

SANG CHAREON GROUP

บริษัท แสงเจริญ ฮอทดิป กัลวาไนซ์ จำกัด

丘建新电镀工厂有限公司

HOT DIP GALVANIZED COATING PROCEDURE

คู่มือปฏิบัติ สำหรับงานชุบกัลวาไนซ์

Certified ISO 9001:2008 By

M-QMR-001 Revision: 5

Distributing allowance to **Only** Sangchareon's Customer!



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Tappan Zee Bridge

Date Galvanized :2008

Environment	Location
Temperate Marine	New York City, NY
Industrial/Urban	Projected First
Reason for Galvanizing: Life-cycle Cost Durability	Maintenance
	85 years
Speed of Execution	

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Preface

**We aim to serve the best quality and punctual
by continuous improvement to meet customer satisfactions.**

Sangchareon Galvanize was established in 1994 with the initial register capital of 25 million baht on the area 6,400 square meters– supported the work of construction and telecommunication field with the kettle size 7 meters and 4 meters for nuts and screws as called spinning method. After growth of Thai industries and construction investment between 1995– 2007, we expand an another factory on Phatumthani to support the work more.



Sangchareon Hot Dip Galvanize is the second factory. It was established in year 2005 with the register capital of 30million baht on the area 52,800 square meters – able to support the work through the kettle size 9 meters with capacity more than 4,500 tons a month. Our kettle (made in Germany) and furnace system was designed by British engineering team with British standard and looked at environment by using LPG energy and water treatment system. Recently we have a plan to expand the factory I from 6,400 square meters to 28,800 square meters to support the expansion of the future infrastructure construction.



Capacity and Manpower

Sangchareon Galvanize Factory I

5/2 Moo 1 Kukuang Ladlumkaew Pathumthani
12140

Tel: 0-2976-2118-20, 0-2976-3021-2

Fax: 0-2976-2118-20

Kettle 1 Size 7.0 x 1.5 x 2.0 metres

Capacity: 3,000 Tons/ Month

Kettle 2 Size <Spinning> 4.0 x 1.2 x 1.5 metres

Capacity: 1,000 TM

Worker: 50 persons



Sangchareon Hot Dip Galvanize

Factory II

1/1 Moo 4 Kukuang Ladlumkaew Pathumthani
12140

Tel/Fax: 662-599-4115-20

Kettle Size 9.0 x 1.7 x 2.2 metres

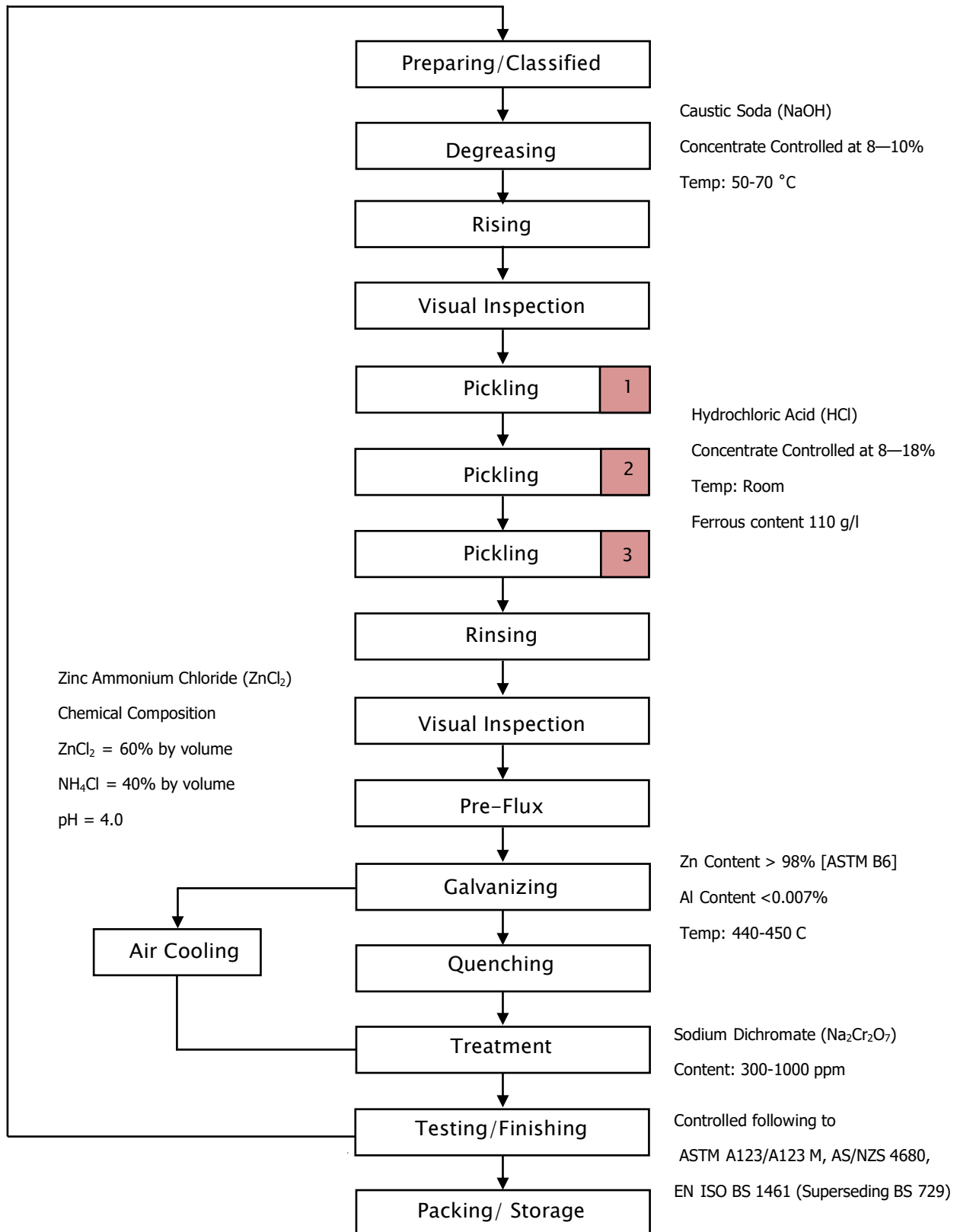
Capacity: 4,500 Tons/Month

Worker: 200 persons

Certification



GALVANIZING PROCESS @ SHG



The hot dip Galvanizing process

The galvanizing process consists of three basic steps: surface preparation, galvanizing and inspection.

SURFACE PREPARATION

Surface preparation is the most important step in the application of any coating. Any failures or inadequacies in surface preparation will immediately be apparent when the steel is withdrawn from the molten zinc because the unclean areas will remain uncoated and immediate corrective action must be taken.

Caustic Cleaning – A hot alkali solution often is used to remove organic contaminants such as dirt, paint markings, grease and oil from the metal surface. Epoxies, vinyls, asphalt or welding slag must be removed before galvanizing by grit-blasting, sand-blasting or other mechanical means.

Pickling – Scale and rust normally are removed from the steel surface by pickling in a dilute solution of sulfuric acid (5–15% by volume) or ambient temperature hydrochloric acid.

Fluxing – Fluxing is the final surface preparation step in the galvanizing process. Fluxing removes oxides and prevents further oxides from forming on the surface of the metal prior to galvanizing.

GALVANIZING – In this step Zinc shall be ASTM B6 High Grade Zinc per 19–01–01 Section 10.3, the material is completely immersed in a bath consisting of a minimum of 98% pure molten zinc. The bath temperature is maintained at about 840 F (449 C). Fabricated items are immersed in the bath until they reach bath temperature. The zinc metal then reacts with the iron on the steel surface to form a zinc/iron intermetallic alloy.

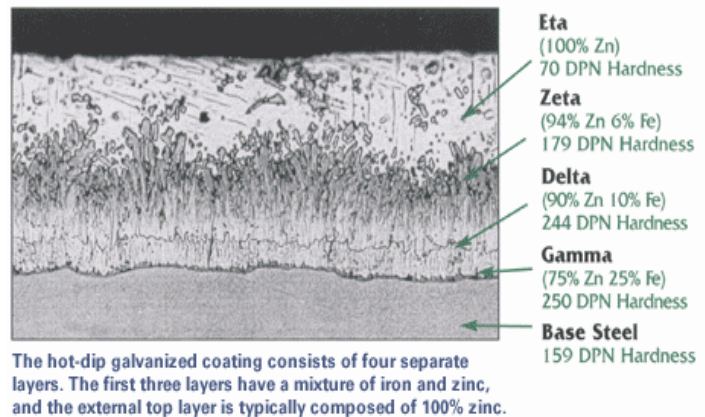
INSPECTION – A variety of simple physical and laboratory tests may be performed to determine thickness, uniformity, adherence and appearance. Products are galvanized according to long-established, well-accepted, and approved standards of ASTM A123/A123M, AS/NZS 4680, and BS EN ISO 1461, BS 729 (supersedes by EN ISO 1461: 2006).



Hot Dip Galvanized Coating

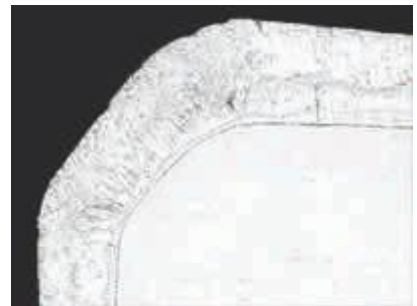
Coating Structure

Galvanizing forms a metallurgical bond between the zinc and the underlying steel or iron, creating a barrier that is part of the metal itself. The figure (left side) is a photomicrograph of a galvanized steel coating cross-section and shows a typical coating microstructure consisting of three alloy layers and a layer of pure metallic zinc.



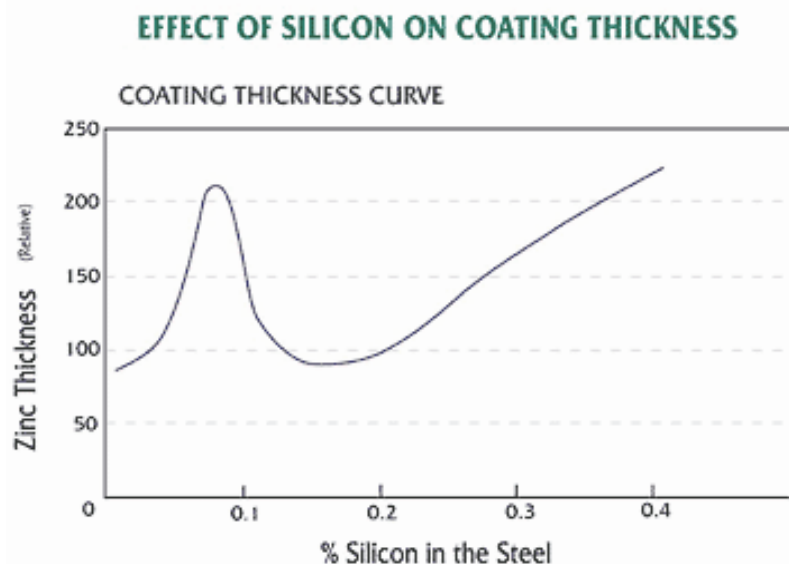
Coating Uniformity

The galvanizing process naturally produces coatings that are at least as thick at the corners and edges as the coating on the rest of the article. As coating damage is most likely to occur at the edges, this is where added protection is needed most. The figure below is a photomicrograph showing a cross-section of a corner of a galvanized piece of steel. Galvanizing provides protection on both exterior and interior surfaces of hollow structures. Hollow structures that are painted (but not galvanized) have no corrosion protection on the inside.



Coating Thickness

The chemical composition of the steel being galvanized is very important. The amount of silicon and phosphorus in the steel strongly influences the thickness and appearance of the galvanized coating. Silicon, phosphorous or combinations of the two elements can cause thick, brittle galvanized coatings. The coating thickness curve shown in the figure below relates the effect of silicon in the base steel to the thickness of the zinc coating.



The carbon, sulfur and manganese content of the steel also may have a minor effect on the galvanized coating thickness. The combination of elements mentioned above, known as “reactive steel” in the galvanizing industry, tends to accelerate the growth of zinc-iron alloy layers. This may result in a finished galvanized coating consisting entirely of zinc-iron alloy. Instead of a shiny appearance, the galvanized coating will have a dark gray, matte finish. This dark gray, matte coating will provide as much corrosion protection as a galvanized coating having a bright appearance. It is difficult to provide precise guidance in the

Hot Dip Galvanized Benefits

CORROSION RESISTANCE–Galvanized coatings protect steel in three ways::

1. The zinc weathers at a very slow rate giving a long and predictable life.
2. The coating corrodes preferentially to provide sacrificial protection to small areas of steel exposed through drilling, cutting or accidental damage.
3. If the damaged area is larger, sacrificial protection prevents sideways creep which can undermine coatings.

COATING TOUGHNESS – Galvanizing is unique. The process produces a coating which is bonded metallurgical to the steel.

COMPLETE COVERAGE – All parts of the surface of the steelwork are coated – external, internal, awkward corners and areas with narrow gaps.

RELIABILITY – Able to specified to many standard BS EN ISO 1461 (Superseding BS 729(, ASTM A123/123 M, and AS/NZS 4680

SPEED OF APPLICATION – Can be applied in minutes

FASTER CONSTRUCTION – No site surface preparation is necessary

LOWEST LIFETIME COST – Competitive initial cost and long life make hot dip galvanizing the most versatile, economic method of protecting steelwork.

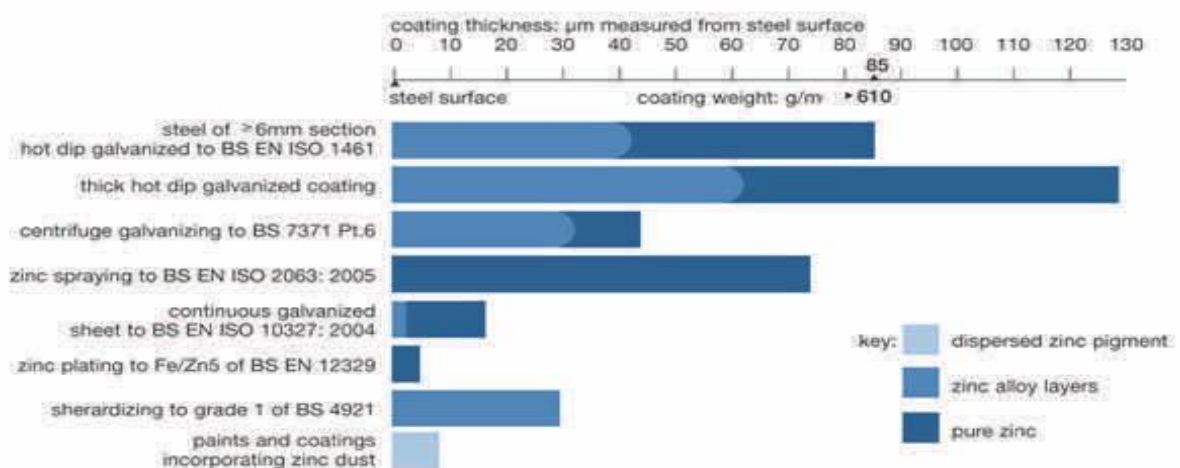
LONG LIFE – Often exceeding 10 years

EASE OF INSPECTION – The nature of the process is such that if the coating looks continuous and sound, it is so.

COMPETITIVE FIRST COST – For many applications the cost is lower than alternative coatings.

BARRIER PROTECTION –Galvanizing provides a barrier between all internal and external steel surfaces and their environment. Galvanizing is a term often wrongly used to describe zinc coatings in general. The diagram below illustrates how the different types of zinc coatings vary in terms of coating thickness. The life expectancy of a zinc coating is largely determined by its thick–

Information from Galvanizers Associations



COATING DEFECT

5 summarizes variations in finish which may be observed. The variations are often caused by surface features of the steel itself, and the acceptability of a coating should usually be judged primarily on its long-term performance and corrosion resistance.

De-lamination



Figure 1: De-lamination

De-lamination or peeling creates a rough coating on the steel where the zinc has peeled off. There are a number of causes for zinc peeling. Many large galvanized parts take a long time to cool in the air and form zinc-iron layers after they have been removed from the galvanizing kettle. This continued coating formation leaves behind a void between the top two layers of the galvanized coating. If there are many voids formed, the top layer of zinc can separate from the rest of the coating and peel off the part. If the remaining coating still meets the minimum specification requirements, then the part is still acceptable. If the coating does not meet the minimum specification requirements then the part must be rejected and re-galvanized. If de-lamination, as seen in Figure 1, occurs as a result of fabrication after galvanizing, such as blasting before painting, then the galvanizer is not responsible for the defect.

Drainage Spikes

Drainage spikes or drips are spikes or tear drops of zinc along the bottom edges of the product. These result when the surfaces of the product are processed horizontal to the galvanizing kettle, preventing proper drainage of the zinc from the surface as the product is withdrawn from the kettle. Drainage spikes, as seen in Figure 2, are typically removed during the inspection stage by a buffing or grinding process. Drainage spikes or drips are excess zinc and will not affect corrosion protection, but are potentially dangerous for anyone who handles the parts. These defects must be removed before the part can be accepted.



Figure 2: Drainage Spikes

Distortion



Figure 3: Distortion

Distortion, as seen in Figure 3, is defined as the buckling of a thin, flat steel plate or other flat material such as wire mesh. The cause of this is differential thermal expansion and contraction rates for the thin, flat plate and mesh than the thicker steel of the surrounding frame. In order to avoid distortion, use a thicker plate, ribs, or corrugations to stiffen flat sections or make the entire assembly out of the same thickness steel. Distortion is acceptable, unless distortion changes the part so that it is no longer suitable for its intended use.

COATING DEFECT (Continued)

Flux Inclusion



Figure 4: Flux Inclusion

Flux inclusion can be created by the failure of the flux to release during the hot-dip galvanizing process. If this occurs, the galvanized coating will not form under this flux spot. If the area is small enough, it must be cleaned and repaired; otherwise, the part must be rejected. Flux spots can increase if the flux is applied using the wet galvanizing method, which is when the flux floats on the zinc bath surface. Flux deposits on the interior of a hollow part, such as a pipe or tube, as seen in Figure 4, cannot be repaired, thus the part must be rejected. Any flux spots or deposits, picked up during withdrawal from the galvanizing kettle do not warrant rejection if the underlying coating is not harmed, and the flux is properly removed.

Flaking

Flaking results when heavy coatings develop in the galvanizing process, usually 12 mils or greater. This generates high stresses at the interface of the steel and the galvanized coating and causes the zinc to become flaky and separate from the surface of the steel. Flaking can be avoided by minimizing the immersion time in the galvanizing kettle and cooling of the galvanized steel parts as quickly as possible. Figure 5 shows a micrograph of flaking. In addition, using a different steel grade, if possible, may also help avoid flaking. If the area of flaking is small, it can be repaired and the part can be accepted; however, if the area of flaking is larger than allowed by the specifications, the part must be rejected and re-galvanized.

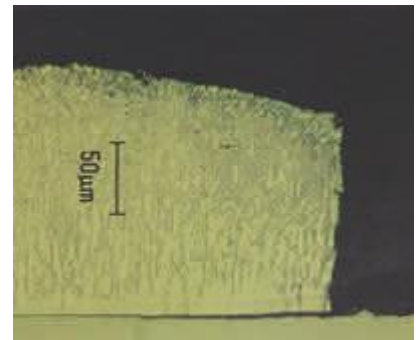


Figure 5: Flaking

Rough Surface Condition



Rough surface condition or appearance is a uniformly rough coating with a textured appearance over the entire product. The cause for this rough surface condition is hot-rolled steel with a high level of silicon content. This can be avoided by purchasing steel with a silicon content less than 0.03% of the steel by weight. Rough surface condition, as seen in Figure 6, can actually have a positive effect on corrosion performance because of the thicker zinc coating produced. One of the few situations where rough coating is cause for rejection is if it occurs on handrails. The corrosion performance of galvanized steel with rough coatings is not affected by the surface roughness

Figure 6: Rough Surface Condition

COATING DEFECT (Continued)



Figure 7: Runs

Runs

Runs are localized thick areas of zinc on the surface. Runs occur when zinc freezes on the surface of the product during removal from the zinc bath. This is more likely to occur on thinner sections with large surface areas that cool quickly. In order to avoid runs, as seen in Figure 7, adjustments of the dipping angles can be made, if possible, to alter the drainage pattern to a more acceptable mode. If runs are unavoidable and will interfere with the intended application, they can be buffed. Runs are not cause for rejection.

Rust Bleeding



Rust bleeding appears as a brown or red stain that leaks from unsealed joints after the product has been hot-dip galvanized. It is caused by pre-treatment chemicals that penetrate an unsealed joint. During galvanizing of the product, moisture boils off the trapped treatment chemicals leaving anhydrous crystal residues in the joint. Over time, these crystal residues absorb water from the atmosphere and attack the steel on both surfaces of the joint, creating rust that seeps out of the joint. Rust bleeding, as seen in Figure 8, can be avoided by seal welding the joint where possible or by leaving a gap greater than 3/32" (2.4mm) wide in order to allow solutions to escape and zinc to penetrate during hot-dip galvanizing. If bleeding occurs, it can be cleaned up by washing the joint after the crystals are hydrolyzed. Bleeding from unsealed joints is not the responsibility of the galvanizers and is not cause for rejection.

Figure 8: Rust Bleeding

Weld Spatter



Welding spatter appears as lumps in the galvanized coating adjacent to weld areas. It is created when welding spatter is left on the surface of the part before it is hot-dip galvanized. In order to avoid welding spatter, welding residues should be removed prior to hot-dip galvanizing. Welding spatter, as seen in Figure 9, appears to be covered by the zinc coating, but the coating does not adhere well and can be easily removed. This type of defect can leave an uncoated area or bare spot if the zinc coating is damaged and must be cleaned and properly repaired.

Figure 9: Weld Spatter

COATING DEFECT (Continued)

Welding Blowouts



Figure 10 : Welding Blowouts

Welding blowout is a bare spot around a weld or overlapping surface hole. These are caused by pre-treatment liquids penetrating the sealed and overlapped areas that boil out during immersion in the liquid zinc. This causes localized surface contamination and prevents the galvanized coating from forming. In order to avoid welding blowouts, as seen in Figure 10, check weld areas for complete welds to insure there is no fluid penetration. In addition, products can be preheated prior to immersion into the galvanizing kettle in order to dry out overlap areas as much as possible. Welding blowouts cause bare areas that must be repaired before the part is acceptable.

Wet Storage Stain

Figure 11 :
Wet Storage Stain



Wet storage stain is a white, powdery surface deposit on freshly galvanized surfaces. It is caused by newly galvanized surfaces being exposed to fresh water, such as rain, dew, or condensation that react with the zinc metal on the surface to form zinc oxide and zinc hydroxide. It is found most often on tightly stacked and bundled items, such as galvanized sheets, plates, angles, bars, and pipes. Wet storage stain can have the appearance of light, medium, or heavy white powder on the galvanized steel product. Each of these appearances can be seen from right to left in Figure 49.

One method to avoid wet storage stains is to passivate the product after galvanizing by using a chromate quench solution. Another precaution is to avoid stacking products in poorly ventilated, damp conditions. Light or medium wet storage stain will weather over time in service and is acceptable. In most cases, wet storage stain does not indicate serious degradation of the zinc coating, nor does it necessarily imply any likely reduction in the expected life of the product. However, heavy wet storage stain should be removed mechanically or with appropriate chemical treatments before the galvanized part is put into service. Heavy storage stain must be removed or the part must be rejected and regalvanized.



Dross Inclusions

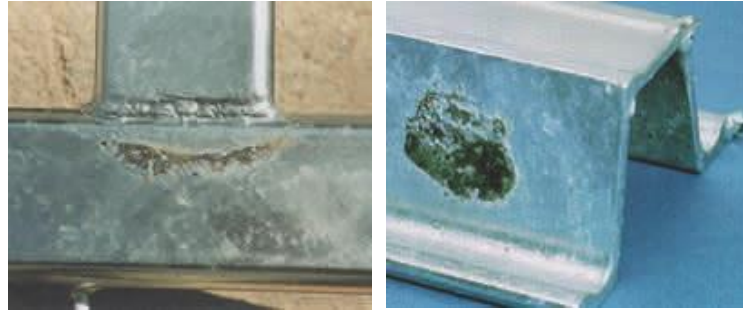
Dross inclusions are a distinct zinc-iron intermetallic alloy that becomes entrapped or entrained in the zinc coating. This is caused by picking up zinc-iron particles from the bottom of the kettle. Dross, as seen in Figure 32, may be avoided by changing the lifting orientation or redesigning the product to allow for proper drainage. If the dross particles are small and completely covered by zinc metal, they will not affect the corrosion protection and are acceptable. If the dross particles are large, then the dross must be removed and the area repaired.

Figure 12 : Dross Inclusions

COATING DEFECT (Continued)

Bare Spots

Figure 13 : Bare Spots



Bare spots, defined as uncoated areas on the steel surface, are the most common surface defect and occur because of inadequate surface preparation, welding slag, sand embedded in castings, excess aluminum in the galvanizing kettle, or lifting aids that prevent the coating from forming in a small area. Only very small areas, less than 1 inch in the narrowest dimension with a total of no more than 0.5% of the accessible surface area, may be renovated using ASTM A 780. This means narrow, bare areas may be repaired; however, if they are greater than one inch-square areas, the product must be regalvanized. In order to avoid bare spots, like those seen in Figure 13, the galvanizer must ensure the surfaces are clean and no contaminants are present after pretreatment. If the size of the bare spot or total surface area causes rejection, the parts may be stripped, regalvanized, and then re-inspected for compliance to the standards and specifications.



Figure 14 :

Sand Embedded in Casting

Sand Embedded in Casting

Another type of surface defect occurs when sand becomes embedded in the castings and creates rough or bare spots on the surface of the galvanized steel. Sand inclusions are not removed by conventional acid pickling, so abrasive cleaning should be done at the foundry before the products are sent to the galvanizer. This type of defect also leaves bare spots and must be cleaned and repaired or the part must be rejected, stripped, and regalvanized. Sand embedded in a casting can be seen in Figure 14

Touch Marks

Another type of surface defect is known as touch marks, which are damaged or uncoated areas on the surface of the product. Touch marks are caused by galvanized products resting on each other or by the material handling equipment used during the galvanizing operation. Touch marks, as seen in Figure 15, are not cause for rejection if they meet the size criteria for repairable areas. They must be repaired before the part is accepted.



Figure 15 :Touch Marks

Design Articles/Fabrications for Galvanizing

Left figure Ampol's high-tech petroleum reformer located in a corrosive environment on the Brisbane River, near the open sea. All structural steel is hot dip galvanized



Early consultation between galvanizer, fabricator and designer is the key to obtaining the best results from the galvanizing process. Design features which aid the access and drainage of molten zinc will improve the quality of the coating.

Good design requires:

- Means for the access and drainage of molten zinc
- Means for escape of gases from internal compartments (venting)

It is important to bear in mind that the steelwork is immersed into and withdrawn from a bath of molten zinc at about 450C. Thus any features, which aid the access and drainage of molten zinc, will improve the quality of the coating and reduce costs.

General principles

1. Holes for venting and draining should be as large as possible. Further information is given in table 4.
2. Holes for venting and draining should be diagonally opposite to one another at the high point and low point of the fabrication as it is suspended for galvanizing.
3. With hollow sections sealed at the ends, holes should be provided, again diagonally opposite one another, as near as possible to the ends.
4. Where holes are provided in end plates or capping pieces, they should be placed diagonally opposite one another, off centre and as near as possible to the wall of the member to which the end plate is connected.
5. Internal and external stiffeners, baffles, diaphragms, gussets etc, should have the corners cropped to aid the flow of molten zinc.

Base metal and combinations

Plain carbon steel, some low-alloy steels and iron and steel castings can all be galvanized. A fabrication consisting of a variety of materials with different surface conditions should be avoided as this could affect the uniformity and appearance of the coating. Where differing materials are used, grit blasting the entire assembly can minimize any differences which may arise due to differing effects of pre-treatment. Preferably, the fabrication should be of similar steel type throughout.

Design Articles/Fabrications for Galvanizing (continued)

Size and shape

When the length or depth of the item exceeds the size of the bath, special techniques may be employed to facilitate dipping. The galvanizer should be consulted.

Moveable parts

Adequate clearance on mating surfaces, such as hinges, should be allowed if they are to move freely after galvanizing. An extra clearance of at least 1 mm is usually sufficient.

Overlapping surfaces

Overlapping surfaces should be avoided as far as possible. Care must be taken not to specify sealed articles for galvanizing. If overlaps are completely sealed by welding there is a risk of explosion during dipping due to increased pressure of any entrapped air. If overlaps are not completely sealed there is a danger of cleaning fluid entering the cavity and then weeping out and causing localized staining.

Castings

Castings must be grit blasted before galvanizing as embedded sand from the casting process cannot be removed by conventional chemical cleaning. When designing castings to be galvanized.

Distortion

Efforts can be made at the design stage and elsewhere to minimize residual stresses, for example:

1. Controlling welding procedures during fabrication.
2. Arranging weld seams symmetrically. The size of weld seams should be kept to a minimum.
3. Avoiding large changes in structural cross-section which may increase distortion and thermal stress in the galvanizing bath.

Surface contamination

Clean steel surfaces are an essential requirement for good hot dip galvanizing. Contamination in the form of grease, tar paint and weld slag cannot be removed by chemical cleaning and may result in black bare spots after hot dip galvanizing. Fabricator should take responsibility to ensure that articles being delivered free from contamination. (otherwise, an additional charge for shot-blasting may be added)

Design Articles/Fabrications for Galvanizing (continued)

Design of structures to be hot-dip galvanized is no different from that for good structural, surface treatment and welding practice in general. However, certain components require special attention.

It is important that larger structural components are matched to the size of the pickling tank and zinc bath (Fig A). Sometimes “double-dipping”, which involves the handling of structural components longer than the zinc bath, is employed. (Fig.B).

Bolted joints are preferred instead of welding, since welding burns off the galvanized coating, which has to be repaired. The weight of the construction. The galvanizing plants can only handle constructions that the cranes can handle.

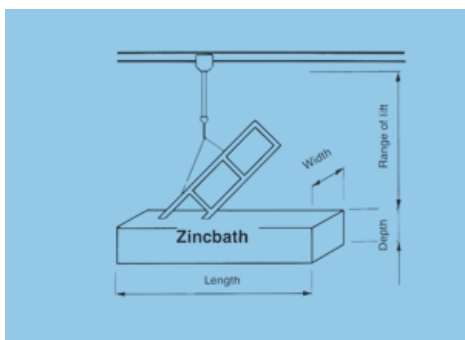


Fig. A. Schematic diagram of hot dip galvanizing.

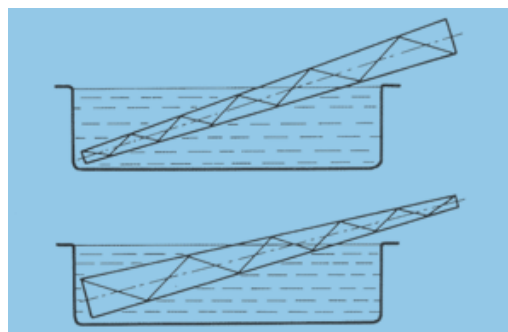


Fig. B. Schematic diagram of double-dipping.

Safety requirements

Hot-dip galvanizing involves dipping components and structures in both pretreatment baths and molten zinc. This means that hollow structures, such as pipes, tubing, and containers and also beam structures, which are welded round the connection point, must be provided with holes for drainage and venting. If a sufficient number of holes is not provided to enable complete venting, there is a significant risk that the structure will explode on immersion. Also, pickling acid is capable of penetrating pores in welds. Upon dipping in the zinc bath the residual pickling liquid is vaporized and the pressure can be so high that the object explodes. The risk of serious injury to personnel, or damage to materials, is great when such explosions occur.

Suitable dimensions for venting holes are given in table below. The holes must be located to enable total venting and to enable pickling acid and molten zinc to run in and out easily. Illustrations show this point. Examples of the location of the holes are given in the illustrations. It is also advisable to contact the galvanizer to discuss alternative hole sizes and locations. Holes can be formed by drilling, grinding or gas cutting.

Internal tube diameter, mm	Hole size, mm
Under 13	5—6
13—25	6—8
25—40	8—10
40—50	10—15
50 and above	< 15



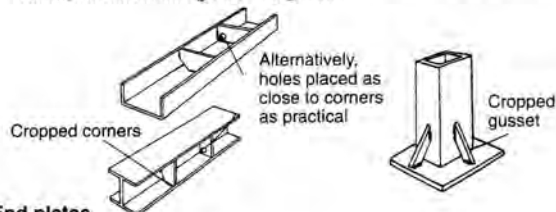
Design Articles/Fabrications for Galvanizing (continued)

Design For Galvanizing

Strengthening gussets and webs

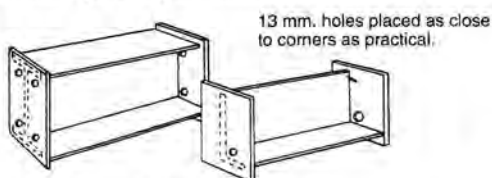
Welded strengthening gussets and webs on columns and beams, and strengthening gussets in members fabricated from channel sections should have corners cropped or holed,

1. To prevent the entrapment of air in pockets and corners allowing complete access of pickle acids and molten zinc to the entire surface of the work, and
2. To facilitate drainage during withdrawal from acid and rinse tanks, and from the galvanizing bath.



End plates

Provide holes at least 13 mm diameter in end plates on rolled steel shapes, to allow access of molten zinc in the galvanizing bath and drainage during withdrawal.



Clearance for moving parts

Drop handles, hinges, shackles, shafts, and spindles require provision of minimum radial clearances as detailed in the table below, to allow for the thickness of the galvanized coating

Shaft or spindle size

Up to 10 mm diameter
10 to 30 mm diameter
Over 30 mm diameter

Minimum radial clearance

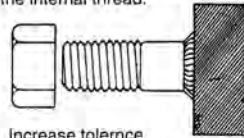
1 mm
2 mm
2.0 to 2.5 mm



Internal threads and nuts must be tapped

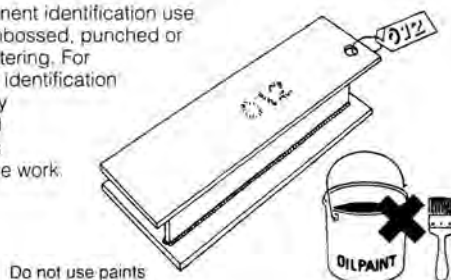
Oversize after galvanizing to accommodate the thickness of the galvanized coating on the stud or bolt.

The galvanized coating on the stud provides corrosion protection for the internal thread.



Identification markings

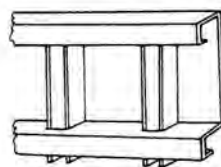
For permanent identification use heavily embossed, punched or welded lettering. For temporary identification use heavily embossed metal tags wired to the work.



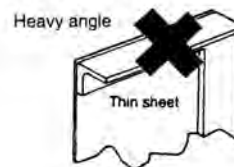
Distortion

Distortion can be prevented or minimised by:

1. Use of symmetrical designs
2. Use of relatively uniform sections
3. Use of accurately preformed members to avoid locked-in stresses
4. Use of balanced or staggered welding techniques to avoid locked-in stresses
5. Large open fabrications and tanks may require temporary cross stays to prevent distortion during galvanizing



Use of symmetrical sections minimises distortion during galvanizing. Avoid combinations of thick and thin materials



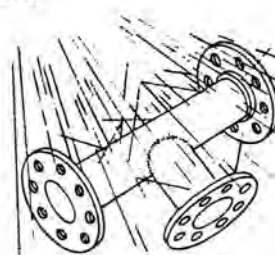
Materials suitable for galvanizing

All ferrous materials are suitable, including stainless steel parts, and sound stress free castings.

Brazed assemblies may be galvanized, but check first with galvanizer. Soft soldered assemblies cannot be galvanized.

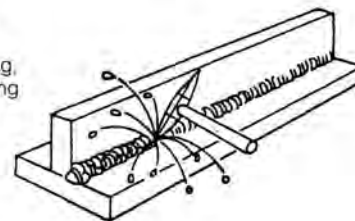
Combinations of ferrous surfaces

Fabrications containing a combination of castings and other steels, and rusted or mill scaled surfaces must be abrasive blast cleaned before galvanizing.



Weld slag

Must be removed by chipping, grinding, abrasive blast cleaning, flame cleaning, or using a pneumatic needle gun.



Provision for handling

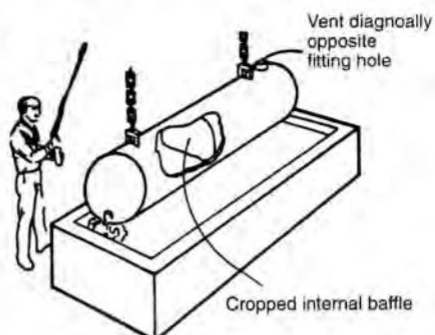
Work not suitable for handling with chains, baskets, hooks or jigs must be provided with suspension holes or fittings. If in doubt check with your galvanizer.

Design Articles/Fabrications for Galvanizing (continued)

Tanks and closed vessels

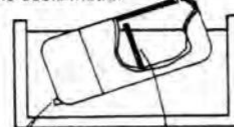
When both internal and external surfaces are to be galvanized at least one filling and draining hole must be provided, with a vent diagonally opposite to allow the exit of air during immersion. Holes should be at least 50 mm diameter for each 0.5 cubic metres.

Internal baffles should be cropped as illustrated. Manholes should finish flush inside to prevent trapping excess zinc.



When vessels and air receivers etc. are not to be galvanized inside, snorkel tubes or extended vent pipes must be fitted after discussion with the galvanizer, to allow air to exit above the level of molten zinc in the galvanizing bath.

Vent hole at least 50 mm. for each 0.5 cubic metre.



Filling hole at least 50 mm. diameter for each 0.5 cubic metre.

Vent pipes connect interior to the atmosphere

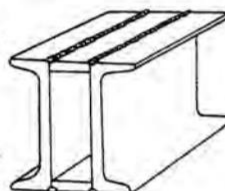
Internal baffles cropped top and bottom to allow free passage of zinc, and prevent trapping of air. Flanges should finish flush inside.

Overlapping surfaces

Avoid narrow gaps between plates, overlapping surfaces, and back-to-back angles and channels.

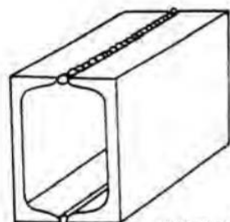
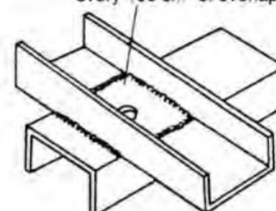
When small overlaps are unavoidable, seal edges by welding

When left unsealed, small overlapping areas may trap pickle acid which can later escape to discolour or damage the galvanized coating.



A Satisfactory

Vent hole 6 mm. diameter for every 100 cm² of overlap area.



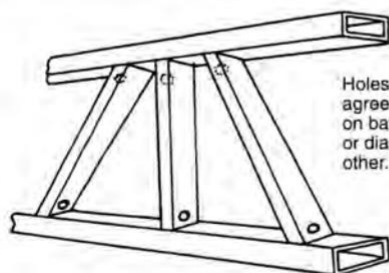
B Satisfactory



C Unsatisfactory

Larger overlapping surfaces

If contacting surfaces cannot be avoided, a hole 6 mm in diameter for every 100 cm² of overlap area should be placed in one of the members, and the perimeter of the contacting area should be continuously welded. The vent hole in one member will ensure the safety of galvanizing personnel and prevent damage to the article.

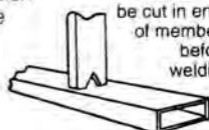


Holes placed at locations agreed with galvanizer ideally on both sides of members, or diagonally opposite each other.

Tubular Fabrications/hollow structurals

Vent holes must be provided, preferably 25% of internal diameter for sections up to 150 mm diameter. This percentage can be dependent on the shape of the fabrication, and consultation with the galvanizer at the design stage is recommended.

Alternatively V notches can be cut in ends of members before welding



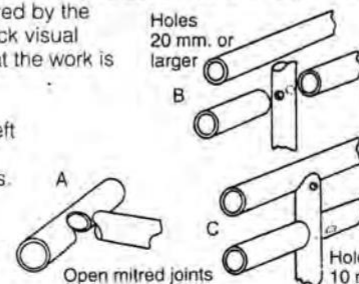
Welded pipe sections

Closed sections must never be incorporated. Sections should be interconnected using open mitred joints as illustrated at 'A', or interconnecting holes should be put in before fabrication as in 'B'.

Alternatively external holes may be positioned as in 'C', a method which is often preferred by the galvanizer, since quick visual inspection shows that the work is safe to galvanize.

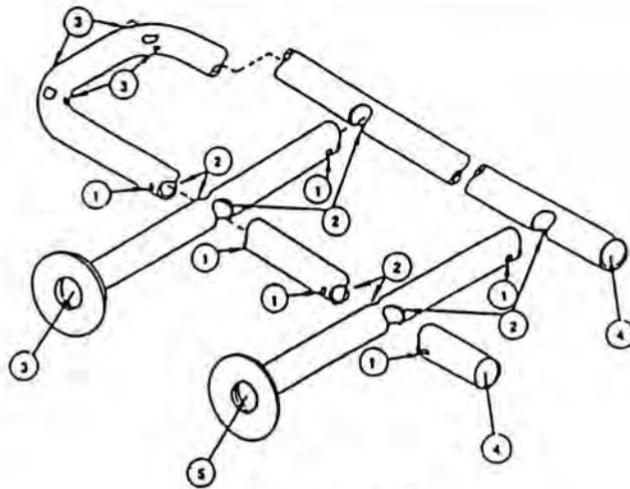
Pipe ends must be left open, or provided with removable plugs.

Small tubular fabrications such as pack racks must be vented, with holes not less than 6 mm diameter.



Unwanted vent holes may be closed by hammering in lead plugs after galvanizing and filling off flush with surrounding surfaces.

Design Articles/Fabrications for Galvanizing (continued)



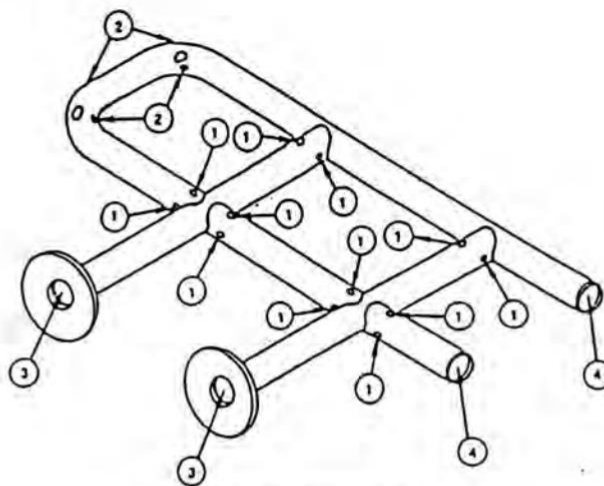
Handrail

The above drawing illustrates desirable design features for fabrication of handrail that requires galvanizing.

- 1.** Vent holes shall be as close to the weld as possible and not less than 3/8 in. (9.5 mm) in diameter.
- 2.** Internal holes shall be the full inside diameter of the pipe for best galvanizing quality and lowest galvanizing cost.
- 3.** Vent holes in end sections or similar section shall be a minimum 1/2 in (12.7 mm) in diameter.

- 4. and 5.** Any device used for erection in the field that prevents full openings on ends of horizontal rails and vertical legs shall be attached after galvanizing.

Vent holes should be visible on the outside of any pipe assembly.



Handrail - Alternative

The above drawing illustrates an acceptable alternative if full internal holes (the full inside diameter of the pipe) are not incorporated in the design of the handrail.

- 1.** Each vent hole shall be as close to the weld as possible, must be 25% of the inside diameter of the pipe, but not less than 3/8 in (9.5 mm) in diameter. The two holes at each end and at each intersection shall be 180° apart and in the proper location as shown.

- 2.** Vent holes in end sections or in similar sections shall be at least 1/2 in. (12.7 mm) in diameter.

- 3. and 4.** Any device used for erection in the field that prevents full openings on end of horizontal rails and vertical legs shall be attached after galvanizing.

Vent holes shall be visible on the outside of any pipe assembly.

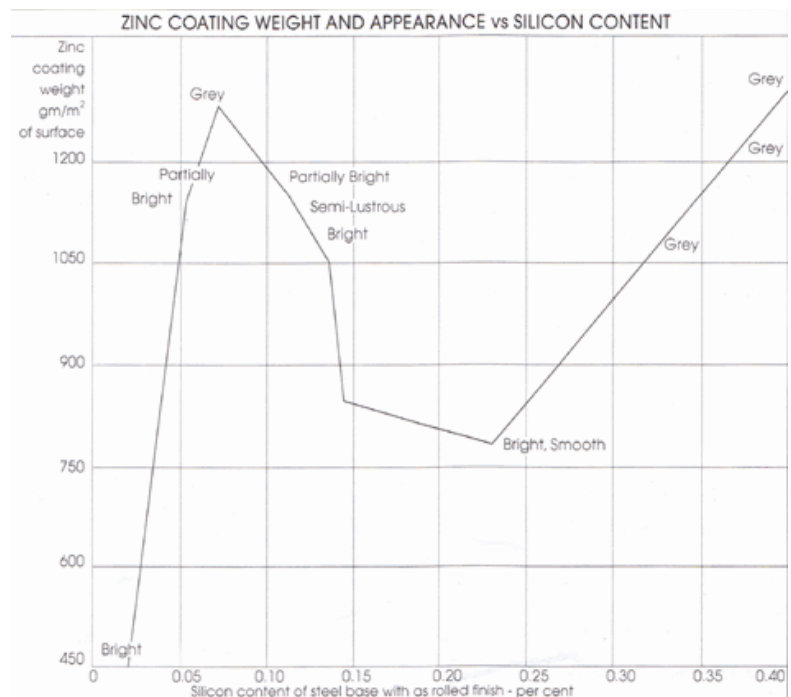
EFFECT OF SILICON ON COATINGS

The presence of silicon in the base steel significantly affects the structure and properties of the resulting galvanized coating. Certain silicon levels can be responsible for excessively thick galvanized

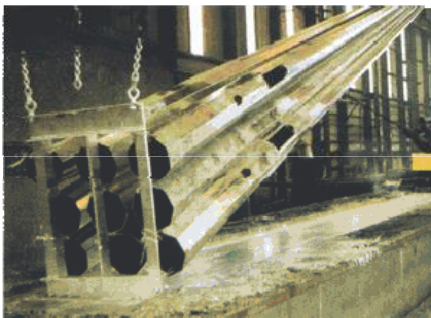
coatings which are often brittle and dull in appearance.

The effect of silicon content on galvanized coatings is shown in the graph. In general, a peak in zinc pick-up occurs between 0.05 and 0.1% Si followed by a trough at around 0.15% to 0.20% Si after which the reaction rate increases again. Galvanizing temperature and immersion time also affect the location of the peak and trough of the graph.

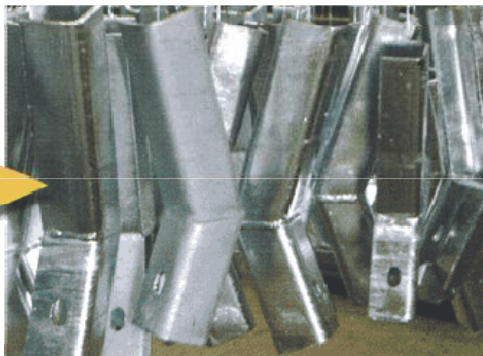
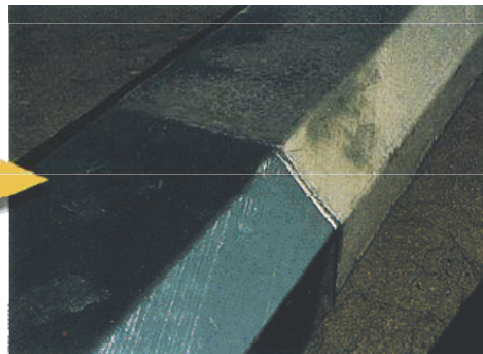
Since the life of the coating is proportional to its thickness, heavy grey coating, provided they are sound and continuous, are beneficial.



Source: Compagnie Royale Asturienne des Mines, Auby, France



High Silicon Reactive Steel results in extra zinc pick-up and causes a dull and brittle grey coating.



INSPECTION COATING and CONTINUITY

As a final step in the galvanizing process, the hot-dip galvanized coating is inspected for compliance with specifications. The coating thickness is the single most important component in determining a galvanized coating's quality. Coating thickness, however, is only one inspection criteria. Coating uniformity, adherence, and appearance should also be checked. Inspection of the galvanized product can be most effectively and efficiently conducted at the galvanizer's plant where questions can be asked and answered quickly.



There are a number of simple magnetic gauges used to give a convenient and reliable measurement of the zinc coating thickness, provided the instruments are properly calibrated. The three most common types of metal coating thickness gauges are: Magnetic balance gauges, sometimes called "banana gauges," measure variation in the force of attraction between two ferromagnetic bodies as a function of the distance between them. This type of gauge has the advantage of being able to measure the coating thickness in a horizontal or vertical position.

Pull-off magnetic gauges are also based on magnetic attraction to the underlying steel. These devices are shaped somewhat like a pen and are very convenient to make quick, rough estimates to determine whether the coating thickness meets specification. Electronic gauges are the easiest and most accurate coating thickness measurement gauges available. They have the ability to connect to an assortment of probes, providing the ability to measure on any orientation. One of the major advantages to specifying hot-dip galvanized steel is the ease of identifying coating defects immediately after galvanizing. Any areas that may remain uncoated are easily identifiable. If large areas (see ASTM A 123) of the steel remain uncoated due to residues left on the steel from fabrication, then the steel must be stripped free of zinc and processed again. If small areas are left ungalvanized, they can be reconditioned using one of the three accepted methods of touch-up and repair, see ASTM A 780.

Elcometer 456 can be used in accordance with:



FERROUS (F)	NON-FERROUS (NF)	DUAL FERROUS and NON-FERROUS (FNF)
ASTM B 499	ASTM D 1400	All of the Ferrous and Non-Ferrous List plus; ASTM E 376
ASTM D 1186	ASTM B 244	
ASTM D 7091	BS 5411-3	
BS 5411-11	BS 3900-C5-6Ba	
BS 3900-C5-6Aa	BS 5599	
BS EN ISO 146 1	DIN 50984	
DIN 50981	ISO 2360	
ISO 2178	ISO 2808-6Ba	
ISO 2808-6Aa		
ISO 19840		
SSPC-PA2		

SPECIFICATIONS RELATING TO HOT-DIP GALVANIZING

ASTM Standards Hot-Dip Galvanizing

A 123/A 123M : Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

A 143: Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement

A 153/A 153M: Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

A 384: Practice for Safeguarding Against War page and Distortion During Hot-Dip Galvanizing of Steel Assemblies

A 385: Practice for Providing High-Quality Zinc Coatings (Hot-Dip)

A 767/A 767M: Specification for Zinc Coated (Galvanized) Steel Bars for Concrete Reinforcement

A 780: Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

B 6: Specification for Zinc

D 6386: Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting

E 376: Practice for Measuring Coating Thickness by Magnetic-Field or Eddy-Current (Electromagnetic) Examination Methods

Canadian Standards Association (CSA) – Hot-Dip Galvanizing

G 164: Galvanizing of Irregularly Shaped Articles

International Standards Organization (ISO) – Hot-Dip Galvanizing

1461: Hot-Dip Galvanized Coatings on Fabricated Iron and Steel Articles – Specification and Test Methods
(Supersedes BS 729: 1971)

RELATED SPECIFICATIONS-HOT DIP GALVANIZING/ GALVANIZING MATERIALS

ASTM A 36: Specification for Structural Steel

A 500: Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

A 501 : Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing

A 563 : Standard Specification for Carbon and Alloy Steel Nuts

A 572 : Specification for High-Strength Low-Alloy Columbium-Vanadium Steels of Structural Quality

A 944 : Standard Test Method for Comparing Bond Strength of Steel Reinforcing Bars to Concrete Using Beam-End Specimens

A 992 : Specifications for Steel Structural Shapes for Use in Building Framing

B 201 : Standard Practice for Testing Chromate Coatings

Sourced by American Galvanizers Association.

STANDARDIZATION

Sangchareon Hot Dip Galvanize Co. Ltd. supply the service in hot dip galvanizing coatings comply with the standards and specifications of British / European Standard (BS EN ISO 1461), Australia & New Zealand Standard (AS/NZS 4680), American Standard (ASTM A123 / A123M), Japanese Standard (JIS H 8641) and International Standards (ISO 1460), etc.

ASTM A123/A123 M:

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

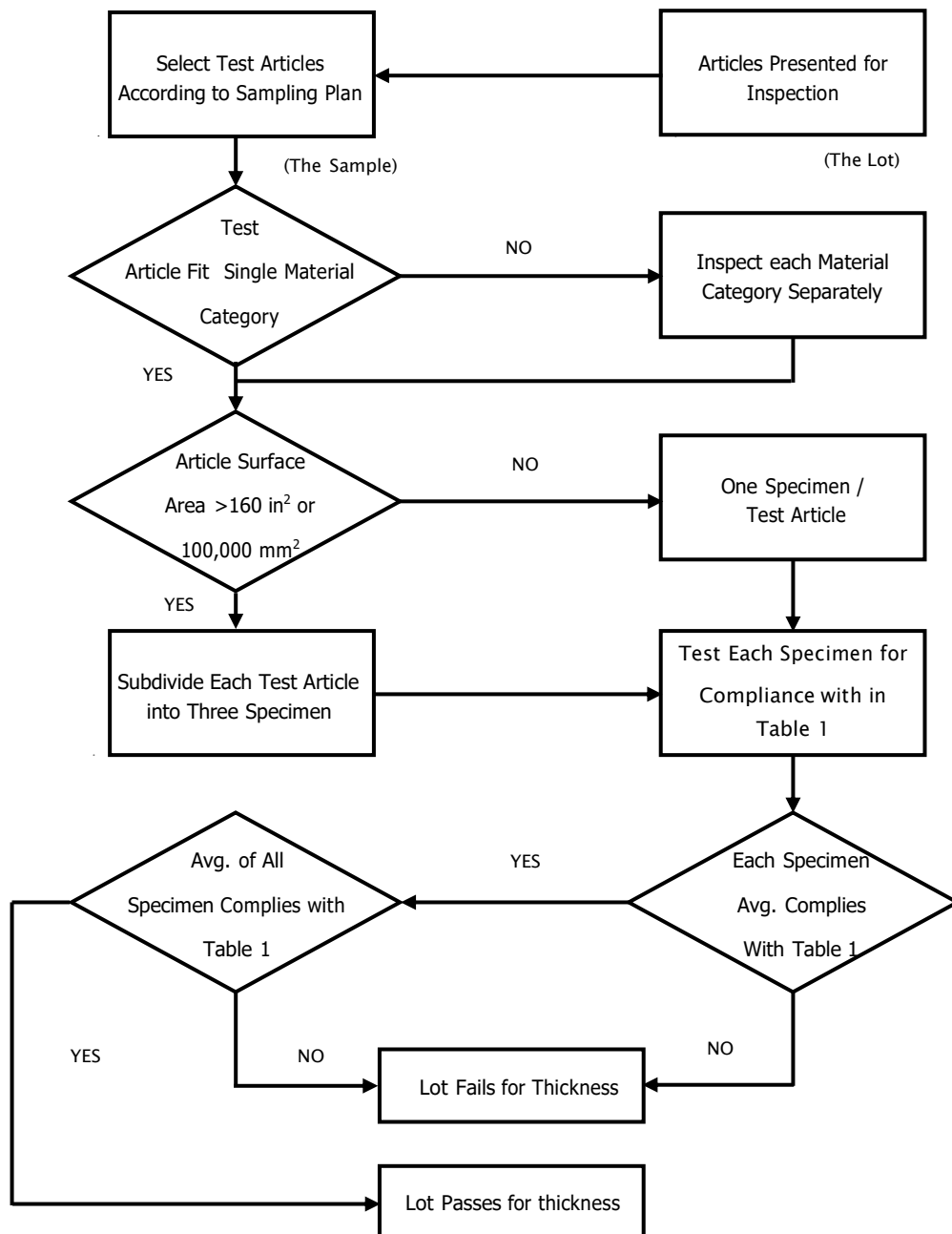


Fig shown Coating Thickness Inspection Steps

STANDARDIZATION (Continued)

ASTM A123/A123 M-13:

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

Table 1 Minimum Average Coating Thickness Grade by Material Category (unit measured in μm)

Material Category	All Specimens Tested Steel Thickness Range (Measured), in. [mm]					
	$<1/16$	$1/16$ to $<1/8$	$1/8$ to $3/16$	$>3/16$ to $<1/4$	$\geq 1/4$ to $<5/8$	$>5/8$
	[<1.6]	[1.6 to <3.2]	[3.2 to 4.8]	[>4.8 to <6.4]	[≥ 6.4 to <16.0]	[>16.0]
Structural Shapes	45	65	75	75	100	100
Strip and Bar	45	65	75	75	75	100
Plate	45	65	75	75	75	100
Pipe and Tubing	45	45	75	75	75	75
Wire	35	50	60	65	80	80
Reinforcing Bar	100	100

The weighing test:

For large articles, or where comparatively heavy weights are concerned, weighing the work before and after galvanizing is a simple and fairly accurate expedient. If weighed before pickling, allowance must be made for the loss in weight due to pickling. In some cases the calculation of surface area may be tedious, but it is justified where batches or repeated runs of one type of article are encountered

Table relating coating thickness to coating weight*							
Thickness		Weight		Thickness		Weight	
μm	in	g/m^2	oz/ft^2	μm	in	g/m^2	oz/ft^2
5	0.0002	36	0.12	70	0.0028	504	1.68
10	0.0004	72	0.24	76	0.0030	549	1.80
20	0.0008	144	0.48	80	0.0032	576	1.92
30	0.0012	216	0.72	85	0.0033	610	2.00
40	0.0016	288	0.96	90	0.0035	648	2.16
42	0.0017	305	1.00	97	0.0038	702	2.30
47	0.0019	335	1.10	100	0.0039	720	2.40
50	0.0020	360	1.20	139	0.0055	1000	3.28
60	0.0024	432	1.44	150	0.0059	1080	3.60
64	0.0026	458	1.50	208	0.0082	1500	4.92

*Relationship assumes the density of the coating to be $7.2 \text{ g}/\text{cm}^3$.

ASTM A153/ A153M -09: Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

Table 2 Minimum Weight and Thickness Coating on Samples that are centrifuged

Class of Material	Weight [Mass] of Zinc Coating, oz/ft ² [g/m ²] of Surface, Minimum Average of Specimens Tested		Coating Thickness, mils [microns], Minimum Average of Specimens Tested	
	Any Individual Specimen		Any Individual Specimen	
Class A-Castings-Malleable Iron, Steel	2.00[610]	1.80[550]	3.4[86]	3.1[79]
Class B-Rolled, Pressed, and forged articles (except those which would be included under Classes C and D): B-1-3/16 in. (4.76 mm.) and over in thickness and over 15 in. (381 mm) in length	2.00[610]	1.80[550]	3.4[86]	3.1[79]
B-2-under 3/16 in (4.76 mm) in thickness and over 15 in. (381 mm) in length	1.50[458]	1.25[381]	2.6[66]	2.1[53]
B-3- any thickness and 15 in. (381 mm) and under in length	1.30[397]	1.10[336]	2.2[56]	1.9[48]
Class C-Fasteners over 3/8 in. (9.52 mm) in diameter and similar articles. Washers 3/16 in. and 1/4 in. (4.76 and 6.35 mm) in thickness	1.25[381]	1.00[305]	2.1[53]	1.7[43]
Class D-Fasteners 3/8 in. (9.52 mm) and under in diameter , rivets, nails and similar articles. Washers under 3/16 in. (4.76 mm) in thickness	1.00[305]	0.85[259]	1.7[43]	1.4[36]

STANDARDIZATION (Continued)

British Standard

BS EN ISO 1461:2009 (Superseding BS 729:1971)

Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods

Table 3—Coating minimum thicknesses on samples that are not centrifuged

Article and its thickness	Local coating thickness (minimum) ^a μm	Mean coating thickness (minimum) ^b μm
Steel ≥ 6mm	70	85
Steel ≥ 3.0 mm to < 6.0 mm	55	70
Steel ≥ 1.5 mm to < 3.0 mm	45	55
Steel < 1.5 mm	35	45
Casting ≥ 6mm	70	80
Casting < 6mm	60	70

a = local coating thickness
the mean value of coating thickness obtained from the specified number of measurements within a reference area for a magnetic test or the single value from gravimetric test

b = mean coating thickness
the average value of the local thicknesses either on one large article or on all the articles in the control sample

Note : Table 3 is for general use: individual product standards may include different requirements including different categories of thickness. A requirement for thicker coatings or additional requirements can be added without otherwise affecting conformity to this standard.

Table 4—Coating minimum thicknesses on samples that are centrifuged

Article and its thickness	Local coating thickness (minimum) ^a μm	Mean coating thickness (minimum) ^b μm
Article with threads:		
≥ 20 mm diameter	45	55
≥ 6.0 mm to < 20 mm diameter	35	45
< 6.0 mm diameter	20	25
Other articles (including castings):		
≥ 3.0 mm	45	55
< 3.0 mm	35	45

a = local coating thickness
the mean value of coating thickness obtained from the specified number of measurements within a reference area for a magnetic test or the single value from gravimetric test

b = mean coating thickness
the average value of the local thicknesses either on one large article or on all the articles in the control sample

Note : Table 4 is for general use: fastener coating standards and individual product standards may have different requirements.

STANDARDIZATION (Continued)

Australian/New Zealand Standard

AS/NZS 4680:2006

Hot-dip galvanized (zinc) coatings on fabricated ferrous articles

Table 5—Requirements for coating thickness and mass for articles that are not centrifuged

Article thickness mm	Local coating thickness minimum µm	Average coating thickness minimum µm	Average coating mass minimum µm
≤ 1.5	35	45	320
>1.5 to ≤ 3	45	55	390
>3 to ≤ 6	55	70	500
>6	70	85	600

Note : 1 g/m² coating mass = 0.14 µm coating thickness.

Table 6—Requirements for coating thickness and mass for articles that are centrifuged

Thickness of articles (all components including castings) mm	Local coating thickness minimum µm	Average coating thickness minimum µm	Average coating mass minimum µm
<8	25	35	250
≥ 8	40	55	390

Notes :

1. For requirements for threaded fasteners refer to AS1214
2. 1 g/m² coating mass = 0.14 µm coating thickness.

REPAIRING GALVANIZED

If the galvanized product does not meet all of the requirements of the specification, it must be repaired or rejected along with the lot it represents. When repair of the product is allowed by the specification or bare spots are present, the galvanizer is responsible for the repair unless directed otherwise by the purchaser. The specifications allow for some retesting of products that represent lots or retesting after the lot has been sorted for non-conformance. The coating thickness of the repaired area must match the coating thickness of the surrounding area. However, if zinc-rich paint is used for repair, the coating thickness must be 50% higher than the surrounding area, but not greater than 4.0 mils because mud cracking tends to result when the paint coating is too thick. The maximum sizes for allowable areas that can be repaired during in-plant production are defined in the specifications as summarized below.

Maximum Size of Repairable Area

ASTM A 123/A 123M:

One inch or less in narrowest dimension. Total area can be no more than 0.5% of the accessible surface area to be coated or 36 square inches per piece, whichever is less

ASTM A 153/A 153M:

The bare spots shall have an area totaling no more than 1% of the total surface area to be coated, excluding threaded areas of the piece

ASTM A 767/A 767M:

No area given If the coating fails to meet the requirement for finish and adherence, the bar may be stripped, regalvanized, and resubmitted. Damage done to the coating due to fabrication or handling shall be repaired with a zinc-rich formulation

Repair Methods

Any repairs made to galvanized products must follow the requirements of ASTM A 780, which defines the acceptable materials and the required procedures. Repairs are normally completed by the galvanizer before the products are delivered, but under certain circumstances, the purchaser may perform the repairs on their own. The touch-up and repair materials are formulated to deliver an excellent color that matches either brightly coated, newly galvanized products or matte gray, aged galvanized products.

Materials used to repair hot-dip galvanized products include zinc-based solder, zinc-rich paint, and zinc spray metallizing, and are explained in the following sections or galvanizing repairs shall be performed using System 4 or System 5 as outlined in GP 19-01-01. Vendor to include specific system details for either System 4 or System 5 as applicable based on operating conditions.

REPARING GALVANIZED

Zinc rich paints

The application of an organic zinc rich paint is the most rapid and convenient method of repair. The paint should conform to ASTM A 780 "Zinc rich organic priming paint" applied in two coats by brush to provide a total film thickness of 100 µm and for optimum performance should contain not less than 65% zinc in the dried paint film. Where color matching is required aluminum paint or aerosol lacquer (Bright Silver) may be applied over the hardened zinc rich paint. Zinc metal spraying. In certain circumstances, by prior agreement, zinc metal spraying may be used as a method of coating repair. The damaged area must be grit blasted to SSPC-SP5 (White metal) followed by zinc metal spraying to a coating thickness equivalent to that of the undamaged coating, and seal coated using an aluminum vinyl paint.

ZINC RICH PAINT

Zinc-rich paint is applied to a clean, dry steel surface by either a brush or spray as seen in Figure 56, and usually contains an organic binder pre-mix. Zinc-rich paints must contain either between 65% to 69% metallic zinc by weight or greater than 92% metallic zinc by weight in dry film. Paints containing zinc dust are classified as organic or inorganic, depending on the binder they contain. Inorganic binders are particularly suitable for paints applied in touch-up applications around and over undamaged hot-dip galvanized areas.

Surface Preparation

According to ASTM A 780, the surface to be repaired shall be blast cleaned to SSPC-SP10/NACE No.2 near white metal for immersion applications and SSPC-SP11 near bare metal for less aggressive field conditions. When blasting or power tool cleaning is not practical, hand tools may be used to clean areas to be reconditioned. The blast cleaning must extend into the surrounding, undamaged, galvanized coating.

Application

This method of repairing galvanized surfaces must take place as soon as possible after preparation is completed and prior to the development of any visible oxides. The spraying or brushing should be in an application of multiple passes and must follow the

paint manufacturer's specific written instructions. In

addition, proper curing of the repaired area must occur before the product is put through the final inspection process. This repair can be done either in the galvanizing plant or on the job site and is the easiest repair method to apply because limited equipment is required. Zinc-rich painting should be avoided if high humidity and/or low temperature conditions exist because adhesion may be adversely affected.



Final Repaired Product

The coating thickness for the paint must be 50% higher than the surrounding coating thickness, but not greater than 4.0 mils, and measurements should be taken with either a magnetic, electromagnetic or eddy current gauge. Finally, the surface of the painted coating on the repaired area should be free of lumps, coarse areas, and loose particles.

EX REPORT



บริษัท แสงเจริญ ฮอทดิป กัลวาไนซ์ จำกัด

SANG CHAROEN HOT DIP GALVANIZE CO.,LTD.

丘建新電鍍工廠有限公司

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1/1 Moo.4 Thumbol Kukuang Amphur Ladlumkaew Pathumthani 12140 Tel/Fax:+66-2-599-4115-9

Record of Thickness Coating

OWNER:	Date Issued:	00/00/2016
CLIENT:	Inspection Sheet No:	SCG/II. 16/000
PROJECT:	Reference:	

Standard Reference: ASTM A123 /A123 M - 13

(Standard Specification for Zinc (Hot Dip Galvanized) Coatings
on Iron and Steel Products)

Sample Size:	3
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Testing Method: Magnetic Thickness Measurements

Lot Size:

Serial Number :

[illegible]

Minimum Average Coating Thickness Grade by Material Category

Material Category	All Specimens Tested					
	Steel Thickness Range (Measured), in. (mm)					
	<1/6 <1.6	1/16 to 1/8 (1.6 to 3.2)	1/8 to 3/16 (3.2 to 4.8)	3/16 to 1/4 (4.8 to 6.4)	1/4 to 5/8 (6.4 to 16.0)	>5/8 (>16.0)
Structural Shapes	45	65	75	75	100	100
Strip and Bar	45	65	75	75	75	100
Plate	45	65	75	75	75	100
Pipe and Tubing	45	45	75	75	75	75
wire	35	50	60	65	80	80
Reinforcing Bar	-	-	-	-	100	100

Remark: $1\mu\text{m} = 7.092 \text{ gram per square meter}$

Inspected By:	Approved By:
(Mr. Tanawat Sukned) Q.C. Engineer	(Mr. Palungboon Charoensook) Factory Manager