

भारतीय मानक

दाब पात्र व बॉयलर के लिए मध्यवर्ती और उच्च तापमान  
सेवाओं के लिए इस्पात प्लेटें — विशिष्ट

( दूसरा पुनरीक्षण )

*Indian Standard*

**STEEL PLATES FOR PRESSURE VESSELS FOR  
INTERMEDIATE AND HIGH TEMPERATURE  
SERVICE INCLUDING BOILERS —  
SPECIFICATION**

**( *Second Revision* )**

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

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Price Group 3

## FOREWORD

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

This standard was first published in 1962 and revised in 1982.

In the present revision assistance has been drawn from German Standard DIN 17155 : 1983 'Creep resistance steel plate and strip; technical delivery conditions'.

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

# Indian Standard

## STEEL PLATES FOR PRESSURE VESSELS FOR INTERMEDIATE AND HIGH TEMPERATURE SERVICE INCLUDING BOILERS — SPECIFICATION

( *Second Revision* )

### 1 SCOPE

This standard covers three grades of plain carbon steel plates 5 mm thick and above, intended for use in pressure vessels for intermediate and high temperature service which include boilers.

- 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 steel plates which can be used for welding, flame cutting, and flanging in the hot condition; and
- c) Grade 3 — High tensile steel plates which can be used for welding, flame cutting, and hot flanging under controlled conditions.

### 2 REFERENCES

2.1 The following Indian Standards are necessary adjuncts to this standard.

IS No.	Title
228 : 1966	Methods for chemical analysis of steel
1599 : 1985	Method for bend test ( <i>second revision</i> )
1608 : 1972	Method for tensile testing of steel products ( <i>first revision</i> )
4225 : 1979	Recommended practice for straight beam ultrasonic testing of steel plates ( <i>first revision</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 to steel plates and wide flats.

### 3 TERMINOLOGY

3.0 For the purpose of this standard, the following definition shall apply.

#### 3.1 Plates 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.

### 4 GENERAL REQUIREMENTS

General requirements relating to the supply of steel plates for pressure vessels shall conform to IS 8910 : 1978.

### 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. An austenitic grain size of 2 to 5 as determined by the carburizing method specified in IS 2853 : 1964 is recommended.

### 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:

Constituent	Variation Over the Specified Maximum or Under the Minimum Limits Percent
Carbon	0.03
Silicon	0.03
Sulphur	0.005
Phosphorous	0.005
Manganese	0.05

NOTE — Variation shall not be applicable both over and under the specified limits in several determinations in a heat.

### 7 HEAT TREATMENT

Unless specified otherwise, plates above 12 mm thickness shall be supplied in the normalized condition.

Table 1 Chemical Composition

Grade	Carbon, Percent Max	Manganese Percent	Silicon Percent	Sulphur, Percent Max	Phosphorus, Percent Max
(1)	(2)	(3)	(4)	(5)	(6)
1	0.18	0.50—1.20	0.15—0.35	0.040	0.035
2	0.20	0.50—1.20	0.15—0.35	0.040	0.035
3	0.22	0.50—1.20	0.15—0.35	0.040	0.035

NOTES

- 1 Carbon content over the maximum specified shall be increased by:  
For plates over 25 mm up to and including 65 mm thick—0.02 %, *Max*  
For plates over 65 mm thick—0.04 %, *Max*
- 2 Aluminium content shall not exceed:  
For plates up to 150 mm thick—0.020%  
For plates over 150 mm thick—0.035%
- 3 Nitrogen content, shall not exceed 0.012%. This should be ensured by the manufacture by occasional check analysis.
- 4 Residual copper shall not exceed 0.10 percent
- 5 Whenever any alloying elements are added for achieving strength, maximum carbon equivalent shall not exceed 0.44 for steels to be used for welding.

Carbon Equivalent ( CE ) based on ladle analysis

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

8 FREEDOM FROM DEFECTS

8.1 Plates shall be cleanly 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 or defective spots shall not be permitted.

8.2 Edge imperfect 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 a 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 plane 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 is permitted shall be done as per IS 12457 : 1988.

Table 2 Permissible Deviations from the Nominal Thickness and Permissible Difference in Thickness of the Same Plate  
( Clause 9.1 )

Nominal Thickness mm		Permissible Deviation from the Nominal Thickness mm	Permissible Differences Between the Smallest and Largest Thickness of the Same Plate for Nominal Widths mm				
From	Up to but not including	Usual lower deviation from the nominal thickness	From 600 up to but not in- cluding 2 000	From 2 000 up to but not in- cluding 2 500	From 2 500 up to but not in- cluding 3 000	From 3 000 up to but not in- cluding 3 500	From 3 500 up to 4 000
5	8	+ 1.1 — 0.4	0.9	0.9	1.0	1.0	—
8	15	+ 1.2 — 0.5	0.9	1.0	1.0	1.1	1.1
15	25	+ 1.3 — 0.6	1.0	1.1	1.2	1.2	1.3
25	40	+ 1.4 — 0.8	1.1	1.2	1.2	1.3	1.3
40	80	+ 1.8 — 1.0	1.2	1.3	1.4	1.4	1.5
80	150	+ 2.2 — 1.0	1.3	1.4	1.5	1.5	1.6
Above	150						

To be agreed between supplier and purchaser

## 9 TOLERANCES

### 9.1 Thickness

The tolerance on thickness shall comply to Table 2.

### 9.2 Width

The tolerance on width shall comply to Table 3.

### 9.3 Length

The tolerance on length shall comply to Table 4.

### 9.4 Flatness

The permissible deviation from flatness for any 2 000 mm of length shall not exceed the limits given in Table 5.

**Table 3 Permissible Upper Deviation from the Nominal Width in Case of Plate with Cut Edges**  
( Clause 9.2 )

Nominal Width ( mm )		Permissible Deviation Over the Nominal Width mm
From	Up to but not including	
(1)	(2)	(3)
600	2 000	20
2 000	3 000	25
3 000	4 000	30
	included	

**Table 4 Permissible Upper Deviation from the Nominal Length**  
( Clause 9.3 )

Nominal Length, mm		Permissible Upper Deviation from the Nominal Length mm
From	Up to but not Including	
(1)	(2)	(3)
—	4 000	20
4 000	6 000	30
6 000	8 000	40
8 000	10 000	50
10 000	15 000	75
15 000	25 000	100
	( including )	

**Table 6 Permissible Upper Deviation from the Theoretical Mass ( The values shown in the table below apply to consignments weighing 25 tons, up to but not including 75 tons )**  
( Clause 9.6 )

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 includ- ing 2 000	From 2 000 up to but not includ- ing 2 500	From 2 500 up to but not includ- ing 3 000	From 3 000 but not includ- ing 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	2.2	3.5	3.5	3.5	3.5	3.5
	including						
Over 150							

To be agreed between supplier and purchaser.

**Table 5 Permissible Deviations from Flatness**  
( Clause 9.4 )

Nominal Thickness, mm		Deviation mm
From	Up to but not Including	
(1)	(2)	(3)
5	8	12
8	15	11
15	25	10
25	40	9
40	150	8
	including	

9.4.1 For the test of deviations from flatness, the plates shall be laid on a flat horizontal surface. They shall rest freely thereon and be subjected only to their own weight. The deviation from flatness is deemed to be the maximum distance between the plate and a straight edge 2 000 mm long, which can be laid in any desired direction. Only that part between two points of contact between the plate and the straight edge may be taken into consideration. The deviations from flatness shall be measured at a distance of at least 25 mm from the longitudinal edges and at least 200 mm from the ends of the plate.

### 9.5 Rolling Mass

Permissible deviation from the theoretical mass shall comply to Table 6.

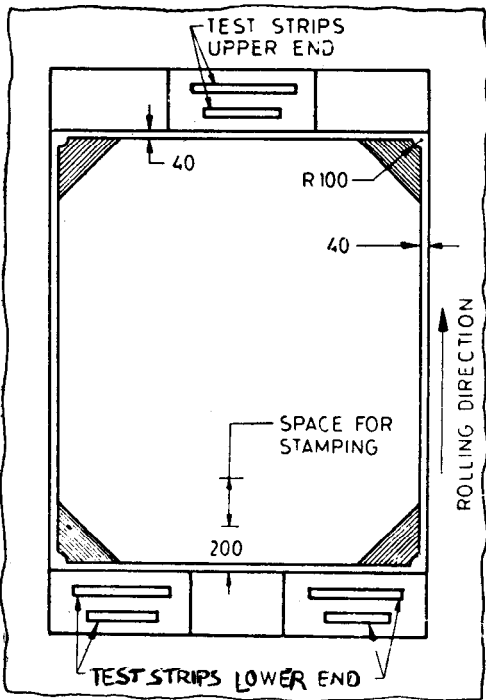
## 10 CALCULATION OF MASS

The mass of plate shall be calculated on the basis that steel weighs 7.85 g/cm<sup>3</sup>.

## 11 SELECTION OF TEST SAMPLES

11.1 Test samples of the required size shall be cut transverse to the rolling direction, from the center of the top end of each rolled plate ( see Fig. 1 ).

11.2 The size of the test sample should be such that a retest specimen, if necessary, may be prepared from it.



All dimensions in millimetres.  
FIG. 1 POSITION OF TEST STRIPS IN ROLLED PLATES

- 11.3 Test samples shall not be removed from the plates except with the approval of the purchaser or his authorised representatives.
- 11.4 Before the test samples are parted from the plates, full particulars regarding cast number, size, mass and the mass rolled from each cast shall be furnished by the supplier to the purchaser.
- 11.5 The test samples shall not be annealed or otherwise subjected to any further heat treatment. The samples should be parted from the plates only after heat treatment of the plate, if any.
- 11.6 Any straightening of the test sample, which may be required shall be done cold.
- 11.7 The cut edges of the test bars shall be so finished that any possible influence on the properties of the material, due to the cutting

process, is satisfactorily removed. All rough edges shall be smoothened out by suitable means. The rolled surface of the material should be maintained on the test bar.

11.8 In case of a plate not exceeding 7 meters in length one sample shall be taken from one end of each rolled plates. In case of a plate exceeding 7 meters in length, one sample shall be taken from both ends of each plate.

12 TENSILE TEST

12.1 Test sample shall be selected as per clause 11.

12.2 The tensile stress, yield stress and percentage elongation, when determined in accordance with IS 1608 : 1972, shall conform to the requirements specified in Table 7.

12.2.1 The rolled surfaces shall be retained on the two opposite faces of the test piece where practicable. If the test piece has to be reduced in thickness for testing purposes, at least one surface should be as rolled.

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 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 ( $E_t$ ).

- a) i) By producing adequate record of test results on the type of steel concerned; and
- ii) By showing that the steel supplied actually conforms to the requirements, by ladle analysis and by a statement that, the manufacturing processes has remained comparable; or

Table 7 Mechanical Properties  
( Clause 12.2 )

Grade	Tensile Strength MPa			Yield Stress MPa, Min					% Elongation on 5.65/So Gauge Length, Min	
Thickness	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 to 480	360 to 480	350 to 480	235	225	215	200	185	24	23
2	410 to 530	410 to 530	400 to 530	265	255	245	215	200	22	21
3	460 to 580	450 to 570	440 to 570	290	285	280	255	230	21	20

- b) 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 ):

- a) 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;
- b) 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 8 ) may be taken without verification at the time of acceptance.

### 13 BEND TEST

13.1 Test samples shall be selected as per clause 11.

13.2 The bend test shall be carried out in accordance with IS 1599 : 1985.

13.2.1 The test pieces 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  $180^\circ$ , 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. 2, 3 and 4 ) 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 : 1979 for internal soundness.

#### 15.2 Acceptance Standards

15.2.1 Any discontinuity indication causing a total loss of back reflection which cannot be contained within a circle, 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

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

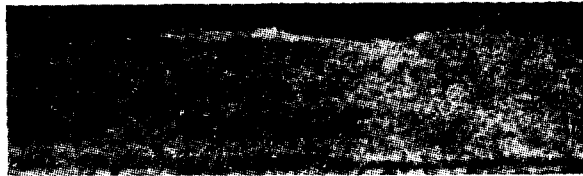
### 17 RE-TESTS

17.1 Should any one of the test pieces, first selected, fail to pass any of the tests specified in this standard, two further samples shall be

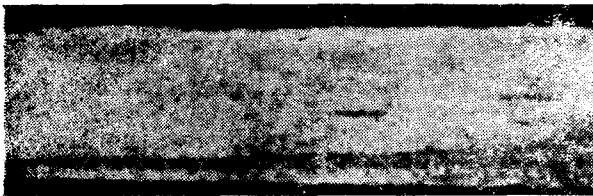
**Table 8 Minimum Values for the Ratio of the Stress at Proof Limit 0.2 Per cent at Elevated Temperature (  $E_t$  ) to the Minimum Specified Tensile Strength at Room Temperature (  $R$  ) of Carbon Steel Boiler Plates**  
[ Clause 12.3.1 ( Note 2 ) ]

Temperature	250°C	275°C	300°C	325°C	350°C	375°C	400°C	425°C
	( See Note )							
$E_t/R_{20}$	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.



**FIG. 2 PHOTOGRAPH SHOWING FINE GRAINED FRACTURE WITHOUT ANY DEFECT — ACCEPTABLE. MAGNIFICATION 2 X**



**FIG. 3 PHOTOGRAPH SHOWING FINE GRAINED FRACTURE WITH PERMISSIBLE DEFECT — ACCEPTABLE. MAGNIFICATION 2 X**

selected for testing in respect of each failure. If the test pieces prepared from both the additional samples comply with the requirements of the test, the material represented by the samples, shall be deemed to comply with the requirements of that particular test. If the test piece from either of the samples fails in test, the material represented by the test samples shall be liable for rejection.

### **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.



**FIG. 4 PHOTOGRAPH SHOWING PRESENCE OF LAMINATION — NOT ACCEPTABLE. MAGNIFICATION 2 X**

### **19 MARKING**

**19.1** Every plate shall be legibly marked with

- a) Manufacturer's name or trade-mark, if any
- b) 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
- c) The direction of final rolling.

**19.2** The material may also be marked with the Standard Mark.



### **Standard Mark**

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 Standard 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. Standard 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 Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

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### Revision of Indian Standards

Indian Standards are reviewed periodically and revised, when necessary and amendments, if any, are issued from time to time. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition. Comments on this Indian Standard may be sent to BIS giving the following reference:

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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 : 331 01 31, 331 13 75

Telegrams : Manaksanstha  
( Common to all Offices )

### Regional Offices :

Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg  
NEW DELHI 110002

Telephone  
{ 331 01 31  
{ 331 13 75

Eastern : 1/14 C. I. T. Scheme VII M, V. I. P. Road, Maniktola  
CALCUTTA 700054

{ 37 84 99, 37 85 61  
{ 37 86 26, 37 86 62

Northern : SCO 445-446, Sector 35-C, CHANDIGARH 160036

{ 53 38 43, 53 16 40  
{ 53 23 84

Southern : C. I. T. Campus, IV Cross Road, MADRAS 600113

{ 235 02 16, 235 04 42,  
{ 235 15 19, 235 23 15

Western : Manakalaya, E9 MIDC, Marol, Andheri ( East )  
BOMBAY 400093

{ 632 92 95, 632 78 58,  
{ 632 78 91, 632 78 92

Branches : AHMADABAD, BANGALORE, BHOPAL, BHUBANESHWAR, COIMBATORE  
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**AMENDMENT NO. 1 DECEMBER 1993**  
**TO**  
**IS 2002 : 1992 STEEL PLATES FOR PRESSURE VESSELS**  
**FOR INTERMEDIATE AND HIGH TEMPERATURE**  
**SERVICE INCLUDING BOILERS — SPECIFICATION**

*( Second Revision )*

[ *Page 1, clause 1 (b) Grade 2* ] — Substitute the following for the existing sentence:

*'b) Grade 2 — Medium tensile steel plates which can be used for welding, flanging and flame cutting.'*

( *Page 2, Table 1, Note 2, line 1* ) — Substitute the word 'Total aluminium' for 'Aluminium'.

( *Page 2, Table 1, Note 2, line 2* ) — Substitute '0.022 %' for '0.020 %'.

( *Page 2, clause 8.2, line 1* ) — Substitute the word 'imperfection' for 'imperfect'.

**AMENDMENT NO. 2 OCTOBER 1997**  
**TO**  
**IS 2002 : 1992 STEEL PLATES FOR PRESSURE**  
**VESSELS FOR INTERMEDIATE AND HIGH**  
**TEMPERATURE SERVICE INCLUDING BOILERS —**  
**SPECIFICATION**

*( Second Revision )*

( *Page 1, clause 2.1* ) — Substitute '1608 : 1995 Mechanical testing of metals — Tensile testing ( *second revision* )' for '1608 : 1972 Method for tensile testing of steel products ( *first revision* )'.

( *Page 1, clause 3.1* ) — Insert the following at the end of para:

'Plates produced from coil means the plates which have been levelled or flattened and cut-to-length.'

( *Page 4, clause 12.2, line 3* ) — Substitute 'IS 1608 : 1995' for 'IS 1608 : 1972'.

( MTD 4 )

**AMENDMENT NO. 3 JUNE 2001  
TO  
IS 2002 : 1992 STEEL PLATES FOR PRESSURE  
VESSELS FOR INTERMEDIATE AND HIGH  
TEMPERATURE SERVICE INCLUDING BOILERS —  
SPECIFICATION  
( *Second Revision* )**

*( Page 4, clause 11.8 ) — Delete.*

( MTD 4 )

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Reprography Unit, BIS, New Delhi, India

**AMENDMENT NO. 4 NOVEMBER 2002  
TO  
IS 2002 : 1992 STEEL PLATES FOR PRESSURE  
VESSELS FOR INTERMEDIATE AND HIGH  
TEMPERATURE SERVICE INCLUDING BOILERS —  
SPECIFICATION**

**( *Second Revision* )**

**( *Foreword* )** — Insert the following before last para:

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

**( MTD 4 )**

Reprography Unit, BIS, New Delhi, India