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SPECIFICATION FOR ELECTROPLATED COATINGS OF CADMIUM ON IRON AND STEEL

(Second Revision)

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

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Indian Standard

SPECIFICATION FOR ELECTROPLATED COATINGS OF CADMIUM ON IRON AND STEEL

(Second Revision)

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Indian Standard

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0. FOREWORD

0.1 This Indian Standard (Second Revision) was adopted by the Indian Standards Institution on 10 September 1986, after the draft finalized by the Metallic and Non-metallic Finishes Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 This standard was first published in 1960, revised in 1968 and covered three grades of cadmium plating depending on thickness of the coating. In the first revision of the standard, thickness requirements had been modified keeping in view the utility of the coatings and the trade practices followed in the country. Efforts have been made to include many details left out in the first revision to make the second revision a comprehensive one. Additional terms have also been included under terminology and limitations are referred to regarding finish and appearance under coating requirements. More details have been incorporated under information to be given by the purchaser and information regarding materials and manufacture, chromate passivation, test for coating, handling, inspection and packaging. A reference to barrel-plated items has also been made under Table 1, Note 2.

0.3 In view of its toxicity, cadmium should not be used as a coating for any article used as a food container or cooking utensil or for any article likely to come in contact with food or beverages.

0.3.1 Cadmium vapours and cadmium oxide fumes are highly toxic when inhaled. Therefore, cadmium plated articles must not be welded, spot-welded, soldered or otherwise strongly heated without adequate ventilation which will efficiently remove all toxic fumes.

0.3.2 Cadmium is subjected to corrosion by vapours which may be released by cardboard, wood, plastics, certain electrical insulating materials, paints and other organic substances.

0.3.3 Attention is drawn to the fact that electroplated cadmium is more readily soldered than electroplated zinc.

0.4 Like zinc, cadmium also protects steel cathodically, that is, by sacrificial protection in most environments. It is superior to zinc coatings in purely marine atmospheres. Chromate conversion coatings on cadmium provide additional protection against corrosion and should be applied unless there is a reason to the contrary. Cadmium-plated articles to be painted may require alternative treatment such as phosphating to provide good adhesion.

0.4.1 Cadmuim dissolves in most mineral acids but unlike zinc, does not react with alkalis.

0.4.2 Chromate passivated cadmium coatings contain hexavalent chromium which may irritate the skin and cause ulcers on the skin. Cotton, nylon or rubber hand-gloves may be used to prevent skin ulceration while handling chromated cadmium-plated parts. This will also prevent fingerprint corrosion on cadmium coatings.

0.5 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.

0.6 General Information — This specification includes the whole range of iron and steel products as basis metals. Designers are advised, however, that all forms of iron and steel are not equally readily electroplated. Many castings can be satisfactorily plated, but are considered to be more difficult than forgings. Cadmium is mostly plated from a cyanide bath. Suitable pretreatments must be used to satisfactorily electrodeposit cadmium on difficult-to-plate substrates. Adequate precautions must be taken against the danger of hydrogen embrittlement.

Attention is also drawn to the effects of the contour of the article to be plated. In general, the requirements for minimum thickness apply only to those portions of the article which may be described as significant surfaces. It helps to reduce process cost if the designer of an electroplated part consults a plating specialist before the design is finally issued for production.

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

1. SCOPE

1.1 This standard covers requirements for electrodeposited cadmium coatings applied to iron or steel articles except for coatings applied to components having threads of basic major diameter from 1·25 to 12·5 mm and coatings applied to sheet or wire in the unfabricated form or to close-coiled springs.

1.2 Requirements are specified for appearance, thickness, adhesion, heat treatment before or after plating, precleaning standards and if the coating is chromate-passivated, the corrosion resistance.

2. TERMINOLOGY

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

2.1 Surface — The part of the surface on which the electroplater has to work.

2.2 Significant Surface — Significant surfaces are those surfaces, normally visible directly or by reflection, which are essential to the appearance or serviceability of the article when assembled in normal position, or which can be the source of corrosion products that deface visible surfaces on the assembled article and are subject to wear or corrosion or both, or surfaces on which the coating is otherwise functionally necessary.

NOTE 1 — The significant surface may be generally defined as that part of the visible surface which can be touched with a ball of diameter 20 mm or a diameter agreed upon by the manufacturer and the purchaser.

NOTE 2 — The designation of significant surface shall be agreed upon by the manufacturer and the purchaser and may be indicated in the drawings.

2.3 Non-significant Surfaces — Surfaces such as holes, recesses, bases of angles and similar areas where a controlled deposit ordinarily cannot be obtained, are designated as non-significant surfaces.

2.4 Minimum Local Thickness — This is defined as the lowest value of the coating thickness at any point on the significant surfaces.

2.5 Minimum Average Thickness — This is the average of thicknesses at a number of points on the significant surfaces.

2.6 Iridescent Passivation — When a stable and adherent chromate coating is formed over cadmium electrodeposits by reaction with an acidified dichromate solution under suitable *p*H and duration of passivation, producing more than one or two interference colours, the passivation is termed as iridescent passivation.

2.7 Post-Plating Treatment — Heat treatment for relief of hydrogen embrittlement, bright dipping, chromate passivation, dyeing, lacquering, painting or other organic coatings after plating, are termed post-plating treatments.

2.8 Hydrogen Embrittlement — Embrittlement caused by the entry of hydrogen into a metal.

3. COATING CLASSIFICATION NUMBER

3.1 Manner of Specifying Requirements — When ordering the electroplating of articles, the purchaser shall state the number of this standard, the date of issue, the class or service condition number and type (*see* Table 1). If necessary, the purchaser shall include, on his part, if specified, the following.

3.1.1 *Electroplating Application to High-Strength Steel, If Specified*

3.1.2 *Thickness, If Other than that Specified in This Standard*

3.1.3 *Lustre*

3.1.4 *Location of Significant Surface*

3.1.5 *Corrosion Resistance Test, If Specified*

3.1.6 *Hydrogen Embrittlement Test, If Required*

3.1.7 *Sample Size for Inspection, If Other than the Specified*

3.1.8 *Supplementary Requirements, If Applicable*

3.2 Grading of Service Conditions — In order of increasing severity of service conditions, numbers 1 to 3 have been allotted, to be referred to as Service Grade Numbers. The purchaser shall specify the service grade number and, if desired, also the classification number (*see* **3.3**). Typical service conditions which correspond to various service grade numbers have been explained in Appendix A, for guidance.

3.3 Classification of Coatings — The classification number comprises:

a) Chemical symbol for the basis metal (iron or steel), Fe, followed by an oblique stroke;

b) Chemical symbol for cadmium, Cd;

c) A number indicating the minimum local thickness (micrometres) of the cadmium coating; and

d) If appropriate, symbols indicating the presence of, and type (if required), of the chromate conversion coating (*see* IS : 9839-1981*).

3.3.1 *Example of Complete Classification Number* — Fe/Cd 8 CA shall denote a coating on iron or steel consisting of 8 micrometres of cadmium followed by A type chromate conversion coating, where

C refers to the chromate conversion coating, and

A is the type of chromate conversion coating.

4. COATING REQUIREMENTS

4.1 Finish and Appearance

4.1.1 Over the significant surface, the plated article shall be free from clearly visible plating defects such as blisters, pits, roughness, nodules, cracks, burning or unplated areas and shall not be stained or discoloured. On articles, usually where a contact mark is inevitable, this contact mark is excluded for inspection of appearance. Superficial stains that result from rinsing or slight discolouration resulting from drying or heating operation to relieve hydrogen embrittlement shall not be the cause for rejection.

NOTE 1 — Unless otherwise specified, the finish shall be bright, semi-bright or dull. The plated article shall, however, be clean and free from any damage.

NOTE 2 — Defects on the surface of the basis metal, such as scratches, porosity, pits, inclusions, cracks, roll marks and die marks may adversely affect the appearance of coatings applied thereto, despite the observance of the best electroplating practices. Accordingly, the electroplater's responsibility for defects in the coating resulting from such conditions shall be waived.

4.2 Thickness and Type of Cadmium Coating

4.2.1 *Thickness* — The minimum thickness of cadmium coating is designated by the classification number (*see* **3.3**).

4.2.2 *Local Thickness* — The minimum local thickness of the cadmium coating shall be measured at points on the significant surface as agreed to between the purchaser and the supplier and shall satisfy the requirements of Table 1.

4.2.3 *Average Thickness* —In cases where it is not possible to measure local thickness, the average thickness of cadmium coating shall satisfy the appropriate requirements of Table 1.

*Specification for chromate conversion coatings on electroplated zinc and cadmium coatings.

TABLE 1 REQUIREMENTS OF CADMIUM COATING ON IRON AND STEEL

(*Clauses* 0.2, 3.1, 4.2.2, 4.2.3 *and* 4.6)

Sl No.	Service Grade Number	Classification Number	Minimum Local Thickness	Average Thickness
(1)	(2)	(3)	(4)	(5)
			μm	μm
i)	3	Fe/Cd 12	12	18
ii)	2	Fe/Cd 8	8	12
iii)	1	Fe/Cd 5	5	8

NOTE 1 — In any particular environment, the protective value of a cadmium coating is directly proportional to its mass per unit area. The marked superiority shown by cadmium coatings over zinc coatings of equal thickness in the standard salt spray test cannot be taken as a fact valid for all the environments (zinc is superior in industrial environments whereas cadmium is superior in humid/marine atmospheres).

NOTE 2 — Barrel-plated items like screws, nuts, bolts, etc, are usually plated according to classification Fe/Cd 5 and Fe/Cd 8.

NOTE 3 — Average thickness is determined for small parts and fasteners where minimum local thickness cannot be determined.

4.3 Adhesion — The coating shall continue to adhere to the basis metal.

4.4 — Unless otherwise specified by the purchaser, a bright, semi-bright or dull lustre shall be acceptable.

4.5 Corrosion Resistance — Corrosion resistance shall be carried out on parts which have not been after-treated with protective substances such as waxes, greases and oils or on parts chromized by the methods given in **7.2.**

4.6 Coatings Appropriate to Each Service Grade Number — Table 1 gives the coating classification number, minimum local thickness and minimum average thickness appropriate for each service condition number.

5. BASIS METAL

5.1 Cleaning of Basis Metal — This standard does not specify requirements for the surface of the basis metal prior to electroplating but proper preparatory procedures and thorough cleaning of the basis metal shall be done in accordance with the procedure given in IS : 3194-1980* to ensure satisfactory adhesion and corrosion resistance performance of the coating.

*Recommended practice for cleaning metals prior to electroplating (*first revision*).

6. HEAT TREATMENT

6.1 Heat treatment shall be performed on certain basis metals to reduce the risk of damage by hydrogen embrittlement. In all cases, the duration of heat treatment shall commence from the time at which the whole of each part attains the specified temperature.

6.1.1 Parts made from steels with maximum specified tensile strengths of 1 050 MPa or higher (corresponding hardness values of approximately 34 HRC, 340 HV or 325 HB) and surface-hardened parts shall require heat treatment. It is recommended that unless otherwise specified, steels having tensile strength greater than 1 450 MPa (corresponding hardness 45 HRC, 440 HV or 415 HB) should not be electroplated with cadmium by conventional methods.

6.2 With the exception of surface-hardened parts, the heat treatment conditions shall be selected on the basis of the specified maximum tensile strength. Steels shall be categorized according to specified maximum tensile strength according to Table 2. If the steel specification is only in terms of minimum tensile strength, the corresponding maximum tensile strength shall be determined from Table 2.

TABLE 2 CATEGORIES OF STEELS AND MAXIMUM TENSILE STRENGTH CORRESPONDING TO SPECIFIED MINIMUM TENSILE STRENGTH

Sl No.	Minimum Specified Tensile Strength, *Rm Min*	Corresponding Maximum Tensile Strength, *Rm Max*
(1)	(2)	(3)
	MPa	MPa
i)	$Rm\ Min \leq 1\ 000$	$Rm\ Max \leq 1\ 050$
ii)	$1\ 000 < Rm\ Min \leq 1\ 400$	$1\ 050 < Rm\ Max \leq 1\ 450$
iii)	$1\ 400 < Rm\ Min < 1\ 750$	$1\ 450 < Rm\ Max < 1\ 800$
iv)	$1\ 750 < Rm\ Min$	$1\ 800 < Rm\ Max$

6.3 Stress-Relief Before Plating — All steel parts having an ultimate tensile strength of 1 050 MPa (corresponding hardness 34 HRC, 340 HV or 325 HB approx) and above, and that have been machined, ground or cold-formed, or cold-strengthened, shall be heat-treated for stress-relief. As a guide, they may be heat-treated at the highest temperature within the limit imposed by the tempering temperature for 30 minutes or maintained at a temperature of 190 to 220°C for not less than 1 hour.

NOTE 1 — If stress-relief is given after shot-peening or other cold-working processes, the temperature shall not exceed 230°C.

NOTE 2 — Some steels which have been carburized, flame-hardened or induction-hardened, and subsequently ground would be impaired by the treatment given in Note 1 and should instead be stress-relieved at a lower temperature, for example, at 170°C for not less than 1 hour. Guidance is given in Table 3.

TABLE 3 GUIDANCE OF HEAT TREATMENT FOR STRESS-RELIEF BEFORE ELECTROPLATING

(excluding surface-hardened parts)

SL NO.	MAXIMUM SPECIFIED TENSILE STRENGTH, *Rm Max*	TEMPERATURE	TIME
(1)	(2)	(3)	(4)
	MPa	°C	h
i)	$Rm\ Max \leq 1\ 050$	Not required	—
ii)	$1\ 050 < Rm\ Max \leq 1\ 450$	190-220	1
iii)	$1\ 450 < Rm\ Max \leq 1\ 800$	190-220	18
iv)	$1\ 800 < Rm\ Max$	190-220	24

6.4 Heat-Treatment After Plating Hydrogen Embrittlement Relief — Components subject to fatigue or sustained loading stress in service and made from severely cold-worked steels or nitrided steels or steels of tensile strength of 1 050 MPa (corresponding hardness 34 HRC, 340 HV or 325 HB approx) or greater should be heat-treated after plating. Guidance is given in Table 4.

TABLE 4 GUIDANCE OF HEAT TREATMENT FOR HYDROGEN EMBRITTLEMENT RELIEF AFTER ELECTROPLATING

(excluding surface-hardened parts)

SL NO.	MAXIMUM SPECIFIED TENSILE STRENGTH, *Rm Max*	TEMPERATURE	TIME
(1)	(2)	(3)	(4)
	MPa	°C	h
i)	$Rm\ Max \leq 1\ 050$	Not required	—
ii)	$1\ 050 < Rm\ Max \leq 1\ 450$	190-220	8
iii)	$1\ 450 < Rm\ Max \leq 1\ 800$	190-220	18
iv)	$1\ 800 < Rm\ Max$	190-220	24

6.4.1 In case the heat-treatment temperature would be harmful, for example, to surface-hardened steels (except for nitrided steels), it may be necessary to apply a lower temperature for a longer time.

NOTE 1 — The baking should be done as soon as possible after electroplating and before any supplementary chemical treatment of the plated surfaces. The best time and temperature in some cases shall be established by experiment.

NOTE 2 — Electroplated springs and other parts subject to flexure shall not be flexed before hydrogen embrittlement relief treatment. Steel springs shall be treated in boiling water for not less than 2 hours. The spring rating may be affected at a higher temperature.

NOTE 3 — Other conditions of time and temperature may be specified and used if they have been shown to be effective for the particular part and are acceptable to the purchaser but parts shall not be heat-treated above their tempering temperature.

6.5 Activation Treatment — Electroplated surfaces passivated as a result of the baking operation shall be reactivated before receiving a supplementary treatment. Surface intended for supplementary treatment, namely A, B, C and D types may by activated by immersion in a dilute acid solution. Surfaces shall be activated as soon as possible following baking and should be handled carefully to avoid contamination.

7. SUPPLEMENTARY TREATMENTS

7.1 Chromate passivation of cadmium plating should always be applied unless there is an agreement to the contrary. As it increases the protective value of cadmium plating, the articles are passivated after cadmium plating. If it is to be heat-treated, this should be done before passivation.

7.1.1 *Chromate Conversion Coating* — Chromate conversion coating on cadmium plating shall be done in accordance with IS : 9839-1981*. If specified by the purchase order, chromate conversion coatings shall be further protected by organic protective coatings like water soluble lacquer, nitrocellulose lacquer or paint.

7.1.2 *Phosphate Conversion Coating* — Phosphate conversion coating shall be done in accordance with IS : 3618-1974†. If specified by the purchase order, this coating shall also be covered by painting.

7.2 Corrosion Resistance of Chromate Coating — The protective value of a chromate coating shall be determined by exposing the clean specimen to a 5 percent solution of salt spray and conducting the test in accordance with

*Specification for chromate conversion coatings on electroplated zinc and cadmium coatings.

†Specification for phosphate treatment of iron and steel for protection against corrosion.

IS : 6910-1985*. The white corrosion product which is easily determinable by eyes, shall not emerge on the chromate coating surface within 48 hours.

7.2.1 Alternatively, other method, such as exposure to a humidity environment shall be used as given in IS : 8602-1977†. Break-down of the film, or the appearance of white corrosive products after 2 cycles of the test constitute failure to comply with this standard.

7.3 Appearance of Chromate Coating — The appearance of a chromate film on cadmium-plated parts may vary from olive drab, olive green shading to brown or bronze, iridescent yellowish green to practically colourless. In the case of iridescent passivation, the combination of colours may vary according to the process conditions like *p*H, conditions of the basis metal and cadmium deposit, temperature, time of reaction, agitation and composition of the passivation bath.

7.4 Covering — A chromate film should be free from bare patches. The presence of the film is verified by the test methods, for colourless and bleached passivation as prescribed in IS : 8602-1977†.

7.5 Adhesion for Chromated Coatings — A chromate film shall be adherent. Its adhesion shall be tested by the method prescribed in IS : 8602-1977†.

NOTE 1 — The cadmium surface is attacted by supplementary treatments, thereby diminishing the amount of metallic cadmium present. Therefore, it is recommended that no supplementary treatments be applied to cadmium coatings, having a minimum thickness of less than about 3 micrometres.

NOTE 2 — Since cadmium surface is soft, the coloured chromate films are likely to be scratched when chromated cadmium plated articles rub each other. Adequate case is taken to minimize such damages to the passivated film.

8. SELECTION OF SAMPLES

8.1 Out of each lot of similar parts, a number of samples shall be selected at random. The size of the lot and the number of samples to be selected shall be agreed upon between the manufacturer and the purchaser. All the samples selected shall be visually examined for any defects referred to in.

9. TEST SPECIMENS

9.1 If separate test specimens are used to represent the coated articles in a test, the specimens shall be same in nature, size and number and be processed as required in the purchaser's order.

NOTE — Unless a need can be demonstrated, separately prepared specimens shall not be used in place of production items for non-destructive and visual examinations.

*Method of testing corrosion resistance of electroplated and anodized aluminium coatings by acetic acid salt spray test (*first revision*).

†Methods of tests for chromate conversion coatings on zinc and cadmium surfaces.

9.2 Thickness and Adhesion Test Specimens — If separate specimens for thickness and adhesion tests are required, they shall be strips approximately 25 mm wide, 100 mm long and 1 mm thick.

9.3 Corrosion Resistance Test Specimens — If separate specimens for corrosion resistance tests are required, they shall be panels not less than 150 mm long, 100 mm wide and approximately 1 mm thick.

9.4 Hydrogen Embrittlement Test Specimens — If specimens are required, the configuration shall be specified by the purchaser.

10. TEST METHODS

10.1 Thickness

10.1.1 The local thickness of coating may by determined by the methods prescribed in IS : 3203-1982*.

10.1.2 The method as given in Appendix B shall be used for determining average thickness in the case of cadmium coating on small articles as prescribed in **4.2.3**.

NOTE 1 — Other methods may also be used if it can be demonstrated that the uncertainty of the measurement with these methods is less than 10 percent.

NOTE 2 — If the coatings are rough or matt, the microscopical and profilometric methods may give unreliable results, and magnetic/eddy current methods may give measurements which are somewhat greater than those obtained on smooth coatings of the same mass.

10.1.3 Thickness measurements of cadmium coatings may be made after application of the supplementary treatments. When methods as per IS : 3203-1982* (BNF jet test method) are used, remove the supplementary treatment prior to testing. The chromate film may be removed by using a very mild abrasive (a paste of levigated alumina rubbed on with the finger). Phosphate coating is to be treated with a concentrated (28%) ammonia solution to quickly dissolve the phosphate coating without affecting the underlying cadmium.

10.2 Adhesion — Adhesion of the coating shall be such that when examined in accordance with Appendix C, the coating shall not show separation from the basis metal at the interface.

10.3 Visual Examination — Examine material for compliance with requirements of lustre (**4.4**) and appearance (**4.1** and **7.3**) after electroplating and passivation.

*Methods of testing local thickness of electroplated coatings (*first revision*).

10.4 Conversion Coatings — Conversion coatings, if applied, shall be tested for the requirements and the methods given in **7.2** to **7.5**.

11. REJECTION

11.1 Coatings not conforming to this specification or to authorized modification shall be rejected.

12. PACKAGING AND PACKING

12.1 Presentation, packaging and packing methods for cadmium electroplated parts or articles employed by a supplier shall be such as to preclude damage during shipment and handling.

13. MARKING

13.1 The marking related to the coating shall include service grade and classification numbers as specified in this standard and the name or trademark of the manufacturer.

13.1.1 The coated article may also be marked with the Standard Mark which shall relate to the coating of the article.

NOTE — The use of the Standard mark is governed by the provisions of the Bureau of Indian Standards Act, 1986 Rules and Regulations made thereunder. The BIS Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by BIS and operated by the producer. BIS marked products are also continuously checked by BIS for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the BIS Certification Mark may be granted to manufacturers or processors may be obtained from the Bureaa of Indian Standards.

APPENDIX A

(*Clause* 3.2)

EXAMPLES OF SERVICE CONDITIONS CORRESPONDING TO EACH SERVICE NUMBER

A-1. SERVICE GRADE NO. 3

A-1.1 Severe service conditions involving exposure to marine atmospheres and tropical conditions of high humidity. Some examples of articles subjected to such conditions are aircraft components and defence electronic components.

A-2. SERVICE GRADE NO. 2

A-2.1 Moderate service conditions involving outdoor exposure under dry conditions. Some examples of articles subjected to such conditions are automobile parts and barrel-plated items.

A-3. SERVICE GRADE NO. 1

A-3.1 Mild service conditions involving indoor dry conditions. Some examples of articles subjected to such conditions are domestic radio chassis and barrel-plated items.

NOTE 1 — The conditions of exposure and use of electroplated steel are so varied that it is not possible to predict the average life of articles electroplated in accordance with Grades 3, 2 and 1. Such a selection should be based upon the experience of the manufacturers and users.

NOTE 2 — It is recognized that uses exist for which coatings thicker than those of Grade 3 may be required.

APPENDIX B

(*Clause* 10.1.2)

METHOD FOR DETERMINATION OF AVERAGE THICKNESS

B-1. STRIPPING SOLUTION

B-1.1 Dissolve 20 g of antimony trioxide in 1 000 ml of cold, concentrated hydrochloric acid (sp gr 1·16).

B-2. PROCEDURE

B-2.1 Accurately determine the area of the plated part. Degrease it with an organic solvent, such as trichloroethylene, dry thoroughly and weigh to an accuracy of one part in 10 000. Then totally immerse it and turn it over so that the reagent has free access to all surfaces. After the effervescence has eased, remove the sample, immediately wash, wipe to remove the loose coating of antimony and immerse in clean acetone to remove any trapped water. Then remove the sample, dry by the process previously used and reweigh.

NOTE 1 — If the article is of a complex shape, an area should be agreed to between the contracting parties.

NOTE 2 — The presence of a chromate passivation film can be ignored in this test.

B-3. CALCULATION

B-3.1 The thickness of cadmium coating in micrometres is given by

$$\frac{116 - 10^3 (m_1 - m_2)}{A}$$

where

m_1 = original mass in g of the sample,

m_2 = final mass in g of the sample, and

A = area in mm² of coating.

NOTE — The above calculation assumes a density of 8·65 g/cm³ for cadmium.

APPENDIX C

(*Clause* 10.2)

BURNISHING TEST FOR ADHESION

C-1. PROCEDURE

C-1.1 Rub an area of not more than 650 mm² of the plated surface, selected at the discretion of the inspector, rapidly and firmly with a smooth metal implement for 15 seconds.

C-1.2 A suitable burnishing implement is a copper disc (for example, a copper coin) used edgewise, and broadside. The pressure shall be sufficient to burnish the film at every stroke, but not so great as to cut the deposit. A poor adhesion will be shown by the appearance of a loose blister which grows as the rubbing is continued. If the quality of the deposit is also poor, the blister may crack and the plating will peel away from the base metal.

C-1.3 More than one area may be tested, if desired.

भारतीय मानक

अतप्त लघुकृत अल्प कार्बन इस्पात की चादर एवं पत्ती

(पाचँवा पुनरीक्षण)

Indian Standard

COLD REDUCED LOW CARBON STEEL SHEET AND STRIP

(Fifth Revision)

ICS 77.140.50

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

April 2008

Price Group 5

FOREWORD

This Indian Standard (Fifth Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Wrought Steel Products Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This standard was first published in 1954 and revised in 1963, 1973, 1986 and 1994. While reviewing this standard, in the light of experience gained during these years, the Committee decided to revise it to bring in line with the present manufacturing and trade practices being followed in the country in this field.

In the present revision, the following modifications have been made:

a) ISO designations have been adopted,

b) Table 1 and Table 3 have been modified,

c) New grade CR5 Extra Deep Drawing (stabilized interstitial free) has been added,

d) Corelation of old designations with new designations has been given for information (*see* Annex A),

e) A new clause on references has been incorporated,

f) Amendments No. 1 and 2 have been incorporated,

g) IS 8910 : 1978 has been adopted for general technical delivery requirements,

h) Clause on retest has been modified,

j) Values for plastic anisotropy (r) and strain hardening exponent (n) have been incorporated,

k) Applicable period for mechanical and physical properties has been included,

m) Requirements of dimensional and shape tolerances have been separated from the standard and adopted IS/ISO 16162 : 2005 'Continuously cold-rolled steel sheet products — Dimensional and shape tolerances', and

n) A clause for alternate test method specified in relevant ISO/IEC Standard has been added.

Assistance has been derived from the following:

ISO 3574 : 1999	Cold-reduced carbon steel sheet of commercial and drawing qualities
BS EN 10130 : 1991	Cold rolled low carbon steel flat products for cold forming: Technical delivery conditions

The composition of the Committee responsible for formulation of this standard is given in Annex C.

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 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

COLD REDUCED LOW CARBON STEEL SHEET AND STRIP

(Fifth Revision)

1 SCOPE

This standard covers the requirements of cold reduced low carbon steel sheets and strips for bending and drawing purpose and where the surface is of prime importance. It covers sheets and strips up to 4.50 mm thick, both in coil form and cut lengths.

2 REFERENCES

The following standards contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
228 (Relevant Parts)	Method for chemical analysis of steel
1501 : 2000/ ISO 6507-1 : 1997	Method for Vickers hardness test for metallic material (*third revision*)
1586 : 2000	Method for Rockwell hardness test for metallic material (Scales A-B-C-D-E-F-G-H-K) (*third revision*)
1599 : 1985	Method for bend test (*second revision*)
1608 : 2005/ ISO 6892 : 1998	Metallic materials — Tensile testing at ambient temperature (*third revision*)
8910 : 1978	General technical delivery requirements for steel and steel products
10175 (Part 1) : 1993	Mechanical testing of metals — Modified Erichson cupping test — Sheet and strip: Part 1 Thickness up to 2 mm (*first revision*)
11999 : 1987	Method for determination of plastic strain ratio '*r*' for steel sheets
15756 : 2007/ ISO 10275 : 1993	Metallic materials — Sheet and strip — Determination of tensile strain hardening exponent
IS/ISO 16162 : 2005	Continuously cold-rolled steel sheet products — Dimensional and shape tolerances

3 CLASSIFICATION OF GRADES

Sheets and strips shall be classified in the CR1, CR2, CR3, CR4 and CR5 grades/designations.

4 SUPPLY OF MATERIAL

4.1 General requirements relating to the supply of cold rolled low carbon steel sheets and strips shall conform to IS 8910.

4.2 Sheets and strips may be supplied either with mill or trimmed edges.

4.3 Sheets and strips of CR1 grade may be supplied in any of following tempers. Sheets and strips of CR2, CR3, CR4 and CR5 grade shall be supplied in annealed and skin-passed condition:

Temper Designation	*Temper*	*Processing*
H	Hard	Produced by heavy cold rolling
1/2H	Half Hard	Produced by cold rolling followed by annealing and further cold rolling to give strip of intermediate hardness
1/4H	Quarter Hard	do
SP	Skin Passed	Produced by light cold rolling after annealing
A	Annealed	Produced by a final annealing process

For specific applications, sheets and strips may also be supplied in any other temper subject to agreement between the supplier and the purchaser.

4.4 Non-ageing Characteristics

4.4.1 The manufacturer shall guarantee the absence of stretcher strains on being cold worked in the case of non-ageing quality with a non-ageing guarantee for six months from the date of dispatch.

4.4.2 CR4 and CR5 grade sheets and strips shall be supplied only in non-ageing quality with a non-ageing guarantee for six months from the date of dispatch.

4.4.3 A stability test as per Annex B may be carried out to assess the non-ageing characteristics of skin passed stabilized steels with mutual agreement between the manufacturer and the purchaser.

4.4.3.1 The steel shall be considered stabilized if the percentage increase in load does not exceed 6 when tested as per Annex B.

5 MANUFACTURE

5.1 The method of manufacture of the steel for sheets and strips shall be left at the discretion of the manufacturer.

5.2 Sheets and strips shall be supplied rimmed, semi-killed or killed as agreed between the purchaser and the manufacturer. However, CR4 and CR5 grades shall be supplied only in fully aluminium killed or in a fully stabilized condition.

6 CHEMICAL COMPOSITION

6.1 Ladle Analysis

The ladle analysis of steel, when carried out either by the methods specified in relevant parts of IS 228 or any other established instrumental/chemical method, shall be as given in Table 1. In case of any dispute, the procedure given in relevant parts of IS 228 shall be the referee method.

6.1.1 Alternatively, the method specified in relevant ISO/IEC standard may be used.

6.2 Product Analysis

Permissible variation in the case of product analysis from the limits specified in Table 1 shall be as given in Table 2.

7 MECHANICAL AND PHYSCIAL PROPERTIES

7.1 Tensile Test

7.1.1 Tensile test shall be carried out only, if specified by the purchaser.

7.1.2 When specified, the tensile test shall be carried out in accordance with IS 1608 as applicable, and the values of tensile strength, yield stress and percentage

Table 1 Chemical Composition

(*Clauses* 6.1 *and* 6.2)

Sl No.	Quality		Constituent, Percent, *Max*				
	Designation	Name	Carbon	Manganese	Sulphur	Phosphorus	Titanium
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	CR1	Commercial	0.15	0.60	0.035	0.050	–
ii)	CR2	Drawing	0.12	0.50	0.035	0.040	–
iii)	CR3	Deep Drawing	0.10	0.45	0.030	0.025	–
iv)	CR4	Extra Deep Drawing Aluminium Killed (Non-ageing)	0.08	0.40	0.030	0.020	–
v)	CR5	Extra Deep Drawing (Stabilized Interstitial Free)	0.06	0.25	0.020	0.020	0.15

NOTES

1 Restricted chemistry for CR4 and CR5 grade may be mutually agreed between the purchaser and the supplier.

2 When the steel is killed by aluminium alone the total aluminium content should be 0.020-0.070 percent. When steel is silicon killed, the silicon content shall not be less than 0.1 percent. When the steel is aluminium-silicon killed, the silicon content shall not be less than 0.03 percent and total aluminium content shall not be less than 0.01 percent.

3 The nitrogen content of the steel shall not be more than 0.007 percent. However for CR1, the nitrogen content shall not exceed 0.012 percent. This shall be ensured by the manufacturer by occasional check analysis.

4 The material may be supplied in the copper bearing quality in which case the copper shall be between 0.20 and 0.35 percent on ladle analysis. In case of product analysis, the copper content shall be permissible in between 0.17 and 0.38 percent.

5 The steel can be made with micro-alloying elements like niobium, vanadium, titanium and boron either individually or in combination, on mutual agreement in which case the total micro-alloying elements should not exceed 0.2 percent in ladle analysis. However, in case of boron, the limit shall be 0.006 percent.

6 The titanium may be replaced totally or partially by niobium or vanadium and may be completely stabilized.

Table 2 Permissible Variation for Product Analysis

(*Clause* 6.2)

Sl No.	Constituent	Variation Over Specified Limit Percent, *Max*
(1)	(2)	(3)
i)	Carbon	0.02
ii)	Manganese	0.03
iii)	Sulphur	0.005
iv)	Phosphorus	0.005

NOTE — Product analysis shall not be applicable to rimming steel.

elongation shall conform to the requirements specified in Table 3.

7.1.3 Tensile test values apply to transverse specimen in case of sheet/strips. Strips having a width of 250 mm and below shall be tested longitudinally.

7.1.4 The yield strength values apply to the 0.2 percent proof stress, if the yield strength is not clearly distinctive, otherwise the values apply to lower yield strength.

7.1.5 The values specified in Table 3 are applicable for the period indicated in Table 4 from the time that the steel is available for shipment.

7.2 Cupping Test

7.2.1 Cupping test shall be applicable only for sheets, strips and coils of CR2, CR3 and CR4 grades having thickness from 0.5 mm up to 2.00 mm.

7.2.2 Cupping test shall be carried out in accordance with IS 10175 (Part 1), and the minimum Erichson cupping test values shall be as given in Fig. 1.

NOTE — The shape of the cup fracture may be as mutually agreed between the purchaser and the supplier.

7.3 Hardness Test

Cold rolled sheets and strips shall conform to the hardness requirements specified in Table 3 and Table 5, when tested in accordance with IS 1586 and IS 1501 as applicable. However, by way of departure from these standards, a visible deformation on the back side of the specimen is permitted. The values determined in this way shall be identified by using symbols HRBm and HR30Tm, so as to differentiate these from the hardness values determined on thicker products (which are not allowed to exhibit a visible deformation on the back side of the specimen).

7.4 Bend Test

7.4.1 Bend test shall be carried out in accordance with IS 1599.

7.4.2 The angle of bend and the internal diameter of the bend for the different grades of material shall be as given in Tables 6 and 7. The axis of the bend shall be in the direction of rolling. The test pieces shall be deemed to have passed the test if the outer convex surface is free from cracks.

7.5 Plastic Strain Ratio, *r*

7.5.1 The plastic strain ratio is an index of drawability (*r*), shall be applicable only to thicknesses between 0.5 to 2.0 mm. For thicknesses more than 2.0 mm, the *r* value is reduced by 0.2.

7.5.2 The plastic strain ratio shall be checked in accordance with IS 11999, and the minimum *r* value shall be as given in Table 3.

7.6 Tensile Strain Hardening Component, *n*

7.6.1 The tensile strain hardening component is an index of the stretchability (*n*), shall be applicable only to thicknesses between 0.5 mm and 2.0 mm. For thicknesses more than 2.0 mm the *n* value is reduced by 0.02.

7.6.2 The tensile strain hardening component shall be checked in accordance with IS 15756 and the minimum *n* value shall be as given in Table 3.

7.7 Retest

If a test does not give the specified results, two additional tests shall be carried out at random on the same lot. Both retests shall conform to the requirements of this standard, otherwise, the lot shall be rejected.

8 SURFACE FINISH

8.1 Cold-Reduced Steel Sheet

This product is normally supplied skin passed (*see* **8.2**) but may be supplied annealed last (that is without a skin pass), if specified by the purchaser on his order.

8.2 Skin Pass

The purpose of skin passing is one or more of the following:

a) To temporarily minimize the appearance of coil breaks, stretcher strains (Luders lines) or fluting during fabrication of finished parts,

b) To obtain the required surface finish suitable for ordinary decorative painting, and

c) To control the shape.

Some increase in hardness and some loss in ductility will result from skin passing.

8.3 Strain Ageing

Cold reduced sheet in qualities CR1, CR2 and CR3

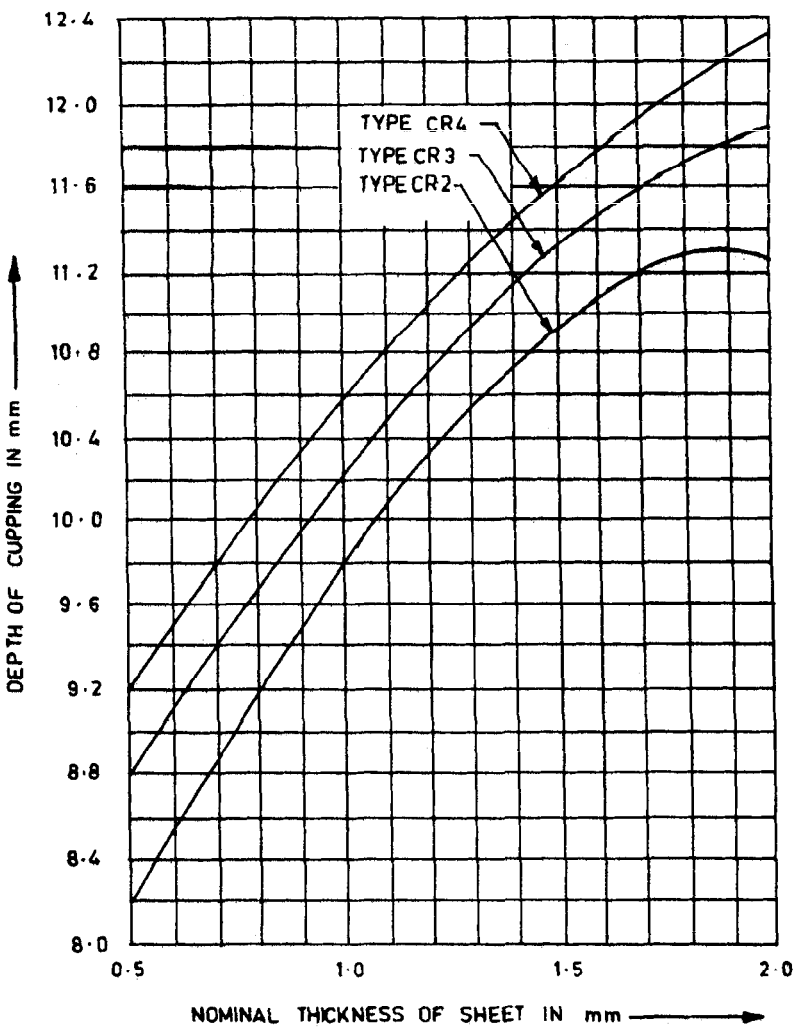

FIG. 1 MINIMUM ERICHSON VALUES

Table 3 Mechanical Properties at Room Temperature in as Delivered Condition for Annealed/Skin Passed Sheets and Strips (Cut Lengths and Coils)

(*Clauses* 7.1.2, 7.1.5, 7.3, 7.5.2 *and* 7.6.2)

Sl No.	Quality		Yield Stress R_e MPa	Tensile Strength R_m MPa	Elongation Percent A *Min*		Hardness *Max*		*r*-Bar *Min*	*n*-Bar *Min*
	Designation	Name	*Max*		L_o = 80 mm	L_o = 50 mm	HRB	HR (30T)		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
i)	CR1	Commercial	280	410	27	28	*See* Table 4		–	–
ii)	CR2	Drawing	240	370	30	31	65	60	–	–
iii)	CR3	Deep Drawing	220	350	34	35	57	55	–	–
iv)	CR4	Extra Deep Drawing Aluminium Killed (Non-ageing)	210	350	36	37	50	50	–	–
v)	CR5	Extra Deep Drawing (Stabilized Interstitial Free)	190	350	38	40	–	–	1.7	0.22

NOTES

1 1 MPa = 1 N/mm² = 1 MN/m² = 0.102 0 kgf/mm².

2 The minimum tensile strength for qualities CR2, CR3 and CR4 would normally be expected to be 270 MPa. All tensile strength values are determined to the nearest 10 MPa. For designing purposes, the lower limit for R_e may be assumed to be 140 MPa for grades CR1, CR2, CR3 and CR4 and 120 MPa for grade CR5.

3 For materials up to and including 0.6 mm in thickness, the elongation values in the table shall be reduced by 1.

4 Equivalent Vickers hardness values are allowed on agreement between the interested parties at the time of ordering. The hardness of sheet thinner than 0.6 mm shall be measured exclusively in compliance with the HR 30T scale.

5 Mechanical properties are not generally done on Commercial Quality Products and the values in this table are for information only.

6 For CR4 Grade *r* bar value can be given based on mutual agreement between the purchaser and the supplier.

supplied in the skin-passed condition tends to strain-age and this may lead to the following:

a) Surface markings from stretcher strains (Luders lines) or fluting when the steel is formed, and

b) Deterioration in ductility.

Because of these factors, it is essential that the period between final processing at the mill and fabrication be kept to a minimum. Rotation of stock, by using the oldest material first, is important. Stocking of such steels for extended periods of time should be avoided; for optimum performance the period should not exceed six weeks.

For skin-passed sheet in qualities CR1, CR2 and CR3 and with due regard to the foregoing precautions, reasonable freedom can be achieved by effective roller levelling immediately prior to fabrication at the purchaser's plant. Freedom from stretcher strain and fluting for a period of six months can be achieved by the supply of skin-passed non-ageing steels. Grades CR4 or CR5 shall be specified in such cases where Luder's lines are not acceptable and where roller levelling is not possible.

8.4 Surface Condition

8.4.1 The condition of the surface of cold-reduced steel sheet of drawing qualities (CR2, CR3, CR4 and CR5) is not required to be same for unexposed parts as it is for exposed parts.

8.4.2 Surface condition of sheet for unexposed parts may contain pores, some slight pitting, small markings, scratches, other minor defects and a light discoloration. The surface of sheet for exposed parts shall be reasonably free of these conditions. Unless otherwise agreed, only one side is inspected.

8.5 Surface Finish

8.5.1 Cold-reduced steel sheet may be supplied in a smooth finish and matt finish, dull in appearance, which is suitable for ordinary decorative painting but is not recommended for electroplating. Surface

Table 4 Applicable Period for Values Specified in Table 3

(*Clause* 7.1.5)

Sl No.	Designation	Period
(1)	(2)	(3)
i)	CR2	8 days
ii)	CR3	8 days
iii)	CR4	6 months
iv)	CR5	6 months

Table 5 Hardness of Different Tempers at Room Temperature for CR1 Grade

(*Clause* 7.3)

Sl No.	Temper	Hardness HRB	
		Min	*Max*
(1)	(2)	(3)	(4)
i)	Hard (H)	85	–
ii)	Half Hard (1/2 H)	75	85
iii)	Quarter Hard (1/4 Hard)	60	75
iv)	Skin Passed (SP)	–	70
v)	Annealed (A) (Dead Soft)	–	68

NOTES

1 For tempers other than those mentioned in this table, the values shall be as agreed to between the contracting parties.

2 Equivalent Vickers hardness values are allowed on agreement between the interested parties at the time of ordering. The hardness of sheet thinner than 0.6 mm shall be measured exclusively in compliance with the HR30T scales.

Table 6 Bend Test for Sheets/Strips in Cut Lengths and Coils in Annealed and Skin Pass Condition

(*Clause* 7.4.2)

Sl No.	Steel Grade	Angle of Bend Degree	Internal Diameter of Bend
(1)	(2)	(3)	(4)
i)	CR1	180	t
ii)	CR2	180	Close
iii)	CR3	180	Close
iv)	CR4	180	Close
v)	CR5	180	Close

Where t is the thickness of test piece.

roughness value μ_{ra} may be given subject to mutual agreement between the supplier and the purchaser.

8.5.2 When cold-reduced steel sheet is deformed during fabrication, localized areas may roughen to some degree and such affected portions of the part may require hand finishing to prepare the surface for the intended application.

8.6 Oiling

As a deterrent to rusting, a coating of oil is usually applied to the product. The oil is not intended as a drawing or forming lubricant and should be easily removable with degreasing chemicals. The product may be ordered not oiled, if required, in which case, the supplier has limited responsibility, if oxidation occurs.

9 FREEDOM FROM DEFECTS

9.1 The finished sheets and strips shall be free from harmful defects, such as scale, rust, blisters, lamination, pitting, porosity, cracked or torn edges or any other defects which are harmful to the intended use.

9.2 The degree or amount of surface defects in a coil may be expected to be more than in cut lengths because of the impossibility of rejecting portions of a coil. This shall be taken into account by the purchaser in his assessment of the material. An excessive amount of defects may be a cause for rejection.

9.3 The sheets shall be reasonably flat and edges cleanly sheared and squared to the specified dimensions.

10 DIMENSIONS AND TOLERANCES

10.1 Unless otherwise agreed to between the manufacturer and the purchaser, standard dimensions of cold rolled sheets and strips shall be as given below:

Thickness, mm = 0.18 , 0.20, 0.22, 0.25, 0.28, 0.30, 0.32, 0.35, 0.40, 0.45, 0.50, 0.55, 0.63, 0.70, 0.80, 0.90, 1.00, 1.20, 1.25, 1.40, 1.50, 1.60, 1.80, and 2.00.

The following are the preferred thicknesses for sheets above 2.00 mm:

2.50 mm, 2.65 mm, 3.00 mm, 3.25 mm, 3.50 mm, and 4.00 mm.

10.2 Unless otherwise specified, the dimensional and shape tolerances applicable to cold rolled sheets and strips shall be as given in IS/ISO 16162 : 2005.

11 SAMPLING FOR TESTS

11.1 One representative sample from a coil or a lot of sheets shall be taken for tensile testing. A lot consists of 50 tonnes or less of sheets or strips of the same quality

Table 7 Bend Test for Sheets/Strips of 'CR1' Grade

(Clause 7.4.2)

Sl No.	Steel Grade	Angle of Bend Degree	Internal Diameter of Bend
(1)	(2)	(3)	(4)
i)	Hard (H)	–	–
ii)	Half Hard (1/2 H)	180	3 t
iii)	Quarter Hard (1/4 Hard)	180	2 t
iv)	Skin Passed (SP)	180	t
v)	Annealed (A) (Dead Soft)	180	t t

Where t is the thickness of test piece.

rolled to the same thickness and condition. If the lot consists of more than one heat, samples from each heat shall be tested.

11.2 For cupping, hardness and bend tests, one sample from each lot of 50 tonnes of the same heat or part thereof or one sample from each coil shall be taken.

11.2.1 The specimens shall not undergo any treatment on either surface before testing. In the case of coils, samples shall be taken from the beginning or end of the coil.

12 MARKING

12.1 The following shall be legibly marked on the top of each bundle of package of sheets or shown on a tag attached to each coil:

a) Manufacturer's name or trade-mark,

b) Quality designation,

c) Product dimensions,

d) Cast or identification mark by which the sheet or strip may be traced to cast or casts from which they were made,

e) Mass/Net weight, and

f) Date of dispatch.

12.2 BIS Certification Marking

The material may also be marked with the Standard Mark.

12.2.1 The use of the Standard Mark is governed by the provisions of *Bureau of Indian Standards Act*, 1986 and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

12.3 Packing

12.3.1 Each sheet shall be treated on both sides with non-hardening type rust preventive oil, which can be easily washed with aqueous alkali solution.

12.3.2 Sheets and strips shall preferably be supplied in bundles or packages not weighing more than 3 tonnes or as agreed to between the purchaser and the manufacturer.

12.3.3 Sheets and strips shall be securely packed in waterproof material and covered all over with steel envelope and securely tied round with steel straps and preferably with wooden battens underneath to prevent the sheets from rusting and damage during transit.

ANNEX A

(*Foreword*)

CORRELATION OF OLD AND NEW GRADES/DESIGNATIONS

Old Designation		*New Designation*	
Designation	Name	Designation	Name
O	Ordinary quality	CR1	Commercial
D	Drawn quality	CR2	Drawing
DD	Deep drawn quality	CR3	Deep drawing
EDD	Extra deep drawn quality	CR4	Extra deep drawing Aluminium killed (Non-ageing)
–	–	CR5 (*New grade added*)	Extra deep drawing (Stabilized interstitial free)

ANNEX B

(*Clauses* 4.4.3 *and* 4.4.3.1)

STABILITY TEST

B-1 A tensile test piece shall be subjected to a total strain of 10 percent and the load (P_1) required to produce this strain shall be noted. The test piece shall then be subjected to an accelerated ageing treatment by heating at a nominal temperature of 100°C for 30 min. The test piece shall thereafter again be strained to 10 percent, calculated on the original (unstrained) gauge length, and the load (P_2) noted.

The steel shall be considered stabilized, if the percentage increases in load $= \frac{P_2 - P_1}{P_1} \times 100$ does not exceed 6.

ANNEX C

(Foreword)

COMMITTEE COMPOSITION

Wrought Steel Products Sectional Committee, MTD 4

Organization	*Representative(s)*
Tata Steel Ltd, Jamshedpur	DR D. BHATTACHRJEE ***(Chairman)***
	SHRI INDRANIL CHAKRABORTY (*Alternate* I)
	DR A. N. BHAGAT (*Alternate* II)
All India Induction Furnace Association, New Delhi	SHRI R. P. VARSHNEY
	SHRI L. N. GOSWAMI (*Alternate*)
Central Boilers Board, New Delhi	SHRI V. K. GOEL
Central Public Works Department (CPWD), New Delhi	CHIEF ENGINEER (NDZ) V
	SUPERINTENDING ENGINEER (Central Store) (*Alternate*)
DGS&D, Bhilai Nagar/Delhi	REPRESENTATIVE
	SHRI B. S. RANA (*Alternate*)
Escorts Knowledge Management Centre, Faridabad	SHRI ALOK NAYAR
Institute of Steel Development & Growth, Kolkata	DR R. K. P. SINGH
	SHRI JAYANTA K. SAHA (*Alternate*)
JSW Steel Ltd, Vasind	SHRI M. K. MAHESHWARI
M. N. Dastur & Co Ltd, Kolkata /Delhi	SHRI SUBHABRATA SENGUPTA
	SHRI V. K. TYAGI (*Alternate*)
Ministry of Defence (DGOFB), Kolkata	SHRI TAPABRATA BASU
	SHRI S. BHATTACHARYA (*Alternate*)
Ministry of Defence [DQA (M&E)], Ichapur	ADDITIONAL DIRECTOR
	DEPUTY DIRECTOR (Met/PScO) (*Alternate*)
Ministry of Railways (RDSO), Lucknow	DIRECTOR (M&C)
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Ministry of Steel (Government of India), New Delhi	SHRI S. S. SAHA
	SHRI A. C. R. DAS (*Alternate*)
National Physical Laboratory, New Delhi	DR ANIL KUMAR GUPTA
	SHRI R. C. ANANDANI (*Alternate*)
Rashtriya Ispat Nigam Ltd (VSP), Visakhapatnam	SHRI R. RANJAN
	SHRI S. MANDAL (*Alternate* I)
	SHRI P. SRINIVAS (*Alternate* II)
SAIL, Bhilai Steel Plant, Bhilai	REPRESENTATIVE
	SHRI K. K. KUMAR (*Alternate* I)
	SHRI P. K. DATTA (*Alternate* II)
SAIL, Bokaro Steel Plant, Bokaro	SHRI G. B. PRADHAN
	DR M. M. S. SODHI (*Alternate*)
SAIL, Central Marketing Organization, Kolkata/Bangalore	SHRI P. C. JHA
	SHRI B. V. S. PANDIT (*Alternate*)
SAIL, Durgapur Steel Plant, Durgapur	REPRESENTATIVE
SAIL, Research & Development Center for Iron & Steel, Ranchi	DR S. K. CHAUDHURI
	DR B. K. PANIGRAHI (*Alternate*)
SAIL, Rourkela Steel Plant, Rourkela	REPRESENTATIVE
Steel Re-rolling Mills Association of India, Mandi Gobindgarh	REPRESENTATIVE
	SHRI H. D. KHERA (*Alternate*)
Tata Consulting Engineers, Jamshedpur	DR M. D. MAHESHWARI
Tata Motors Limited, Pune	SHRI J. D. HARIDAS
	SHRI B. R. GALGALI (*Alternate*)
In personal capacity [*403, Udaigiri, Kaushambi, Dist Ghaziabad, U.P.*]	SHRI N. MITRA
BIS Directorate General	DR (SHRIMATI) SNEH BHATLA, Scientist 'F' & Head (MTD) [Representing Director General (*Ex-officio*)]

Member Secretary
SHRI DEEPAK JAIN
Scientist 'E' (MTD), BIS

Flat Steel Products Subcommittee, MTD 4 : 3

Organization	*Representative(s)*
TCE Consulting Engineers, Jamshedpur	DR M. D. MAHESHWARI (***Convener***)
Apex Chambers of Commerce, Ludhiana	SHRI P. D. SHARMA
Essar Steels Ltd, Dist Surat	SHRI R. K. BALASUBRAMANIAM
	SHRI S. R. BHATT (*Alternate*)
Federation of Engineering Industries of India, New Delhi	SHRI H. L. BHARDWAJ
	SHRI H. L. BANSAL (*Alternate*)
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Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act*, 1986 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

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Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards: Monthly Additions'.

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Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones: 2323 0131, 2323 3375, 2323 9402 *website* : www.bis.org.in

Regional Offices: Telephones

Central	: Manak Bhavan, 9 Bahadur Shah Zafar Marg, NEW DELHI 110002	2323 7617, 2323 3841
Eastern	: 1/14 C.I.T. Scheme VII M, V.I.P. Road, Kankurgachi, KOLKATA 700054	2337 8499, 2337 8561, 2337 8626, 2337 9120
Northern	: SCO 335-336, Sector 34-A, CHANDIGARH 160022	260 3843, 260 9285
Southern	: C.I.T. Campus, IV Cross Road, CHENNAI 600113	2254 1216, 2254 1442, 2254 2519, 2254 2315
Western	: Manakalaya, E9 MIDC, Marol, Andheri (East), MUMBAI 400093	2832 9295, 2832 7858, 2832 7891, 2832 7892

Branches : AHMEDABAD. BANGALORE. BHOPAL. BHUBANESHWAR. COIMBATORE. FARIDABAD. GHAZIABAD. GUWAHATI. HYDERABAD. JAIPUR. KANPUR. LUCKNOW. NAGPUR. PARWANOO. PATNA. PUNE. RAJKOT. THIRUVANANTHAPURAM. VISAKHAPATNAM.

Printed at Simco Printing Press, Delhi

[redacted]

Line	Zone	No.	Designation	Description	Qty	Note
ВСКД						
				Documents		
13			3Д6.060 СБ	Assembly Drawing		
				Parts		
12		1	3Д6.005	Body	1	
11		2	3Д6.006	Lug	1	

4-26941 P-A0487-79

3Д6

060

BODY

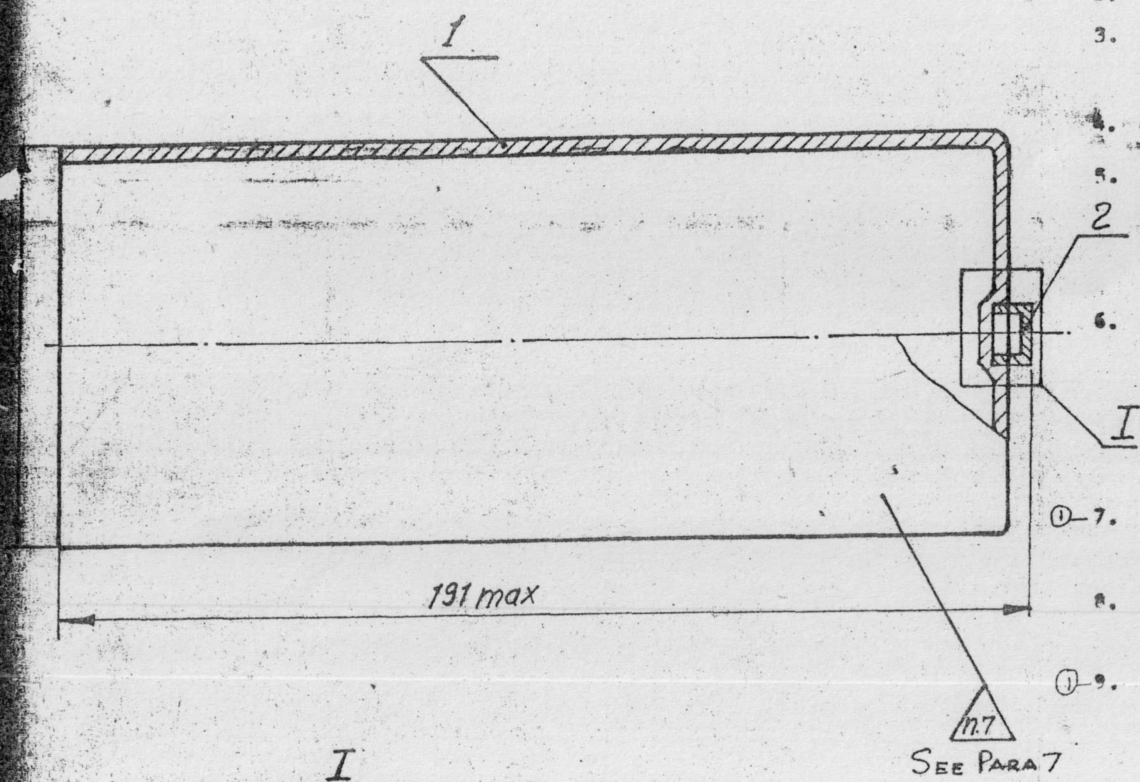
R Nº	DATE	AUTHORITY	REVISION	ZONE	SD	D.D. SIG.
	6/4/85	D.C.I. 33760A	DRG. SEALED PROV.			

APPD. [signature]
FOR C.I.(A)

AHSP:- C.I.(A) KIRKEE

4-26941 ⬡ 3Д6060СБ

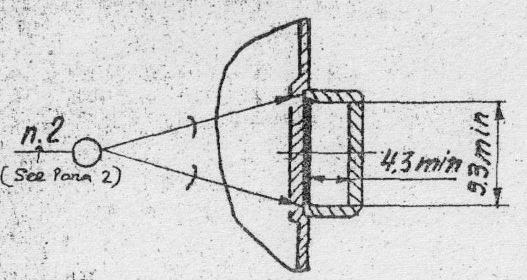
ECKA



*

1. Dimension for reference
2. Brass Л63, ГОСТ 15527 - 70
3. Coating Zn ⁹ Cr. Thickness of coating on inner surface not to be checked provided the whole of surface is coated.
4. Cracks on part item 1 are not allowed.
5. 1% of items from batch, but not less than 5 pieces to be tested for strength of soldered joint under a load of 50 Kg, applied in parallel with axis of part No.1. Minimum test time, 1 minute. Break impermissible.
6. To be pressure tested for airtightness at 0.6 to 0.7 Kgf/cm². Test time 60-70 seconds. For checking apply soap solution to joints. Bubbles and pressure drop not permitted. Pressure test at 0.6 to 0.7 Kgf/cm² (positive) is allowed. For checking dip component in water for 60 to 70 seconds. Air bubbles not permitted.
7. (1) Apply QID Stamp. Use black paint ФЛ-5Ф, ТУ 6Ф 10-1043 - 79. Black Enamel ЭП - 51 ГОСТ 9640 - 75 permitted.
8. For the rest of requirements, refer to ОСТ 92-1111 - 71 and ОСТ В84 - 1Я6 - 70
9. (1) Alloy АКБ 062—0.2—0.04—0.5 ГОСТ 16130 - 72 is allowed as alternative to brass Л63, ГОСТ 15527-70.

Scale 2:1 / M2:1 — I



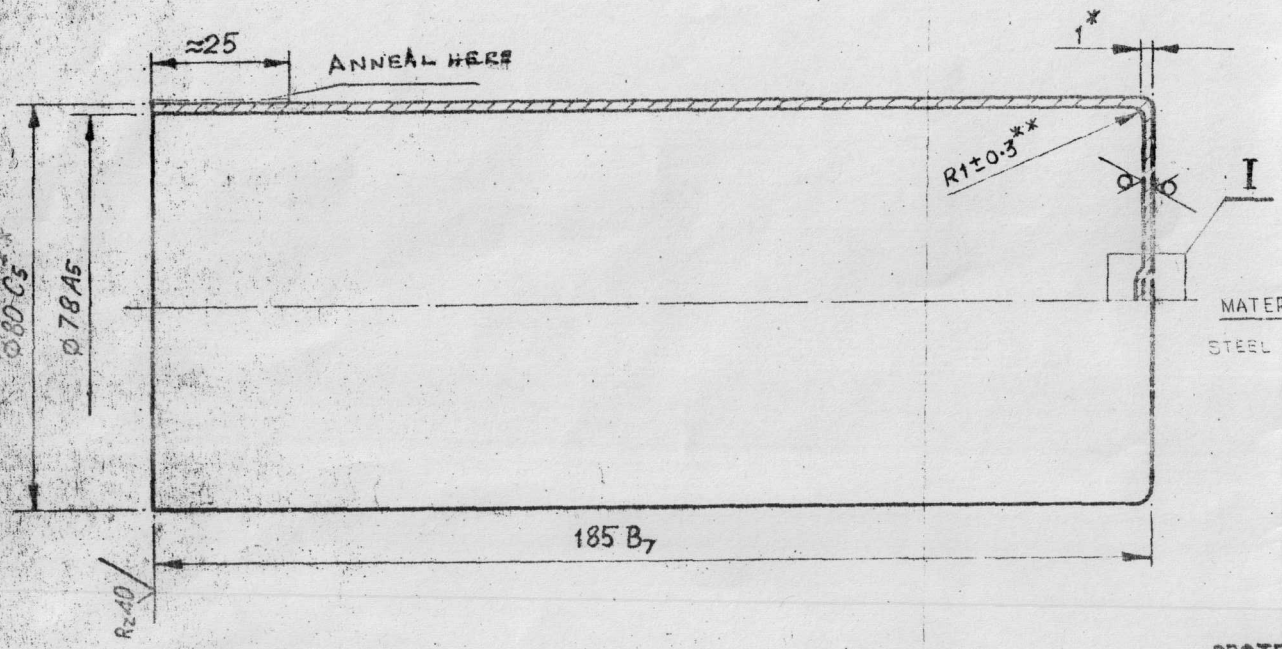
R. No	DATE	AUTHORITY	REVISION	ZONE	AHSP. SIG	D.O. SIG
	17-11-87	DC 34269-A	SCALE & EST. MASS ADDED.			
	4-6-85	D.C.I. 33760-A	DRAWING SEALED PROV.			

SCALE :- 1:1	EST. MASS :- 0.394 kg.
4-26941	3Д6 060СБ
BODY ASSEMBLY DRAWING	
APPD. FOR C.I.(A)	
AHSP :- C.I.(A) KIRKEE	

ECKA

4-26941 O 3A6 005

Rz 20



1.* Dimensions for reference

2.** Dimensions ensured by tool.

3. For the rest of requirements refer to OST 234 - 338 - 78

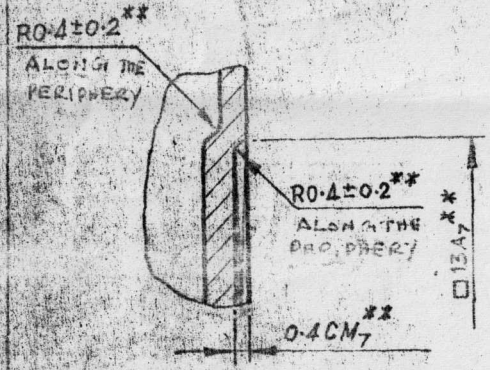
4. All over annealing permitted.

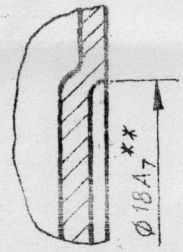
MATERIAL	SPECIFICATION No.	APPROVED/ALTERNATIVE INDIGENOUS EQUIVALENTS
STEEL SHEET	i) GOST 9045-70	IS 513 TYPE D D OR EDD IN ANNEALED/SKIN PASSED CONDITION OR,
	ii) GOST 19904-75	BS 1449 PART 1, GRADE 1, OR 2 OR 3 (CR/CS) IN ANNEALED/SKIN PASSED CONDITION. ALTERNATIVELY BS 1449 PART 1, GRADE 1 OR 2 OR 3 IN HR/HS CONDITION WITH MAX. U.T.S. OF 360 MPa

PROTECTIVE TREATMENT :- CADMIUM PLATING FOLLOWED BY CHROMATE PASSIVATION TO SPECIFICATION IS : 1572 Cd 8.

I
SCALE :- 5:1

I ALTERNATIVE
SCALE - 5:1





	20-12-94	D.C 35878-A	NEW DETAILS RE MATERIAL & PROTECTIVE TREATMENT INCORPORATED				
	17-11-87	DC 34269-A	SCALE & EST. MASS ADDED.				
	4-6-85	D.C.I. 33760-A	DRAWING SEALED PROV.				
R No.	DATE	AUTHORITY	REVISION	ZONE	AHSP SIG.	D.O	

APPD [signature] FOR CGH(A)

AHSP :- CGH(A) KIRKEE

SCALE :- 1:1 | EST. MASS :- 0.394 kg.

4-26941 3A6

005

BODY

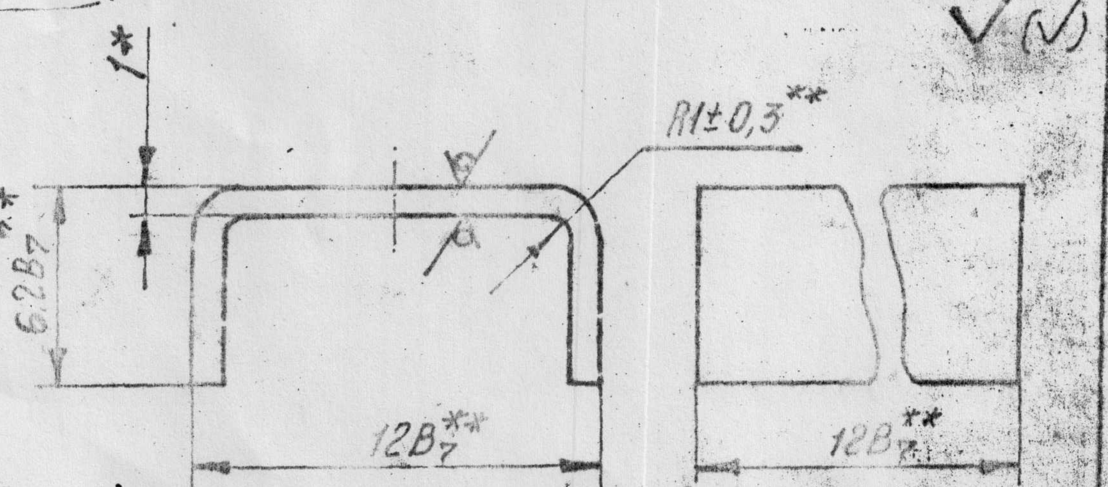
Sheet 1 GOST 19904 - 74

OR : II GOST 9045 - 70

[redacted]

31

ЕСКД



MATERIAL	SPECIFICATION №	APPROVED/ALTERNATIVE INDIGENOUS EQUIVALENTS
STEEL SHEET.	i) GOST 16523-70 ii) GOST 503-71 iii) GOST 9045-74	IS:513 GRADE DD/EDD IN ANNEALED CONDITION FOR GRADE D, & SUITABLY STRESS RELIEVED CONDITION FOR GRADE DD/EDD.

PROTECTIVE TREATMENT: CADMIUM PLATING FOLLOWED BY CHROMATE PASSIVATION TO SPECIFICATION IS 1572 Cd 8.

1. Permitted

   a) Steel sheet 08K ... GOST 16523-70 or ... GOST 9045-70.

   b) Tape 08KП .OM-HT-2-01 GOST 503-71.

2. * Dimensions for reference.

3. ** Dimensions ensured by tool.

4. For the rest of tech. requirements refer to OST B 84-186-70.

R №	DATE	AUTHORITY	REVISION	ZONE	SIG
	4.6.85	D.C133760A	DRAWING SEALED PROV.	AN DO	
	17.11.87	DC34269-A	SCALE & EST. MASS ADDED.		
	20.12.94	D...5978-A	NEW DETAILS RE: MATERIAL AND PROTECTIVE TREATMENT INCORPORATED.		

SCALE :- 5:1

EST. MASS :- 0.002 Kg.

APPD. [signature] FOR CQ(A)

AHSP:- CQA(...) KIRKEE

4-25941 3D6

...006

LUG

Sheet 1 GOST 19904-74 / 10 K 17 GOST 16523-70