A153 (2009) - Standard Specification for zinc coating (Hot-Dip) on iron and Steel Hardware

ASTM 780 (2009) - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

BS EN 1461 (2009) - Hot dip galvanized coatings on iron and steel articles – specifications and test methods

12-SAMSS-07 (2009) - Fabrication of Structural and Miscellaneous Steel Project Specification

(All the specification and standard mentioned with this procedure are latest edition and revision)

3.0 RESPONSIBILITIES

3.1 Plant Operation Manager

Ensure compliance by all parties to this procedure, Inspection& Test plan and relevant Customers Specifications, Drawings and current Industry Codes.

3.2 Production Foreman

Ensure the planning for production in accordance with this procedure; ensure that all crafts men follow this procedure and specific quality requirements

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3.3 **Quality Control Inspector**

Conducts inspections in accordance with this procedure and the ITP.

4.0 ACTIVITIES

4.1 Degreasing – All black materials must be treated to remove oil, Grease and dust.

4.2 Surface preparation- Material for galvanizing is cleaned by Abrasive (shot / grit) blasting until free from any contaminants.The surface profile measurement by replica tape (Press-O-Film or testex tape) is performed after blasting to make sure the blasted surface reaches the required profile.

4.3 Pickling- Furthermore, material is treated to remove oxides, scales, and dirt. This will make the Material clean. It is done by immersing the material in 16% hydrochloric acid solution. For Shot-blasted materials, 5 to 10 minutes of pickling is sufficient.

4.4 Rinsing – After pickling, adhering acid and salt from pickling solution are removed by rinsing with Water.

4.5 Fluxing – Material is immersed in flux solution to prevent oxidation prior to galvanizing. Bahrain Galvanizing Factory used 2 Kg Zinc Ammonium Chloride per 5 liters of water.

4.6 Galvanizing – The material is immersed in the galvanizing bath at a temperature range of 445 – 460° Degrees Celsius. The molten zinc is having a purity of 99.995%. The material stays in the hot molten zinc until bubbling ceases. The material is withdrawn slowly from the zinc bath while ensuring that no ash will cling to the surface of the material being galvanized. The time of immersion depends on how thick a coating is required.

4.7 Finishing – Quality, visual inspection is done in this area. Grinding is done to remove spikes, flux residues, dross and ash inclusions and other undesired matter clinging to the surface. Afterwards, material is packed with enough ventilation to avoid white rust.

5.0 PROCESS CONTROL

5.1 MATERIAL PREPARATION

The material for galvanizing must be free from the following:

1. Paint
2. Grease
3. Varnish
4. Scales
5. Welding slag,spatters,burs, and sharp edges

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6. Other Contaminants

If traces of the above are present in the material, it is necessary to undergo abrasive blasting (BGF uses steel grit for this purpose) or clean the material by other means.

5.2 PICKLING

Control parameters for the pickling solution are as follows:

1. Specific Gravity – The specific gravity of the pickling solution determines its iron content. For a fresh pickling solution, it has a usual specification gravity of 1.18 – 1.25. going beyond these values could be a single for a solution heavily laden with iron.
2. Free Acid Content – The free Acid Content determines the strength of the pickling solution. This is expressed in grms. Hydrochloric Acid (HCL) per liter of solution.
3. Iron Content – Conducted every 2 weeks, pickling solution is rendered useless for the purpose if the concentration of iron exceeds 80gms per liter. It may be used for stripping rather than pickling.
4. Temperature – At low temperature, chemical reaction is slower. Cleaning will take more time. For pickling solution, ideal start-up Temperature is 15 degrees
5. Level – At least 30 cm from the top is required in a pickling tank. A 50-50 ratio of HCL and water may be added to tank if the iron Content is lower than 80 gms Fe per liter of solution.

5.3 RINSING

To maintain its normal level, fresh water is added. If pH is excessively low, water is totally changed with a fresh one.

5.4 FLUXING

Control parameters for the fluxing solution are as follows:

1. Specific Gravity
2. Free Acid – Flux solution containing 2gm Hydrochloric Acid (HCL) per liter of free acid should be neutralized by 25% Ammonia.
3. Iron Content – Iron content of less than 10 gms per liter must be observed. Otherwise, excessive dross will be formed by the precipitation of the sludge when iron content is excessive. The flux solution could be treated with hydrogen peroxide to remove iron in the solution.

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4. PH Value – The ideal pH value for flux solution is 5 to 5.5

5. Temperature – Ideal temperature is 15 degrees Celsius.

6. Level- The level of the fluxing solution must not be less than 30 cm from the top.

5.5 GALVANIZING

Control parameters for galvanizing process:

1. Temperature – The temperature range of the BGF zinc Is 445 – 460 degree Celsius. It is electronically monitored. A drop below 445 degree will necessitate in cleaning the heating cover area. Accumulated Zinc ash should be removed for an effective heat transfer to the zinc bath surface.

2. Zinc Level – 10 cm below the top. If level falls below this Line, Zinc ingots are added one by one. It must be dry for safety reason.

3. Zinc dross level – Maximum allowable level of dross is 30 cm. This could be removed from the bath by means of a dross grab.

4. Aluminum Content – Maximum value must keep at 0.007%.

5. Zinc Content – An assay of the zinc shipment should be done and must conform to the ASTM B6 of at least 98% minimum and with the British Standard.

   The minimum zinc content 98% shall checked periodically every six months by independent laboratory and the cerificates available with factory at any time.

5.6 FINISHING

Finished materials must confirm to the ASTM and the British standard. It must be smooth and free from blisters, flux stain, dross inclusion, black spots, etc.

6.0 INSPECTION AND TESTING

Inspection and testing of galvanized coating includes coating thickness Measurement, visual inspection and Adherence testing to determine whether a sample confirms with the applicable standard.

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The thickness of the coating shall conform to the requirements of Appendix 1 and 2 for thickness of the material being galvanized. Where welded products consisting of various material thicknesses are galvanized, the coating thickness for each thickness of material shall be as shown in Appendix

1 and 2

6.1 VISUAL INSPECTION

I. Finish- The coating shall be continuous, and as reasonably smooth and uniform in the thickness as the weight, size and shape of the item and necessary handling of the item during dipping and draining operations at the galvanizing kettle will permit. The distribution of the zinc coating shall be determined by visual inspection. Except for local excess coating thickness which would interfere with the use of the product, or make it inconvenient or dangerous to handle (edge tears or spikes), rejection for non-uniform coating shall be made only for plainly visible excess coating not related to design factors such as holes, joints or special drainage problems. Since surface smoothness is a relative term, minor roughness that does not interfere with the intended use of a part or roughness that is related to the as-received (un-galvanized) surface condition shall not be grounds for rejection.

II. Appearance – Galvanized articles shall be free from uncoated areas blisters, flux deposits, acids and black spots, and dross inclusions. Lumps, projections, globules, or heavy deposits of zinc which will interfere with the intended use of the material will not be permitted. All holes shall be clean and reasonably free from excess zinc. Mark in the zinc coating caused by tongs or other items used in handling the article during the galvanizing operation shall not be a cause for rejection un less such mark have exposed the base metal or have scraped the zinc from the surface. The pieces shall be handled so that after galvanizing they will not freeze together.

6.2 TEST METHODS

The following tests shall be conducted to ensure that the zinc coating is being furnished in accordance with the specification. Adhesion test of the zinc coating to the surface of the base metal by means of cutting or prying with the point of stout knife and to be applied for considerable pressure in a manner tending to remove a portion of the coating (ASTM – A123).

I. Magnetic thickness measurement – A minimum of 5 readings shall be taken (in each location) near the ends and in the middle of each piece being tested. The average coating thickness for the item shall be the average of the values obtained in 3 locations and shall not be less than the value listed in tables given under Appendix 1 and 2.

II. Stripping Method – The average weight of Zinc coating maybe determined by stripping an entire piece in accordance with test Method A90.

III. Weight before and after galvanizing – The average weight of the zinc coating maybe determine by weighing the article before and after galvanizing, subtracting the first weight

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from the second, and dividing the result by the surface area. The first weight shall be determined after pickling and drying, the second after cooling to ambient temperature.

IV. Referee Method – a dispute regarding coating thickness may be resolved by the use of magnetic thickness gauge which have been calibrated for accuracy against standard reference material thickness standards.

V. Adherence Test Method – Zinc coating shall withstand handling consistent with the nature and thickness of the coating and the normal use of the article, without peeling or flaking. Adhesion of the zinc coating to the surface of the base metal is determined by cutting or prying with the point of a stout knife(ASTM – A123 AND A153), applied with considerable pressure in a manner tending to remove a portion of the coating. The adhesion shall be considered inadequate if the coating flakes off in the form of a layer of the coating so as to expose the base metal in advance of the knife point. Testing is not done or carried out at edges or corners (points of lowest coating adhesion) to determine adhesion of the coating. Likewise, it is not advisable to remove small particles of the coating by paring or whittling to determine the failure.

VI. Uniformity Testing - Variations in coating thickness are not usually of concern with materials galvanized after fabrication provided the minimum coating weight requirements are satisfied. Where the coating thickness is not uniform, the service life of the galvanized coating generally will be governed by the amount of zinc available at the place where the coating is thinnest rather than by the overall or average thickness of the coating. Standard magnetic measuring instruments are quick and convenient method for determining local coating thickness. By taking a number of readings on a galvanized surface, uniformity as well as actual thickness can be easily checked.

6.3 SAMPLING

To properly evaluate galvanized coatings, it is essential that selected specimens be representative of the inspection lot. A lot is a unit production or shipment from which a sample may be taken for testing. It may be a collection of galvanized articles of the same time, in the same manner, and in the same galvanizing kettle, and are being submitted for acceptance as a group. Unless otherwise agreed upon by galvanizer and purchaser, or established within the ASTM A 123 specification, the lot shall be as follows:

For testing at a galvanizer facility, a lot is one or more articles of the same type and size comprising of a single order or a single delivery load, whichever is smaller, or any number of articles identified as a lot by the galvanizer, when these have been galvanized within a single production shift and in the same bath. For test by purchaser after delivery, the lot consists of the single order or the single delivery load, whichever is smaller, unless the lot identity, established in accordance with the above, is maintained and clearly indicated in the shipment by the galvanizer. For small objects such as nut, bolt, washers, etc,an entire article should be test specimen, or even several articles taken together. For fabricated products such as plates, bar, angle sections, etc.

Test specimens of more convenient and smaller size might be substituted for evaluation of the entire article. In this instance, specimens should be of the same shape as the material they are intended to represent. In the case of sections, specimen size should be at least 3 feet in length. When convenient

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size specimens are substituted, they should be made from material with the same composition and surface as that being galvanized and should be processed at the same time and in the same manner as the material they represent. Coupon specimens such as small pieces of flat plate, do not give a true indication of the weight of coating on the structural shapes and are not acceptable as test specimens for this class of work.

The minimum number of specimen from each lot shall be as follows:

Number of pieces in lot	Number of specimens
3 or less	all
4 to 500	03
501 to 1200	05
1201 to 3200	08
3201 to 10,000	13
10,001 and over	20

Where a number of identical items are to be galvanized, a statistical sampling may be desired. Such a plan is contained in test method B602 which addresses sampling procedures for the inspection of electrodeposited metallic coatings and related finishes. If the method B605 is used, the level of sampling shall be agreed upon by the galvanizer and purchaser at the time of order is placed.

7.0 REJECTION AND RETEST

When inspection of material to determine conformity with visual requirements of the ASTM A 123 specification warrants rejection of a lot, the galvanizer may sort the lot and submit it once again for acceptance after non-confirming materials are removed and replaced them with confirming articles. The sampling plan that was used when the lot was first inspected shall be used for re-sampling of a sorted lot.

If the thickness of coating does not confirm to the requirements specified in Appendix 1 and 2, re-test of a mutually agreeable number of additional members shall be made. Failure of the re-test to meet the requirements of Appendix 1 and 2, constitutes ground for rejection of the lot, unless the members are accepted by test on an individual basis.

Materials that have been rejected for reasons other than brittlement may be stripped and re-galvanized and again submitted for inspection and test at which time they shall conform to the requirements of the specification.

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8.0 REPAIR OF DAMAGED AND UNCOATED AREAS OF HOT-DIP GALVANIZED COATINGS

Our Repair Procedure is according to ASTM 780, for your reference standard is attached below

ASTM 780: Standard practice for Repair of damaged and uncoated areas of Hot Dip Galvanized Coatings

SCOPE

8.1 This practice describes methods which may be used to repair damaged hot-dip galvanized coatings on hardware, structural shapes, and other products fabricated prior to hot-dip galvanizing, and uncoated areas remaining after initial hot-dip galvanizing. The damage may be the result of welding or cutting, in which case the coating will be damaged predominantly by burning. This practice can also be used to repair hot-dip galvanized coatings damaged by excessively rough handling during shipping or erection. Requirements concerning the renovation of uncoated areas remaining after initial hot-dip galvanizing are contained within the applicable material speciation.

8.2 This practice describes the use of, paints containing zinc dust.

8.3 The extent of repair shall be limited to an area mutually agreeable to the contracting parties. Similarly, contracting parties shall agree to the repair method to be used.

8.4 Paints Containing Zinc Dust: These are usually based on organic binders, pre-mixed and formulated specially for use on steel surfaces. Paints containing zinc dust, with concentrations of zinc dust in the range of 65 to 69 % or above 92 % in the dried film, are considered equally effective for the repair of damaged galvanized coatings. The repair paint to be used shall be selected by the galvanizer, unless the purchaser specifies a particular concentration or paint system. Corrosion resistance and service performance are very dependent on the properties of the paint system, the extent of surface preparation, and skills of individual applicators.

8.1.1 Preparation of the damaged surface will be in upended by the type of paint selected and the anticipated service conditions. Experience shows that in general, organic zinc-rich systems are tolerant of marginal surface preparation most organic paints containing zinc dust are not critical of climatic or atmospheric conditions for curing. The following general guidelines shall apply:

8.1.2 Surfaces to be reconditioned with paints containing zinc dust shall be clean, dry, and free of oil, grease, pre-existing paint, and corrosion by-products.

8.1.3 Where anticipated, field service conditions include immersion, blast clean the surface in accordance with SSPCSP10/NACE No. 2 near white metal. For less critical field exposure conditions, clean the surface to bare metal, in accordance with SSPC-SP11, as a minimum. Where circum-stances do not allow blast or power tool cleaning, it is permissible to hand tool areas clean in accordance with SSPC-SP2. To ensure that a smooth reconditioned coating can be effected,

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surface preparation shall extend into the undamaged galvanized coating. The method and extent of surface preparation shall be mutually agreeable to the contracting parties.

8.1.4 If the area to be reconditioned includes welds, first remove all weld flux residue and weld spatter (of a size that cannot be removed by wire brushing or blast cleaning) by mechanical means, such as chipping, grinding, or power scaling, etc.

8.1.5 Spray or brush-apply the paints containing zinc dust to the prepared area. Apply the paint as in accordance with the manufacturer's printed instructions in a single application employing multiple passes to achieve a dry film thickness to be agreed upon between the contracting parties. Allow adequate curing time before subjecting repaired items to service conditions in accordance with the manufacturer's printed instructions.

8.1.6 Take thickness measurements with either a magnetic, electromagnetic, or eddy-current gage to ensure that the applied coating is as specified in accordance with SSPC-PA2.

9.0 CERTIFICATION

When specified in the purchase order / contract or requested by purchaser, he shall be furnished certification that samples representing each lot have been either tested or inspected as directed by the specification and the requirements have been met.

Appendix -1

Table - Minimum Average Coating Thickness Grade by Material Category

Steel Thickness Range, inches (mm)

Material Category	<1/16(<1.6)	1/16 to <1/8 (1.6< 3.2)	1/8 to 3/16 (3.2 to 4.8)	>3/16 to <1/4 (>4.8 to<6.4)	≥1/4 (≥6.4)
Structural Shapes & Plate	45	65	75	85	100
Strip & Bar	45	65	75	85	100
Pipe &Tubing	45	45	75	75	75
Wire	35	50	65	65	80

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Appendix – 2

Table - Coating Thickness Grade

Coating Grade	Mils	Oz/ft2	Micron	Gram/m2
35	1.4	0.8	35	245
45	1.8	1.0	45	320
50	2.0	1.2	50	355
55	2.2	1.3	55	390
60	2.4	1.4	60	425
65	2.6	1.5	65	460
75	3.0	1.7	75	530
80	3.1	1.9	80	565
85	3.3	2.0	85	600
100	3.9	2.3	100	705

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