

इंटरनेट

मानक

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IS 2002 (2009): Steel plates for pressure vessels for intermediate and high temperature service including boilers [MTD 4: Wrought Steel Products]



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Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”

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भारतीय मानक

दाब पात्र एवं बॉयलर के लिए मध्यवर्ती और उच्च तापमान
सेवाओं हेतु इस्पात की प्लेट

(तीसरा पुनरीक्षण)

Indian Standard

**STEEL PLATE FOR PRESSURE VESSEL FOR
INTERMEDIATE AND HIGH TEMPERATURE SERVICE
INCLUDING BOILERS**

(Third Revision)

ICS 77.140.30; 77.140.50

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

FOREWORD

This Indian Standard (Third 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 1962 and subsequently revised in 1982 and 1992. 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 practices being followed by the Indian industry and overseas standards of hot rolled steel plates for pressure vessels including boilers.

In this revision the following changes have been made:

- a) Clauses on scope, terminology, manufacture, heat treatment, tolerances, tensile test and re-tests have been modified;
- b) Definitions of Normalizing and Normalizing Rolling have been added;
- c) Amendment Nos. 1, 2, 3 and 4 have been incorporated;
- d) A new clause on references has been incorporated;
- e) Requirements of tolerances on dimensions and shape has been added and adopted ISO 7452 : 2002 'Hot-rolled structural steel plates — Tolerances on dimensions and shape'; and
- f) Figure for position of test strips in rolled plates has been deleted.

For the tests specified in this standard (chemical/ physical/ others), the method as specified in the relevant ISO Standard may also be followed as an alternate method.

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

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.

AMENDMENT NO. 1 NOVEMBER 2012
TO
IS 2002 : 2009 STEEL PLATE FOR PRESSURE VESSEL
FOR INTERMEDIATE AND HIGH TEMPERATURE
SERVICE INCLUDING BOILERS

(Third Revision)

(Page 3, clause 9.3) — Substitute the following for the existing clause:

‘9.3 Rolling Mass

Permissible upper deviation from the theoretical mass shall comply to Table 2.
Whereas, the permissible lower deviation shall be calculated based on the
negative tolerance on the thickness as per **9.1.**’

(MTD 4)

Reprography Unit, BIS, New Delhi, India

Indian Standard

STEEL PLATE FOR PRESSURE VESSEL FOR INTERMEDIATE AND HIGH TEMPERATURE SERVICE INCLUDING BOILERS

(*Third Revision*)

1 SCOPE

This standard covers the requirements of plain carbon steel plates produced in discrete cut lengths of flat product or plates that have been leveled and flattened and cut to length from a coiled product. These plates are intended for use in pressure vessels for intermediate and high temperature service which include boilers.

Plates under this standard are available in three grades as follows:

- a) *Grade 1* — Low tensile steel plates for fire boxes and boiler plates which require welding, flanging or flame cutting;
- b) *Grade 2* — Medium tensile plates which can be used for welding, flanging and flame cutting; and
- c) *Grade 3* — High tensile steel plates which can be used for welding, flame cutting, and hot flanging under controlled conditions.

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:

<i>IS No.</i>	<i>Title</i>
228 (relevant parts)	Methods of chemical analysis of steel
1599 : 1985	Method for bend test (<i>second revision</i>)
1608 : 2005	Metallic materials — Tensile testing at ambient temperature (<i>third revision</i>)
1956 (Part 4): 1975	Glossary of terms relating to iron and steel: Part 4 Steel sheet and strip
4225 : 2004	Recommended practice for straight beam ultrasonic testing of steel plates (<i>second revision</i>)
4748 : 1988	Methods for estimating average grain size of metals (<i>first revision</i>)

<i>IS No.</i>	<i>Title</i>
8910 : 1978	General technical delivery requirements for steel and steel products
12457 : 1988	Code of practice for evaluation, repairs and acceptance limits of surface defects in steel plates and wide flats
IS/ISO 7452 : 2002	Hot-rolled structural steel plates — Tolerances on dimensions and shape

3 TERMINOLOGY

For the purpose of this standard, the following definitions in addition to those given in IS 1956 (Part 4) shall apply.

3.1 Plate as Rolled — This term refers to the unit plate (5 mm thick and above) as rolled from the slab or directly from an ingot, in its relation to the location and number of specimens, and not to its condition. Plates produced from coil means the plates which have been levelled or flattened and cut to length.

3.2 Normalizing — It is a heat treating process in which a steel plate is reheated to a uniform temperature above the upper critical temperature and then cooled in air to below the transformation range.

3.3 Normalizing Rolling — A hot rolling process in which the final rolling passes are carried out at a suitable higher temperature, followed by cooling in natural air to a temperature below the transformation temperature, in order to produce a structure, analogous to that obtained by a separate normalizing treatment of hot rolled product.

4 GENERAL REQUIREMENTS

General requirements relating to the supply of steel plates for pressure vessels shall conform to IS 8910.

5 MANUFACTURE

5.1 Steel shall be manufactured by any process of steel making except Bessemer process. It may be followed by secondary refining or secondary vacuum treatment.

5.1.1 The steel shall be fully killed and made to coarse grain practice.

5.1.2 The material shall have a carburized austenitic grain size number in the range 1 to 5 as determined by the carburizing method specified in IS 4748. However, the above grain size requirement shall be deemed as fulfilled if, on ladle analysis, the total aluminium content is not more than 0.020 percent.

5.1.3 The plates are produced in either discrete cut lengths of flat product or from coils.

6 CHEMICAL COMPOSITION

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

6.2 Permissible variation in case of product analysis from the limits specified in 6.1 shall be as follows:

<i>Constituent</i>	<i>Variation Over the Specified Maximum or Under the Minimum Limits Percent</i>
(1)	(2)
Carbon	0.03
Silicon	0.03
Sulphur	0.005
Phosphorus	0.005
Manganese	0.05

NOTE — Variation shall be applicable both over and under the specified limits in several determinations in a heat.

Table 1 Chemical Composition

(Clause 6.1)

SI No.	Grade	Carbon Percent <i>Max</i>	Manganese Percent <i>Max</i>	Silicon Percent	Sulphur Percent <i>Max</i>	Phosphorus Percent <i>Max</i>
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	1	0.18	0.50-1.20	0.15-0.35	0.040	0.035
ii)	2	0.20	0.50-1.20	0.15-0.35	0.040	0.035
iii)	3	0.22	0.50-1.20	0.15-0.35	0.040	0.035

NOTES

- Carbon content over the maximum specified shall be increased by:
 - For plates over 25 mm up to and including 65 mm thick — 0.02 percent *Max*; and
 - For plates over 65 mm thick — 0.04 percent *Max*.
- Total aluminium content shall not exceed 0.020 percent for all thicknesses.
- Nitrogen content, shall not exceed 0.012 percent. This should be ensured by the manufacturer by occasional check analysis.
- Residual copper shall not exceed 0.10 percent.
- Whenever any alloying elements are added for achieving strength, maximum carbon equivalent shall not exceed 0.44 for steels used for welding.

Carbon equivalent (CE) based on ladle analysis:

$$CE = \frac{C + Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

7 HEAT TREATMENT

7.1 Unless specified otherwise, plates shall be supplied in normalized condition/controlled rolled condition.

7.2 Subject to agreement between the purchaser and the manufacturer, normalizing may be replaced with normalizing rolling process.

7.3 Plate in coiled form rolled under controlled rolling condition in a hot strip mill and straightened by levelling as plates up to 12 mm thickness are considered self normalized and accepted as-rolled condition.

8 FREEDOM FROM DEFECTS

8.1 The plates shall be rolled to the dimensions specified. The material shall be free from harmful defects. Scale pits and other minor surface defects may be removed by grinding. The depth of grinding being such that the thickness of the plate shall not go below the specified value at the spot where the dressing is done. The grinding shall be even and smooth and shall be widened enough to remove sharp ridges. Dressing with a hammer or welding of defective spots shall not be permitted.

8.2 Edge imperfection may be rectified subject to mutual agreement between the purchaser and the manufacturer.

8.2.1 Laminar type discontinuities, 25 mm and less in length and visible to the unaided eye on the edges of plate, as prepared for shipment by the manufacturer are acceptable and do not require exploration.

8.2.2 All larger discontinuities shall be explored to determine their depth and extent. Discontinuities shall be considered continuous when located in the same plate within 5 percent of the plate thickness and separated by a distance less than the length of the smaller of two adjacent discontinuities.

8.2.3 Repair by Welding

Repair welding shall be permitted only with the approval of the purchaser. Preparation for repair welding shall include inspection to assure complete removal of the defect. Repair if permitted shall be done as per IS 12457.

9 DIMENSIONS AND TOLERANCES

9.1 Unless otherwise agreed the dimensional tolerances for hot-rolled steel sheet shall be as given in IS/ISO 7452.

9.2 Unless otherwise agreed the restricted thickness tolerances shall be as given in IS/ISO 7452.

9.3 Rolling Mass

Permissible deviation from the theoretical mass shall comply to Table 2.

10 CALCULATION OF MASS

The mass of plate shall be calculated on the basis that steel weighs 7.85 g/cm³.

11 SELECTION OF TEST SAMPLES

11.1 For plates produced from plate mill, one test

sample shall be taken from corner of each plate as-rolled in transverse to the rolling direction.

11.2 For plates produced from coils one sample from each coil should be drawn. All the plates produced from the coil are acceptable if the sample meets the requirements of the specification. The size of the sample should be such that a retest specimen, if necessary, may be prepared from it.

12 TENSILE TEST

12.1 Test sample shall be selected as per 11.

12.2 The tensile strength, yield stress and percentage elongation, when determined in accordance with IS 1608, shall conform to the requirements specified in Table 3.

12.2.1 The rolled surfaces shall be retained on the two opposite faces of the test piece where practicable. If the test specimen has to be reduced in thickness for testing purposes, at least one surface should be as rolled. For plates over 20 mm in thickness, round specimens are permitted, where the axis of the specimen shall be located, as nearly as possible, midway between the centre of the thickness and top or bottom surface of the plate.

12.2.2 Should the test piece break outside the middle half of the gauge length and the percentage elongation is less than that specified, the test may be discarded at the option of the supplier and another test made from the same test sample.

12.3 Subject to mutual agreement between the

Table 2 Permissible Upper Deviation from the Theoretical Mass
(The Values Shown in the Table Apply to Consignments Weighing 25 tonne,
Up to but not Including 75 tonne)
(Clause 9.3)

Nominal Thickness mm		Permissible Upper Deviation from the Nominal Thickness mm	Permissible Upper Deviation from the Theoretical Weight in Percentage for Nominal Width mm				
From	Up to but not Including		From 600 Up to but not Including 2 000	From 2 000 Up to but not Including 2 500	From 2 500 Up to but not Including 3 000	From 3 000 Up to but not Including 3 500	From 3 500 Up to 4 000
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
5	8	1.1	7	7.5	8.5	9	—
8	15	1.2	6	6	6.5	7	7.5
15	25	1.3	4.5	4.5	5	5	5.5
25	40	1.4	3.5	3.5	4	4	4
40	80	1.8	3.5	3.5	4	4	4
80	150 including	2.2	3.5	3.5	3.5	3.5	3.5
Over 150		To be agreed between the supplier and the purchaser					

Table 3 Mechanical Properties

(Clause 12.2)

Grade Thickness	Tensile Strength MPa			Yield Stress MPa, Min					% Elongation on Gauge Length $5.65\sqrt{S_0}$, Min	
	60	60 to 100	100 to 350	≤ 16	>16 to 40	>40 to 60	>60 to 100	100 to 350	≤ 60	>60 to 350
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1	360-480	360-480	350-480	235	225	215	200	185	24	23
2	410-530	410-530	400-530	265	255	245	215	200	22	21
3	460-580	450-570	440-570	290	285	280	255	230	21	20

purchaser and the supplier, the supplier shall guarantee the required yield stress at any higher temperature (E_t).

12.3.1 The plate manufacturer should satisfy the boiler maker and his representative that the steel supplied is capable of meeting the value (E_t).

- By producing adequate record of test results on the type of steel concerned; and
- By showing that the steel supplied actually conforms to the requirements by ladle analysis and by a statement that, the manufacturing process has remained comparable; or In absence of data mentioned in (a) i) by proof stress test at the design temperature stated on the individual order.

NOTES

1 By special arrangement between the plate manufacturer and the boiler maker and/or his representative, proof stress test may be required for the individual order.

2 For all steels (Carbon):

- When the steel maker has collected a sufficient number of tests for application to a statistical definition of E_t on the grade of steel; E_t should be equal to the average value of the test results at temperature 't' less two standard deviation.
- When a sufficient number of test results are not available E_t should be taken as a minimum value guaranteed by the steel maker which should be checked at the time of acceptance. For carbon steels the value of the proof stress given by the ratio E_t/R_{20} (taken from Table 4) may be taken without verification at the time of acceptance.

13 BEND TEST

13.1 Test samples shall be selected as per 11.

13.2 The bend test shall be carried out in accordance with IS 1599.

13.2.1 The test piece shall be about 230 mm long and not less than 40 mm wide. The test piece, when cold, shall withstand without fracture being bent over through 180° either by pressure or by slow and steady blows from a hammer till the internal diameter is not greater than twice the thickness of the test piece in the

case of Grade 1 and Grade 2 plates and three times the thickness of the test piece in the case of Grade 3 plates.

13.2.2 During the test, the rolled surface shall be on the tension side.

14 HOMOGENEITY TEST (FOR GRADE 1 PLATE FOR FIRE BOXES ONLY)

14.1 The object of this test is to open and render visible to the eye any internal defect in the steel, like blow holes, inclusions, etc. The test shall be done at the rate of one test per cast.

14.2 One test piece 230 mm long and not less than 40 mm wide, shall be prepared as given under 13.2.1. For plates 20 mm and under in thickness, the test piece shall be nicked or grooved, about 1.5 mm deep, transversely in three places at 50 mm intervals starting at 50 mm from one end. The first and third grooves shall be on one face and the middle one on the opposite face. For plates over 20 mm in thickness, the grooves shall be about 3 mm deep. The test piece shall be broken at each groove by hammering or by pressing.

14.3 The fracture shall be clean and shall not show any seam, lamination, blow holes or inclusions more than 6 mm in length in the case of plates 20 mm and under in thickness and not more than 10 mm in length in the case of plates over 20 mm in thickness.

14.4 Three typical photographs (Fig. 1, 2 and 3) showing boiler plates of 10 mm thickness indicating acceptance and unacceptable limits are given below for guidance only.

15 ULTRASONIC TESTING (25 MM THICK AND ABOVE)

15.1 If agreed between the manufacturer and consumer, plates (25 mm thick and above) shall be tested for ultrasonic testing in accordance with IS 4225 for internal soundness.

15.2 Acceptance Standards

15.2.1 Any discontinuity indication causing a total loss

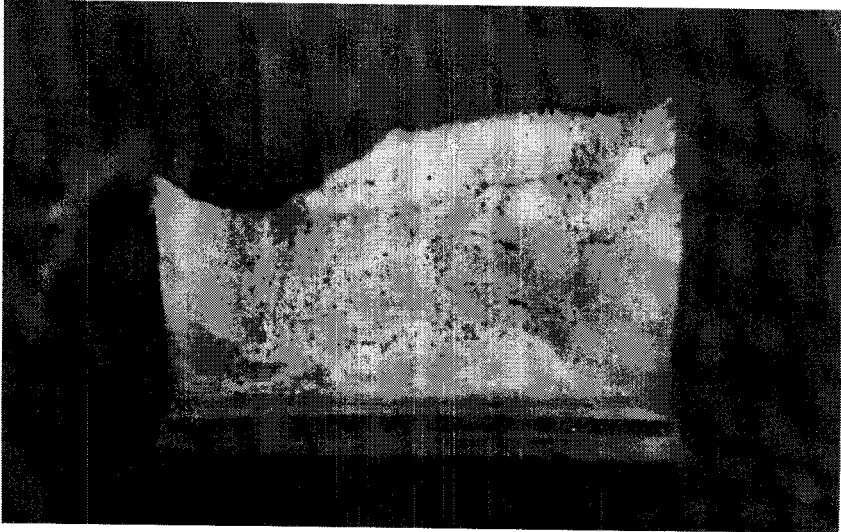


FIG. 1 PHOTOGRAPH OF 30 mm THICK PLATE SHOWING FRACTURE WITHOUT ANY DEFECT — ACCEPTABLE

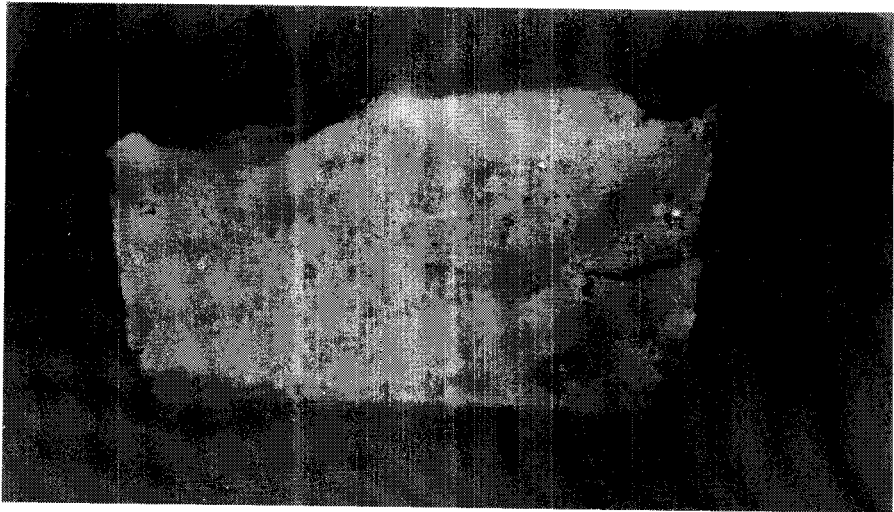


FIG. 2 PHOTOGRAPH OF 30 mm THICK PLATE SHOWING FRACTURE WITH PERMISSIBLE

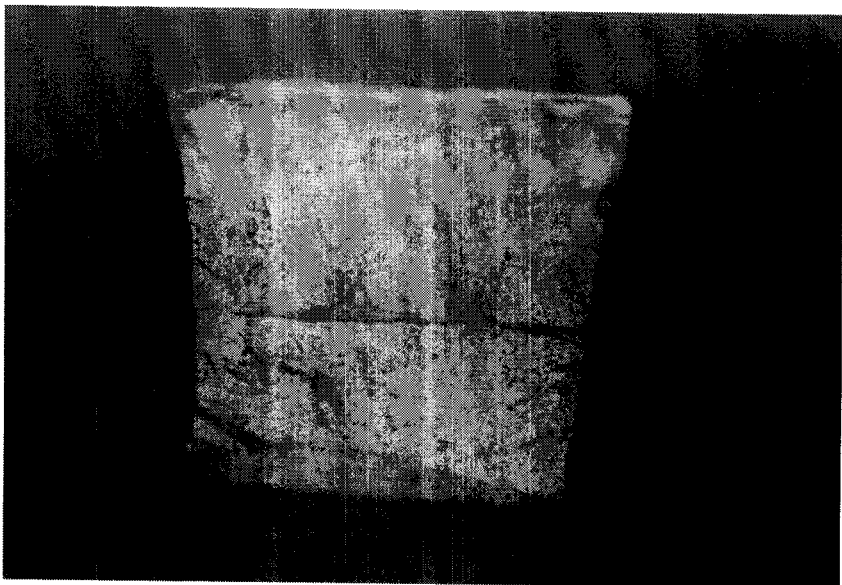


FIG. 3 PHOTOGRAPH OF 40 mm THICK PLATE SHOWING PRESENCE OF LAMINATION — NOT ACCEPTABLE

**Table 4 Minimum Values for the Ratio of the Stress at Proof Limit 0.2 Percent
at Elevated Temperature (E_t) to the Minimum Specified Tensile Strength
at Room Temperature (R) of Carbon Steel Boiler Plates**

[Clause 12.3.1 (Note 2)]

Temperature, °C	250 (see Note)	275	300	325	350	375	400	425
E_t/R_{20}	0.40	0.38	0.36	0.34	0.33	0.32	0.31	0.30
NOTE — For temperature lower than 300°C, any test required for acceptance purposes (in default of records of previous tests at these temperatures) should be made at 300°C in which case the proof stress should be not less than the value obtained by calculation from the specified minimum tensile strength.								

of back reflection which cannot be contained within a circle of, the diameter of which is 75 mm or one half of the plate thickness, whichever is greater is unacceptable.

15.2.2 Acceptable adjacent discontinuity indications shall be separated from each other by a distance equal to or larger than the larger of the adjacent discontinuity indications unless the adjacent defects can be contained in a circle of diameter equal to the acceptance standard for a single defect.

15.3 Supplementary Requirements

Supplementary requirements if any, will be specified in the purchase order.

16 OTHER TESTS

Any test other than those specified above, may be agreed upon at the time of inquiry and order.

17 RE-TESTS

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

18 RUST PROTECTION

If so desired by the purchaser, each plate shall be painted with one coat of boiled linseed oil or a suitable rust preventive material (as agreed to between the

supplier and the purchaser) after inspection and acceptance.

19 TOLERANCES ON DIMENSIONS AND SHAPE

Unless otherwise agreed the tolerances on dimensions and shape shall be as given in IS/ISO 7452.

20 MARKING

20.1 Every plate shall be legibly marked with the following:

- Manufacturer's name or trade-mark, if any;
- Cast number or identification mark by which the steel can be traced to the cast from which it was made and Plate number so that correlation with T.C. is possible; and
- Direction of final rolling.

20.2 BIS Certification Marking

The material may also be marked with the Standard Mark.

20.2.1 The use of the Standard Mark is governed by the provisions of the *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 the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards

ANNEX A

(Foreword)

COMMITTEE COMPOSITION

Wrought Steel Products Sectional Committee, MTD 4

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SAIL, Central Marketing Organization, Kolkata	SHRI P. C. JHA SHRI B. V. S. PANDIT (<i>Alternate</i>)
SAIL, Durgapur Steel Plant, Durgapur	SHRI A. KANAN
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Tata Motors Limited, Pune	SHRI B. R. GALGALI

<i>Organization</i>	<i>Representative(s)</i>
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Flat Steel Products Subcommittee, MTD 4 : 3

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Review of Indian Standards

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'.

This Indian Standard has been developed from Doc: No. MTD 4 (4733).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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Southern : C.I.T. Campus, IV Cross Road, CHENNAI 600 113	{ 2254 1216, 2254 1442 2254 2519, 2254 2315
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