





**GOVERNMENT OF INDIA
(Ministry of Railways)**

**SPECIFICATION FOR
SPINEL BASED REFRACTORY
BRICKS FOR WORKING LAYER AND
ALUMINA REFRACTORY BRICKS
FOR SAFETY LAYER OF LADLE
LINING**

Issued by

**MECHANICAL DRAWING OFFICE
RAIL WHEEL FACTORY
YELAHANKA, BANGALORE-560 064
INDIA**

 24/4/13	 24/4/2013	 24/4/13	
CME	CWE/W	Dy. CME/Mfg.	SSE/D
APPROVED	REVIEWED	VERIFIED	PREPARED

**SPECIFICATION FOR
SPINEL BASED REFRACTORY BRICKS FOR WORKING LAYER AND
ALUMINA REFRACTORY BRICKS FOR SAFETY LAYER OF LADLE LINING**


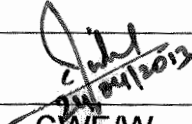


1.0 SCOPE

The specification covers the manufacture, supply and fitment of sets of Spinel based refractory bricks with mortar for ladle sidewall and bottom-lining and sets of High Alumina fired bricks with Magnesite mortar for safety lining of ladle to RWF Drg No. RWF/SK/MW - 443 to Rail Wheel Factory, Yelahanka, Bangalore 560 064, Karnataka State, to get minimum expected life as per clause 5.0. One full set consists of one set of Spinel based working layer bricks and one set of High Alumina layer bricks in adequate numbers required for one ladle lining as per Drg No. RWF/SK/MW – 443, and High Alumina mortar & Magnesite mortar as described in Clause 8 of the specification. Diameter and height of the ladle after lining shall not be less than 1625mm and 1620mm respectively.

Suppliers shall have proven capability for design and manufacture of refractories and should be regular supplier of refractories to reputed plants. The manufacturer shall have experience in the manufacture of spinel refractory and shall produce the documentary evidences of the satisfactory performance indicating the expected wear to the specified, minimum 72 heats per lining, either through the usage elsewhere or through the experiments conducted in their laboratory or others' on their spinel bricks. The suppliers are to submit documentary evidence to this effect.

The offers received shall be scrutinised for technical adequacy based on the documentary evidences. Prospective tenders are short-listed based on the technical suitability of the offers. Such short listed tenderers shall submit 6 bricks of the offered quality to RWF. The tenderer shall submit 6 numbers of Spinel based bricks for working layer within 15 days free of cost basis for primary evaluation of the performance. These bricks shall be used in ladle along with the regular HA 70 bricks for comparison of wear, within 30 days from receipt at RWF.

Residual thickness of the facing cross section of the bricks, i.e., across working layer thickness (115mm) is measured and compared with the adjacent HA70 Bricks after condemnation of the brick lining. The spinel brick wear is judged to be satisfactory if the wear is less than or equal to one third ($1/3^{\text{rd}}$) of the wear of adjacent HA70 bricks.

 24/4/13	 24/04/2013	 24/4/13	
CME	CWE/W	Dy. CME/Mfg.	SSE/D
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Offer of the tenderer whose samples performed unsatisfactory will not be considered for supply. Suppliers, those who have already submitted their samples and tried satisfactorily at RWF, need not submit the samples again. The samples shall be accompanied with the Material Test Certificate for the parameters specified in Clause 6.1 a, b & c of the specification.


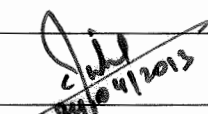
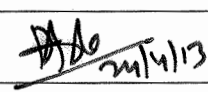

As the overall performance of the ladle depends on the quality of safety & working layer refractories and the mortars used to lay the bricks. All the refractory items covered in this specification shall be of same make and used for assessing the performance. Under no circumstances different make items are used in one ladle.

2.0 GENERAL DESCRIPTION

Spinel based bricks, pre-cast and pre-fired, of various sizes specified in Clause 6.1 c of this specification will be used for lining the side wall and bottom of the ladle and High alumina fired bricks of sizes specified in Clause 6.2 c of this specification will be used for safety lining of the side wall and bottom of the ladle in which molten metal is tapped from the Electric Arc Furnace at temperature up to 1715°C. The same ladle is used for casting Railway wheels through upward pressure pouring technique at a temperature range of 1610 - 1500°C, for about 45-55 minutes. Thus, the medium carbon killed quality liquid steel will reside at the ladle bottom at least for a period about 144 hours (6days) continuously. The ladle bricks shall be capable of withstanding the operating conditions described above and shall possess good resistance to slag attack & thermal shock.

3.0 MANUFACTURING FACILITY

The manufacturing facility shall have their own grinding mills & grading devices to grind & grade the raw materials. The spinel bricks shall be pre-cast and pre-fired. The manufacturer shall have mixer to mix the spinel containing low cement castable. Casting or forming of the spinel bricks shall be carried out under vibration. The formed spinel bricks shall be water cured under controlled atmosphere. Cured spinel bricks shall be dried under a temperature range of 110 - 150°C for a period not less than 24 hrs. The dried bricks shall be fired at a temperature of 800-850°C for a period of 4 hrs. The firing kilns shall be operated with liquid or gaseous fuel and be capable of heating to a temperature not less than 850°C. The heating schedule shall be established and documented. The details of temperature control and records shall be offered for verification of RWF's representative on demand during capacity/capability assessment or

 24/5/13	 24/5/2013	 24/4/13	
CME	CWE/W	Dy. CME/Mfg.	SSE/D
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inspection. Spinel bricks shall be segregated for physical damages like cracks, corner breakages etc. and stacked properly before offering for inspection.

4.0 QUALITY ASSURANCE PROGRAMME (QAP) AND PERFORMANCE

The manufacturer shall have an established and documented Quality Assurance Programme (QAP). The first time suppliers shall submit the QAP along with the offer for the approval of RWF. The minimum expected life of working layer of the ladle by using the Spinel Based Bricks is of 72 heats and that of safety layer is 24 months under RWF standard operating conditions. The manufacturer shall specify chemical composition and physical properties of supplied bricks and mortar along with the offer. The tenderers are required to tune their QAP to ensure the performance. The QAP will be verified/inspected/audited by RWF or their authorised representatives either during the inspection of the products or independently at short notice.

5.0 PERFORMANCE CRITERIA

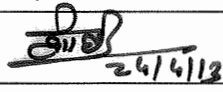

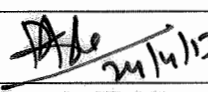

Presently, RWF use High Alumina HA 70 refractory bricks for ladles yielding a ladle life of 22-24 heats per lining and safety bricks yielding a life of 6months under the standard operating conditions. Ladles bricked with the proposed Spinel based bricks of this specification are expected to yield a ladle life of minimum 72 heats and Minimum expected life of safety lining of this specification shall be 24 months. The supplier shall guarantee that the wear rate shall not be more than one third of the present wear rate. Final supply will be accepted if the wear rate is less than one third of the wear rate of HA 70 bricks. For evaluation of performance, one set of Spinel based refractory bricks with mortar for ladle sidewall and bottom-lining and one set of High Alumina fired bricks with Magnesite mortar and High Alumina Mortar for safety lining will be used for complete lining of one ladle.

6.0 MATERIAL

6.1 The following chemical composition and physical properties of spinel based bricks for working layer are common for bricks of all sizes.

a) CHEMICAL COMPOSITION (for guidance only)

- 1) Al₂O₃ : 84% Minimum.
- 2) Fe₂O₃ : 0.8% Maximum.
- 3) Alkalis : 1.0% Maximum.

 24/4/13	 24/03/2013	 24/4/13	
CME	CWE/W	Dy. CME/Mfg.	SSE/D
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4) MgO : 8.0% max

b) PHYSICAL PROPERTIES (for guidance only)

- i) Pyrometric Cone Equivalent (PCE) : +37 OC (1820°C) Min
- ii) Cold Crushing Strength (CCS) : 1200 Kg/cm² Min.
- iii) Apparent porosity (AP) : 16% Max.
- iv) Permanent Linear Change at 1500°C
For 2 hrs (PLC) : +3.5% Max.
- v) Size Tolerance (Covering both warpage & shrinkage) : ±1.0% or ±1 mm whichever is greater.
- vi) Refractoriness Under Load (RUL) : 1640 °C Min.
- vii) Bulk Density (BD) : 3.0 gm/cc Min.

c) SIZE:

The general sizes in mm for the different types of spinel bricks constituting one set of working lining are as follows. The exact number of spinel bricks required will be as per the indent.

- i) 230 X 115 X 76/65 S.A. X 300 Nos.
- ii) 230 X 115 X 76/70 S.A. X 210 Nos.
- iii) 280 X 115 X 76/65 S.A. X 40 Nos.
- iv) 280 X 115 X 76/70 S.A. X 40 Nos.
- v) 230 X 115 X 76 Std. Brick for bottom working layer X170 Nos

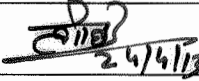



6.2 The following are the chemical composition and physical properties of alumina refractory bricks of all sizes for safety lining.

a) CHEMICAL COMPOSITION (for guidance only)

- 1) Al₂O₃ : 60% Min.
- 2) Fe₂O₃ : 2.5% Max

b) PHYSICAL PROPERTIES (for guidance only)

- i) Pyrometric Cone Equivalent (PCE) : +35 OC (1785°C) Min
- ii) Cold Crushing Strength (CCS) : 450 Kg/cm² Min.
- iii) Apparent porosity (AP) : 23% Max.
- iv) Reversible Thermal Expansion at 1000°C : 0.60% Min.

 24/4/13	 24/4/13	 24/4/13	
CME	CWE/W	Dy. CME/Mfg.	SSE/D
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- v) Size Tolerance (Covering both warpage & shrinkage) : ±1.5% or ±2 mm whichever is greater.
- vi) Refractoriness Under Load (RUL) : 1420 °C Min.
- vii) Bulk Density (BD) : 2.5 gm/cc Min.

c) SIZE

The general sizes in mm for bricks constituting 1 set of safety layer are as follows. The exact number of bricks required will be as per the indent.

- i) 230x115x65 x 220 Nos (for bottom)
- ii) 230x115x40 x 420 Nos (for side)
- iii) 230x115x25 x 6 Nos

7.0 REFRACTORY PARTICLE SIZE

Bricks should be compact having close grains. The raw material should not have more than 3 mm size refractory particles. When bricks are cut either for sampling or for lining purpose, they should not show any signs of lamination or refractory particle loosening due to large grains or inadequate bonding.

8.0 MORTAR FOR BRICK LINING



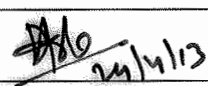
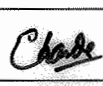
8.1 The supply of Spinel based refractory bricks shall be accompanied with 250 kg per set of High Alumina mortar as specified below **(for guidance only)**

- Al₂O₃ : 84% Min
- Fe₂O₃ : 0.8% Max
- Pyrometric Cone Equivalent (PCE) : +37 OC (1820°C)
- Size grading : 0 to 0.5 mm
- Weight % retained on 0.5mm : 3% Max.

The mortar shall be supplied in polythene lined gunny bags.

8.2 MORTAR FOR SAFETY LINING

8.3 The supply of High alumina fired bricks shall be accompanied with 115 kg of Magnesite mortar for application on the ladle shell and 140 kg of High Alumina Mortar as specified below. The mortar shall be supplied in polythene lined gunny bags.

 24/4/13	 24/4/2013	 24/4/13	
CME	CWE/W	Dy. CME/Mfg.	SSE/D
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a) Specification for Magnesite mortar for shell (for guidance only)

MgO (on loss free basis)	: 70% Min
Setting	: Chemical
Pyrometric Cone Equivalent (PCE)	: +35 OC (1785°C)
Service Temperature	: 1700°C Min.
Shelf life from the date of manufacturing	: 6 months
Packing	: 25 kg or part thereof.

b) Specification for High Alumina Mortar (for guidance only)

Al ₂ O ₃ (on loss free basis)	: 60% Min
Fe ₂ O ₃ (on loss free basis)	: 2% Max
Setting	: Chemical
Pyrometric Cone Equivalent (PCE)	: +35 OC (1785°C) Min
Service Temperature	: 1700°C Min.
Shelf life from the date of manufacturing	: 6 months
Packing	: 25 kg or part thereof.

9.0 TESTING FACILITIES & MANUFACTURER'S TEST CERTIFICATE (MTC)

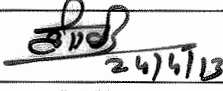

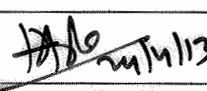

The firm should have complete test facilities to carry out raw material & in-process check and the product inspection. Supply shall accompany the MTC for all items supplied.

10.0 INSPECTION NORM

- a. **SAMPLING NORM:** IS-1528 Pt. VII – 1974.
- b. **ACCEPTANCE CRITERIA:** IS-1528 Pt. VII - 1974.

11.0 PACKING

The bricks shall be packed in disposable wooden base and top pallets of 1 to 1.5 M/T capacity, capable of being handled by 3 Ton Forklifts as shown in Annexure-I. The edges of the bricks should be protected with cardboard paper and strapped on to the base and top pallets. Additional corrugated cardboard of adequate thickness has to be used on all faces to avoid damage to brick edges due to strapping force.

 24/4/13	 24/4/13	 24/4/13	
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12.0 TRANSPORT

The bricks should be transported to RWF stores by road directly from the firm's premises to avoid any damages to the bricks. Utmost care should be taken during the transportation of these bricks by adequately covering them with tarpaulin, etc to avoid bricks getting exposed to rain water during transit.

13.0 STORAGE

The supplier should have arrangement to store the bricks and mortars under covered accommodation to protect them from water.

14.0 HANDLING

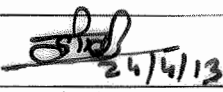



Special care should be taken by the supplier to ensure that the edges do not get chipped off during manufacturing and subsequent handling. The bricks that are chipped off are liable to be rejected and would have to be replaced by the firm at their expense.

15.0 PAYMENT TERMS

Payment will be released only after usage of each set as the minimum expected life of the proposed spinel bricks is 72 heats. No payment will be made if the life is less than 48 heats and payment on prorata basis will be made if the life achieved is equal and above 48 but below 72 heats, due to reasons attributable to refractory.

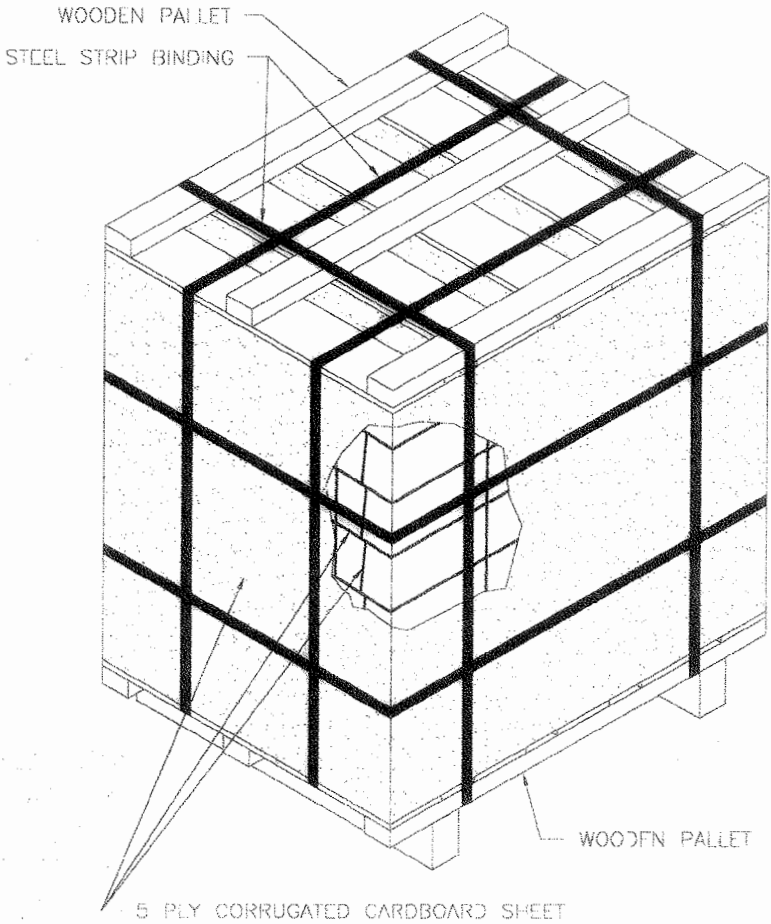
Minimum expected life of safety lining of this specification shall be 24 months, reckoned from the date of first heat tapped into the ladle using the safety bricks supplied, under normal cycles of usage. The payment will be made against PG bond for full value of the safety bricks. PG bond for full amount will be encashed if the life achieved is less than 18 months and prorata payment only will be made if the achieved life is more than 18 months but less than 24 months.

No bonus payment will be made for either or both the spinel and alumina bricks if the life achieved is more than expected life.

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ANNEXURE-1

PACKING ARRANGEMENT FOR SPINEL BASED BRICKS



NOTE: USE CORRUGATED CARDBOARD SHEETS FOR PACKING ALL FACES.

<i>APD Bostii</i> 9.2.04		<i>9/9/04</i>	<i>Rev 9/9/04</i>
CME	CWE/Mfg	Dy. CME/Mfg	SSE/D
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PAGE 5 OF 6

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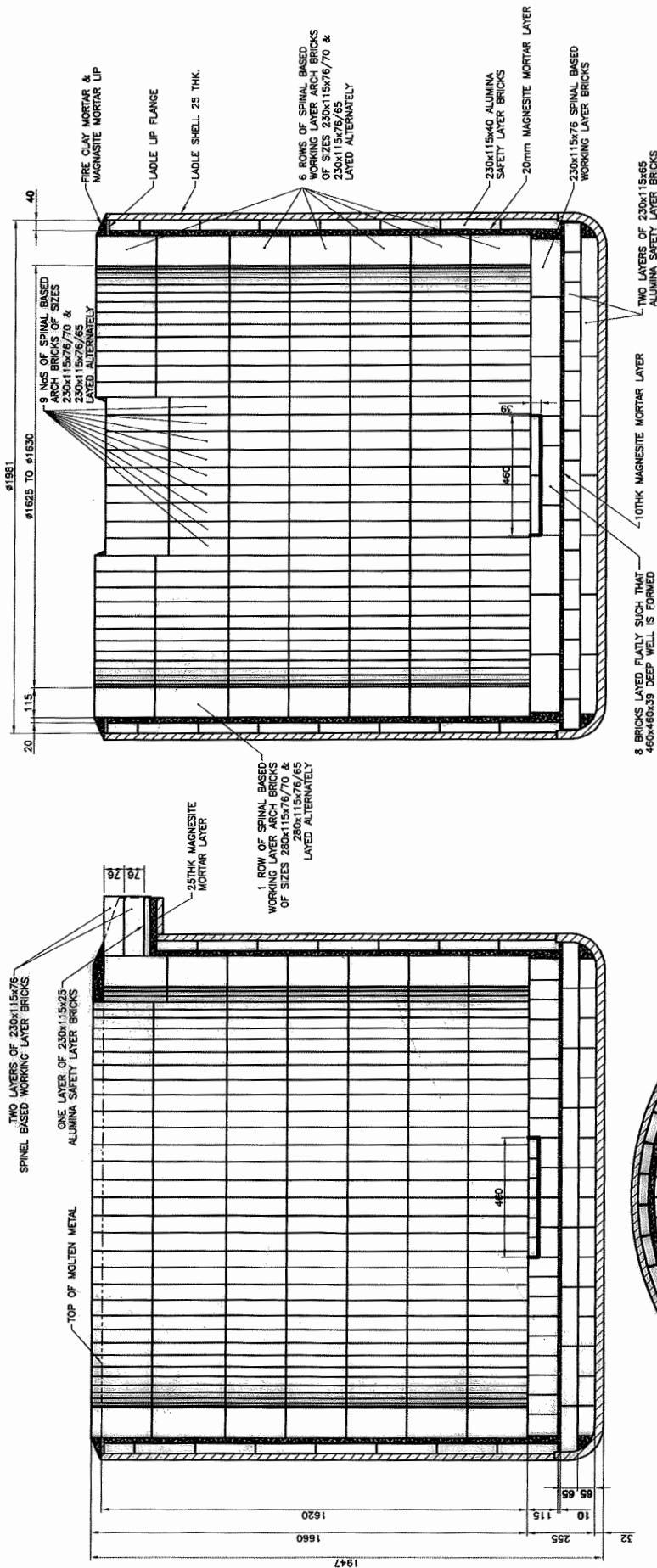
DO NOT SCALE DRAWING

ALT

DESCRIPTION

JOB No.

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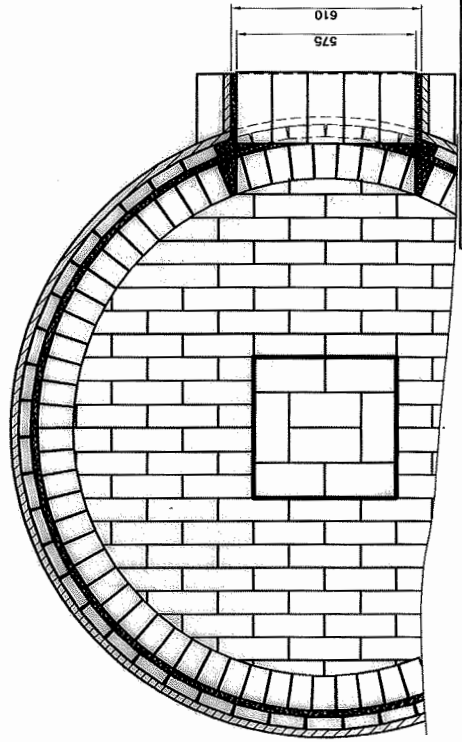


NOTE: 1. GAPS FORMED BETWEEN BRICKS AND LADLE BODY ARE TO BE FILLED WITH MAGNESITE MORTAR.
2. BRICKS ARE TO BE CUT TO REQUIRED SHAPES AND SIZES WHEREVER NECESSARY.

SCALE		AM/ED	24.04.13
PROJECTION		SSE/D	24.04.13
ALT		CHD	24.04.13
		DRN	04.04.13
		RAVI	
REF DRG.		RWF/SK/MW-443	
JOB No.		6058	
SHEET		OF	

INDIAN RAILWAYS
 MODIFIED LADLE LINING ARRANGEMENT
 WITH SPINEL BRICKS
 FOR 23.4 T CAPACITY LADLE (C/M/E-6/12)

RAIL WHEEL FACTORY
 BANGALORE



PARTIAL PLAN WITH LIP FLANGE REMOVED

ALL DIMENSIONS ARE IN mm UNLESS SPECIFIED OTHERWISE.
 PERMISSIBLE DEVIATION FOR UNTOLERANCED DIMENSIONS AS PER IS:2102 CLASS 'm'