	CORPORATE PURCHASING SPECIFICATION	AA10213
		Rev No. 07
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HOT ROLLED / FORGED MEDIUM CARBON STEEL BARS, Gr: 30C8 – NORMALISED

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1.0 GENERAL:

This specification governs the quality requirements of Hot Rolled / forged Carbon Steel Bars, suitable for machining.

2.0 APPLICATION

General engineering purposes.

3.0 CONDITION OF DELIVERY

Hot Rolled / forged and Normalised.

Note: Sizes upto 100mm in hot rolled
>100 to 180mm in hot rolled or forged
above 180mm in forged

Bars shall be supplied in straight lengths with ends square and true.

4.0 COMPLIANCE WITH NATIONAL STANDARDS:

Material shall comply with the requirements of the following National standards and also meet the requirements of this specification.

IS : 1570-Part 2, Section 1-1979 Gr:30C8 (C30), Normalised	Schedule for wrought Steels Part 2 Carbon Steels (Unalloyed Steels) Sec.1: Wrought Products (other than wire) with specified Chemical composition and related properties

5.0 DIMENSION AND TOLERANCES

5.1 Sizes:

Bars shall be supplied to the dimensions specified on BHEL order.

5.1.1 Length:

Unless otherwise specified, hot rolled bars shall be supplied in lengths 3 to 6 metres and forged bars shall be supplied in lengths of 1.5 to 3 metres. Tolerances:

5.1.2 For Forged bars:

The tolerances shall be + 8 mm -0mm.

5.1.3 Tolerances on hot rolled bars shall comply with those of Grade 2 of IS: 3739: Dimensional Tolerances for Carbon and Alloy Constructional Steel Products reproduced below:

5.1.3.1 Round and Square Bars:

Nominal Size mm		Tolerances, mm	
Over	**Up to & Including**	**Permissible deviation**	**Out of round/ square**
---	25	± 0.50	0.50
25	50	± 0.75	0.75
50	80	± 1.00	1.00
80	100	± 1.25	1.25
> 100		± 1.6% of diameter or width of side	75% of total tolerance (+ and -)

5.1.4 Straightness:

Unless otherwise agreed to the permissible deviation in straightness shall not exceed 5 mm in any 1 metre length.

6.0 MANUFACTURE

Material shall be manufactured from fully killed steel.

7.0 HEAT TREATMENT

The bars shall be normalised at a temperature of 860 – 890°C.

8.0 FREEDOM FORM DEFECTS

The bars shall be sound, straight and free from internal and surface defects, such as seams, laps, cracks or any other defects which may impair the end use.

Bars shall be free from twists and bends.

9.0 CHEMICAL COMPOSITION

The melt analysis of steel and the permissible variation in the composition of the material from the melt analysis shall be as follows:

Element	Melt analysis, percent,		Permissible variation, percent,
	Min.	Max.	
Carbon	0.25	0.35	± 0.02
Silicon	0.10	0.35	± 0.03
Manganese	0.60	0.90	± 0.04
Sulphur	---	0.035	± 0.005
Phosphorus	---	0.035	± 0.005

10.0 TEST SAMPLES:

10.1 One sample shall be taken from each melt for chemical analysis.

10.2 One sample shall be taken from each heat treatment batch for testing of mechanical properties. Test pieces for mechanical tests shall be taken in the longitudinal direction of the piece.

For ruling section up to and including 40mm, the test piece shall be machined coaxially from the test bars. For ruling section above 40mm the longitudinal axis shall be at least 12.5 mm from surface of the test bars.

Test methods for determining mechanical properties shall be as per IS: 1608 (For tensile test).

10.3 For ruling section above 200mm, tensile test samples can be taken in tangential or transverse direction**.**

11.0 MECHANICAL PROPERTIES (IN NORMALISED CONDITION):

Mechanical properties of the material shall be as follows:

Tensile strength : 500 - 600 N/mm2

Yield strength : 275 N/mm2 , min

% of elongation : 21%, min.

12.0 ULTRASONIC TEST:

Each bar above 100 mm shall be tested ultrasonically in accordance with BHEL standard AA0850118 to ensure freedom from internal defects.

The norms of acceptance shall be as per category 2 of the above standard.

13.0 TEST CERTIFICATES

Three copies of test certificates shall be supplied, unless otherwise stated on the order.

In addition, the supplier shall ensure to enclose one copy of the test certificate along with their despatch documents to facilitate quick clearance of the material.

The test certificate shall bear the following information:

AA10213; Rev. No. 07
BHEL order No,

Supplier's Reference:
Name:
Identification No.:
Melt No.:
Details of heat treatment:

Results of Tests:
Results of Dimensional inspection:
Results of chemical analysis, mechanical tests & Ultrasonic test:

14.0 PACKING AND MARKING:

The material shall be suitably packed in bundles-hessian wrapped to prevent sagging, corrosion and damage during transit. A suitable clear temporary rust preventive shall be applied on all the bars.

Each bar of 50 mm & above shall be stamped with AA10213, melt no, BHEL order no, at one end or on the end face.

Bars below 50mm shall be bundled together and tied with wire at 3 to 4 places along the length of the bars.

A metal label shall be securely attached to each bundle and shall bear the following information:

AA10213 : Hot Rolled / Forged Medium Carbon Steel Bars, Gr: 30C8 – Normalised.
BHEL Order No.:
Consignment/Identification No.:
Melt No.:
Size and Weight:
Supplier's Name:

15.0 REFERRED STANDARDS (Latest publications including amendments):

1) IS: 1570 Part II 2) IS: 1608 3) IS: 3739 4) AA0850118

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HOT ROLLED CARBON STEEL SHEET (330 N/mm² Tensile)

1.0 GENERAL:

This specification governs the quality requirements of Hot Rolled Carbon Steel Sheet of thickness of 2.5 mm to 4.0 mm (both inclusive).

2.0 APPLICATION:

Suitable for cold forming / drawing / fabrication by welding.

3.0 CONDITION OF DELIVERY:

Sheets shall be supplied in hot rolled, decaled and oiled condition. Imported sheets shall be supplied in straight lengths. The edges shall be flattened and sheared. Mill edges are not acceptable. Sheets shall be free from waviness and shall have a uniformly dull (matt) finish.

Oil used for rust prevention should be free from pungent smell. The following oils are suggested:

a) SERVO RP 125 of M/s. IOC.
b) RUSTOP 387/388 of M/s. HPC
c) Bharat TCPF of M/s. Bharat Petroleum
d) Any other TRP conforming to IS : 1154

4.0 COMPLIANCE WITH NATIONAL STANDARDS:

The material shall comply with the requirements of the following National standards and also meet the requirements of this specification.

IS: 5986 – 2011, Gr.: 205: Hot rolled steel flat products for structural forming and flanging purposes - Specification.

5.0 DIMENSIONS AND TOLERANCES:

5.1 Sizes:

Hot rolled carbon steel sheets shall be supplied to the dimensions in BHEL order.

5.2 Tolerances:

The tolerances on sheets shall comply with the following:

5.2.1 Thickness (IS: 1852):

Thickness, mm	Tolerance, mm
2.50	± 0.20
3.15	± 0.22
4.0	± 0.25

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5.2.2 Width (IS: 1852):

Width, mm	Tolerance, mm
Upto & incld. 1250 mm	+ 6 mm - 0 mm
Over 1250 mm & upto and incld.1550 mm	+ 0.5 percent - 0.0 percent
Over 1550 mm	+ 0.6 percent - 0.0 percent

5.2.3 Length (Continuous mill) IS: 1852:

Length, mm	Tolerance, mm
Upto & incld. 2500 mm	+ 25 mm - 00 mm
Over 2500 mm	+ 1 percent subject to a maximum of 70 mm - 0 percent

5.2.4 Flatness (for cut lengths):

Thickness, mm	Width, mm	Flatness tolerance, mm
From 2.5 to 4.0	Upto & incld. 1200	15
	Over 1200 & upto incld. 1500	20
	Over 1500	25

5.2.5 Edge camber IS: 5986:

The edge camber (i.e. lateral departure of the edge of the material from a straight line forming a chord) of sheets in cut lengths and coil shall not exceed the following values:

5.2.5.1 For Cut Lengths:

Length in meters		Tolerance, mm
Over	Upto & incld.	
--	1.25	5
1.25	1.80	6
1.80	2.50	8
2.50	3.15	10
3.15	3.55	12
3.55	4.00	16
4.00	5.00	19

5.2.5.2 For Coils:

25 mm in any 5000 mm length.

6.0 MANUFACTURE:

Process of manufacture is left to the discretion of the manufacturer except Bessemer process.

Material shall be manufactured from semi killed or killed steel.

7.0 FREEDON FROM DEFECTS:

The sheets shall be free from harmful defects, twists, buckle, rust, scale and waviness and shall be reasonably smooth, flat and square.

8.0 CHEMICAL COMPOSITION:

The melt analysis of steel and the permissible variation in the composition of the material from the melt analysis shall be as follows:

Element	Melt analysis, percent, max.	Permissible variation, percent, max.
Carbon	0.15	0.03
Manganese	0.80	0.05
Sulphur	0.040	0.005
Phosphorus	0.040	0.005

9.0 TEST SAMPLES:

9.1 Tensile Test:

One sample shall be taken per thickness per consignment from each melt.

As far as possible test pieces shall be cut transverse to the direction of rolling and shall be of full thickness of the sheet rolled.

9.2 Bend Test:

One sample shall be taken per thickness per consignment from each melt.

Bend test pieces shall be cut so that the axis of the bend is parallel to the direction of rolling viz. transverse.

Note: When more than one thickness is rolled from the same melt, one additional test piece for each thickness shall be taken.

10.0 MECHANICAL PROPERTIES:

10.1 Bend:

When tested in accordance with IS: 1599, the test pieces shall be capable of being bent cold through 180º close. The outer convex surface of the test piece shall be free from cracks.

10.2 Tensile:

When tested as per IS: 1608, the test pieces shall show the following properties:

Tensile strength	: 330 – 440 N/mm²
Yield strength	: 205 N/mm², min.
Elongation:	
For sheets up to & Incl. 3 mm, thick	: 20 %, minimum on 80 mm gauge length
For sheets above 3 mm, thick	: 28 %, minimum in 5.65 √So gauge length

11.0 HARDNESS (VICKERS):

When tested in accordance with IS: 1501, the material shall show a Vickers hardness in the range of 100 – 140 HV.

Note: Hardness test shall be conducted only when tensile test cannot be performed.

12.0 TEST CERTIFICATES:

Unless otherwise specified, three copies of test certificates shall be supplied.

In addition, the supplier shall ensure to enclose one copy of the test certificate along with their dispatch documents to facilitate quick clearance of the material.

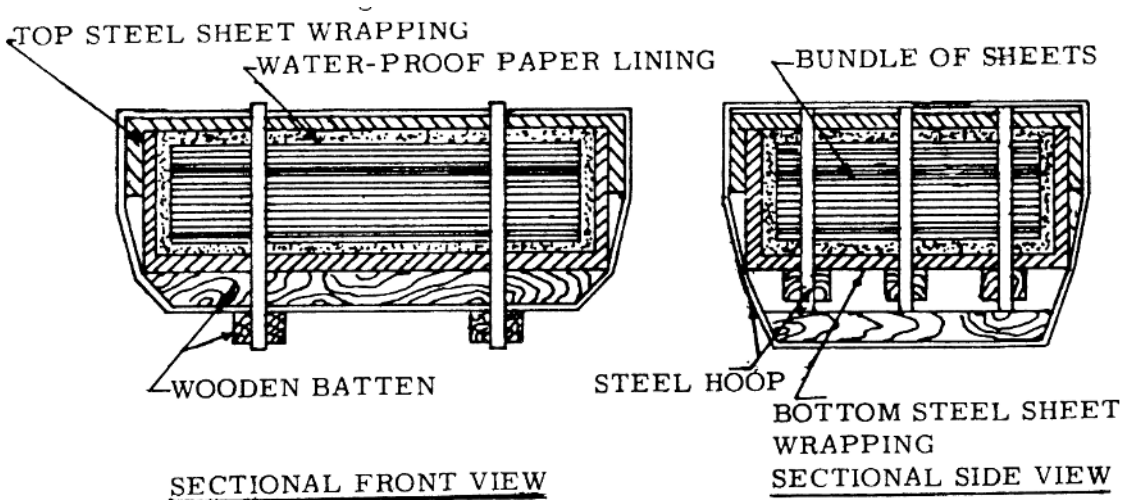
The test certificate shall bear the following information:
AA10113, Rev 07: HOT ROLLED CARBON STEEL SHEET (330 N/mm² Tensile)
BHEL Order No,
Supplier's name,
Identification No
Melt No,
Process of manufacture
Details of pickling, descaling and oiling
Results of dimensional inspection
Results of Chemical analysis and Mechanical tests,

Note: Material procured, supplied and certified as AA10113 / IS: 5986, Gr.:205 and comply with the requirements of this specification is acceptable.

13.0 PACKING AND MARKING:

Steel sheets shall be supplied in bundles and shall be suitably packed in bundles to prevent corrosion and damage during transit.

The recommended packing for imported material shall be as shown below.



Note:

a) Water proof paper lining shall be preferably Volatile Corrosion Inhibitor (V.C.I.) Coated Paper with an additional polythene (100 micron) enveloped.

b) Approximate weight of each bundle shall be 2 to 3 tonnes. Bundle weighing 2 metric tonnes is however preferred.

A metal label shall be securely attached to each bundle and shall bear the following information:

AA10113:HOT ROLLED CARBON STEEL SHEET (330 N/mm^2 Tensile)
BHEL Order No,
Supplier's Name & Identification No,
Size & Thickness of sheets
Weight

14.0 REFERRED STANDARDS (Latest publications including amendments):

1) IS: 1154 2) IS: 1501 3) IS: 1852 4) IS: 1599 5) IS: 1608

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PERMISSIBLE DEVIATIONS FOR UNTOLERANCED DIMENSIONS OF CASTINGS

1.0 SCOPE:

This standard pertains to permissible dimensional tolerances on the as-cast surfaces of castings. his is not applicable to pressure die castings of non-ferrous metals and for castings which are difficult to produce from the technological point of view, in which case the deviations shall be agreed mutually.

NOTE: Supply in line with IS:4897 is also acceptable.

2.0 NOMENCLATURE:

2.1 Nominal Dimensions:

Nominal dimension is the dimension specified in the production drawing or in the production documents or the one to which the production deviations of the components are applicable.

2.2 Actual Dimension:

Actual dimension is the dimension measurable on the rough castings. Wherever possible several measurements of the dimensions are made and the maximum and minimum values are considered for assessment as to the compliance with tolerance limits, e.g. diameter of a ring or disc at various diametrically opposite points, the diameter of a cylinder at various points along the height, the lengths and breadths of a plate, etc.

2.3 Governing Dimensions:

Governing dimension is the maximum measurable dimension of the concerned part of the casting, in the plane perpendicular to the nominal dimension. With every nominal dimension, the corresponding governing dimension should be considered.

Governing dimension along with the nominal dimension on the rough casting, determines the limiting deviation of casting or its parts. Examples of governing dimensions for various cases are given in Table-1.

2.4 Allowable Dimensional Deviations:

a) Upper allowable deviation:

Upper allowable deviation is the difference between the upper limiting dimension and nominal dimension (of casting).

b) Lower allowable deviation:

Lower allowable deviation is the difference between the bottom limiting dimension and nominal dimension (of casting).

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Revisions:			APPROVED : INTERPLANT MATERIAL RATIONALIZATION COMMITTEE-MRC(FCF+HTM)		
Cl 29.2.2 of MOM of MRC-FCF+HTM					
Rev. No. 01	Amd.No.	Reaffirmed	Prepared	Issued	Dt. of 1st Issue
Dt:15.02.2005	Dt :	Year :01.10.10	Corp.R&D	Corp. R&D	MARCH, 1980

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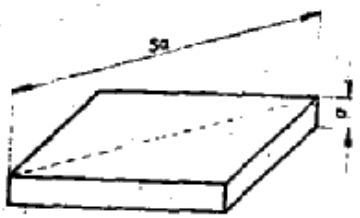
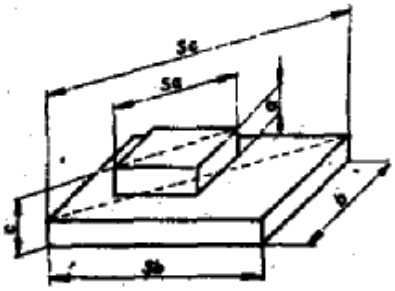
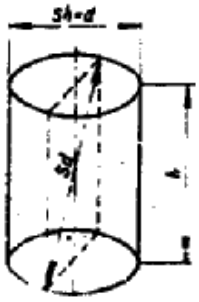
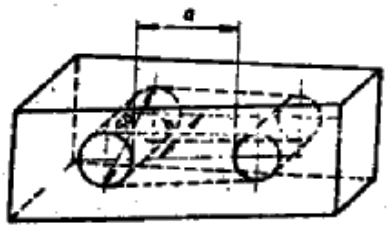
TABLE –1: GOVERNING DIMENSIONS (S)

Sl. No.	Figure	Definition
1		If 'a', the thickness, is the nominal dimension, the corresponding governing dimension will be diagonal, 'Sa' lying in a plane perpendicular to 'a' since it is the greatest dimension in the plane.
2		If 'a' is the nominal dimension 'Sa' is the governing dimension. For the nominal dimension 'c', the governing dimension is 'Sc'. For Nominal dimension 'b', the governing dimension is 'Sb', (Diagonal of the adjacent sides for smaller thickness of the lower prism, differs very much less, from the length of adjacent sides).
3		For the nominal dimension 'd', the diagonal 'Sd' along the plane perpendicular to the nominal dimension, is the governing dimension, because it is the greatest dimension, in the plane along the axial section. For the nominal dimension 'h', the governing dimension is Sh = d. For simplicity, dimension Sd can be changed to the nearest lower measurable dimension (h or d), whichever is greater.
4		Distance of the holes 'a' in the casting, is assumed as separate part, and hence for the nominal dimension 'a', the diagonal 'Sa' will be the governing dimension, which is greater of the two holes, and which lies in the plane of 'a'. For simplicity, we can replace with the nearest lower dimension 'h', or the diameter of the bigger hole.

3.0 TOLERANCE CLASSES:

3.1 General:

Tolerance limits are given under five different classes in the light of different casting techniques and trade practices that could be followed. The numerical values of tolerances for a series of Nominal and Governing dimensions according to classes 1 to 5 are respectively given in tables 2 to 6. The manufacturing foundry shall choose to itself the proper tolerance limits on dimensions of pattern equipment in accordance with those of the castings to be adhered to. For dimensions not covered by the tables given, tolerances shall be specified separately and the mutually agreed upon.

3.2 Tolerance class 1:

Tolerance limits under class 1, according to Table 2 is for high precision castings, such as investment castings.

TABLE 2: TOLERANCE CLASS 1

Nominal dimension (rough casting), mm		Governing Dimension, mm							
		From							
			6	10	18	30	80	180	315
		To							
From	To	6	10	18	30	80	180	315	500
	6	± 0.08	± 0.10	± 0.12	± 0.12	± 0.15	± 0.15	± 0.20	± 0.25
6	10	± 0.10	± 0.12	± 0.12	± 0.15	± 0.15	± 0.20	± 0.25	± 0.30
10	18	± 0.12	± 0.12	± 0.15	± 0.15	± 0.20	± 0.25	± 0.30	± 0.30
18	30	± 0.12	± 0.15	± 0.15	± 0.20	± 0.25	± 0.30	± 0.40	± 0.40
30	80		± 0.15	± 0.20	± 0.25	± 0.30	± 0.40	± 0.40	± 0.50
80	180			± 0.20	± 0.25	± 0.30	± 0.40	± 0.50	± 0.50
180	315			± 0.25	± 0.25	± 0.30	± 0.40	± 0.50	± 0.60
315	500			± 0.25	± 0.30	± 0.40	± 0.50	± 0.60	± 0.60

3.3 Tolerance class 2:

Tolerance limits under class 2, according to Table 3 is for precision castings (e.g. castings from metal patterns, shell moulding or gravity die castings).

TABLE 3: TOLERANCE CLASS 2

Nominal dimension (rough casting), mm		Governing Dimension, mm							
		From							
			6	10	18	30	80	180	315
		To							
From	To	6	10	18	30	80	180	315	500
	6	± 0.20	± 0.25	± 0.30	± 0.30	± 0.35	± 0.40	± 0.50	± 0.60
6	10	± 0.25	± 0.30	± 0.30	± 0.35	± 0.40	± 0.50	± 0.60	± 0.80
10	18	± 0.30	± 0.30	± 0.35	± 0.40	± 0.50	± 0.60	± 0.80	± 0.80
18	30	± 0.30	± 0.35	± 0.40	± 0.50	± 0.60	± 0.80	± 1.00	± 1.00
30	80	± 0.35	± 0.40	± 0.50	± 0.60	± 0.80	± 1.00	± 1.00	± 1.20
80	180			± 0.50	± 0.60	± 0.80	± 1.00	± 1.20	± 1.20
180	315			± 0.60	± 0.60	± 0.80	± 1.00	± 1.20	± 1.40
315	500			± 0.60	± 0.80	± 1.00	± 1.20	± 1.40	± 1.60

3.4 Tolerance class 3:

Tolerance limits under class 3, according to Table 4 is for mass or series production of castings requiring high degree of dimensional accuracy.

TABLE 4: TOLERANCE CLASS 3

Nominal dimension (rough casting), mm		Governing Dimension, mm							
		From							
			18	30	80	180	315	500	800
		To							
From	To	18	30	80	180	315	500	800	1250
	6	± 0.5	± 0.5	± 0.5	± 0.6	± 0.8	± 1.0	± 1.2	± 1.5
6	10	± 0.5	± 0.5	± 0.6	± 0.8	± 1.0	± 1.2	± 1.5	± 2.0
10	18	± 0.5	± 0.6	± 0.8	± 1.0	± 1.2	± 1.2	± 1.5	± 2.0
18	30	± 0.6	± 0.8	± 1.0	± 1.2	± 1.5	± 1.5	± 2.0	± 2.5
30	80	± 0.8	± 1.0	± 1.2	± 1.5	± 1.5	± 2.0	± 2.0	± 2.5
80	180	± 0.8	± 1.0	± 1.2	± 1.5	± 2.0	± 2.0	± 2.5	± 2.5
180	315	± 1.0	± 1.0	± 1.2	± 1.5	± 2.0	± 2.5	± 2.5	± 2.5
315	500	± 1.0	± 1.2	± 1.5	± 2.0	± 2.0	± 2.5	± 2.5	± 3.0
500	800	± 1.2	± 1.2	± 1.5	± 2.0	± 2.5	± 2.5	± 3.0	± 3.0
800	1250	± 1.2	± 1.5	± 2.0	± 2.5	± 2.5	± 3.0	± 3.0	± 3.5

3.5 Tolerance class 4:

Tolerance limits under class 4, according to Table 5 is for series or mass production of castings Employing hand moulding with match plate patterns.

TABLE 5: TOLERANCE CLASS 4

Nominal dimension (rough casting), mm		Governing Dimension, mm									
		From									
			18	30	80	180	315	500	800	1250	2000
		To									
Fro m	To	18	30	80	180	315	500	800	1250	2000	3150
	6	± 0.6	± 0.8	± 0.8	± 0.8	± 1.0	± 1.5	± 1.5	± 2.0	± 2.5	± 3.0
6	10	± 0.8	± 0.8	± 0.8	± 1.0	± 1.5	± 1.5	± 2.0	± 2.5	± 3.5	± 4.0
10	18	± 0.8	± 1.0	± 1.2	± 1.5	± 1.5	± 2.0	± 2.5	± 3.5	± 4.0	± 4.0
18	30	± 0.8	± 1.2	± 1.5	± 1.5	± 2.0	± 2.5	± 3.5	± 4.0	± 4.5	± 5.0
30	80	± 1.0	± 1.2	± 1.5	± 2.0	± 2.5	± 3.0	± 3.5	± 4.0	± 4.5	± 5.0
80	180	± 1.0	± 1.5	± 2.0	± 2.5	± 3.0	± 3.5	± 4.0	± 4.5	± 5.0	± 5.0
180	315	± 1.2	± 1.5	± 2.0	± 2.5	± 3.0	± 3.5	± 4.0	± 4.5	± 5.0	± 5.5
315	500	± 1.5	± 1.5	± 2.5	± 3.0	± 3.5	± 4.0	± 4.5	± 5.0	± 5.0	± 6.0
500	800	± 2.0	± 2.0	± 2.5	± 3.5	± 4.0	± 4.5	± 5.0	± 5.0	± 5.5	± 6.0
800	1250	± 2.0	± 2.5	± 3.5	± 4.0	± 4.0	± 4.5	± 5.0	± 5.5	± 6.0	± 6.0
1250	2000	± 2.5	± 3.5	± 4.0	± 4.0	± 4.5	± 5.0	± 6.0	± 6.0	± 7.0	± 7.0
2000	3150	± 3.5	± 4.0	± 4.5	± 4.5	± 5.0	± 6.0	± 6.0	± 7.0	± 8.0	± 8.0

3.6 Tolerance class 5:

Tolerance limits under class 5, according to table 6 is for piece production of castings by employing hand moulding including pit, sweep and skeleton moulds.

TABLE 6: TOLERANCE CLASS 5

Nominal dimension (rough casting), mm		Governing Dimension, mm											
		From											
			18	30	80	180	315	500	800	1250	2000	3150	5000
		To											
From	To	18	30	80	180	315	500	800	1250	2000	3150	5000	8000
	6	± 0.8	± 1.0	± 1.2	± 1.2	± 1.5	± 2.0	± 2.5	± 3.5	± 4.0	± 5.0	± 6.0	± 7.0
6	10	± 1.0	± 1.0	± 1.2	± 1.5	± 2.0	± 2.5	± 3.5	± 4.0	± 5.0	± 6.0	± 6.0	± 7.0
10	18	± 1.0	± 1.2	± 1.5	± 2.0	± 2.5	± 3.5	± 4.0	± 5.0	± 6.0	± 6.0	± 7.0	± 8.0
18	30	± 1.2	± 1.5	± 2.0	± 2.5	± 3.0	± 4.0	± 5.0	± 6.0	± 7.0	± 7.0	± 8.0	± 9.0
30	80	± 1.2	± 2.0	± 2.5	± 3.0	± 3.5	± 4.0	± 5.0	± 6.0	± 7.0	± 8.0	± 9.0	± 10
80	180	± 1.5	± 2.5	± 3.0	± 3.5	± 4.0	± 5.0	± 6.0	± 7.0	± 8.0	± 8.0	± 9.0	± 10
180	315	± 2.0	± 2.5	± 3.0	± 3.5	± 4.5	± 5.0	± 6.0	± 7.0	± 8.0	± 9.0	± 10	± 11
315	500	± 2.5	± 3.0	± 3.5	± 4.5	± 5.0	± 6.0	± 7.0	± 8.0	± 8.0	± 9.0	± 10	± 11
500	800	± 3.0	± 3.5	± 4.0	± 5.0	± 6.0	± 7.0	± 7.0	± 8.0	± 9.0	± 10	± 11	± 12
800	1250	± 3.5	± 4.5	± 5.0	± 6.0	± 6.0	± 7.0	± 8.0	± 9.0	± 9.0	± 10	± 11	± 12
1250	2000	± 4.0	± 5.0	± 6.0	± 6.0	± 7.0	± 8.0	± 8.0	± 9.0	± 10	± 11	± 12	± 12
2000	3150	± 5.5	± 6.0	± 7.0	± 8.0	± 8.0	± 9.0	± 9.0	± 10	± 11	± 12	± 13	± 14
3150	5000	± 7.0	± 8.0	± 8.0	± 9.0	± 9.0	± 10	± 11	± 12	± 13	± 14	± 15	± 16
5000	8000	± 8.0	± 9.0	± 9.0	± 10	± 10	± 11	± 12	± 13	± 14	± 15	± 16	± 18

4.0 TOLERANCES ON THICKNESS OF WALLS OR RIBS AND WIDTH OF GROOVES OR CHANNELS:

For deviations on thickness of walls or ribs and width of grooves or channels, the values given in Table 7 are applicable.

In these cases, the wall thickness is the nominal dimension and related maximum dimension (length, height or diagonal) shall be taken as the governing dimension.

TABLE 7: Permissible Tolerances on Thickness of walls or ribs and width of grooves or channels.

Max. overall dimension of casting,	Thickness of wall or rib/width of groove or channel, mm		Permissible Tolerances, mm Tolerance class		
mm	Over	Upto & incl.	1 & 2	3 & 4	5
UP TO 500		6	± 0.2	± 0.4	± 0.8
	6	10	± 0.3	± 0.5	± 1.0
	10	18	± 0.5	± 0.8	± 1.5
	18	30	± 0.8	± 1.0	± 1.5
	30	50	± 0.8	± 1.2	± 2.0
	50	80	± 1.0	± 1.5	± 2.5
	80	120	± 1.0	± 1.8	± 2.5
ABOVE 500 UP TO 1250		10	± 0.3	± 0.8	± 1.2
	10	18	± 0.5	± 1.2	± 1.5
	18	30	± 0.8	± 1.5	± 2.0
	30	50	± 1.0	± 1.8	± 2.0
	50	80	± 1.2	± 2.0	± 2.5
	80	120	± 1.5	± 2.5	± 3.0
ABOVE 1250 UP TO 2500		10	± 0.5	± 1.2	± 1.5
	10	18	± 0.8	± 1.5	± 2.0
	18	30	± 1.0	± 2.0	± 2.5
	30	50	± 1.2	± 2.5	± 3.0
	50	80	± 1.8	± 2.5	± 3.0
	80	120	± 2.0	± 3.0	± 3.5
ABOVE 2500 UP TO 4000		18	± 1.0	± 1.5	± 2.0
	18	30	± 1.2	± 2.0	± 2.5
	30	50	± 1.5	± 2.5	± 3.0
	50	80	± 2.0	± 3.0	± 3.5
	80	120	± 2.5	± 3.5	± 4.0
ABOVE 4000		18	--	± 2.0	± 3.0
	18	30	--	± 2.5	± 3.5
	30	50	--	± 3.0	± 4.0
	50	80	--	± 3.5	± 4.5
	80	120	--	± 4.0	± 5.0

5.0 GUIDELINES FOR SELECTION OF TOLERANCE CLASS:

Given in Table 8 for information.

Material	Technology	Tolerance Class				
		1	2	3	4	5
Non-ferrous metals	Metallic dies, Shell moulds, High precision moulds	Precision work in mass production	Precision work in mass production	Large batch production	--	--
	Sand cast, Centrifugally cast	--	--	Large batch production	Piece to batch production	Piece to small batch production
GCI, Malleable and SG iron	Expandable pattern (Investment process)	Most precision work	--	--	--	--
	Metallic dies, CO2, shell moulds, High precision moulds	--	Precision work in mass production	Large batch production	Piece to batch production	--
	Sand cast, Centrifugally cast		Sample castings in mass production	Large batch production	Piece to batch production	Piece to small batch production
Cast steel	Expandable pattern	Most precision work	--	--	--	--
	Metallic dies, CO2, Shell moulds, High precision moulds and Ceramic moulds	--	Precision work in mass production	Large batch production	Piece to batch production	--
	Sand cast, Centrifugally cast	--	--	Large batch production	Piece to batch production	Piece to small batch production

6.0 SPECIFYING OF TOLERANCE CLASS:

The tolerance class required shall be specifically mentioned in the casting drawing.

NOTE: If required, BHEL may specify closer or liberal tolerance, other than the ones specified above, which may be indicated in the drawing/order.

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SPECIFICATION FOR AIR DRYING PAINT FINISH FOR TRACTION MACHINES (THIS SPEC. SUPERSEEDS SPEC. NO. BP0674184)

1. GENERAL:

This standard details the process to be followed to provide the standard paint finish for traction motors, traction generators/alternators, motor generators, motor alternators & ECC, Auxiliary machines, oil rig motors & alternators for application in Indian Railways/Oil Rigs. This standard also covers the painting requirements of traction machines/oil rig machines for coastal areas/export. The finishing of the outer surfaces of the field coils and armature, including commutators and creepage surfaces, is covered by the appropriate Insulation Process Specifications where a special finish is required, it will be called for on the appropriate drawings and specification sheets.

2. COMPLIANCE WITH STANDARDS:

This standard to be used along with corporate standard AA0674123.

3. MATERIALS:

3.1 Materials Required:

The finish painting of different traction machines/oil rig machines shall be as per table-4 of the specification unless otherwise mentioned in the drawing/work order/MID.

Note: The materials shall be used after ensuring that material TC's is as per the requirement of paint specification & expiry date of paint is not crossed.

3.1.1 Primer Paint:

i) Anti Corrosive priming paint to AA56101 (Red).

ii) Inorganic ethyl zinc silicate primer to AA56113.

3.1.2 Intermediate Paint:

i) High build intermediate epoxy paint to AA56112.

3.1.3 Finish Paints:

i) **Polyurethane finishing paint to AA56142:** For requirements of Industrial, Oil rigs & Traction machines including for coastal areas & export.

ii) **Paint to AA56128 (Aluminum):** For blower motors.

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iii) Oil Resistant Air Drying Synthetic Enamel to AA56132 (Jasmine Yellow shade): For surfaces in contact with lubricant.

iv) Epoxy Red Gel Coat (Base, Hardner & Diluent) to BP27476 or Anti Tracking Red Insulating Varnish to BP 27599 or Becktol Red- Prop of M/s Dr Beck & Co.Pune: For coils & insulation.

v) Anti Tracking Epoxy based finishing paint to CIT-033: For interior surfaces of frame & pole pads.

vi) Silicone based finishing paint to CIT-064: For field coils & pole assy. and connections.

vii) Grey Insulating Enamel to BP 27595: For terminal box interiors.

3.1.4 Thinners:

The application of thinners for different primer/finish paints are as given in clause 3.2.

i) White Spirit Gr. 145/205 to AA56701.

ii) Xylole-Industrial Solvent Grade to AA56703.

iii) Special Thinner for Epoxy Red Gel Coat/MEK.

iv) Derusting Solution (hydrochloric acid/sulphuric acid) to BP0690086.

3.2 Consistency of Materials at normal shop temperature in cup No.4 of IS:3944:

Paint	Thinner	Applicant	Consistency in Seconds to 27^0 C
AA56101 (Red)	White spirit	Spray	30±2 sec
AA56128 (Aluminum)	White spirit	Spray	30±2 sec
AA56142	As recommended by supplier	Spray	30±2 sec
AA56132(Jasmine Yellow)	White Spirit	Spray	30±2 sec
BP25795	Xylole	Spray	30±2 sec
BP27476/ BP2799 Becktol Red.	Special Thinner/ MEK	Spray	30 – 40 sec

For application by spray, the paints shall be obtained ready for use or thinned down to the flow time shown on the chart when measured at the shop temperature. The consistency of the paint require adjustment, the appropriate thinner given in the above chart shall be used.

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3.3 Compatibility chart for Primer Paint, Intermediate Paint & Finish Paint:

Primer Paint	Intermediate Paint	Finish Paint
AA56113	AA56112	AA56142
AA56101	-	AA56128

For achieving better quality of painting, the combinations of primer paint, intermediate paint & finish paint as mentioned in above table shall be used.

3.4 MIXING OF PAINTS:

3.4.1 Before application, any skin formed on the paint in the tin shall be carefully removed, any settled pigment broken up and loosened, and the paint shall be thoroughly stirred to ensure complete and uniform mixing of the constituents. Care shall be taken to avoid air entry into the paint whilst stirring.

3.4.2 AA56113 PRIMER:

AA56113 primer as supplied consists of two separate ingredients viz primer base and accelerator. Shortly before use mix together primer base and accelerator in the proportion 1:1 by volume or as recommended by supplier, care being taken not to entrain air while mixing. It is important that only small quantity of primer which can be consumed within 4 hours can be mixed. Further thinning of the paint prepared as above is not required for application by spraying.

3.4.3 EPOXY RED GEL COAT (BP27476):

This consist of 3 parts viz Epoxy red gel coat, Hardner EH411 and Diluent C. These to be mixed in the ratio 100:40:10 by weight. Should the consistency of the paint require adjustment the same to be done by using special Thinner/MEK.

4. APPLICATION :

A complete paint (as per Table 1, 2, 3 & 4) should be applied so that the equipment has a well finished appearance & adequate protection against corrosion. It is important that each coat of paint is completely dry before the next is applied. **The paint shall be applied by spraying/air less spraying only.**

5. PROCESS FOR PAINTING OF TRACTION/OIL RIG/INDUSTRIAL MACHINE COMPONENTS:

For the painting of Traction/Oil rig/Industrial machines components, the process mentioned in painting scheme no. 8 of annexure-II(a) of corporate standard AA0674123 shall be followed.

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TABLE NO. 1

FINISHING PAINT FOR NON-ROTATING PARTS OF TRACTION MACHINES

Part	Traction Motors		Other Machines	
	Paint	Coats	Paint	Coats
Exterior surfaces of machines including gearcase	AA56142 (Black)	2	AA56142 (Traffic Green)	2
	AA56142 (Traffic Green)	2	AA56142 (Light Grey)	2
	AA56142 (Light Grey)	2		2
Interior Surface of machines	CIT-033 (See note-2)	2	CIT-033 (See note-2)	2
Surface in contact with Lubricant	AA56132 (Jasmine Yellow)	2 2	AA56132 (Jasmine Yellow)	2 2
Terminal Box Interiors	BP27476/ BP27599 Becktol Red.	2	BP 27595	2
Field coils & pole assy. and Connections	CIT-064	2	CIT-064	2
Brush gear and brush gear Insulators	Plant Standard BP0674183 to be followed			

NOTES:

1. Light alloy & glass fibre cover and other readily detachable parts in the traction machines shall not be painted.
2. Interior surface of frames & pole pads to be painted with CIT-033 for adjacent coils, cable etc.
3. Epoxy bonded components must not be painted prior to bonding.
4. The paint/colour of finish painting in different traction machines/oil rig machines is mentioned in table-4 of this specification.

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TABLE-2
FINISHING PAINT FOR ROTATING PART OF TRACTION MACHINES

Part	Paint	Coats	Remarks
Steel Fans:			
1) TM4601, TM4603	AA56142 (Traffic Green)	2	-
2) AG3101, AG2702, TA10102	AA56142 (Light Grey)	2	

TABLE-3
FINISHING PAINT FOR MISCELLANEOUS EQUIPMENT

Equipment	Part	Paint	Coats
Eddy Current Clutch and gear boxes surface	Steel surfaces	AA56142 (Traffic Green)	2
	Coil	See Insulation Spec.	-
	Interior of gear box	AA56132	2

TABLE-4
PAINT/COLOUR FOR FINISH PAINTING OF DIFFERENT TRACTION/OIL RIG MACHINES

Note: The finish painting of different traction machines/oil rig machines shall be as per table-4 of the specification unless otherwise mentioned in the drawing/work order/MID.

Type of machine	Paint/Colour*
A) Traction Motors:	
TM4906AZ	AA56142(Black)
TM4907BZ	
TM4603AZ	
HS15250A	
TM3701AZ	
TM4605AZ	
TM5002AZ	AA56142 (Light grey) (631 export) & Black for WDP2
TM4303CZ/BY & TM4303DY	AA56142 Traffic Green for CZ/BY (EMU & MEMU application) & Black for DY (DEMU application)

Type of Machine	Paint/Colour*
IM3601AZ	AA56142(Light Grey)
IM3301AZ/IM3302AZ	
TAO-659	
OIM5101AZ	
IM4504AZ	
IM4506AZ	
6FRA6068	As per customer/BHEL drawing
6FXA7059	
OM4903BX/CX	AA56142(Traffic Green)
TM4601BY/BX	
IM4507AZ/BZ	AA56142(Black)
B) Traction Alternators & Generators:	
All traction alternators, Generators, AG's & Gear boxes	AA56142(Light Grey)
ECC9005/2/M	AA56142(Traffic Green)
BM2101AZ	AA56128 (Aluminium)
DY3423/M	
MG51BX/CW	AA56142(Black)
AG903CW	
AG1404AZ	
NA5105AZ (490KW)	IS:14209 (Colour: Pista green shade 216 of IS:5)
TG5005AZ (500KW MMG)	
TG10932AZ (1MW MMG)	
NA6401AZ (1350KW)	

Note:-

(*) – Latest customer PO/specification/drawing/Engineering information/MID shall be referred for any changes in paint grade/colour of a machine.

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Annexure-I

Acceptance criteria for Painting of Traction Machines

The acceptance criteria for the check points, which are to be ensured during painting of Traction Machines as per the requirements of specification TM94217, are as given below. The supplier to furnish below mentioned check points for each component in the format as per annexure-II along with consignment.

1) Checking of Painting Material:

Sl. no.	To be checked	Acceptance criteria
i.	Expiry date of primer & intermediate paint.	Primer & intermediate paint shall be within expiry date.
ii.	Expiry date of finish paint.	Paint shall be within expiry date.
iii.	Verification of supplier's TC as per paint specification.	Painting material shall be used only after verification of TC.

2) Surface Preparation (Before Primer Painting):

Sl. no.	Operation	Acceptance criteria
i.	Dressing & grinding of all flame-cut edges, welds & any major imperfections.	No sharp edges or protrusions.
ii.	Degreasing by using white sprite to AA56701 & removal of varnish in wet condition.	Free from grease & varnish.
iii.	Removal of light rust by hydrochloric acid/sulphuric acid to BP0690086 and removal of heavier localized rust by using emery cloth, steel scratch brush or portable power tool with abrasive tool & then applying hydrochloric acid/sulphuric acid.	Surface should exhibits grey colour in place of red rust.
iv.	In case surface is widely rusted to such an extent that pitting with hard rust flakes is exhibited, the surface shall be sand/shot blasted.	Surface should exhibits clean & grey colour in place of red rust.
v.	Visual inspection of condition of surface of components before application of primer paint.	As per the requirement of clause 5.
vi.	Checking of surface finish of the components.	Surface finish shall be as per IS:3073.

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3) Measurement of Primer & Intermediate Paint Thickness (As per AA0674105):

Sl. no.	Description of Paint	Acceptance criteria
i.	Measurement of primer paint thickness after one coat of primer paint as per clause 2.1.1, 2.1.2 & 2.1.3 of AA0674105.	60-90 microns
ii.	Measurement of total paint thickness (primer + intermediate) after one coat of intermediate paint as per clause 2.1.1, 2.1.2 & 2.1.3 of AA0674105.	120-180 microns

4) Inspection for Process Control (After Finish Painting):

Sl. no.	Type of inspection	Acceptance criteria
i.	Visual inspection of finished components for various paint film defects such as gloss, uniformity of shade, wrinkle, orange peel effect, blistering etc.	Free from paint film defects.
ii.	Measurement of total thickness of paint as per clause 2.1.1, 2.1.2 & 2.1.3 of AA0674105.	160-220 microns with high spots of 250 microns

5) Adhesion by Tape Test (As per AA0674105):

Sl. no.	Description of Test	Acceptance criteria
i.	Test is carried out by the application of a cross-cut test in accordance with BHEL Standard AA0674105.	Detachment of small flakes of the coating at the intersections of the cuts. A cross cut area not significantly greater than 5% is affected.

Note: The sample size for quality checking of painting of traction machines should be as per IS: 2500 Part-2, Level 4 and AQL 1% as mentioned below:-

Lot size	Sample size
2 to 8	3
9 to 15	3
16 to 25	4
26 to 50	5
51 to 100	7
101 to 150	10
151 to 300	15
301 to 500	20

Imp.: When sample size equals or exceeds lot size, every item in the lot shall be inspected.

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Annexure-II

Checklist for Painting of Traction Machines

Machine type: **Machine/Component no.:**

Date of Painting:

Sl. No.	Check points as per the requirement of annexure-I	Checking Remark (100%TP & 20%QC)
1.	**Checking of Painting Material:**	
	i. Expiry date of primer & intermediate paint	(ok/not ok)
	ii. Expiry date of finish paint	(ok/not ok)
	iii. Verification of supplier's TC as per paint specification	(ok/not ok)
2.	**Surface Preparation (Before Primer Painting):**	
	i. Visual inspection for absence of sharp edges or protrusions	(ok/not ok)
	ii. Visual inspection for absence of grease & varnish	(ok/not ok)
	iii. Visual inspection for absence of light rust	(ok/not ok)
	iv. Visual inspection for absence of widely spread rust	(ok/not ok)
	v. Visual inspection for condition of surface as per the requirement of clause 5	(ok/not ok)
	vi. Surface finish of the component	.....microns (ok/not ok)
3.	**Measurement of Primer & Intermediate Paint Thickness:**	
	i. Paint thickness after one coat of primer paint	.....microns (ok/not ok)
	ii. Total paint thickness (primer + intermediate) after one coat of intermediate paint	.....microns (ok/not ok)
4.	**Inspection for Process Control (After Finish Painting):**	
	i. Visual inspection of finished component for absence of paint film defects	(ok/not ok)
	ii. Total thickness of paint	.....microns (ok/not ok)
5.	**Adhesion by Tape Test (As per AA0674105):**	
	i. Adhesion by tape test	(ok/not ok)

Abbreviations:-

TP – Task Performer, QC – QTM/BHEL Authorized Quality Inspection Agency

Note: **1)** For the components supplied by the supplier in finish painted condition, the supplier to furnish dully filled checklist for each component along with consignment.

2) The acceptance criteria shall be as per annexure-I.

(Task performer's signature) **(QC's signature)**

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CARBON STEEL CASTINGS-FUSION WELDING QUALITY

1.0 GENERAL

This specification governs the quality requirements of Carbon Steel Castings-Fusion Welding Quality.

2.0 APPLICATION

For pressure containing parts for high temperature service and of quality suitable for assembly with other castings or wrought steel parts by fusion welding.

3.0 CONDITION OF DELIVERY

Normalised / Normalised & tempered

Rough machining of the castings shall be carried out, unless otherwise specified in BHEL order/drawing.

Castings shall not be painted

4.0 COMPLIANCE WITH NATIONAL STANDARDS

There is no Indian standard covering this material. However, assistance has been derived from ASTM A 216-1993, Gr: WCC, in preparing this specification.

5.0 DIMENSIONS AND TOLERANCES

The castings shall be true to the pattern/drawing.

Holes for machining up to and including 50 mm in diameter are to be cast solid, unless otherwise stated in BHEL order/drawing.

Unless otherwise specified in BHEL order/drawing, untoleranced dimensions for the castings shall be as per tolerance class 4 of BHEL standard AA 023 04 02.

Revisions : 36th MOM of MRC-FCF+HTM			APPROVED : INTERPLANT MATERIAL RATIONALISATION COMMITTEE-MRC (FCF+HTM)		
Rev. No. 09	Amd.No.	Reaffirmed	Prepared HYDERABAD	Issued Corp. R&D	Dt. of 1st Issue MARCH, 1978
Dt: 01.10.2005	Dt :	Year;04-11-2011			

6.0 MANUFACTURE

The steel for the castings shall be made by basic electric furnace process or such other process as may be agreed to between BHEL and the manufacturer.

The steel shall be fully killed.

7.0 HEAT TREATMENT

Heat treatment shall be carried out at suitable temperatures to give the properties specified.

Any flame or arc cutting which may have to be done, shall be carried out before heat treatment.

Test pieces shall also be heat treated along with the castings they represent.

8.0 FINISH

All castings shall be properly fettled and dressed and all surfaces shall be thoroughly cleaned.

Machined surfaces shall have the surface finish as indicated in the drawing

9.0 FREEDOM FROM DEFECTS

Castings shall be free from defects such as porosity , blow holes, sand inclusion, shrinkage, cavities, hard spots, cold shuts, cracks, etc., which may adversely affect machining and utility of castings.

When it is necessary to remove risers by flame cutting, care shall be taken to make the cut at a sufficient distance from the body of the casting so as to prevent any defect being introduced into the casting due to local heating.

10.0 CHEMICAL COMPOSITIION

The melt analysis of steel and the permissible variation in the composition of the castings from the melt analysis shall be as specified below:

Element	Melt analysis, Percent, max	Permissible Variation, percent
*Carbon	0.25	0.02
Silicon	0.60	0.05
*Manganese	1.20	0.06
Sulphur	0.045	0.008
Phosphorus	0.040	0.008

Note: 1. In the interest of uniform welding, the concentration of the unspecified alloying elements shall not exceed the limits specified below. Whenever specified in the enquiry/order, the test results of these elements shall also be included in the test certificate. However, the manufacture shall ensure that these elements are within the limits specified.

Element	Percent, Max.
Copper	0.30
Nickel	0.50
Chromium	0.50
Molybdenum	0.20
Vanadlum	0.03
1. Total content of these unspecified elements	1.00

2. For each reduction of 0.01% below the specified maximum carbon content, an increase of 0.04% Mn above the maximum specified will be permitted up to a maximum of 1.40%.

11.0 TEST SAMPLES

Manufacturers shall carryout mechanical testing as per following sampling plan.

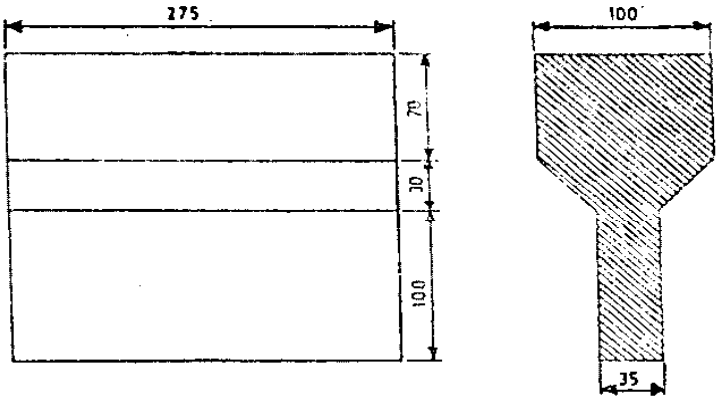
11.1 Unless otherwise specified for castings weighting up to 500 kg. piece weight one keel block, separately cast per melt per heat treatment batch shall be supplied according to the sketch given below:

11.2 Unless otherwise specified castings weighing more than 500 kg shall be provided with integrally cast keel block.

11.3 Retests shall be carried out as per IS : 8800

11.4 Keel blocks with proper identification and representative of the castings shall be supplied along with the consignment for testing at BHEL works.

DETAIL OF KEEL BLOCK



ALL DIMENSIONS IN mm

12.0 MECHANICAL PROPERTIES:

The test pieces, after being heat treated as per clause Cl.7.0 above, shall show the following properties:

12.1 Tensile

The test pieces shall show the following properties when tested in accordance with ASTM A 370

Tensile strength	:	485 - 655 N/mm^2
Yield strength	:	275 N/mm^2, min.
Elongation on 50mm gauge length	:	22 percent, min.
Reduction in area	:	35 percent, min.

12.2 Hardness (Brinell): for information only:

150 - 205 HB.

13.0 NON-DESTRUCTIVE TESTS:

The following tests shall be conducted:

1) Ultrasonic examination to BHEL standard AA 085 01 04 / AA 085 01 05
2) Liquid penetrate examination to BHEL standard AA 085 0131.
3) Magnetic particle examination to BHEL standard AA 085 01 33 and norms of acceptance as per BHEL standard AA 085 01 34.

Norms of acceptance shall be as specified in BHEL order/drawing

14.0 REPAIR OF CASTINGS

The manufacturer without the prior permission of BHEL shall not carry out repair of castings.

15.0 SCOPE OF THIRD PARTY INSPECTION:

Wherever, separate quality plan is not attached, the scope of third party inspection shall be as follows:

1. Review of supplier's declared chemical composition.
2. Selection of test samples for mechanical tests and witness of mechanical tests.
3. Witness of Non-destructive tests as applicable.
4. Review of HT charts.
5. Dimensional inspection.

16.0 TEST CERTIFICATES

Three copies of test certificates shall be supplied unless otherwise stated in BHEL order, preferably in the test certificate format annexed to this specification (Annexure -1).

In addition, the supplier shall ensure to enclose one copy of the test certificate along with their dispatch documents to facilitate quick clearance of the material.

The test certificate shall bear the following information:

i) Dimensional inspection.

ii) Detail of heat treatment

iii) Chemical composition & unspecified alloying elements whenever called for

iv) Results of mechanical tests

v) Results of NDT tests.

17.0 PACKING AND MARKING

Castings shall be suitably packed to prevent corrosion and damage during transit. Machined surfaces shall be properly protected with anticorrosive compounds. Each package or casting (when supplied separately) shall be legibly marked with the following information.

AA 195 11: C.S. Castings - F.W. Quality
BHEL Order No.
Consignment/Identification No.
Melt No.
Weight
Supplier's Name

18.0 REFERRED STANDARDS (Latest Publications Including Amendments):

1. AA 023 04 02	2. AA 085 01 04	3. AA 085 01 05	4. AA 085 01 31
5. AA 085 01 34	6. ASTM A 216	7. ASTM A 370	8. IS : 8800

ANNEXURE 1 - RECOMMENDED TEST CERTIFICATE FORMAT FOR CASTINGS

SUPPLIERS'S NAME AND ADDRESS

1. Customer :
2. TC No. & Date :
3. PO No. :
4. Process of Melting :
5. Deoxidisation Process
6. Cast No. & Date :
7. Batch No. :
8. Heat Code :
9. Spec., No. :
10. Test Bar Size

II. CASTING COVERED BY T.C.

Sl. No.	Drawing No. & Item No.	Description	Quantity & Weight

12. CHEMICAL COMPOSITION (PERCENT)

Element	C	Si	Mn	S	P										
As per Spec. Min.															
As per Spec. Max..															
Actual Values.															

13. HEAT TREATMENT
(To be accompanied by Recorder Chart, wherever called for)

Condition	Temp.°C	Soaking Time. Hrs..	Cooling Medium

14. MECHANICAL PROPERTIES

	T.S. N/mm2	Y.S. 0.5/0.2% Proof N/mm2	% E on GL 5.65 SO	% R.A. Min	Hardness BHN Min. 3 Values	Impact Value, Joules	Bend	
As per Spec. Min.								
As per Spec. Max.								
Actual Values.								

15. Surface Finish (When called for in the order/drg)	
16. DIMENSIONAL INSPECTION	

17.NON-DESTRUCTIVE TESTS

Nature of Test	Acceptance Level	Instrument used	Range	Results	Any other details
Ultrasonic					
Radiographic					
Dye Penetrant/ Magnetic Particle					

18. OTHER TESTS, IF ANY (MICRO-Scopic, Hydraulic, Etc.)	
19. IDENTIFICATION ON CASTING AS PER CPS.	

We hereby certify that the items mentioned above have been tested and inspected in our presence and are found to be in accordance with the drawings, specifications and purchase order.

Signature & Seal of the Inspecting Officer
(Purchase Representative)

Signature and Seal of the Chief of Quality Control
Chief Metallurgist of the Supplier.

Date :

Date :

INSTRUCTION:

a) If steel is produced by LD or Oxygen process, Nitrogen content should be furnished and shall not exceed 0.009%
b) Test Certificates are to be furnished as per Purchase Order and Specifications, in A4 Size transparent paper.
c) All the entries including signature should be in black ink.
d) If testing is done by outside agencies, the original TCs shall be furnished.
e) The actual Test Certificate may run into more than one A4 size paper, if needed, to facilitate filling up of details.

CLASSIFICATION OF WELDS, THEIR INSPECTION, TESTING AND ACCEPTANCE

1.0 SCOPE

1.1 This standard defines four grades of welds in steels viz. grade-I, grade-II, grade-III and grade-IV that are carried out in BHEL. It also covers the inspection requirements, testing and acceptance standards for these grades of welds to ensure that quality welds are produced.

1.2 Welds occurring on products manufactured to any particular code of practice by contractual or statutory obligations shall follow welding, inspection, testing acceptance etc. as per the relevant codes.

1.3 The grade of welds shall be chosen and specified in the drawings based on considerations of weld joint efficiency and the type of joints.

2.0 CLASSIFICATION

2.1 GRADE-I

Grade-I shall apply to full penetration butt welds, full throat welds and corner welds for following applications.

a) Welds subjected to stresses more than 60% of yield point of the welded metal at working temperature.

OR

b) Structures subjected to highly dynamic or severe alternating stresses.

OR

c) Structures operating above 250°C or below 0°C

2.2 Grade-II

2.2.1 Grade-II shall apply to full penetration or partial penetration butt welds for following applications

a) Welds subjected to stresses between 40 to 60% of yield point of the welded metal at working temperature

OR

b) Structures subjected to dynamic or alternating stresses of medium intensity or severe static stresses.

OR

c) Structures operating above 150° C to 250° C

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2.2.2 Grade-II partial penetration welds are not desirable and shall only be used where stress concentration at the root of welds is not of in significance.

2.3 GRADE-III

2.3.1 Grade-III shall apply to full penetration or partial penetration butt welds and fillet welds for following applications

a) Welds subjected to stresses below 40% of yield point of the welded metal at working temperature.

OR

b) Structures subjected to light to medium static stresses and no dynamic loading is involved.

OR

c) Weld seams which are not possible to be checked for leaks by conventional methods of testing such as hydraulic testing etc.

2.4 Grade-IV

2.4.1 Grade-IV shall be specified for all general production welding of lightly stressed nature and for weld seams which can be checked by hydraulic testing for leaks.

2.5 Qualified welding procedure and welders shall be used for all grades of welds.

2.5.1 For the purpose of classification of welds a compound weld i.e. a combination of butt and fillet welds, shall be considered as butt weld.

2.5.2 Type of joints not covered in the standard shall be decided by the designer in consultation with welding technologist.

3.0 INSPECTION REQUIREMENTS

3.1 Table-1 indicates the inspection requirements during various stages of welding for each grade of weld.

Table-1 Inspection Requirements during various stages of welding

Requirement	Grade-I	Grade-II	Grade-III	Grade -IV
3.1.1 Type of joint	Stress relieved full penetration butt joints welded from both the sides or one side.	Stress relieved full penetration or partial penetration butt joints welded from both sides or one side.	Full penetration or partial penetration butt welds or fillet welds, welded from both the sides or one side.	All types of general production welds. Can be used for partial, full penetration fillet or butt welds, welded form both the sides or one side.
3.1.2 Weld joint Efficiency (Applicable for full Penetration butt Welds only)	1.00	0.85	0.70	0.55
3.1.3 Edge preparation before welding	(a) Weld preparation shall be made by machining/ flame cutting as called for in drg. The flame cut preparation shall be ground to about 1.5 mm to get bright smooth face. (b) Visual examination of weld preparation, supplemented by random dye penetrants testing and visual examination for fit up. In case of Steam Turbine Cylinders & Chest etc. 100 mm width to be radiographed as specified in relevant drawing. (c) Examine ultrasonically for lamination and harmful segregation in an area 75 mm deep along the edge preparation, if the visual or dye penetrant inspection reveals defect	(a) Weld preparation shall be made by flame cutting and grinding. (b) Visual examination of weld preparation and for fit up.	(a) Weld preparation shall be made by flame cutting and grinding. (b) Visual examination of weld preparation and for fit up.	(a) Weld preparation shall be made by flame cutting or grinding (b) Visual examination of weld preparation and fit up.

CORPORATE STANDARD

Requirement	Grade-I	Grade-II	Grade-III	Grade -IV
3.1.4 Back chipping of run in joints welded from both sides	(a) Back chipping shall be done. (b) 100% visual examination shall be carried out (magnifying glasses can be used) and supplemented by random dye penetrant test/magnetic particles test.	(a) Back chipping shall be done only in the case of full penetration welds. (b) 100% visual examination shall be carried out (magnifying glasses can be used) and supplemented by random dye penetrant test/magnetic particles test.	(a) Back chipping shall be done only in the case of full penetration welds. (b) 100% visual examination shall be carried out (magnifying glasses may be used). If considered necessary will be examined by dye penetrant/magnetic particles test.	(a) Back chipping not required.
3.2 On completion of butt welds	(a) 100% visual examination shall be carried out in the vicinity of welds for the strikers, undercuts, cleats, tacks & blended. The entire butt weld area & heat affected zone shall be dye penetrant/magnetic particles tested. (b) 25 to 100% of weld length shall be examined by radiographic/ultrasonic tests depending upon the product and customer requirement. Extent of percentage of testing shall be specified on the drawing by the designer. Weld to be radiographed need not be ground or otherwise smoothened for the purpose of radiographic test unless its surface irregularities or junction with base metal would interfere with the interpretation of weld defects observed in the radiographs.	(a) 100% visual examination shall be carried out in the vicinity of welds for arc strikes, undercuts, cleats, tacks & gouges & shall be ground and blended. The entire butt weld area & heat affected zone shall be dye penetrant/magnetic particles tested. (b) 10% of weld length shall be examined by radiographic/ ultrasonic tests depending on the product & customer requirement. Weld to be radiographed need not be ground or otherwise smoothened for the purpose of radiographic test unless its surface irregularities or junction with the base metal could cause objectionable weld defects to be observed in the radiographs.	(a) 100% visual examination shall be carried out in the vicinity of welds for arc strikes, undercuts, cleats, tacks & gouges & shall be ground and blended. The entire butt weld area shall be dye penetrant/magnetic particles tested. (b) Ultrasonic or radiographic testing is not required unless specified by customer/product needs.	(a) Weld shall be subjected to visual examination, only zones of doubt may be subjected to dye penetrant/magnetic particle testing.

Requirement	Grade-I	Grade-II	Grade-III	Grade -IV
As above	(c) Weld surface shall be ground smooth when tested by ultrasonic means. On either side where the probe has to traverse, the search surface should be free of weld spatter, dirt and loose scale so as to permit intimate contact with the surface.	(c) Weld surface shall be smooth when tested by ultrasonic means and sharp ripples on weld surface to be removed by grinding or chipping.	(c) Weld surface shall be ground smooth when tested by ultrasonic means and sharp ripples on weld surfaces to be removed by grinding or chipping.	
Note: Ultrasonic test or Radiographic test shall be carried out before heat treatment. For items subject to critical service conditions specified by the designers, ultrasonic/radiographic tests may be repeated after heat treatment.				
3.3 On completion of fillet welds	Not applicable, as fillet welds are not to be used for grade-I welds.	Not applicable, as fillet welds are not to be used for grade-II welds.	Quality of weld shall be assessed on the basis of; (a) Fit up of the joint (b) Visual appearance of the finished weld (c) Dye penetrant/magnetic particles inspection of the complete length of weld shall be carried out only in case of doubt. (d) Air testing shall be carried out if considered necessary.	Weld shall be subjected to visual examination and only zones of doubt may be subjected to dye penetrant/magnetic particle testing.

3.3.1 JOINT EFFICIENCY

a) The joint efficiency will be less by 5% of the specified joint efficiency, if the joint is welded from one side only.

b) The joint efficiency for un-stress relieved fabrication of grade-I and grade-II will be 5% less than the specified joint efficiency. For the other grades joint efficiency is given on the basis of joints without stress relieving.

3.3.2 ULTRASONIC/RADIOGRAPHIC EXAMINATION-EVALUATION AND RETESTS

a) In case the above examination reveals that the examined length of the weld is acceptable as per the standard, the entire representative length of the weld shall be considered acceptable.

b) In case this examination reveals that the examined weld is un-acceptable as per this standard the quantum of length of weld inspected adjacent to the defective region shall be doubled for radiographic/ultrasonic test. If the additional examination also shows that the weld is unacceptable the 100% radiographic/ultrasonic examination of all welds must follow, for acceptance or rejection.

c) If on examination of double the length it is found acceptable then the defective portion noticed earlier shall be rectified and retested for ultrasonic/ radiographic examination.

3.3.3 Welded joints will be subjected to hydraulic or other leak tests called for on the drawing.

3.3.4 Hydraulic tests if called for shall be carried out after stress relieving (if stress relieving is required).

4.0 ACCEPTANCE STANDARDS

4.1 Unacceptable defects in any grade of weld are detailed below and are dependent upon whether the joint being welded is a full penetration butt weld, partial penetration butt weld or a fillet weld. If these defects are not present then the welds are considered acceptable.

4.2 UNACCEPTABLE DEFECTS

Table 2, 3, 4, 5 below give unacceptable defects for grade-I, grade-II, grade-III & grade-IV welds respectively.

TABLE-2 UNACCEPTABLE DEFECTS FOR GRADE-I WELDS

Nature of defect	BUTT WELDS		FILLET WELDS
	Full Penetration	Partial Penetration	
Crack	Unacceptable		
Lack of fusion	Unacceptable		
Lack of Penetration	Unacceptable (a) If the individual slag line is greater than ⅓ T for T upto 56mm. 19mm for T above 56mm. OR (b) If the width of the individual slag line is greater than 1.6 mm for weld thickness upto 19mm. 2.4 mm for weld thickness from 19 mm to 56 mm. 3.2 mm for weld thickness above 56 mm.	Not applicable	Not applicable
Group of slag inclusion	Any group of slag inclusions in a line with an aggregate length greater than T in a length shorter than 12T is unacceptable, except when the distance between the successive imperfections exceeds 6L where L is the length of the longest imperfection in the group.		
Porosity	Porosity in excess of that shown in the ASME Sec VIII Div-1 appendix 8 is acceptable. The radial (through wall) nature of worm holes as to be considered in stringent level compared to porosity.		
Surface defects	Weld bead shall smoothly match the base metal. No undercut is acceptable.	Not applicable	Not applicable

POROSITY FOR GRADE-I WELDS OF STEAM TURBINE COMPONENTS ONLY

In case of grade-I welds of Steam Turbine components e.g. H.P & I.P. Cross under pipe welds and any other primary H.P or I.P. Steam Pipe welds, the porosity shall be adjudged as given below

a) The total area of porosity which when projected radially through the weld shall not exceed 0.025 cm^2/cm thickness of the weld in any square cm. of projected weld area (or shall not exceed 0.01 sq. inch per inch thickness of the weld, in any sq. inch of projected weld area). If it exceeds the weld is not acceptable.

b) Any single pore or gas hole having a diameter greater than those below shall be unacceptable

1.6 mm for weld thickness upto and including 12 mm.

2.4 mm for weld thickness over 12 mm upto and including 25 mm.

4 mm for weld thickness over 25 mm upto and including 50mm.

4.3 mm for weld thickness over 50 mm upto and including 75 mm.

5.6 mm for weld thickness above 75 mm.

c) Aligned porosity shall be acceptable provided the summation of the diameters of the pores is not more than T in a length of 12T and each pore is separated by a distance atleast 6 times the diameter of the largest adjacent pore.

Surface defects: Welds with significant undercuts or overlaps which form a notch at the toes of the welds or abrupt ridges or valleys or excessive weld reinforcements are not acceptable.

Note: 'T' is the thickness of thinner plate being welded in mm.

TABLE-3 UNACCEPTABLE DEFECTS FOR GRADE-II WELDS

Nature of defect	BUTT WELDS		FILLET WELDS
	Full Penetration	Partial Penetration	
Crack	Unacceptable	Unacceptable	
Lack of fusion	Unacceptable	Unacceptable	
Individual slag line	Unacceptable if the individual slag line is longer than ⅔ T. The maximum length of acceptable imperfections shall be 19 mm. Any imperfection shorter than 6 mm shall be acceptable for any plate thickness.		
Group of slag inclusion	Any group of slag inclusion in line with an aggregate length greater than T, in a length of 6 T (or proportionately for weld length shorter than 6 T) is unacceptable when the distance between the successive imperfections exceeds 3 L, where 'L' is the length of longest imperfection in the group.		Not applicable
Porosity	Excessive porosity is unacceptable. It shall be assessed as per porosity chart given in ASME Sec VIII Div-1 Appendix 8.		
Surface defects	The undercut shall not exceed 0.5 mm for the thickness of plate upto and including 20 mm and 0.8 mm beyond 20 mm. The left out thickness after undercut shall not be however less than the minimum required thickness.		

TABLE-4 UNACCEPTABLE DEFECTS FOR GRADE-III WELDS

Nature of defect	BUTT WELDS		FILLET WELDS
	Full Penetration	Partial Penetration	
Crack	Unacceptable	Unacceptable	Unacceptable
Lack of fusion	Unacceptable	Unacceptable	Unacceptable
Lack of penetration	Unacceptable	Unacceptable	Unacceptable
Slag inclusion	Unacceptable if the individual slag line is longer than T. The maximum length of acceptable imperfection shall be 25 mm. Any imperfection shorter than 6 mm shall be acceptable for any plate thickness.		Unacceptable
Group of slag inclusion	Any group of slag inclusion in line with an aggregate length greater than T, in a length 4 T (or proportionately for weld length shorter than 4 T) is unacceptable except when the distance between the successive imperfections exceeds 3L where 'L' is the length of longest imperfection in the group.		
Porosity	Excessive porosity is unacceptable		
Surface defects	Weld with pronounced undercuts, overlaps or abrupt ridges or valleys are not acceptable		
Leg lengths	Not applicable	Not applicable	In case of fillet weld the variation in leg lengths shall not exceed 3 mm provided the shorter length conform to required min. leg lengths.

Reinforcement: Reinforcement below 1.5 mm & beyond 3 mm is not acceptable

TABLE-5 UNACCEPTABLE DEFECTS FOR GRADE-IV WELDS

Nature of defect	BUTT WELDS		FILLET WELDS
	Full Penetration	Partial Penetration	
Crack	Any crack visible on the surface will not be acceptable		
Lack of fusion	Not applicable		
Lack of penetration	Not applicable		
Slag inclusion	Not applicable		
Groups of slag inclusion	Not applicable		
Porosity	Excessive porosity exposed to surface is not acceptable		
Surface defects	Welds with excessive amount of pronounced undercuts, abrupt ridges or valleys and spatters shall not be acceptable		
Leg lengths	Not applicable	Not applicable	

Reinforcement: Reinforcement below 1.5 mm & beyond 3 mm is not acceptable

4.3 PERMISSIBLE DEFECTS IN PARTIAL PENETRATION AND FILLET WELDS

4.3.1 Permissible defects in Grade-II/III partial penetration Butt Welds

Defects not exceeding those permitted i.e. Table-3 for Grade-II and Table-4 for Grade-III partial penetration butt welds and defects at the root of a weld in an area that shall not extend further than 3 mm from the bottom of penetration, when examined by non-destructive means.

4.3.2 Permissible defects in GRADE-III Fillet Welds

Defects not exceeding those permitted in Table-4 for grade-III fillet welds and defects at the root of the weld not exceeding further than 1.5 mm from the junction of the plates when examined by non-destructive testing means.

5.0 Referred Standards

1) ASME Sec VIII Div-1

बी एच ई एल BHEL	**CORPORATE PURCHASING SPECIFICATION**	AA10108 Rev No. 11 PAGE 1 of 2

STRUCTURAL STEEL-STANDARD QUALITY

(PLATES, SECTIONS, STRIPS, FLATS & BARS)

(ORDERING DESCRIPTION)

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1.0 GENERAL:

This specification governs the quality requirements of structural steel plates, strips, flats, bars and sections such as angles, beams, channels and tees etc. of IS: 2062 – 2011, Gr: E250, Quality A

2.0 APPLICATION:

For general engineering purpose.

3.0 CONDITION OF DELIVERY:

Plates, Bars & Sections: Hot rolled in straight lengths without twists & Bends

4.0 COMPLIANCE WITH NATIONAL STANDARDS:

Material shall comply with the requirements of IS: 2062 – 2011, Gr: E250, Quality A

Material offered to EN 10025-2:2004 Gr. S275JR is also acceptable. The tolerance on dimensions for plates shall comply with EN 10029.

5.0 DIMENSIONS AND TOLERANCES:

5.1 DIMENSIONS:

5.1.1 Sizes

Material shall be supplied to the dimensions specified on BHEL Order.

5.1.2 Length

Unless otherwise specified, hot rolled bars and sections shall be supplied in 3 to 6 metres length.

5.2 Tolerances:

5.2.1 The tolerances on hot rolled material shall comply with IS: 1852. However, no plate shall be under the specified thickness at any point.

Revisions: As per Cl. No. 38.1 of MOM of MRC-S&GPS			**APPROVED:** INTERPLANT MATERIAL RATIONALISATION COMMITTEE – MRC(S&GPS)		
Rev No.11	Amd No.	Reaffirmed	Prepared	Issued	Dt. of 1st Issue
Dt:22-02-2014	Dt:	Year:	HPEP, Hyderabad	Corp.R&D	July, 1976

5.2.2 Straight for hot rolled bars:

Unless otherwise specified, the permissible deviation in straightness shall not exceed 5 mm in any 1000 mm length.

6.0 HARDNESS (BRINELL):

When tested in accordance with IS: 1500, the material shall show a brinell hardness in the range of 120-156 HB.

Note: Hardness test shall be conducted only when tensile test cannot be performed.

7.0 TEST CERTIFICATES:

Unless otherwise specified, three copies of test certificates shall be supplied.

In addition, the supplier shall ensure to enclose one copy of the test certificate along with their dispatch documents to facilitate quick clearance of the material.

The test certificate shall bear the following information.

AA10108 Rev.11 / IS:2062 Grade: E250 Quality A / EN 10025-2 Gr. S275JR,

BHEL order no., Melt no. Size, Results of chemical analysis and Mechanical tests, Supplier's name, Identification no. TC no., Signature of competent authority etc.

8.0 PACKING AND MARKING:

Plates shall be transported suitably to avoid damage during transit.

For plates below 10 mm thick, each pile (preferably of 16 plates) and each plate 10 mm thick & over shall be marked with melt no. AA10108, BHEL order no., Supplier's name, Identification no., Size & weight on any one corner and encircled with paint preferably of white colour.

9.0 REFERRED STANDARDS (Latest publications including amendments):

1) IS: 1500 2) IS: 1852 3) EN 10029

TME 2019	PRODUCT STANDARD TME DIVISION, BHOPAL	TM 12548 Rev. No. 01 PAGE 01 OF 04

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Specification for Identification Marking of Traction Machines Components

1.0 Scope: This specification governs the requirements for identification marking of all components of traction machines (except electrical items, hardwares & bearings) either manufactured in-house or outsourced in raw material, semi-finished or fully finished condition.

2.0 Identification marking of components: The component manufacturer shall provide the identification marking depending upon the type of component (raw material/semi-finished castings, raw material/semi-finished forgings & fabricated components, fully finished components or sheet metal components) manufactured by it as per guidelines given below:-

A) CASTED COMPONENTS:

Sl. No.	Condition of supply	Identification marking requirement
1.	Castings/ semi-finished castings	**a) Method of marking in castings:** Each casting shall be **embossed & punched** on un-machined surface/ **etched** on machined surface legibly and indelibly with following details:- **i) Supplier's name initial , Heat no.** ← To be embossed. **(Example: SAIL/341)** **ii) xxxxx , MM-YY** ← To be embossed/punched on cast surface or etched on machined surface. └ 4 digits of date of manufacturing in MM-YY format └ Manufacturer's unique job serial no. **(Example: 00345/0319)** **b) Method of marking in semi-finished castings:** Each casting shall be **embossed & punched** on un-machined surface/ **etched** on machined surface legibly and indelibly with following details:- **i) Supplier's name initial , Heat no.** ← To be embossed. **(Example: SAIL/341)** **ii) xxxxx , MM-YY** ← To be embossed/punched on cast surface or etched on machined surface. └ 4 digits of date of manufacturing in MM-YY format └ Manufacturer's unique job serial no. **(Example: 00345/0319)** **c) Size & location:** For size and location of identification marks, supplier to take prior approval from BHEL unless otherwise specified in the drawing.

Rev. No. 01	Distribution	Prepared	Checked	Approved
Date: 16/03/2019	TME – 2 MNX - 1 TXM – 1 TAM – 1 QTM – 1	(J. Kumar)	(R.Chaudhry)	(M.Verma)

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2.	Machined castings on labour basis	**a) <u>Method of marking after finish machining:</u>** **i) When embossed marking is not removed:** In case the embossed marking is not removed during finish machining of the component, the component shall be punched with following details below the already existing embossed marking:- **Supplier's name intial , xxxxx , MM-YY** └ 4 digits of date of manufacturing in MM-YY format └ Manufacturer's unique job serial no. **(Example: SAIL/341)** ←Already embossed. **ABCD/00345/0319** ← To be punched.
		ii) When embossed marking is removed: In case the component is machined all over & the embossed marking is removed, the same shall be re-punched on fully finished component. Date of finish machining in MM-YY format & manufacturer's details shall be punched below the above punched marking as per details given below:- **Supplier's name intial , xxxxx , MM-YY** └ 4 digits of date of manufacturing in MM-YY format └ Manufacturer's unique job serial no. **(Example: SAIL/341)** ← To be punched. **ABCD/00345/0319** ← To be punched. **b) <u>Size & location:</u>** For size and location of identification marks, supplier to take prior approval from BHEL unless otherwise specified in the drawing.
3.	Fully finished casted components	**a) <u>Method of marking in finished components:</u>** **i) When embossed marking is not removed during machining:** Each component shall be **embossed & punched** on un-machined surface/ **etched** on machined surface legibly and indelibly with following details:- **Supplier's name initial , Heat no.** ← To be embossed/already embossed. **(Example: SAIL/341)** **xxxxx , MM-YY** ← To be embossed/punched. └ 4 digits of date of manufacturing in MM-YY format └ Manufacturer's unique job serial no. **(Example: 00345/0319)**

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		ii) When embossed marking is removed during machining: In case the component is machined all over & the embossed marking is removed, the same shall be re-punched on fully finished component. Date of finish machining in MM-YY format & manufacturer's details shall be punched below the above punched marking as per details given below:- **Supplier's name intial , xxxxx , MM-YY** MM-YY: 4 digits of date of manufacturing in MM-YY format xxxxx: Manufacturer's unique job serial no. **(Example: SAIL/341)** ← To be punched. **ABCD/00345/0319** ← To be punched. **b) <u>Size & location:</u>** For size and location of identification marks, supplier to take prior approval from BHEL unless otherwise specified in the drawing.
B) FORGING / FABRICATED COMPONENTS:		
1.	Raw material/ semi-finished forgings and fabricated components	**a) <u>Method of marking in forgings & fabrications:</u>** Each component shall be **punched** legibly and indelibly with following details:- **Supplier's name initial , xxxxx , MM-YY , xxx** xxx: Heat no. MM-YY: 4 digits of date of manufacturing (forging/fabrication) in MM-YY format xxxxx: Manufacturer's unique job serial no. **(Example: SAIL/00345/0319/341)** **b) <u>Size & location:</u>** For size and location of identification marks, supplier to take prior approval from BHEL unless otherwise specified in the drawing.
2.	Machined forgings/ fabrications on labour basis	**a) <u>Method of marking after finish machining:</u>** **i) When punched marking is not removed:** In case the punched marking is not removed during finish machining of the component, the component shall be punched with following details below the already existing punched marking:- **Supplier's name intial , xxxxx , MM-YY** MM-YY: 4 digits of date of manufacturing in MM-YY format xxxxx: Manufacturer's unique job serial no. **(Example: SAIL/00345/0319/341)** ← Already punched. **ABCD/00345/0319** ← To be punched.

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It must not be used directly or indirectly in any way detrimental to the interest of the company

		ii) When punched marking is removed: In case the component is machined all over & the punched marking is removed, the same shall be re-punched on fully finished component. Date of finish machining in MM-YY format & manufacturer's details shall be punched below the above punched marking as per details given below:- **Supplier's name intial , xxxxx , MM-YY** └ 4 digits of date of manufacturing in MM-YY format └ Manufacturer's unique job serial no. **(Example: SAIL/00345/0319/341)** ← To be punched. **ABCD/00345/0319** ← To be punched. **b) <u>Size & location:</u>** For size and location of identification marks, supplier to take prior approval from BHEL unless otherwise specified in the drawing.
3.	Fully finished forged/ fabricated components	**a) <u>Method of marking in finished components:</u>** Each component shall be **punched** on un-machined surface/ **etched** on machined surface legibly and indelibly with following details:- **Supplier's name initial / xxxxx / MM-YY / xxx** └ Heat no. └ 4 digits of date of manufacturing in MM-YY format └ Manufacturer's unique job serial no. **(Example: SAIL/00345/0319/341)** **b) <u>Size & location:</u>** For size and location of identification marks, supplier to take prior approval from BHEL unless otherwise specified in the drawing.
C) SHEET METAL COMPONENTS:		
1.	Sheet metal components	**a) <u>Method of marking:</u>** Each component shall be **etched** or **punched** as the case may be legibly with following details:- **Supplier's name initial , xxxxx , MM-YY** └ 4 digits of date of manufacturing in MM-YY format └ Manufacturer's unique job serial no. **(Example: SAIL/00345/0319)** **b) <u>Size & location:</u>** For etching/painting and size & location of identification marks, supplier to take prior approval from BHEL unless otherwise specified in the drawing.

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CARBON STEEL FORGINGS, CLASS 4 Î

1.0 GENERAL:

This specification governs the quality requirements of Carbon Steel Forgings, class 4. Î

2.0 APPLICATION:

Suitable for general engineering purposes.

3.0 CONDITION OF DELIVERY:

Normalised/Normalised and tempered.

Rough machining of the forgings shall be carried out, unless otherwise specified in the BHEL order/drawing.

4.0 COMPLIANCE WITH NATIONAL STANDARDS:

The forgings shall comply, in general with the requirement of the following National standards and also meet the requirements of this specification.

IS::2004: 1991(RA 2001) (RA-2006) } Carbon Steel Forgings For General Engineering

Gr: Class 4 (45C8), } Purposes. Î

5.0 DIMENSIONS AND TOLERANCES:

The dimensions and tolerances shall be as specified in the order/ drawing. Wherever these are not specified, specified, the machining allowances and tolerances shall be as specified below:

For finish machined drawings : 3 ± 1 mm

For rough machined drawings : ± 1 mm

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Revisions : 36th MOM OF MRC+HTM			APPROVED : INTERPLANT MATERIAL RATIONALISATION COMMITTEE-MRC (FC&F+HTM)		
Rev. No. 09	Amd.No.	Reaffirmed	Prepared	Issued	Dt. of 1st Issue
Dt. 23.01.2007	Dt :	Year:04-11-2011	HARDWAR	Corp. R&D	JANUARY 1978

6.0 **MANUFACTURE:**

Forgings shall be manufactured from steel produced by the open hearth, electric or such other process as may be agreed to between BHEL and the manufacturer.

Steel shall be fully killed.

Sufficient discard shall be made from each ingot to ensure freedom from pipe, segregation and other defects.

The amount of hot working and finishing temperature shall be such as to ensure complete soundness and adequate uniformity of structure and mechanical properties after heat treatment. The forgings shall not be overheated.

The minimum reduction ratio when forgings are made out of ingots shall be 4:1.

For sizes above 250 mm ruling section, the minimum reduction ratio shall be 3.5:1

Note: Raw material like Ingots/Blooms/Billets required for forgings should be procured from BHEL approved sources along with test certificate."

7.0 HEAT TREATMENT:

Forgings shall be normalised / normalised and tempered at suitable temperature to achieve the mechanical properties specified. Î

Test pieces shall also be heat treated along with the forgings they represent.

8.0 FINISH:

As mentioned in the drawing.

9.0 FREEDOM FROM DEFECTS:

The forging shall be free from defects, such as cracks, fold, flakes, seams, segregation, nonmetallic inclusions and other defects which may affect the utility of the forging.

10.0 CHEMICAL COMPOSITION:

The melt analysis of steel and permissible variation in the composition of the forgings form the melt analysis shall be as follows:

Element	Melt analysis, percent		Permissible variation, percent
	Min.	Max.	
Carbon	0.40	0.50	± 0.03
Silicon	0.15	0.35	± 0.03
Manganese	0.60	0.90	± 0.04
Sulphur	---	0.040	+ 0.005
Phosphorus	---	0.040	+ 0.005

Notes:

1. Elements not quoted above shall not be added to the steel, other than for the purpose of finishing the heat and shall not exceed the following limits:

Element	Percent, max.
Nickel	0.30
Chromium	0.30
Copper	0.25
Molybdenum	0.05
Vanadium	0.05
Tin	0.05
Boron	0.0003

2. When steel is aluminium killed or killed with both aluminium and silicon, the requirements of minimum silicon content shall not apply. For aluminium killed steel the total aluminium content shall be with in 0.02 to 0.05 percent.

3. Mo ≤ 0.15%, limiting to meeting conditions of Cr + Mo + Ni = 0.5%.

11.0 TEST SAMPLES:

11.1 Unless otherwise specified in the order/drawing, test samples shall be taken form each melt and each heat treatment batch. Test samples should be cut from the heat treated forgings by cold process only and shall no further heat treatment.

Test samples shall be taken form locations indicted on the drawing, leaving enough material, if required for testing at BHEL's end, integral with forgings.

The samples shall be cylindrical or rectangular in shape and cut at a distance of 12.5mm below the heat treated surface.

11.2 When integral test pieces are not called for, a test sample, having similar reduction ratio and heat treatment, as the forgings it represents, shall be provided per heat, per heat treatment batch, for check testing at BHEL, along with the forgings. The samples shall be properly identified and correlated with the Heat/Heat treatment Batch No./ Test Certificate No. Test samples shall be taken, at a distance of 12.5mm below the heat-treated surface.

11.3 Test samples shall generally be taken in the longitudinal direction. However, for economic reasons or where the size/ configuration does not permit the same, test samples may be taken in the transverse or radial direction.

12.0 MECHANICAL PROPERTIES:

The test pieces, after being heat treated as per clause 7.0 above, shall show the following properties upto a limiting ruling section of 800 mm. Properties for thicker sections shall be subject to agreement between BHEL and the mainufacturer. Test methods are specified below:

12.1 Tensile test : IS:1608

12.2 Hardness test (Brinell) : IS:1500

12.3 Charpy Impact Value (2mm U-Notch) : IS:1499

This test applicable for forgings of sizes above 16mm only.

Property	Sample (See Cl.11.3)	Limiting ruiing section, mm			
		Upto & incl 100	>100 & upto 300	> 300 & upto 500	>500 & upto 800
Tensile strength N/mm^2	Longitudinal/ Transverse/ Radial/Tangential	620	620	530	530
Yield strength min, N/mm^2	Longitudinal/ Transverse/ Radial/Tangential	320	320	275	275
Elongation on 5.65 √So gauge length percent, min	Longitudinal	15	14	15	13
	Transverse	8	7	8	6
	Radial	10	9	10	8
	Tangential	11	10	10	9
Reduction in area, percent min.	Longitudinal	38	35	32	30
	Transverse	23	21	19	18
	Radial	25	24	21	19
	Tangential	30	28	24	23
*Hardness, Brinell,HB	—	175-207	175-207	149-197	149-197
Charpy Impact Value (2mm, U-Notch) min.,Joules	Longitudinal	31	27	23	23
	Transverse	16	14	12	12
	Radial	19	16	14	14
	Tangential	24	21	16	16

Note: 1. Unless otherwise stated on the order/drawing, small forgings of non-critical nature weighing less than 300kg shall be accepted on the basis of chemical composition and hardness.

* 2. Hardness test can be conducted only, when tensile test can not be performed.

13.0 ULTRASONIC TESTS: Î

13.1 For forgings ordered by BHEL, Hyderabad: Unless other wise specified on the drawing, ultrasonic test shall be carried out as per BHEL standard AA 085 01 18 and norms of acceptance shall be as per category 2.

3.13.2 For forgings ordered by other units: If specified on the drawing/order, ultrasonic test shall be carried out as per BHEL standard AA 085 01 18 and norms of acceptance shall be as per category 2, unless otherwise specified.

14.0 ADDITIONAL TESTS:

If specified in the drawing/order, the following tests shall be conducted:

14.1 Bend Test (Longitudinal):
The test pieces (230mm long and 32 mm square with edges rounded off, where the dimensions permit) shall be capable of being bent cold by direct pressure without fracture, until the sides are parallel, round a mandrel having a diameter of 44 mm when tested as per IS:1599. Î

14.2 Magnetic particle test.

14.3 Any other tests: Norms of acceptance shall be as specified in the drawing/order.

15.0 SCOPE OF THIRD PARTY INSPECTION:

Wherever, separate quality plan is not attached, the scope of third party inspection shall be as follows:

1. Review of supplier's declared chemical composition.
2. Selection of test samples for mechanical tests and witness of mechanical tests.
3. Witness of Non-destructive tests as applicable.
4. Review of HT charts.
5. Dimensional inspection.

16.0 TEST CERTIFICATE:

Three copies of test certificates shall be supplied unless otherwise stated in the order, preferably in the test certificate format annexed to this specification (Annexure 1).

In addition, the supplier shall ensure to enclose one copy of the test certificate along with their dispatch documents to facilitate quick clearance of the material.

The following details shall be furnished in the test certificate:

i) Reduction ratio

ii) Dimensional Inspection.

iii) Chemical composition including trace elements.

iv) Results of mechanical tests.

v) Results of Ultrasonic test

vi) Details of heat treatment

vii) Results of additional tests called for in the drawing/order.

17.0 PACKING & MARKING:

Forgings shall be suitably packed to prevent corrosion and damage during transit.

Machined surfaces shall be properly protected with anticorrosive compounds.

Each package or forging (when supplied separately) shall be legibly marked with the following information:

AA 193 33 : Carbon Steel Forgings, Class 4 Î

BHEL Order No.

Suppliers Name

Consignment/ Identification No.

Batch No.

Weight.

18.0 REFERRED STANDARDS (Latest publications Including Amendments):

1) AA 085 01 18 2) IS:1499 3) IS:1500 4) IS:1599
5) IS: 1608 6) IS: 2004

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ANNEXURE-I: RECOMMENDED TEST CERTIFICATE FORMAT FOR FORGINGS

SUPPLIER'S NAME AND ADDRESS

TEST CERTIFICATE FOR FORGINGS

1. Customer:
2. TC No. & Date:
3. PO No.:
4. Process of Melting Ingot:
5. Deoxidisation Process:
6. Forging Method:
7. BHEL's Reference for Approval of Bloom
8. Discard: Top_____%; Bottom _____%
9. Reduction Ratio } Ingot to Bloom, Bloom to Blank
10. Batch No.:
11. Heat/Melt No.
12. Spec.No.
13. Test Bar Size & Nos.
14. Supplier of the ingot/billet/ Bloom and TC reference.

15. FORGINGS COVERED BY TEST CERTIFICATE

S.No.	Drawing No. & Item No.	Description	Quantity & Weight

16. CHEMICAL COMPOSITION (PERCENT)

Element		C	Si	Mn	S	P											
As Per Specn.	Min.																
	Max.																
Actual Values																	

17. HEAT TREATMENT
(To be accompanied by Recorder Chart, Whenever called for)

Condition	Heating Rate, °C/hr.	Temp. °C	Soaking Time, Hrs.	Cooling Rate, °C/hr	Cooling Medium

18. MECHANICAL PROPERTIES

		T.S. N/mm²	Y.S. 0.5/0.2% Proof N/mm²	% Elongation $5.65\sqrt{So}$ GL	% R.A. Min.	Hardness BHN (Min.3 values)	Impact Value Joules	Bend Test: Angle of bend	Bend Test: Dia of mandrel	Bend Test: Result
As Per Specn.	Min.									
	Max.									
Actual Values										

19. SURFACE FINISH (When called for in the order/drg.)

20. DIMENSIONAL INSPECTION

21. NON-DESTRUCTIVE TESTS

Nature of Test	Acceptance level	Instrument used	Range	Results	Any other detail
Ultrasonic					
Radiographic					
Dye penetrant/ Magnetic Particle					

22. METALLOGRAPHIC EXAMINATION
(To be conducted if called for and photo micrographs to be attached along with a report)

Location of Sample	Etchant used	Magnification	Constituent observed	Relative %	
Microstructure	Macroetch	Inclusion Rating			

23. OTHER TESTS IF ANY (MICROSCOPIC, SULPHUR PRINTS, ETC)

24. IDENTIFICATION OF FORGINGS AS PER PURCHASE SPEC.

We hereby certify that the items mentioned above have been tested and inspected in our presence and are found to be in accordance with drawings, specifications and purchase order.

SIGNATURE, NAME & SEAL OF THE INSPECTING OFFICER
DATE:

SIGNATURE, NAME & SEAL OF THE CHIEF OF QUALITY CONTROL/ CHIEF METALLURGIST OF THE SUPPLIER
DATE:

INSTRUCTIONS

a) Details of all heat treatment processes carried out should be furnished sequentially in 17.
b) Test certificates are to be furnished as per Purchase order and specification, in A4 size preferably in transparent paper.
c) All the entries including signature should be in block colour ink.
d) If testing is done by outside agencies, the original TCs shall be furnished.
e) The actual TC may run into more than one A4 size paper, if needed, to facilitate filling up of details.

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CARBON STEEL FORGINGS, CLASS-3 Î

1.0 GENERAL:

This specification governs the quality requirements of Carbon Steel Forgings, class 3. Î

2.0 APPLICATION:

Suitable for general engineering purposes.

3.0 CONDITION OF DELIVERY:

Normalised/Normalised and tempered.

Rough machining of the forgings shall be carried out, unless otherwise specified in the BHEL order/drawing.

4.0 COMPLIANCE WITH NATIONAL STANDARDS:

The forgings shall comply, in general with the requirement of the following National standards and also meet the requirements of this specification.

IS::2004: 1991 (RA-2006) } Carbon Steel Forgings For General Engineering

Gr: 3 (30C8), } Purposes. Î

5.0 DIMENSIONS AND TOLERANCES:

The dimensions and tolerances shall be as specified in the order/ drawing. Wherever these are not specified, specified, the machining allowances and tolerances shall be as specified below:

For finish machined drawings : 3 ± 1 mm

For rough machined drawings : ± 1 mm

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6.0 **MANUFACTURE:**

Forgings shall be manufactured from steel produced by the open hearth, electric or such other process as may be agreed to between BHEL and the manufacturer.

Steel shall be fully killed.

Sufficient discard shall be made from each ingot to ensure freedom from pipe, segregation and other defects.

The amount of hot working and finishing temperature shall be such as to ensure complete soundness and adequate uniformity of structure and mechanical properties after heat treatment. The forgings shall not be overheated.

The minimum reduction ratio when forgings are made out of ingots shall be 4:1.

For sizes above 250 mm ruling section, the minimum reduction ratio shall be 3.5:1

Note: Raw material like Ingots/Blooms/Billets required for forgings should be procured from BHEL approved sources along with test certificate."

7.0 HEAT TREATMENT:

Forgings shall be normalised / normalised and tempered at suitable temperature to achieve the mechanical properties specified.

Test pieces shall also be heat treated along with the forgings they represent.

8.0 FINISH:

As mentioned in the drawing.

9.0 FREEDOM FROM DEFECTS:

The forging shall be free from defects, such as cracks, fold, flakes, seams, segregation, nonmetallic inclusions and other defects which may affect the utility of the forging.

10.0 CHEMICAL COMPOSITION:

The melt analysis of steel and permissible variation in the composition of the forgings form the melt analysis shall be as follows:

Element	Melt analysis, percent		Permissible variation, percent
	Min.	Max.	
Carbon	0.25	0.35	± 0.03
Silicon	0.15	0.35	± 0.03
Manganese	0.60	0.90	± 0.04
Sulphur	---	0.040	+ 0.005
Phosphorus	---	0.040	+ 0.005

Notes:

1. Elements not quoted above shall not be added to the steel, other than for the purpose of finishing the heat and shall not exceed the following limits:

Element	Percent, max.
Nickel	0.30
Chromium	0.30
Copper	0.25
Molybdenum	0.15
Vanadium	0.05
Tin	0.05
Boron	0.0003

2. When steel is aluminium killed or killed with both aluminium and silicon, the requirements of minimum silicon content shall not apply. For aluminium killed steel the total aluminium content shall be with in 0.02 to 0.05 percent.

3. Mo ≤ 0.15%, limiting to meeting conditions of Cr + Mo + Ni = 0.5%.

11.0 TEST SAMPLES:

11.1 Unless otherwise specified in the order/drawing, test samples shall be taken form each melt and each heat treatment batch. Test samples should be cut from the heat treated forgings by cold process only and shall no further heat treatment.

Test samples shall be taken form locations indicted on the drawing, leaving enough material, if required for testing at BHEL's end, integral with forgings.

The samples shall be cylindrical or rectangular in shape and cut at a distance of 12.5mm below the heat treated surface.

11.2 When integral test pieces are not called for, a test sample, having similar reduction ratio and heat treatment, as the forgings it represents, shall be provided per heat, per heat treatment batch, for check testing at BHEL, along with the forgings. The samples shall be properly identified and correlated with the Heat/Heat treatment Batch No./ Test Certificate No. Test samples shall be taken, at a distance of 12.5mm below the heat-treated surface.

11.3 Test samples shall generally be taken in the longitudinal direction. However, for economic reasons or where the size/ configuration does not permit the same, test samples may be taken in the transverse or radial direction.

12.0 MECHANICAL PROPERTIES:

The test pieces, after being heat treated as per clause 7.0 above, shall show the following properties upto a limiting ruling section of 800 mm. Properties for thicker sections shall be subject to agreement between BHEL and the mainufacturer. Test methods are specified below:

12.1 Tensile test : IS:1608

12.2 Hardness test (Brinell) : IS:1500

12.3 Charpy Impact Value (2mm U-Notch) : IS:1499

This test applicable for forgings of sizes above 16mm only.

Property	Sample (See Cl.11.3)	Limiting ruiing section, mm			
		Upto & incl 100	>100 & upto 300	> 300 & upto 500	>500 & upto 800
Tensile strength N/mm^2	Longitudinal/ Transverse/	490	470	450	450
	Radial/Tangential	490	470	450	450
Yield strength min, N/mm^2	Longitudinal/ Transverse/ Radial/Tangential	270	245	230	220
Elongation on 5.65 √So gauge length percent, min	Longitudinal	21	19	18	17
	Transverse	10	9	8	7
	Radial	14	12	11	10
	Tangential	16	14	13	12
Reduction in area, percent min.	Longitudinal	42	40	35	32
	Transverse	25	24	22	20
	Radial	27	26	24	22
	Tangential	34	32	32	30
*Hardness, Brinell,HB	—	140-192	140-192	135-190	135-190
Charpy Impact Value (2mm, U-Notch) min.,Joules	Longitudinal	35	31	27	23
	Transverse	18	16	14	12
	Radial	21	19	17	15
	Tangential	26	23	20	17

Note: 1. Unless otherwise stated on the order/drawing, small forgings of non-critical nature weighing less than 300kg shall be accepted on the basis of chemical composition and hardness.

* 2. Hardness test can be conducted only, when tensile test can not be performed.

13.0 ULTRASONIC TESTS: Î

13.1 For forgings ordered by BHEL, Hyderabad: Unless other wise specified on the drawing, ultrasonic test shall be carried out as per BHEL standard AA 085 01 18 and norms of acceptance shall be as per category 2.

3.13.2 For forgings ordered by other units: If specified on the drawing/order, ultrasonic test shall be carried out as per BHEL standard AA 085 01 18 and norms of acceptance shall be as per category 2, unless otherwise specified.

14.0 ADDITIONAL TESTS:

If specified in the drawing/order, the following tests shall be conducted:

14.1 Bend Test (Longitudinal):

The test pieces (230mm long and 32 mm square with edges rounded off, where the dimensions permit) shall be capable of being bent cold by direct pressure without fracture, until the sides are parallel, round a mandrel having a diameter of 44 mm when tested as per IS:1599.

14.2 Magnetic particle test.

14.3 Any other tests: Norms of acceptance shall be as specified in the drawing/order.

15.0 SCOPE OF THIRD PARTY INSPECTION:

Wherever, separate quality plan is not attached, the scope of third party inspection shall be as follows:

1. Review of supplier's declared chemical composition.
2. Selection of test samples for mechanical tests and witness of mechanical tests.
3. Witness of Non-destructive tests as applicable.
4. Review of HT charts.
5. Dimensional inspection.

16.0 TEST CERTIFICATE:

Three copies of test certificates shall be supplied unless otherwise stated in the order, preferably in the test certificate format annexed to this specification (Annexure 1).

In addition, the supplier shall ensure to enclose one copy of the test certificate along with their dispatch documents to facilitate quick clearance of the material.

The following details shall be furnished in the test certificate:

i) Reduction ratio

ii) Dimensional Inspection.

iii) Chemical composition including trace elements.

iv) Results of mechanical tests.

v) Results of Ultrasonic test

vi) Details of heat treatment

vii) Results of additional tests called for in the drawing/order.

17.0 PACKING & MARKING:

Forgings shall be suitably packed to prevent corrosion and damage during transit.

Machined surfaces shall be properly protected with anticorrosive compounds.

Each package or forging (when supplied separately) shall be legibly marked with the following information:

AA 193 32 : Carbon Steel Forgings, Class 3 Î

BHEL Order No.

Suppliers Name

Consignment/ Identification No.

Batch No.

Weight.

18.0 REFERRED STANDARDS (Latest publications Including Amendments):

1) AA 085 01 18 2) IS:1499 3) IS:1500 4) IS:1599
5) IS: 1608 6) 2004

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ANNEXURE-I: RECOMMENDED TEST CERTIFICATE FORMAT FOR FORGINGS

SUPPLIER'S NAME AND ADDRESS

TEST CERTIFICATE FOR FORGINGS

1. Customer:
2. TC No. & Date:
3. PO No.:
4. Process of Melting Ingot:
5. Deoxidisation Process:
6. Forging Method:
7. BHEL's Reference for Approval of Bloom
8. Discard: Top_____%; Bottom _____%
9. Reduction Ratio } Ingot to Bloom / Bloom to Blank
10. Batch No.:
11. Heat/Melt No.
12. Spec.No.
13. Test Bar Size & Nos.
14. Supplier of the ingot/billet/ Bloom and TC reference.

15. FORGINGS COVERED BY TEST CERTIFICATE

S.No.	Drawing No. & Item No.	Description	Quantity & Weight

16. CHEMICAL COMPOSITION (PERCENT)

Element		C	Si	Mn	S	P											
As Per Specn.	Min.																
	Max.																
Actual Values																	

17. HEAT TREATMENT
(To be accompanied by Recorder Chart, Whenever called for)

Condition	Heating Rate, °C/hr.	Temp. °C	Soaking Time, Hrs.	Cooling Rate, °C/hr	Cooling Medium

18. MECHANICAL PROPERTIES

		T.S. N/mm²	Y.S. 0.5/0.2% Proof N/mm²	% Elongation $5.65\sqrt{So}$ GL	% R.A. Min.	Hardness BHN (Min.3 values)	Impact Value Joules	Bend Test: Angle of bend	Bend Test: Dia of mandrel	Bend Test: Result
As Per Specn.	Min.									
	Max.									
Actual Values										

19. SURFACE FINISH (When called for in the order/drg.)

20. DIMENSIONAL INSPECTION

21. NON-DESTRUCTIVE TESTS

Nature of Test	Acceptance level	Instrument used	Range	Results	Any other detail
Ultrasonic					
Radiographic					
Dye penetrant/ Magnetic Particle					

22. METALLOGRAPHIC EXAMINATION
(To be conducted if called for and photo micrographs to be attached along with a report)

Location of Sample	Etchant used	Magnification	Constituent observed	Relative %	
Microstructure	Macroetch	Inclusion Rating			

23. OTHER TESTS IF ANY (MICROSCOPIC, SULPHUR PRINTS, ETC)

24. IDENTIFICATION OF FORGINGS AS PER PURCHASE SPEC.

We hereby certify that the items mentioned above have been tested and inspected in our presence and are found to be in accordance with drawings, specifications and purchase order.

SIGNATURE, NAME & SEAL OF THE INSPECTING OFFICER
DATE:

SIGNATURE, NAME & SEAL OF THE CHIEF OF QUALITY CONTROL/ CHIEF METALLURGIST OF THE SUPPLIER
DATE:

INSTRUCTIONS

a) Details of all heat treatment processes carried out should be furnished sequentially in 17.
b) Test certificates are to be furnished as per Purchase order and specification, in A4 size preferably in transparent paper.
c) All the entries including signature should be in block colour ink.
d) If testing is done by outside agencies, the original TCs shall be furnished.
e) The actual TC may run into more than one A4 size paper, if needed, to facilitate filling up of details.