भारतीय मानक

Indian Standard

IS 18755 : 2024

बर्तनों और रसोई उपकरणों के निर्माण के लिए उपयोग की जाने वाली ट्राई-प्लाई (SS-AL-SS) सामग्री — विशिष्टि

Tri-Ply (SS-AL-SS) Material Used for Manufacture of Utensils and Kitchen Appliances — Specification

ICS 77.140.20; 77.150.10

भारतीय मानक ब्यूरो
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July 2024 **Price Group 7**

Alloy Steels and Forging Sectional Committee, MTD 16

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Alloy Steels and Forging Sectional Committee had been approved by the Metallurgical Engineering Division Council.

Clad sheets consist of layers of dissimilar metals that are laminated together, each with its unique properties that provide benefits not found in traditional metals. While multiple metal layers are used in clad sheets, the primary combination utilized is stainless steel and aluminium. Structural integrity is a vital aspect of the cladding's performance, as it is essential for the subsequent drawing operation and final application.

Tri-Ply cladded sheet metal of stainless steels with aluminium in core is used widely for the manufacture of Tri-Ply full body cookware and Tri-Ply full body pressure cookers. It is made by cladding a sheet of aluminium of grade 19000/19500/31000 is laminated between stainless steel 302/304 on one side and induction compatible stainless steel 430/439 on the other side.

With the constant requirement of greater, stringent, and varied requirements for energy efficient materials for cookware and having superior corrosion resistance and enthusiasm to identify, summarize and create a new standard on such products culminated in development of standard on Tri-Ply materials used for utensils.

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.

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

For the purpose of 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 : 2022 ‘Rules for rounding off numerical values (*second revision*)’. 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

TRI-PLY (SS-AL-SS) MATERIAL USED FOR MANUFACTURE OF UTENSILS AND KITCHEN APPLIANCES — SPECIFICATION

1 SCOPE

This standard covers the requirements of Tri-Ply (SS-AL-SS) material supplied in the form of sheets, strips and circles for the manufacture of utensils and kitchen appliances.

2 REFERENCES

The standards given below 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 agreement based on this standard are encouraged to investigate and possibility of applying the most recent edition of these standards:

IS No.	*Title*
IS 737 : 2008	Wrought aluminium and aluminium alloy sheet and strip for general engineering purposes — Specification (*fourth revision*)
IS 1608 (Part 1) : 2022/ISO 6892-1 : 2019	Metallic materials — Tensile testing: Part 1 Method of test at room temperature (*fifth revision*)
IS 1956 Part 4 : 2013	Glossary of terms relating to iron and steel: Part 4 Flat products (*second revision*)
IS 5522 : 2014	Stainless steel sheets and strips for utensils — Specification (*third revision*)
IS 6911 : 2017	Stainless steel plate, sheet and strip — Specification (*second revision*)
IS 8910 : 2022/ ISO 404 : 2013	Steel and steel products — General technical delivery requirement (*second revision*)

3 TERMINOLOGY

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

3.1 Tri-Ply (SS-AL-SS) — Cladded dissimilar metals, bonded integrally and continuously, comprising three layers with aluminium matrix laminated on both the surfaces with stainless steel suitable for food processing environment on top layer and for induction heating on bottom layer.

NOTE — For the purpose of this standard, the Tri-Ply material consists of three layers with aluminium matrix of grade 19000/19500/31000 is laminated on one surface with stainless steel grade 302/304 and stainless steel grade 430/439 on the other, formed by rolling method, often termed as roll bonding, and supplied in the form of sheets, strips and circles for manufacture of kitchen appliances/utensils/cookware.

3.2 T-Peel Strength — The average load per unit width of bond line required to produce progressive separation of two bonded metals under conditions designated in the test method given in this standard.

3.3 Lot — Tri-Ply material manufactured out of individual layers of same batch shall constitute a lot.

4 SUPPLY OF MATERIAL AND DESIGNATION

4.1 General requirements relating to the supply of material shall conform to IS 8910.

4.2 Designation of the product shall comprise the following sequence:

a) Number of ply(s) along with the term ply separated by hyphen; and

b) Numerical symbol of stainless steel (top surface) along with thickness in mm/aluminium grade designation along with thickness in mm/numerical symbol of stainless steel (bottom surface) along with thickness in mm.

Example:

3-Ply 304(0.4)/19500(1.5)/430(0.6)

5 MANUFACTURER

5.1 Unless otherwise agreed, the 3-layer cladded metal with aluminium matrix are produced by rolling under high pressure to form integrally and continuous metallurgical bonding. The process of production may consist of heating the coils in-line,

and then immediately joining them by the rolling method.

5.2 The edges shall be finished such that there is no sharp edges or burrs.

6 CHEMICAL COMPOSITION

The sheets of aluminium for use as matrix of the cladded material shall conform to any of the grade 19000, 19500, 31000 as per IS 737. The stainless steel used for cladding to the top-surface of the aluminium matrix shall conform to the grade 302/304 as per IS 5522 and used for cladding to the bottom-surface of the aluminium matrix shall conform to of grade 430/439 as per IS 6911.

7 MECHANICAL PROPERTIES

7.1 Tensile Requirements

7.1.1 The tensile properties shall be determined by a tension test of the composite material as per IS 1608 (Part 1) and shall meet the requirements given below:

Sl No.	*Designation*	*Apparent Yield Strength Mpa, Min*	*Tensile Strength Mpa, Min*
(1)	(2)	(3)	(4)
i)	304(0.4)/19500 (1.5)/430(0.6)	207.9	252.7
ii)	304(0.4)/19500 (2.0)/430(0.6)	160.2	201.9
iii)	304(0.4)/19500 (2.5)/430(0.6)	122.3	180.6

NOTES

1 For other thicknesses, the requirement shall be as agreed to between the manufacturer and the purchaser, however for thickness lying in between the specified values, the limit for tensile requirements of immediate specified higher thickness is applicable.

2 For grade 302 and 439 of stainless steel and grade 19000/31000, the requirement shall be as agreed to between the manufacturer and the purchaser, however not less than the values specified in the above table for a given thickness.

7.1.2 *Test Specimen*

Dimensions of the specimen shall be as shown in Fig. 1. The gauge length (GL) and width of the gauge length portion shall be 50 mm and 12.5 mm respectively.

7.1.3 *Test Parameters*

To determine yield properties the crosshead speed of tensile testing machine shall be between the range 0.75 mm/min to 7.5 mm/min and to determine tensile strength the crosshead speed shall be between the range 2.5 mm/min to 25 mm/min. However, the recommended speeds to determine tensile properties are given in Table 1. The apparent yield strength shall be calculated using 0.2 percent offset method.

7.2 T-Peel Strength

7.2.1 Bond strength of Tri-Ply material, for both the interfaces with aluminium matrix and stainless steel, shall be determined as given in **7.2.2** to **7.2.4**, using T-peel configuration of interface(s) of the composite material, and shall meet the requirements given below:

7.2.2 *Sample Preparation and Test Specimen*

a) Samples of dimensions 25 mm width and 180mm length to be prepared by milling. Initially, one end (~ 40 mm) of the specimens to be dipped into 5.5 N NaOH solution for 8 h to dissolve the aluminum layer. After dissolving the aluminum layer, the top layer of stainless steel, involving grade SS 304, is to be peeled off till 100 mm from the open end to prepare the specimen of dimensions as given in Fig. 2.

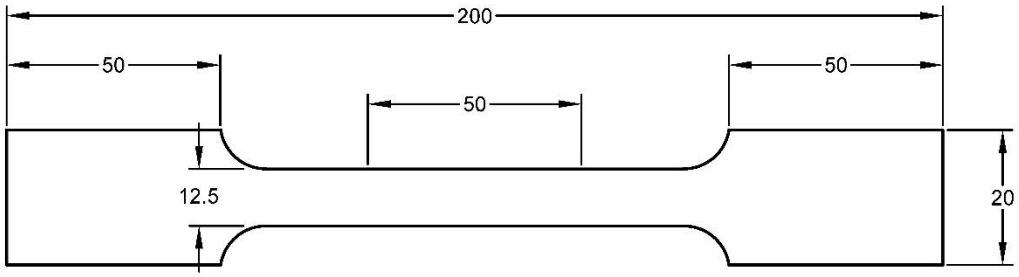
b) Similar procedure is to be repeated for preparing specimen for bond strength of bottom layer of stainless steel, involving grade SS 430, to get the specimen of dimensions shown in Fig. 2.

7.2.3 *Test Apparatus*

Tension testing machine shall be capable of applying a tensile load and equipped with suitable grips capable of clamping the specimens firmly and without slippage throughout the tests. The machine shall be autographic, giving a chart that can be read in terms of separation as one coordinate and applied load as the other coordinate.

7.2.4 *Procedure*

Place the specimen in the testing machine by clamping the unbonded stainless steel in upper grip. Place the other end involving bonded aluminium matrix and stainless steel in the lower grip. Apply the load at a constant head speed of 254 mm/min.During the peel test make an automatic recording of load versus distance peeled. The peel arm positions during the test shall be as shown in Fig. 4A and Fig. 4B.



All dimensions in millimetres.

FIG. 1 TENSILE TEST SPECIMEN OF TRI-PLY (CLAD) WITH GL AND GRIP MARKING

Table 1 Test Parameters for Tensile Test

(*Clause* 7.1.3)

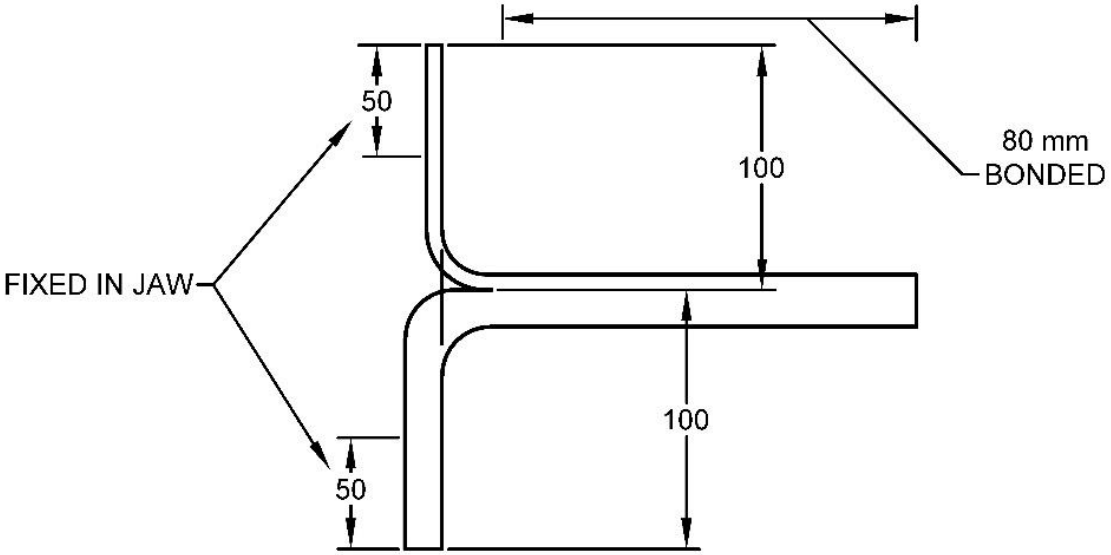
Sl No.	**Parameters**	**Yield Properties (Displacement: 0 mm to 5 mm)**	**Tensile Strength (Displacement: 5 mm to failure)**
(1)	(2)	(3)	(4)
i)	Crosshead speed	2 mm/min	10 mm/min

Table 2 T-Peel Strength Limits of Interfaces in Tri-Ply Material

(*Clause* 8.3)

Sl No.	**Designation**	**T-Peel Strength**, N/mm, *Min*	
		SS304 and Al 19500 interface	SS430 and Al 19500 interface
(1)	(2)	(3)	(4)
i)	304(0.4)/19500(1.5)/430(0.6)	13.2	12.0
ii)	304(0.4)/19500(2.0)/430(0.6)	13.7	15.0
iii)	304(0.4)/19500(2.5)/430(0.6)	20.2	17.3

NOTE — For Tri-Ply material comprising grade 302/439 of stainless steel and/or grade 19000/31000 of aluminium, the requirement shall be as agreed to between the manufacturer and the purchaser. However, not less than the values specified in the above table for a given thickness.



All dimensions in millimetres.

FIG. 2 T-PEEL TEST CONFIGURATION

NOTE — In case of difficulty in peeling SS 430 and aluminium interface, a slanted pre-crack at the interface can be introduced with the help of a sharp chisel as shown in Fig. 3.

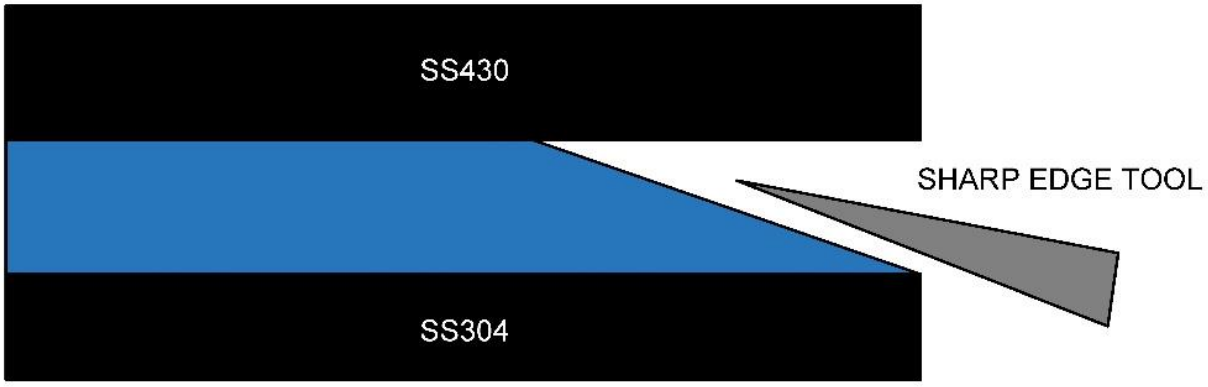


FIG. 3 PRE-CRACK FOR SS430 AND ALUMINIUM INTERFACE PEEL TEST

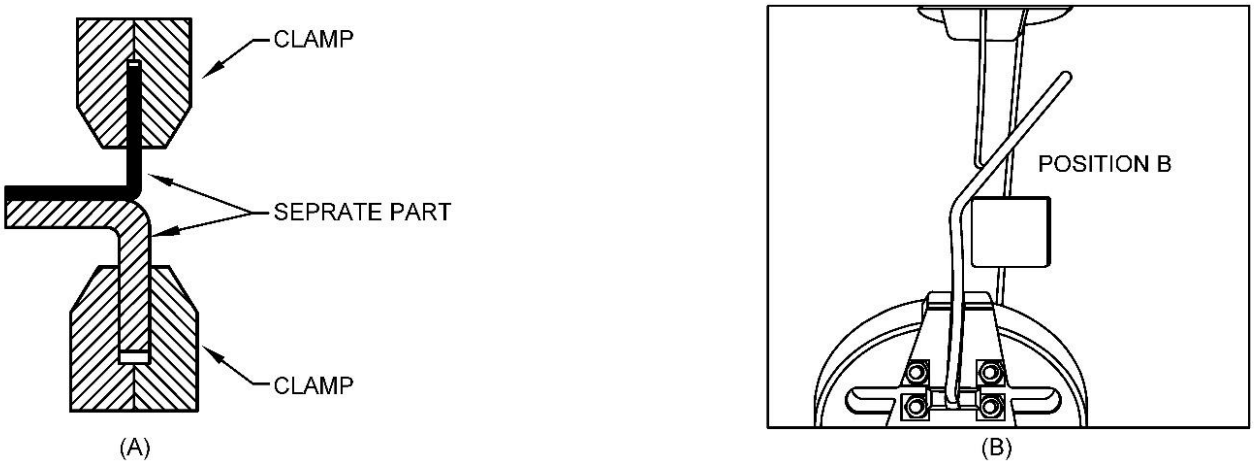


FIG. 4 (A AND B) SPECIMEN AT DIFFERENT STAGES THE TEST

(T-PEEL WITH EXTRA UNBONDED PORTION)

Determine the T-Peel strength of the interface on the basis of the average peel force per unit width, as shown in Fig. 5.

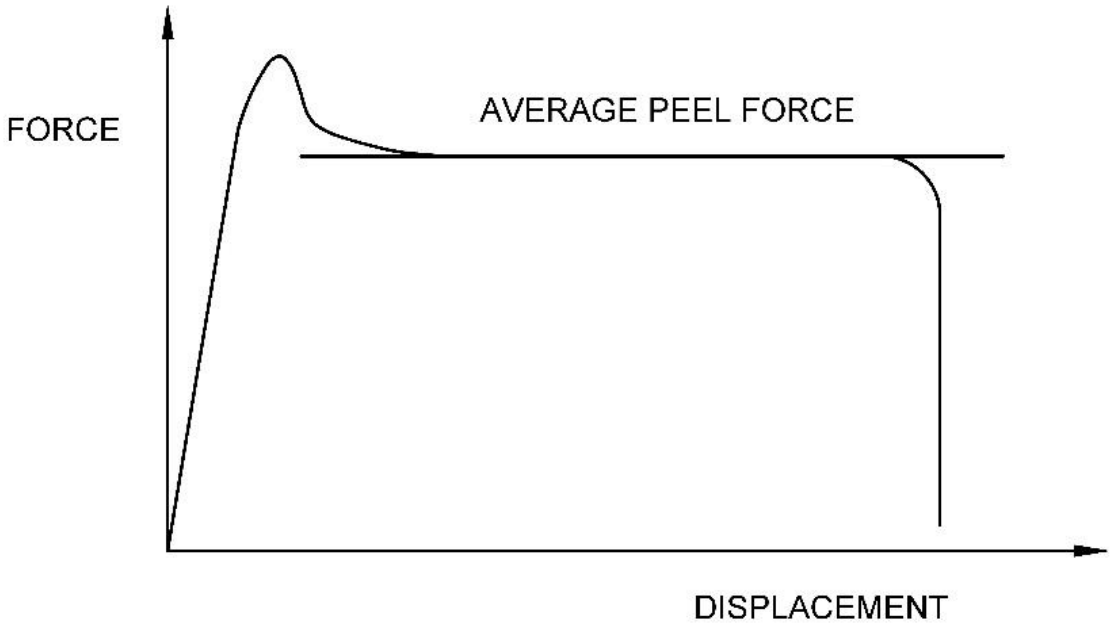


FIG. 5 T-PEEL TEST CURVE

8 THERMAL ADHESION CHARACTERISTICS

Thermal cycling involve subjecting the material to alternating cycles of heating and cooling, as these temperature fluctuations can lead to differential expansion and contraction among the dissimilar metal layers within the Tri-Ply-clad material, thus impacting the bond between the interfaces of different materials and susceptible to delamination.

8.1 Sample of suitable size shall be subjected to 50 cycles of heating to 260 ºC and quenching in water.

8.2 From this sample, specimen for peel strength shall be prepared and tested as per **7.2**.

8.3 The requirements of Table 2 shall be met.

NOTE — Hold (soak) the sample for 2 min at 260 ºC under heating condition and subsequent quenching in ambient temperature water.

9 DIMENSIONS AND TOLERANCES

9.1 Thickness

Thickness of Tri-Ply sheets/strips/circles shall be as given below:

Sl No.	*Tri-Ply thickness, t* mm	*Top Layer Thickness,* t_1 mm (SS 304/ 302)	*Midlayer/ Matrix Thickness,* t_2 mm (Al 19000/ 19500/31000)	*Bottom layer Thickness* t_3 mm (SS 430/ 439)
(1)	(2)	(3)	(4)	(5)
i)	2.5		1.5	
ii)	3.0	0.4	2.0	0.6
iii)	4.0		3.0	

$$t = t_1 + t_2 + t_3$$

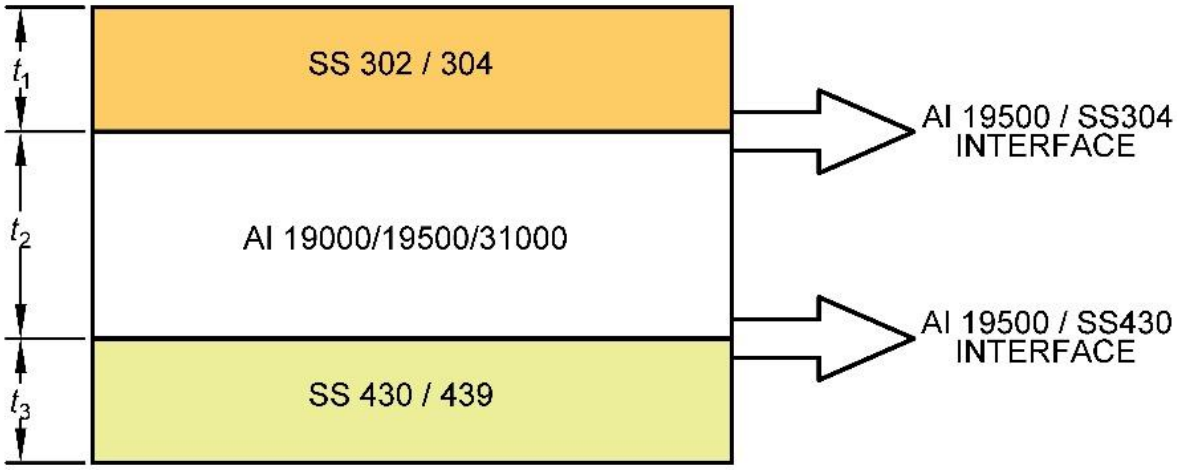


FIG. 6 TRI-PLY MATERIAL

NOTE — Material may be supplied in other thicknesses as agreed to between the manufacturer and the purchaser.

9.1.1 The tolerance on total thickness shall be ± 0.15 mm.

9.2 Diameter

In case of circles, the diameter shall be as mutually agreed upon between the manufacturer and the purchaser. The tolerances on the diameter of Tri-Ply circle shall be ± 1 mm.

9.3 Flatness

Flatness of the Tri-Ply material shall be as mutually agreed upon between the buyer and the manufacturer.

10 SURFACE FINISH

Unless otherwise surface finish of the Tri-Ply material shall be as given in IS 5522.

11 WORKMANSHIP, FINISH, AND APPEARANCE

11.1 The product surfaces shall be free of excess imperfections and extraneous materials as determined by visual examination.

11.2 The material shall be free of injurious defects and shall have a workman like appearance.

12 SAMPLING

12.1 At least one specimen from each lot shall be subjected to tests specified in the standard.

12.2 Sample size for tests on surface finish, dimensions, and workmanship shall be as agreed to between the purchaser and the manufacturer.

13 PACKAGING

Material with suitable packing shall be provided to prevent damages and deterioration in quality during storage, handling and transport. The exact method of packing and weight of each packet shall be mutually agreed to between the purchaser and the supplier.

14 MARKING

14.1 The following shall be legibly and indelibly marked on the top of each coil or package of sheets, strips or circles or shown on a tag attached to each coil or package of sheets, strips or circles:

a) IS No. of this standard;

b) Manufacturer’s name or trademark;

c) Material identification/coil number/packet number/batch number, etc;

d) Product dimensions;

e) Number of sheets or mass;

f) Designation (*see* 4); and

g) Date of manufacture.

14.2 BIS Certification Marking

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations framed there under, and the products may be marked with the Standard Mark.

ANNEX A

(*Foreword*)

COMMITTEE COMPOSITION

Alloy Steels and Forging Sectional Committee, MTD 16

Organization	*Representative(s)*
Mishra Dhatu Nigam Limited, Hyderabad	SHRI T. MUTHUKUMAR **(*Chairperson*)**
All Indian Stainless Steel Industries Association, Mumbai	SHRI HITENDERA BHALARIA SHRI ANIL AGRAWAL (*Alternate*)
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Directorate General Quality Assurance, New Delhi	SHRI L. P. VARTE SHRI BIKAS MANDAL (*Alternate*)
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Indian Stainless Steel Development Association, Gurugram	SHRI ROHIT KUMAR
Indira Gandhi Centre for Atomic Research, Kalpakkam	SHRI UTPAL BORAH
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Ministry of Steel, New Delhi	SHRI PARMJEET SINGH SHRI B. PRADHAN (*Alternate*)
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Panel for Formulation of Standards on SS/Al based Tri-Ply Material for Utensils, MTD 16/P2

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Indian Stainless Steel Development Association, Gurugram	SHRI ROHIT KUMAR **(*Convener*)**
All Indian Stainless Industries Association, Mumbai	SHRI ASHWIN VORA
Autopress India Private Limited, Pune	SHRI RAJIV AGARWAL SHRI DHRUV AGARWAL (*Alternate*)
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Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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