BHARAT HEAVY ELECTRICALS LIMITED

COMPONENT FABRICATION PLANT(CFP),RUDRAPUR

PROJECT: VARIOUS

QUALITY ASSURANCE PLAN (QAP)
FOR
FOUNDATION BOLT

DOC NO: QP/BD/ACC./FB
REV NO: 00
DATE: 25.06.19

SL. NO.	COMPONENT	CHARACTERISTICS	CATEGOR	METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	FORMAT of RECORDS	INSPECTION AGENCY				REMARKS
								P	W	R	H	
1.0	FOUNDATION BOLT	a) Freedom from Defects	Major	Visual	100 %	IS 2629	IR	3	2			
		b) Dimensions	Major	Measurement	10% sample/each type	BHEL DWG	IR	3	2			
		c) Chemical & Mechanical	Major	Review	Sample	IS :2062	TC	3		2		
		d) Uniformity of Zinc Coating/Preece Test	Major	Measurement	Sample	IS: 2629/ IS2633/ IS 6745	IR	3	2			
		e) Mass of Zinc Coating/Stripping Test	Major	Measurement	Sample		IR	3	2			
		f) Adhesion Test	Major	Physical	Sample		IR	3	2			

ABBREVIATIONS:
R= REVIEWED BY
P= PERFORMED BY
W= WITNESSED BY
H= HOLD POINT

TC= TEST CERTIFICATE
IR= INSPECTION REPORT

3= PERFORMER
2= BHEL/BHEL TPIA

PREPARED BY
Ravindra 25/06/19
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IS 2629 (1985): Recommended Practice for Hot-Dip Galvanizing of Iron and Steel [MTD 7: Light Metals and their Alloys]

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(A4)

IS : 2629 - 1985
(Reaffirmed 1994)

Indian Standard

RECOMMENDED PRACTICE FOR HOT-DIP GALVANIZING OF IRON AND STEEL

(First Revision)

Third Reprint AUGUST 1997

UDC 669.1 : 669.586.5

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 7

November 1986

AMENDMENT NO. 1 DECEMBER 1988

TO

IS : 2629 - 1985 RECOMMENDED PRACTICE FOR HOT-DIP GALVANIZING OF IRON AND STEEL

(First Revision)

(*Pages* 15, 16 *and* 17, *Appendix* A, *last column*) — Substitute ' May be rejected ' *for* ' Yes ' and ' May be accepted ' *for* ' No ' wherever appearing.

(SMDC 28)

Printed at Dee Kay Printers, New Delhi, India

(42)

AMENDMENT NO. 2 MARCH 1995
TO
IS 2629 : 1985 RECOMMENDED PRACTICE FOR HOT-DIP GALVANIZING OF IRON AND STEEL

(First Revision)

(*Page* 3, *clause* **0.3.2**, *first sentence*) — Substitute the following for the existing

'The galvanizing process can be grouped together under three categories, namely (a) wet process, (b) dry process, and (c) a combination of dry and wet process by continuous or batch galvanizing.'

(*Page* 9, *clause* **5.4**) — Add the following at the end of clause.

'A lead bed may be maintained as it assists in drossing.'

(*Page* 11, *clause* **5.9**, *line* 7) — Add 'up to' before '1 percent'

(MTD 20)

Printed at Dee Kay Printers New Delhi 110015 India

AMENDMENT NO. 3 JANUARY 2001
TO
IS 2629 : 1985 RECOMMENDED PRACTICE FOR HOT-DIP GALVANIZING OF IRON AND STEEL

(First Revision)

(*Page* 8, *clause* 5.1) — Substitute the following for the existing :

'5.1 **Quality of Zinc** — Zinc used for galvanizing shall conform to any of the grades specified in IS 209 : 1992 Zinc ingot (*fourth revision*) or IS 13229: 1991 Zinc for galvanizing.'

(MTD 20)

Reprography Unit, BIS, New Delhi, India

(40)

Indian Standard

RECOMMENDED PRACTICE FOR HOT-DIP GALVANIZING OF IRON AND STEEL

(First Revision)

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(*Continued on page* 2)

(*Continued from page* 1)

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Indian Standard

RECOMMENDED PRACTICE FOR HOT-DIP GALVANIZING OF IRON AND STEEL

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 20 June 1985, after the draft finalized by the Hot-Dip, Sprayed and Diffusion Coatings Sectional Committee had been approved by the Structural and Metals Division Council

0.2 This standard was first published in 1960 The present revision has been prepared in the light of the experience gained since its first publication and further technical developments in this field The continuous galvanizing process has been included in this revision. The typical photographs for the various defects in galvanized coatings on iron and steel have also been included in Appendix A.

0.3 Hot-dip galvanizing is an old and well known process of applying zinc coating to iron or steel surface for protection against corrosion The zinc coating firstly protects the base metal by acting as an impervious shield between the metal and the atmosphere and secondly affords sacrificial protection even when moderately sized areas (4 mm dia, for example) of the base metal surface are exposed.

0.3.1 When a thoroughly cleaned article is immersed in a galvanizing bath, the metal surface reacts with molten zinc to form a zinc-iron alloy. As the article is withdrawn from the bath, it picks up pure zinc which solidifies on cooling and forms the outer layer. The intermediate alloy layer provides a strong bond between the ferrous base material and the pure zinc and also resists corrosion and abrasion in the event of the pure zinc layer being removed Under same conditions of process or composition of the material the whole coating may consist of zinc-iron alloy layers.

0.3.2 The galvanizing process can be grouped under three broad categories, namely (a) the wet process, (b) the dry process, and (c) the continuous galvanizing process Continuous galvanizing process consists of cleaning base steel surface by first oxidizing and subsequently reducing the surface oxides under controlled atmosphere or by any other in-line cleaning

method. The strip is heat-treated in line annealing/normalizing furnace followed by continuous feeding through molten zinc bath and passivating treatment by suitable agent like chromic acid. After galvanizing, when the sheet emerges from the zinc bath, the excess molten zinc on them is wiped off by air or gas jets. There is no fluxing in this process.

0.3.3 Continuous galvanizing process has got advantages over both wet and dry processes with respect to high productivity, control of coating thickness, uniformity of coating along the length, better coating adherence, less dross formation, better surface appearance, etc.

0.4 A summary of defects, along with the typical photographs for illustration, commonly met with in the hot-dip galvanizing practice, their causes and remedial measures are given in Appendix A. In this appendix, the information given in the last column aids inspectors in interpreting the appearance of the article and help them in arriving at a correct decision for accepting or rejecting the finished material.

0.5 Working conditions and safety measures which should be observed in galvanizing plants are given in Appendix B.

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1. SCOPE

1.1 This standard recommends important guidelines for general hot-dip galvanizing of iron and steel.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Ash — A mixture of zinc oxide and varying quantities of metallic zinc. The former is formed as a result of oxidation of clear zinc on the bath surface and when the oxide is skimmed off, a certain amount of metallic zinc gets entrapped and removed along with it.

2.2 Dross — An intermetallic compound ($FeZn_{13}$), which is a complex mixture of zinc and iron, forms in the galvanizing bath as a result of the reaction of molten zinc with iron or iron salts and settles down at the bottom of the bath. Zinc content in dross will vary between 94 to 97 percent depending on the quantity of metallic zinc entrained in dross during its removal from the pot.

2.3 Flux — A chemical compound applied in the form of an aqueous solution and dried on to the work in the dry process or spread as a molten blanket over the zinc bath in the wet process. The primary purpose of the flux is to help in keeping the surface of both work and molten zinc free from oxide at the time of reaction. In both the galvanizing processes fluxing helps maintaining the surface of work free from oxides.

2.4 Over-Pickling — The undue attack of the underlying ferrous surface by the pickling solution after the removal of scale.

2.5 Inhibitor — A substance added to pickling solution to prevent undue attack on clean metal without affecting the scale removing property of the pickling solution.

2.6 White Rust — A white corrosion product, mainly containing zinc oxide and basic zinc carbonate, that accumulates on the galvanized surface exposed to water film or moist atmosphere.

2.7 Wetting Agent — A substance added to pickling and prefluxing solutions to facilitate wetting of the work surface.

3. BASE METAL FOR GALVANIZING

3.1 Steel — Mild steel is the most common material that is galvanized and the variations in the range of compositions used have little influence on the galvanizing process. The steel, however, should contain minimum amount of segregation, slag inclusions, rolled-in millscale, etc.

3.1.1 Carbon and silicon tend to increase the rate of reaction between steel and molten zinc. This effect, however, is not so apparent in the range of compositions encountered in mild steels as in high carbon and high silicon steels.

3.2 Cast Iron — Cast iron react with zinc differently depending on the exact composition, in particular, the silicon and phosphorus contents.

4. PREPARATION OF THE METAL SURFACE FOR GALVANIZING

4.1 Cleaning — If an article is contaminated by oil, grease or paint, pretreatment in special solvents will be necessary for their removal. Several proprietary reagents are available. Generally a sodium hydroxide solution obtained by dissolving 10 to 15 kg of sodium hydroxide in 100 litres of water is used.

4.1.1 The work should be so handled in the degreasing bath as to allow free circulation of liquid over all parts, taking care to clean the scum that may collect. If necessary, the work should be raised and lowered in order to allow the degreasing solution to enter inaccessible areas, threaded sections, etc, for a thorough cleaning action. When using sodium hydroxide solution, the temperature of the solution may be usually kept between 85 and 90°C and the immersion time varying from 1 to 20 minutes depending on the nature and degree of contamination. When using other proprietary degreasing agents; manufacturers' recommendation should be followed.

4.1.1.1 Immediately after degreasing, the work should be rinsed in hot water (60°C) followed, if possible, by a final rinse in cold running water. An ideal arrangement for rinsing would be to provide an inlet and outlet on two opposite sides of the rinsing tank; the inlet should be at the bottom of the tank and water should overflow from the top. This way the rinse water is in a dynamic state thereby ensuring an efficient and a thorough rinsing operation.

4.1.2 When lubricating materials have contaminated with the surface of the metal, it may be necessary to heat the part to bluing or scaling temperature in order to burn off the offending material. Since this is an expensive and difficult process, prior care should be taken to avoid such contamination.

4.2 Cleaning of Castings — Grey iron and malleable iron castings if not properly cleaned before annealing, develop burnt-on and patches at the surface which are not removed by normal pickling. Except in the case of light castings which would be damaged, all castings should be shot or grit blasted prior to galvanizing. It is generally recommended to give a quick rinse in running water followed by cleaning with one of the pickling acids. It is then processed according to normal fluxing practice

4.2.1 An alternative but less efficient method of cleaning castings with burnt-on sand is to employ a pickle solution containing hydrofluoric acid. For use, the commercial acid is diluted to various strengths, ranging from one volume of acid and 59 volumes of water for a very weak pickle to one volume of acid and 9 volumes of water for a very strong solution. With a weak solution pickling may take as long as 24 hours, while the strong solution should pickle satisfactorily in 10 to 30 minutes.

4.2.1.1 A hydrofluoric acid pickle leaves a gelatinous layer on the surface of the castings which shall be thoroughly removed by hosing with water and scrapping and brushing. The casting shall then go through the ordinary pickling process.

4.2.1.2 Solution containing 6 parts by volume of commercial hydrofluoric acid , 4 parts by volume of technical grade hydrochloric acid (*see* IS : 265-1976*) and 40 parts by volume of water may also by used for pickling. When pickling of castings is done occasionally, a solution consisting of 4 parts of dilute hydrochloric acid (1 : 1) and 1 part of hydrofluoric acid may be used.

4.3 Pickling — Both hydrochloric acid (*see* **4.3.1**) and sulphuric acid (*see* **4.3.2**) solutions may be used for pickling. Hydrochloric acid is used at room temperature while with sulphuric acid best results are obtained when it is hot (60 to 80°C).

*Specification for hydrochloric acid (*second revision*).

4.3.1 *Hydrochloric Acid Solution (100-150 g/l)* — Dilute technical grade acid conforming to IS : 265-1976* with an equal volume of water. The actual concentration of hydrochloric acid solutions and the time of immersion will depend on the nature of the work to be pickled.

4.3.1.1 A suitable inhibitor should be used with hydrochloric acid.

4.3.2 *Sulphuric Acid Solution (100-150 g/l)* — Dilute 6 to 8 ml of technical grade acid conforming to IS : 266-1977† to 100 ml. The actual concentration of sulphuric acid solutions, the temperature of the bath and the time of immersion will depend on the nature of the work to be pickled.

4.3.2.1 A suitable inhibitor should be used with sulphuric acid.

4.3.3 *Agitation* — Mild agitation of the work in the pickling tank reduces the time of pickling. Raise or lower the work once or twice to change the acid layer in contact with the work. Air agitation is not recommended.

4.3.4 *Control of the Acid Solution* — To make the best use of the solution, reasonably close control of its acid content is necessary. The solution should be tested for acid and iron contents at regular intervals in accordance with the methods given in Appendix C. The strength of the solution should be maintained by periodic addition of fresh concentrated acid. The iron salts in the pickling bath gradually accumulate with continued working and when the iron content reaches to about 100 to 120 g/l, the solution should be discarded.

4.3.5 *Disposals of Waste Liquor* — The acid and iron compounds may be recovered from the waste pickling solution. Where this is not done the pickling solution should be neutralized before dumping into sewers or streams.

4.4 Rinsing — After pickling, the article should be rinsed in running water. Two rinse tanks are preferable, the water cascading from one into the other, that is cascading from the second tank into the first tank.

4.5 Cleaning of Strip in the Continuous Galvanizing Process (ARMCO Sendizimir Process) — The cold-rolled strip is passed through an oxidizing furnace at temperature around 450°C where rolling lubricant is burnt and surface gets slightly oxidized. This is followed by reduction of surface oxides in the annealing/normalizing furnace under controlled atmosphere and subsequently allowing the strip to pass through molten zinc bath.

*Specification for hydrochloric acid (*second revision*).
†Specification for sulphuric acid (*second revision*).

4.6 Fluxing

4.6.1 The rinsed article, in the dry process, is dipped in a strong solution of zinc ammonium chloride ($ZnCl_2.3NH_4Cl$), although ammonium chloride is also used to a certain extent. The actual concentration of the flux solution and its temperature depend on the work being undertaken and on individual circumstances. The working level is generally between 200 to 400 g of zinc ammonium chloride per litre. Some wetting agent is usually added to the flux solution. The temperature may range from room temperature to 80°C.

4.6.1.1 When dry galvanizing is adopted, the article shall be thoroughly dried after fluxing over a hot-plate or in an air-oven. The temperature should be about 120°C and should not exceed 150°C as the flux decomposes above this temperature.

4.6.1.2 In the wet process, a deep flux cover is used on the zinc bath and the work is immersed through the flux layer with or without fluxing. In this case drying is not considered essential.

4.6.2 The article that has been prefluxed and dried should be galvanized without delay, as the flux coating picks up moisture from the air and also tends to oxidize. The recommended time limit for galvanizing is within an hour of fluxing.

4.6.3 *Control of Fluxing Solution* — The specific gravity of the flux solution should be controlled by adding required quantities of flux crystals and water to make up for the drag-out losses.

4.6.3.1 Free acid content of the solution should also be checked, particularly if rinsing is not very thorough and pickle is carried over. The method described in Appendix C may be used for determination of free acid but the actual titration should be made on a 100 ml sample as the concentration of acid in the solution will be very low. When more than 2 g of free acid per litre of the solution is present, it should be neutralized by adding ammonia solution or addition of zinc spelter.

5. GALVANIZING

5.1 Quality of Zinc — Zinc containing at least 98·5 percent Zn should be used for the purpose of galvanizing.

5.1.1 *Galvanizing Bath* — The molten metal in the galvanizing bath should contain not less than 98·5 percent by mass of zinc.

Top dross is removed at regular interval from the surface of the bath. Coating rolls and grooves are cleaned regularly.

5.5.2 *Time of Immersion* — The time of immersion for a job depends on several factors like its chemistry, size, thickness, type of job, etc. In most cases the article shall be left in the bath until it reaches the temperature of the bath which is usually indicated by the stopping of the boiling action. It is then withdrawn without much delay.

5.6 Withdrawal — The rate of withdrawal, which determines the thickness of the unalloyed zinc layer left on the article, varies according to the type of the process being operated and the form of article. With long article for which withdrawal occupies a large part of the total handling time, speeds are necessarily maintained at higher levels to ensure a reasonable rate of production. It is better to use special jigs and carriers for dipping and withdrawing the work in batches. The rate of withdrawal should be controlled so that zinc drains freely from the surface.

5.6.1 Articles are withdrawn through a bath of clear zinc to avoid contamination by flux. However, withdrawal through a flux blanket has also its advantages in the removal of surplus zinc from the surface and in producing a uniform coating at relatively higher speeds. In the latter case it is recommended to quench the material (*see* **5.7**) to remove flux residues.

5.7 Water Quenching — Where the article is withdrawn through a flux blanket, the quench water needs to be changed frequently to prevent the accumulation of corrosive salts. For this purpose tanks having overflow weir may be used with advantage.

5.7.1 Light gauge articles should be spun quickly through the surface of water so that they retain sufficient heat after quenching to enable quick drying. Heavy articles retain sufficient heat for drying.

5.8 Centrifuging — Small articles handled in baskets should be centrifuged to remove excess of zinc immediately after galvanizing while the coating is still in the molten condition. The quality of the finish depends on the rapidity with which the material is transferred from the galvanizing bath to the centrifuge. It is also important that the centrifuge should be powered by a high starting torque electric motor to give rapid acceleration to peak speed within 2 to 3 seconds. After centrifuging, the articles should be immediately tipped into water to allow the coating to set and prevent the articles from sticking to each other.

5.8.1 *Thread Brushing* — Threads on articles which are unsuited for centrifuging shall be cleaned with a rotating wire brush immediately after galvanizing and before the coating sets. This process reduces the thickness and the protective value of the coating. It should only be confined to the threaded portions of the article.

5.9 Post-Treatment — The zinc coating on freshly galvanized surfaces when exposed to humid, poorly ventilated conditions during storage and/or transport react with the moisture, carbon dioxide, oxygen, etc, in the atmosphere forming a mixture of salts which are white in colour. This is known as ' white rust ' or ' wet storage stain '. Normally a post-treatment like chromating is recommended This is a temporary treatment and retards white rust attack The chromating solution contains 1 percent sodium dichromate and half percent sulphuric acid solution — the solution is kept at room temperature and its temperature should never be allowed to rise above 65°C The galvanized articles are dipped into the chromating solution after the galvanizing and water quenching operations.

5.9.1 In case of continuous strip galvanizing the strip is sprayed with chromating solution, such as chromic acid and properly spread uniformly by means of squeezer rolls Temperature of the chromic acid bath is maintained around 70-75°C

5.10 Stacking —Articles should not be stacked immediately after quenching (*see* **5.7**) to avoid flaking of coating The galvanized articles should be allowed to dry before any further handling operation

6. TESTING AND INSPECTION

6.1 Freedom from Defects — The zinc coating shall be adherent, smooth, reasonably bright, continuous and free from such imperfections as flux, ash and dross inclusions, bare and black spots, pimples, lumpiness and runs, rust stains, bulky white deposits and blisters

6.2 Uniformity in Thickness — Galvanized articles shall be tested for uniformity in thickness of coating in accordance with preece test given in IS : 2633-1986* For quick approximate measurements of thickness, magnetic gauges may be used, but such instruments shall be suitably calibrated before use.

6.3 Mass of Coating — The mass of zinc coating may be determined in accordance with IS 6745-1972†.

6.4 Adhesion Tests

6.4.1 *Pivoted Hammer Test for Zinc Coated Fabricated Products (Fabricated from Plates, Bars, Strip, etc)* — The adherence of the zinc coating on steel shall be determined by the pivoted hammer test. The hammer used shall conform to the drawing shown in Fig 1. The hammer shall be made of normalized 0 3-0 4 percent carbon steel The hammer blow shall be controlled by holding the pivoted base of the handle on a horizontal surface

*Method of testing uniformity on zinc coated articles (*second revision*)

†Methods for determination of mass of zinc coating on zinc coated iron and steel article.

of the galvanized member and allowing the hammer head to swing freely through an arc from vertical position to strike the horizontal surface. The test shall consist of two or more standards blows forming parallel impressions with 6 mm spacing and a common axis, as illustrated in Fig. 1. No part of an impression shall be closer than 12 mm to the edge of the member. Removal or lifting of the coating in the area between the impressions shall constitute failure. An extruded ridge less than 2 mm wide immediately adjacent to the impression shall be disregarded. The specimen is tested in several places throughout its length.

6.4.2 *Knife Test for Zinc Coated Hardware and Assembled Steel Products* — When the coating is cut or pried into, such as with a stout knife applied with considerable pressure in a manner tending to remove a portion of the coating, it shall only be possible to remove small particles of the coating and it shall not be possible to peel any portion of the coating so as to expose the underlying iron or steel.

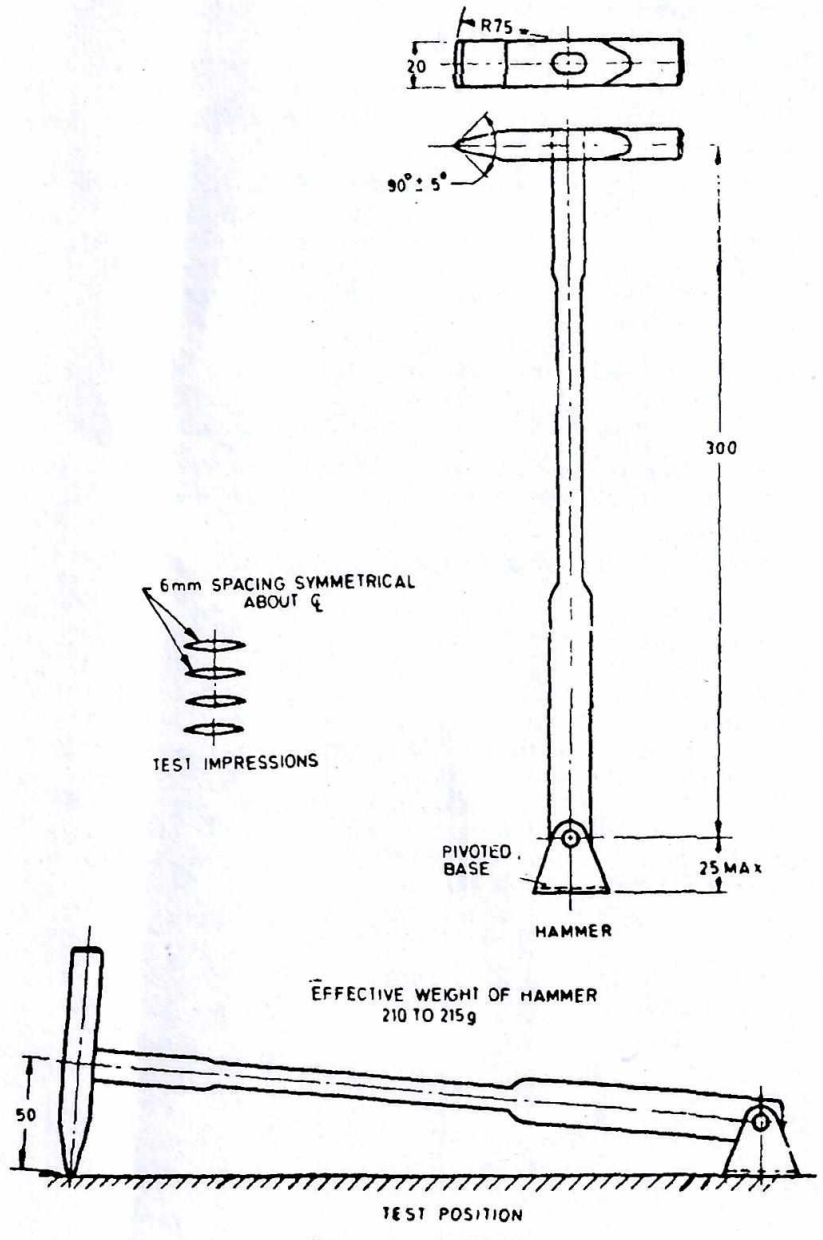
6.4.3 *Bend and Wrapping Tests for Zinc Coated Sheet and Wire* — The material such as sheet or wire shall be tested by bending or wrapping in accordance with tests given in the relevant Indian Standards.

6.5 In case of continuous galvanized sheets, inspection and testing is carried out in accordance with IS : 277-1977* or any other standard specifications.

7. STORING, PACKING AND HANDLING

7.1 Sufficient care should be exercised while storing, packing and handling of galvanized products. While storing and transporting them, adequate ventilation should be provided as otherwise 'while rust' or 'wet storage stain' may result when galvanized coatings react with humidity and atmospheric gases. It is sometimes necessary to store galvanized articles with spacers in between them, they are also kept at an inclination to facilitate drainge of water collected on the articles. In areas where there is a substantial variation in day and night temperatures and hence condensation, the storage area kept warm by provision of heaters. In many cases, it will be advisable to give a post-treatment like chromating to minimise the chances for formation of white rust.

*Specification for galvanized steel sheets (plain and corrugated) (*third revision*).



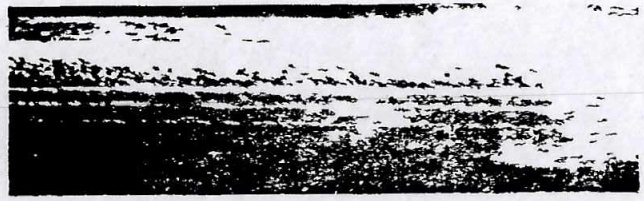
All dimensions in millimetres.

FIG. 1 PIVOTED RIVETING HAMMER

APPENDIX A

(Clauses 0 2 *and* 0 4)

DEFECTS, THEIR CAUSES AND REMEDIAL MEASURES

FIGURE	DEFECTS	CAUSES	RECOMMENDED ACTIONS	GUIDANCE FOR ACCEPTANCE REJECTION
	Bare spots or Black spots	Paint grease, or oil	Check cleaning practices, degreasing recommended	Yes, except where bare spots are small and suitable for patching by treatments like zinc rich paints zinc spraying etc subject to prior agreement between the galvanizer and the buyer Zinc can sacrificially protect bare areas measuring about 4 mm across but here again the allowable size of bare spot should be agreed upon between the galvanizer and the buyer
		Scale or rust residues	Check pickling practices	
		Residual welding slag	Adopt mechanical cleaning avoid coated rods	
		Breakdown of flux coating	Check preflux and drying conditions particularly the temperature on the job being dried	
		Aluminium content of bath too high	Regulate aluminium additions	
		Rolling defects in basis steel	Check steel supply	
		Articles in contact during galvanizing	Keep articles separated	
	General roughness	Analysis or original surface condition of steel	Check steel supply	No except by prior agreement between galvanizer and purchaser
		Overpickling	Reduce pickling time or acid concentration, use inhibitor	
		High galvanizing temperature or long immersion time or both		
	Pimples	Entrapped dross particles	Avoid agitation of dross layer check carry over of pickle salts	No unless dross contamination heavy
				

A pimple under microscope)

FIGURE	DEFECTS	CAUSES	RECOMMENDED ACTIONS	GUIDANCE FOR ACCEPTANCE/ REJECTION
	Lumpiness and runs (uneven drainage)	Withdrawal speed too high	Remove work slowly	Only by prior agreement
		Cold galvanizing bath	Increase temperature	
		Delayed run-off seams, joints, bolt holes, etc	Remove work slowly	
		Articles in contact during withdrawal	Keep articles separated	
	Flux inclusions	Stale flux burnt on during dipping	Refresh or renew flux blanket	Flux stain if left over on the job after flux removal, is not considered as flux inclusion and hence should not be rejected
		Surface residues on steel	Check steel preparation	
		Flux picked up from top of bath	Skim before withdrawal	
	(A microstructure of flux inclusion)			

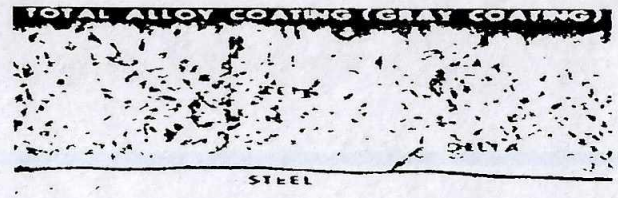
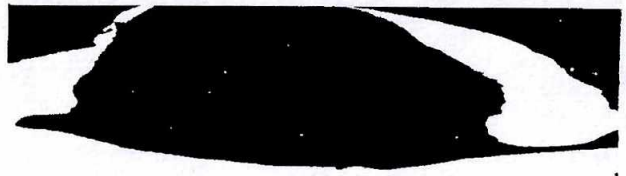
Figure	Defects	Causes	Recommended Actions	Guidance for Acceptance/ Rejection
	Ash inclusions	Ash burnt on during dipping	Skim bath before dipping	Yes, if in gross lumps
		Ash picked up from top of bath	Skim bath before withdrawal	
 (A microstructure of ash inclusion)				
	Dull grey coating (all alloy no free zinc)	Steel composition (high silicon, phosphorus or carbon) or severe cold work	Check steel supply for composition in order to adjust for galvanizing	Not if due to steel composition or condition, or limited to occasional areas. Control by prior agreement. Grey coating is only displeasing to the eye and is, not a defect at all. In fact, grey coating, compared to a bright coating, is abrasion resistant and is chemically more protective in some environment for instance, acidic environment.
		Slow cooling after galvanizing	Avoid hot staking, quench	
		Release of absorbed hydrogen during solidification of coating	Avoid over-pickling, use inhibitor	
 (Under a microscope, the cross section)				
	Rust stains	'Weeping' of acid, etc, from seams and folds	Check product design and fabrication	No
		Storage near rusty material	Check storage condition	

FIGURE	DEFECTS	CAUSES	RECOMMENDED ACTIONS	GUIDANCE FOR ACCEPTANCE REJECTION
	Bulky white deposit (wet storage stain, white rust)	Confinement of close packed articles under damp conditions	Store and ship in dry well-ventilated conditions, separate articles with spacer. A temporary treatment like chromating is recommended	No, thin white deposits can be removed by hand rubbing, brushing, etc; if deposits are heavier, these shall be removed and the zinc coating beneath should be tested for thickness before accepting or rejecting the white rust attacked galvanized products
		Packing of articles while damp	Dry before packing, include desiccant A temporary protective treatment like chromating is recommended	
	(White rust under microscope)			
	Blisters	Expansion of entrapped hydrogen and nonature inflaws	Check steel quality	Yes, if general
		Driving off of hydrogen absorbed during pickling	Use shot blast instead of pickle Check steel supply	
		Improper malleablizing (for malleable iron ca tings only)	Check malleablizing practice	
	(A blister under microscope)			
	Tiny blisters	Effect sometimes observed on quenched work, notably malleable castings	Use shot blast instead of pickle. Check malleablizing treatment Should have no combined carbon near surface of casting	Yes, if blistering is generalized widespread
		May be caused by gas evolved from the work resulting from absorbed hydrogen or breakdown of combined carbon near surface		

APPENDIX B

(*Clause* 0.5)

WORKING CONDITIONS AND SAFETY MEASURES

B-1. WORKING CONDITIONS

B-1.1 The galvanizing shop should be kept neat and tidy. Where possible, increased use should be made of hoods, extraction ducts and exhaust fans to give as good an atmosphere as possible.

B-2. SAFETY MEASURES

B-2.1 All safety measures should be properly exhibited.

B-2.2 The workers at the galvanizing bath should be provided with:

a) eye or face shield,

b) rubber boots,

c) steel-capped boots,

d) leather or leather on woollen base gloves,

e) rubber and leather aprons, and

f) long rubber or PVC or neoprene gloves.

B-2.3 While cleaning the articles with sodium hydroxide solution, the operators should be warned that it produces severe flash burns. Special precautions should be taken to protect them from splashes of sodium hydroxide solution.

B-2.4 Hydrofluoric acid sometimes used for pickling of castings (*see* **4.2**) is dangerous and causes very sever burns and sores when it comes in contact with the skin. It should, therefore, be carefully handled by wearing rubber boots, gloves and aprons.

B-2.5 Arrangement should be made to protect the galvanizer from the fumes over the zinc bath.

APPENDIX C

(*Clauses* 4.3.4 *and* 4.6.3.1)

TEST METHODS

C-1. QUALITY OF REAGENTS

C-1.1 Unless otherwise specified, pure chemicals shall be employed in tests and distilled water (*see* IS : 1070-1977*) shall be used when the use of water as a reagent is intended.

NOTE — ' Pure chemicals ' shall mean chemicals that do not contain impurities which affect the results of analysis.

C-2. DETERMINATION OF ACID CONTENT OF THE PICKLING SOLUTION

C-2.1 Reagents

C-2.1.1 *Standard Sodium Carbonate Solution* — Approximately 0·5 N.

C-2.1.2 *Methyl Orange Indicator Solution* — Dissolve 0·05 g of methyl orange in 100 ml of alcohol.

C-2.2 Procedure — Filter exactly 25 ml sample of the pickle liquor into 250-ml measuring cylinder and make up to 250 ml by adding distilled water mix thoroughly. Pipette out 25 ml of this solution in a 250 ml conical flask. Add a few drops of methyl orange indicator and titrate it with the standard sodium carbonate solution to yellow end point.

C-2.3 Calculation

$$\text{Mass of hydrochloric acid in g/l} = \frac{A \times B \times 36{\cdot}5}{2{\cdot}5}$$

$$\text{Mass of sulphuric acid in g/l} = \frac{A \times B \times 49}{2{\cdot}5}$$

where

A = volume in ml of the standard sodium carbonate solution required, and

B = normality of the standard sodium carbonate solution.

*Specification for water for general laboratory use (*second revision*).

C-3. DETERMINATION OF IRON CONTENT OF THE PICKLING SOLUTION

C-3.1 Measure density of the pickling solution with a hydrometer, then on the corresponding nomograph (*see* Fig. 2 and 3) depending on the acid used for pickling, join with a transparent ruler the point representing this reading shown on the left hand line with the point on the right hand line representing the acid content of the pickle. Read off the iron content on the middle line.

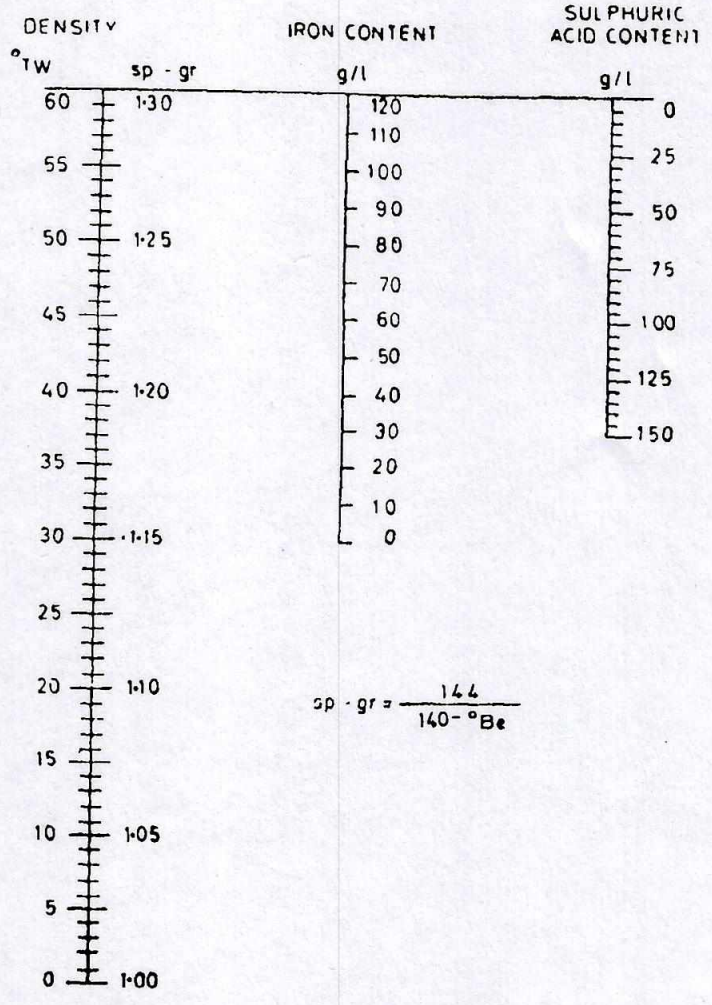


FIG. 2 NOMOGRAPH RELATING THE IRON CONTENT OF SULPHURIC ACID PICKLE TO THE ACID CONTENT AND DENSITY

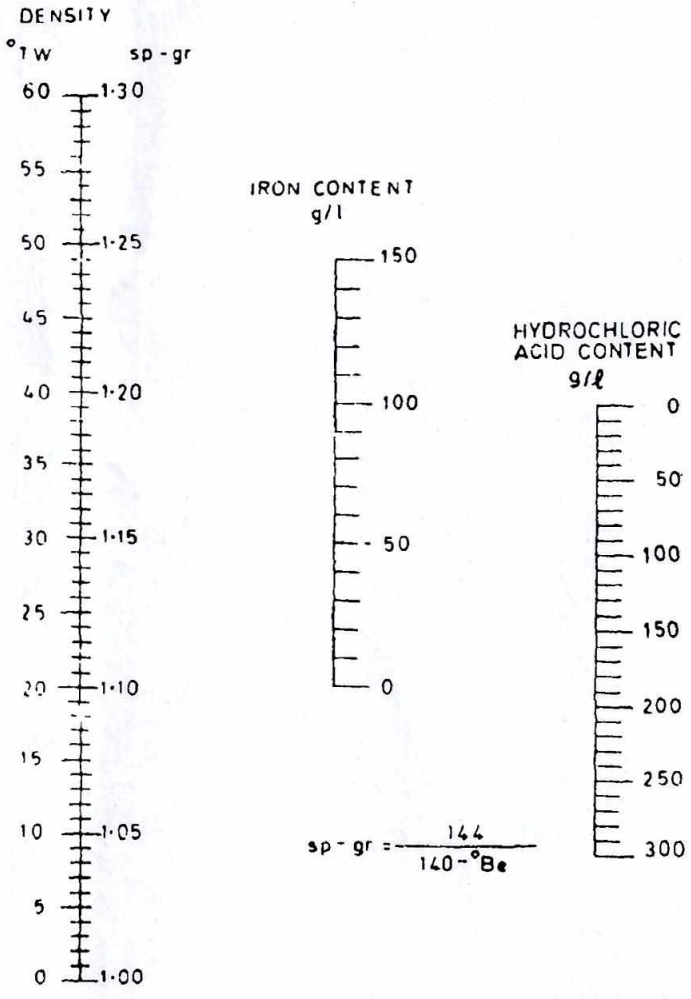


FIG. 3 NOMOGRAPH RELATING THE IRON CONTENT OF HYDROCHLORIC ACID PICKLE TO THE ACID CONTENT AND DENSITY

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Printed at Dee Kay Printers, New Delhi, India

CFP Rudrapur: Process Product Audit findings

Audit Date: 18-19th Jun 2019

Audit team:	Auditee:
1. Rajender Meena/ Dy. Mgr- CQ&BE 2. Swati Singh/ Sr. Engineer- CQ&BE	1. Kapil Bharti/ Manager- Quality 2. Budhiraja/Sr. Engineer- Quality 3. Ajit Sahay/ Sr. Manager-PDN 4. Anuj Kumar/ Sr. Engineer-PDN 5. Parush kumar/ Dy. Mgr- Engineering 6. Deepak Bora/ Dy. Mgr-CDC 7. Rajnish Kumar/ Dy. Mgr- Stores 8. S S Pal/ Dy. Mgr- Maintenance

Observations:

A. **Incoming Section/ Store (C. Stores):**
   1. One lot of Thinner kept at store does not have Mfg date.
   2. Though the number of stores are identified and items to be stored in these stores are also mentioned in the DP, however location of each type of items within a store is not maintained.

B. **Skill, Competence (Production Deptt.):**
   1. Welder Performance Qualification(WPQ) records are available for BHEL and contractor workers. However, Master list of contractor's welders to be maintained.
   2. WPQ records of Sh. Ravi Kumar and Sh. Mondal are not available though they were performing welding during shop audit.

C. **Process & production control (Production Deptt.):**
   1. During shop visit route card no. EH33 for NSPBD was randomly checked. Format no. DP:PDN:F:04B1 Rev-02 of SPBD was found to be used for NSPBD.
   2. Drawing no. was not mentioned in the above route card.
   3. Identification no. for enclosure flaring machine was not available.

D. **Non Conformance Handling (Comml. & Quality Deptt):**
   1. Out of 4 SAR 03 nos. pending for more than 10 days.
   2. Centralized online Shop NC system being followed as on date 03 nos. shop NC registered in the system, but no RCA carried out for the same.

E. **Root cause analysis (Quality & Engg. Deptt):**
   1. During 2018-19 05 RCA carried out. 03 nos. RCA filled in online RCA system. In Document repository system 01 RCA fed which is already available in online RCA system. Unit to ensure uploading of balance 02 RCA carried out offline in document repository system.

F. **Equipment healthiness (Maintenance):**
   1. Master list of critical machines to be updated by MNT deptt.

19/06/19
(Swati Singh)

Auditors

19/06/19
(Rajender Meena)

Auditee

Budhiraja
19/06/19

19/06/19

IS 2633 (1986): Methods for testing uniformity of coating of zinc coated articles [MTD 7: Light Metals and their Alloys]

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IS : 2633 - 1986
(Reaffirmed 2006)

Indian Standard

METHOD FOR TESTING UNIFORMITY OF COATING ON ZINC COATED ARTICLES

(Second Revision)

Third Reprint MARCH 1997

UDC 669.58:669.1-4:620.163

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NEW DELHI 110002

Gr 3

May 1987

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(Reaffirmed 1992)

Indian Standard

METHOD FOR TESTING UNIFORMITY OF COATING ON ZINC COATED ARTICLES

(Second Revision)

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(*Continued on page* 10)

Indian Standard

METHOD FOR TESTING UNIFORMITY OF COATING ON ZINC COATED ARTICLES

(Second Revision)

0. FOREWORD

0.1 This Indian Standard (Second Revision) was adopted by the Indian Standards Institution on 26 September 1986, after the draft finalized by the Hot-Dip Sprayed and Diffusion Coatings Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 This test known as 'Preece Test' is designed as an inspection or acceptance test for determining the thinnest spot in a zinc coating (hot-dipped, electroplated, sherardized or sprayed) on iron or steel articles which are coated after the shape is produced. This standard was first published in 1964 and subsequently revised in 1972. In this revision, more details have been incorporated about preparation of samples and testing procedure for determining the uniformity of zinc coatings. In addition, qualitative tests for all types of zinc coatings have also been incorporated.

0.3 Preece test is designed for newly coated items. In case of aged or weathered zinc coated items, the method given in Appendix A may be used. Preece test should not be used for determining mass of zinc coatings as these are produced by different processes and have widely different rates of solubility in copper sulphate solution. Electroplated and sprayed zinc coatings (*see* IS : 1573-1986* and IS : 5905-1970† respectively) which consist essentially of pure zinc, dissolve rapidly than hot-dipped coatings which are composed of zinc iron alloy layer next to steel, and nearly pure zinc layer in the outer part of the coating.

0.4 The rate of reaction increases with increase in temperature. It has been found that to obtain accuracy of about 10 percent in this test, it is necessary to maintain temperature of copper sulphate solution (*see* 3) at 18 $\pm$ 2°C.

---

*Electroplated coatings of zinc on iron and steel (*second revision*).

†Sprayed aluminium and zinc coatings on iron and steel.

0.5 This test is suitable for the following articles.

0.5.1 Sheet, wire, tube, bolts, nuts and other threaded articles of similar size.

0.5.2 Articles fabricated from strip, bar or tube up to a length of one metre and not exceeding 75 mm in width or 50 mm in diameter.

0.5.3 Castings, angle brackets and structural shapes with an overall size of not more then 200 × 150 × 100 mm of approximate mass not more then 4 kg coated after fabrication.

0.5.4 Articles having dimensions greater than those specified in **0.5.2** and **0.5.3** shall be subjected to visual inspection only as laid down under **0.5.5**.

0.5.5 Samples of such articles, after galvanizing, shall be stored for at least one week under cover, but with all surfaces as far as possible, exposed to free movement of air. The zinc coating as seen by visual inspection at the end of this period after storage shall be clean, smooth, continuous and free from acid spots.

0.6 In the preparation of this standard, assistance has been derived from the following publications:

BS: 729-1971 Hot dip galvanized coatings on iron and steel tubes. British Standards Institution.

ASTM A-239-1973 Locating the thinnest-spot in a zinc (galvanized) coating on iron and steel articles by the Preece test (copper sulphate dip). American Society for Testing and Materials.

JIS H: 0401-1983 Method of test for hot dip galvanized coatings. Japanese Industrial Standards Committee.

0.7 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS: 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard covers the procedure for determining uniformity of zinc coating (hot-dipped, electroplated, sherardized or sprayed) on iron or steel articles.

*Rules for rounding off numerical values (*revised*).

2. SAMPLING AND PREPARATION OF TEST PIECES

2.1 Sampling — The number of samples to be tested shall be as specified in material specification. In the absence of such a standard, the degree of sampling shall be as agreed to between the galvanizer and the purchaser.

2.2 Preparation of Test Pieces

2.2.1 *Sheet* — A test piece of 100 × 100 mm shall be cut off from a sheet selected as per material specification.

2.2.2 *Wire* — The sample length of the wire shall be cut from one or both ends of the coil under test. Portions of wire which are obviously damaged shall not be used as sample. In case of stranded or armoured wire, or wire which has undergone any other similar process, care should be taken to avoid damage in preparing the sample. A sample of suitable length but not less than 150 mm, shall be cut from one or both ends of the selected coil.

2.2.3 *Articles Other Than Sheets and Wires* — Test specimens shall be selected from the material galvanized but if the material is of inconvenient length, shorter pieces of the same section and of the same steel composition, not less than 90 cm long, may be introduced as test specimens.

2.2.3.1 All test specimens shall be treated in the same manner, in the same bath and at the same time as the material whose coating characteristics they are intended to represent.

NOTE — The sample selected for test shall be such that it is free from abrasions or cuts in the zinc coatings except those which occur during manufacture or preparation of sample for testing. Where the area of uncoated surface may materially deplete the strength of copper sulphate solution, precautions may be taken such as plugs for tubular material or lacquer, paraffin or other suitable coatings for the uncoated surface.

2.3 Cleaning of Sample

2.3.1 The test piece shall be cleaned with a volatile organic solvent such as ether, trichloroethylene, carbon tetrachloride, etc, and then rinsed with alcohol and finally washed thoroughly with clean water and wiped dry with clean cotton cloth. Lacquer or varnish coatings shall be removed with a suitable clean volatile organic solvent which will not attack the zinc coating or leave a greasy or waxy deposit. Test pieces shall be brought to a temperature of 15 to 20°C prior to the beginning of the test.

2.3.2 Abnormal cases may arise when, by reason of unusual surface conditions, the copper sulphate solution may not act normally on the zinc coating, for example, the solution may have no apparent attack on all or part of the surface, or false deposits of copper may appear on the zinc coating. If there is any such abnormality of performance of test pieces,

they shall be discarded and new ones selected. The new test pieces shall be cleaned in alcohol, rinsed and wiped dry, and then immersed for 3 minutes in a solution consisting of one part by volume of ammonium hydroxide (sp gr 0·90) and nine parts of distilled water. The test pieces may be scrubbed with cotton cloth during this immersion. After cleaning, the test pieces shall be washed and wiped dry.

3. COPPER SULPHATE SOLUTION

3.1 Preparation

a) Dissolve about 36 g of technical grade copper sulphate crystals conforming to IS : 261-1982* in 100 ml of distilled water (*see* Note). Heat the water to aid solution, but if heated, the solution should be cooled before neutralizing.

b) Neutralize the free sulphuric acid in solution by shaking with excess of copper carbonate (laboratory grade) or copper hydroxide (laboratory grade), (about 1 g/l of solution) and allow to stand for at least 24 hours before filtering or decanting the solution from the sediment.

c) The specific gravity of the test solution during the test shall be 1·186 at 18 $\pm$ 2°C. Adjustment may be made by adding distilled water or solution of higher specific gravity.

NOTE — Chemically pure copper sulphate crystals are preferable to commercial grade, although not necessary for this test.

3.2 Volume of Solution

3.2.1 *Wire* — Test pieces of wire shall be tested in a glass container of at least 50 mm inside diameter for 2·00 mm wires and smaller and with at least 75 mm inside diameter for wires of more than 2·00 mm in diameter. The container shall be filled with fresh test solution to a depth of at least 100 mm. This quantity of solution shall be used for simultaneous testing of one to seven test pieces. The solution shall be discarded after completion of the test and fresh solution used for any additional tests.

3.2.2 *For Articles Other Than Wires* — The volume of the solution shall be sufficient to immerse the test pieces completely and shall not be less than 6 ml/cm^2 of surface area of test piece.

3.3 Temperature of Solution — The temperature of solution shall not vary beyond the limits of 18 $\pm$ 2°C, either at the commencement of the test or through the duration of the test.

*Specification for copper sulphate (*second revision*).

4. PROCEDURE

4.1 The clean test pieces shall be subjected to as many one-minute and half-minute successive dips as prescribed in the relevant standard, in copper sulphate solution (*see* 3) kept at a temperature of 18 ± 2°C. Half-minute dips shall be carried out after completion of all the one-minute dips. If possible, immerse the test pieces completely, taking care that they do not touch each other. During the test, neither the test pieces nor the solution shall be agitated. After each dip, withdraw the test pieces, rinse immediately in clean running water (*see* Note 1). Remove any black deposit including holes and pockets by a suitable brush (*see* Note 2). Wipe and dry the test pieces with a clean soft cloth and return immediately to solution.

4.1.1 Successive dips of one-minute each shall be continued, with washing and wiping of the test pieces after each dip, until the test pieces have withstood the required number of dips or until the end point has been reached.

NOTE 1 — If no running water is available, the rinse water shall be changed often enough, preferably after each dip, to ensure that it is reasonably free from copper sulphate. The temperature of the rinse water should be 15 to 20°C.

NOTE 2 — Brush conforming to IS: 1104-1984* may be used for the purpose.

4.2 Interpretation of Test

4.2.1 The material passes this test if at the end of the specified number of dips, when the test piece is finally rinsed and wiped dry, it does not show any adherent red deposit of copper upon the base metal. In case of wire, any red deposit of copper within 25 mm of the cut end of the sample shall not be interpreted as a failure of the sample.

4.2.2 A fine line appearance of copper on top of screw threads, or on sharp edges of articles, or within 25 mm of a cut portion of a specimen, shall not be judged as failure. Likewise, the failure of a coating at or adjacent to any cut or abrasion present on the original test piece shall not be considered as a failure.

4.2.3 *Detection of Flase End Point* — If it is possible to remove the bright copper deposit with an ink eraser or to peel it with the edge of a blunt tool such as the back of a knife blade, and zinc appears underneath the copper, such an appearance of deposited copper shall be construed as false end point.

5. NUMBER OF DIPS

5.1 Wire — The sample, or samples shall be subjected to specified number of successive dips of exactly one-minute or exactly half-minute duration as

*Specification for brushes, lettering (*second revision*).

prescribed in IS:4826-1979* or any other relevant Indian Standard specification. The half-minute dips shall be carried out after the completion of all the one-minute dips.

5.2 Other Articles — Unless otherwise specified, the sample shall be subjected to four successive dips in the solution, each lasting one minute.

6. SUPPLEMENTARY TESTS

6.0 If at any time during the test, there is any doubt as to the presence of exposed base metal, as determined by visual inspection, one or more of the tests given in **6.1** or **6.2** may be used.

6.1 Supplementary Tests for All Types of Zinc Coatings

6.1.1 *Microscopic Test* — Section the test piece through the copper deposit, mount and polish it metallographically. Etch the polished surface using an etching solution composed of 20 g of chromic acid, 1·5 g of sodium sulphate and 100 ml of distilled water. After etching, wash the test piece with alcohol. Examine the etched test piece under a microscope, using a magnification of 100 diameters, or greater if necessary. Look for the exposed base metal.

6.1.2 *Qualitative Test for Zinc* — Apply a drop (or several drops) of dilute hydrochloric acid (1:1) to the area in question (depending on its size). The presence of zinc is indicated by immediate vigorous effervescence (evolution of hydrogen). If no appreciable zinc is present, the effervescence will be mild. By carefully removing the acid, a confirmatory test for zinc may be made as follows.

6.1.2.1 Neutralize the acid with ammonium hydroxide, acidify with acetic acid and pass hydrogen sulphide into the solution, a white precipitate (zinc sulphide) confirms the presence of zinc.

6.2 Supplementary Test for Electroplated, Sherardized and Sprayed Zinc Coatings

6.2.1 *Water Immersion Test* — Partially immerse the test pieces in distilled water at room temperature. Failure of the coatings is indicated by the appearance of iron rust spots in a few hours to several days. This test may be made on material as received, or to substantiate the Preece test at any stage.

*Specification for galvanized coatings on round steel wires (*first revision*).

APPENDIX A

(*Clause* 0.3)

APPLICATION OF PREECE TEST TO WEATHERED GALVANIZED WARE

A-1. Preece test is not applicable to aged or weathered material because of the corrosion film present on zinc coating. If it is desired to use the Preece test on such material, the corrosion film should be removed before testing, by immersing the test pieces in an ammonium hydroxide solution [1 part by volume of ammonium hydroxide (sp gr 0·90) to 9 parts by volume of distilled water], rinsing them in clean water and wiping them dry.

(*Continued from page* 2)

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