



CORPORATE STANDARD

AA 712 51 04

Rev. No. 07

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SCREWS, GRUB, SLOTTED, TYPE-C (CONICAL ENDS), PRODUCT Gr:A, COARSE PITCH, STEEL, PROPERTY CLASS 4.8 (M12 - M24)

1.0 DESIGNATION:

A product Gr:A, slotted, steel, grub screw conical end (Type-C), thread M12, length 30mm, coarse pitch and conforming to property class 4.8 shall be designated as:

1.1 On drawings:

- i) Material specification column : AA 712 51 04.
- ii) Description column : SCRU GRB SLT C A M12X30 - 4.8

1.2 On indents:

Screw grub C A M12X30 - 4.8: AA 712 51 04

1.3 For issuing enquiries and on purchase orders:

While issuing enquiries and purchase orders, enclose a copy of this BHEL standard.

2.0 COMPLIANCE WITH STANDARDS:

2.1 Dimensions, Tolerances and General Requirements:

As per BHEL standard AA 712 51 04

2.2 Mechanical properties:

Material shall conform to properties given against class 4.8, as specified in Table-3 of IS:1367, Part 3

2.3 Threads:

Pitch-coarse to IS:4218, Part 2
Tolerance quality - Medium.
Tolerance class 6g.

2.4 Identification Marking:

As stated in clause-9 of IS:1367, Part 3

2.5 Finish: Plated as specified in BHEL order.

Revisions : As per Cl. 29.4 of 29th MOM
of WG-F

APPROVED :

**INTERPLANT
STANDARDIZATION COMMITTEE (WG-F)**

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3.0 NOTE:

3.1 Length and diameter combination (refer Table-1 on page 3 of 3) between the bold lines should only be used

3.2 For screw threads, general (Metric) refer to BHEL standard AA 023 18 00

3.3 For tolerance grade, position and class refer to BHEL standard AA 023 02 01

3.4 For sizes less than M12, refer to BHEL standard AA 7125103

3.5 Screws to this standard would be unplated, divisions wishing to have plated screws would have to get them plated.

3.6 Weights given in this standard are for general reference only and are not meant for commercial transactions.

3.7 When fasteners are to be tested with in BHEL, sampling and acceptance plan as per IS:1367, Part 17

4.0 REFERRED STANDARDS (Latest publications including amendment):

1) IS:1367, Pt 3& Pt 17	2) IS:4218, Pt 2	3) AA 023 02 01
4) AA 023 18 00	5) AA 0231852	6) AA 7125103

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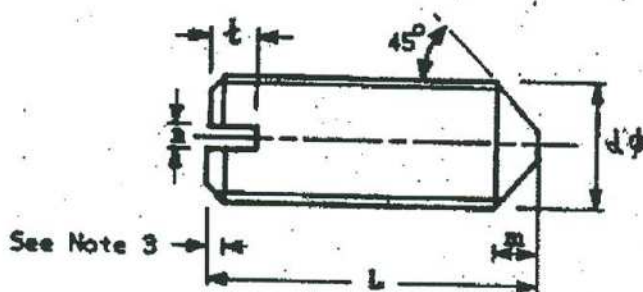


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NOTE:

1. Corporate Sub-Code Numbers are shown in the table 1
2. Weights have been shown in kg. per 1000 Nos.
3. For ends refer AA 0231852.

TABLE - 1

All Dimensions in mm

Size d Nom.	Coni- cal end m Nom.	SLOT			LENGTH (L)													
		Width 7-14 Max. Min.	Depth 1.5-15 Min.		12	14	16	20	25	30	35	40	45	50	55	60	65	70
M12	5.0	2.25	4.24	Sub-Code			037	010	053	029		045						
		2.00	3.76	weight			9.03	11.8	16.0	19.1		26.5						
M16	6.0	2.75	4.74	Sub-Code					061									
		2.50	4.26	weight														
M20	7.0	3.25	5.24	Sub-Code														
		3.00	4.76	weight														
M24	8.0	4.30	6.24	Sub-Code														
		4.00	5.76	weight				11										

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EXPLANATORY NOTE:

This standard was first issued in January 1977 and was based on IS:2388-71 and reaffirmed in 1991 for dimensions, tolerances and general requirements. Subsequently many changes have been agreed upon at International and IPSC level and were reflected in revised version of IS:1367 “Technical supply condition of threaded fasteners”.

Since the IS:2388 has been withdrawn, therefore the following changes have been made in the corporate standard AA712 51 04 :

- Reference of the IS:2388 has been deleted from clause 2.1 of the standard.
- Clause 1.3, 2.1 and 2.4 have been modified accordingly.
- Clause 4.0 has been modified.



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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. This 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).

Revisions:

CI 29.2.2 of MOM of MRC-FCF+HTM

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TABLE -1: GOVERNING DIMENSIONS (S)

Sl. No.	Figure	Definition
1		<p>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.</p>
2		<p>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).</p>
3		<p>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 $S_h = d$. For simplicity, dimension S_d can be changed to the nearest lower measurable dimension (h or d), whichever is greater.</p>
4		<p>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.</p>



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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

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**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	
From	To	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	
Fro	To	To									
m		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



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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

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**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, mm	Thickness of wall or rib/width of groove or channel, mm		Permissible Tolerances, mm		
	Over	Upto & incl.	Tolerance class		
mm			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



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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, CO ₂ , 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, CO ₂ , 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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PROCESS FOR PAINTING OF METAL COMPONENTS AND STEEL SURFACES

1.0 GENERAL:

This standard details the process to be followed to provide a coating on metal components and technical information regarding generic of paint medium and application related information. The paint shall be applied by spray/brush/airless spray and dried by stoving/air drying. The painted surface shall be protecting the components in their environment of exposure. This specification supersedes other AA 0674111 and 0674122.

SPECIFIC DEFINITIONS:

DFT : Dry Film Thickness; the thickness of the dried or cured paint coating film.

Operating Temp. : Temperature at which painting is to be performed.

TDFT : Total Dry Film Thickness, the thickness of the total number of coatings specified after curing.

VS% : Volume Solids Percent

1.1 METHODS OF PAINT APPLICATION

The paint shall be applied in accordance with the paint manufacturer's product data sheet, which shall include the mixing ratio, the maturation time, the method of application, the use of thinners and coating intervals. The dry film thickness of individual coatings shall be as specified. Areas with inadequate coating thickness shall be thoroughly cleaned, if necessary, abraded and additional compatible coats shall be applied until they meet the required film thickness.

Painting shall not be performed when the temperature is less than 3°C above the dew point of the surrounding air or when the relative humidity of the air is greater than 85% unless local conditions dictate otherwise and the Principal is in agreement. Guidance on the estimation of the probability of condensation can be found from the Table referred in Annexure-I.

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In addition, paints shall not be applied under the following conditions:

- when the surface temperature is greater than 40°C (unless a higher temperature is recommended by the paint manufacturer).
- when the air temperature is less than 10°C (depending on local conditions).
- when there is the likelihood of an unfavorable change in the weather conditions within two hours after painting.
- when there is deposition of moisture in the form of rain, condensation, frost etc. on the surface.
- when the available light, ventilation is not adequate for painting.

If condensation, rain, dust or other foreign materials contaminate the surface of a paint coating which is not dry to the touch, the paint shall be removed, the surface re-cleaned and fresh paint is applied in accordance with this specification.

Paints shall not be applied within 50mm of edges which will later have to be welded. Such weld areas should be taped for a distance of 50mm on either side of the weld line.

Extra coats of paint shall be applied on the areas where the shape and/or plane of application result in thinly applied coatings etc., at edges, welds, corners etc. To compensate for these effects, stripes coats of paints shall be applied (normally applied first so that they will be covered by the full coat).

When zinc rich primers are used, care shall be taken to avoid any possibility of over spraying onto duplex or austenitic stainless steels, nickel alloys or 9% nickel steel components.

Note : Zinc rich primers shall not be applied on equipment made from the above mentioned materials unless such equipment is located in a shielded position which will minimise the risk of molten zinc falling onto the equipment in the event of a fire.

Proper application of protective coatings is an important criterion in giving the paint system its required life. To achieve good finish out of paint systems recommended paint putty mastic compound may be used after primer / under coat compatible with system and recommended by manufacturer.

Given below are the four main application procedures along with the advantages and disadvantages of each.

1.1.1 Brush application :

Used frequently for decorative paints, in protective coatings this is in vogue in painting complex areas where the use of spray methods would increase the loss factor. However, a word of caution about brush application, it is difficult to achieve higher thickness with a high build coating by brush application in one coat. The process is relatively slow and may result in a poor finish for thixotropic or high viscosity top coats.



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1.1.2 Conventional spray:

A widely accepted method of paint application where liquid paint is atomised by an air stream. A correct combination of air pressure, air volume and fluid flow has to be selected to achieve full atomisation and a paint film free of defect. One may also face problems like sagging, pin holing and poor paint flow if the control parameters are not monitored properly.

The major disadvantage of conventional spray is that high build coatings cannot be applied by this method, as most paints have to be thinned to a suitable viscosity for satisfactory atomisation.

1.1.4 Airless spray

This is by far the fastest and most versatile method because it enables application at variable thicknesses. The equipment utilises an electric or air driven motor and a high pressure fluid pump to compress the coating to extreme pressures. The paint is then made to pass through a special tip which atomises it, and thus controls the application properties.

The main advantages of this method are :

- High build coatings can be applied without thinning.
- Fast rate of application achievable.
- Reduce pollution and environmental friendly.
- Reduced wastage of material.
- Less air consumption and saving of power.

As already indicated, the special tips used in the spray gun and the pressure control enables one to monitor application of very low to very high viscosity products. Similarly, different slot angles produce spray fans of different widths. The selection of a particular fan width is dependent on the shape and size of the structure to be painted. The choice of fan width is also related to orifice size. For the same orifice size the paint applied per unit area will be less, wider the spray fan. The general indication of orifice sizes is given below to help in choosing the proper orifice size for a paint.

Wet film thickness

Upto 50 microns
100-200 microns
>200 microns
Mastics

Orifice size(mm)

0.02 – 0.03
0.03 – 0.04
0.04 – 0.07
0.10 – 0.15

There are several designs of tips available, the choice of which depends upon the finish required, the ease of application and ease of cleaning blockages from tips.

Table-1.

Mode of Application	FORD CUP: 4 Viscosity in secs.
Brushing	40-60
Spraying	30±2

Note: Viscosity measurement of high build epoxy paint may be done by viscometer.

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Above table gives general guideline about consistency to be maintained for brush/spray/airless spray painting unless otherwise specified by paint manufacturer.

1.2 PREPARATION OF PAINT :

All industrial paints generally consist of a binder medium, pigment, thinner and accelerator. The composition of constituents varies based on performance requirements.

The primer which form first coat on a surface has higher concentration of pigments and extenders than the finish paint which has higher concentration of medium. The concentration and type of accelerator depends on drying cycle requirements. Air drying paints are generally single pack systems except aluminum paints, epoxy, polyurethane etc. Some of the stoving compositions are also available in single pack. The binder mediums generally used in paints are oil based Alkyd phenolics, epoxy, silicone, vinyl ester and urethane resins. Generic information is provided in Cl.3 of this specification. All the paint manufacturers mostly provide processing conditions to be followed before application. However, a few are given below :

- (a) When the containers of air drying paints are opened, the material is observed for skin formation. The skin formed should be carefully removed and settled pigment has to be broken up and loosened by vigorous stirring preferably mechanically to ensure homogenous dispersion. Care should be taken to avoid air entrapment while stirring. The paint, if required may be strained through muslin cloth or 60mesh sieve.

(b) **Maturation process :**

Maturation is an important criterion for two pack products where curing takes place through chemical reaction when the components are mixed before application. The mixed paint is normally matured for about 30 minutes to initiate the reaction process which ensures thickness build up and proper drying of the paint film unless otherwise specified.

Maturation time is, however, to be adjusted depending on pot life and ambient temperature. Products having a short pot life should be allowed less maturation time as recommended by supplier to provide the adequate effect during film formation.

1.3 APPLICATION LOSSES AND SPREADING RATE ESTIMATION

It is extremely complicated to estimate accurately the quantity of paint required for a particular job since the theoretical spreading rate does not take into account the various "losses" involved during application.

In the following paragraphs general guidelines are described taking into account major areas of losses and to arrive at appropriate requirement. Usually two types of losses are considered : "**Apparent Losses**" where the paint-though on the surface-does not contribute to the required thickness, and "**Actual Losses**" where the paint is wasted.



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Apparent Losses

Effect of blast profile: On a blasted surface the film thickness over the peaks is less than the thickness over the troughs. However, it is the thickness over the peaks which is most important in relation to performance of the paint coating and hence it can be considered that the paint which does not contribute to this thickness is "lost in the steel profile". The extent of paint "loss" is proportional to the surface roughness produced by blasting or in other words, the dimension and type of abrasive used.

Typical "losses" in dry paint film thickness for given blast profiles are given below:

<u>Surface</u>	<u>Blast profile</u>	<u>DFT loss</u>
- Steel blasted using round	0-50 microns	10 microns
- Shot And shop primed		
- Fine open blasting	50-100 microns	35 microns
- Coarse open blasting	100-150 microns	60 microns
- Old pitted steel-reblasted	150-300 microns (or more)	125 microns (or more)

Paint distribution loss : This is loss of paint resulting from over-application when an attempt is made to achieve the minimum specified paint thickness with reasonable certainty.

The extra paint consumed over and above that calculated from the theoretical spreading rate is dependent on the method of application as well as on the type of structure being painted. A simple structure with a high proportion of flat surfaces should not incur heavy losses, but for complex structure losses will be high. Typical details given below:

<u>Application</u>	<u>Type of structures</u>	<u>Loss(%)</u>
Brush + Roller	Simple structures	5%
-do-	Complex structures	10-15%
Spray } Air / Airless	Simple structures	20%
Spray }	Complex structures	60% for single coat 40% for two coats 30% for three coats

When an open complex structure is sprayed, no realistic estimate can be made of paint distribution loss. In case the specification calls for a minimum thickness at all measured points, the distribution losses would be higher than those indicated above.

Actual losses: These include the paint loss during application and wastage

Application Loss: The paint which drips from a brush or roller during transfer from the container to the surface being painted can be termed as application loss. With care, this can be discounted as a significant contribution to overall "loss".

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When application is done by spraying, losses are inevitable and their extent is dependent largely on the shape of the structure being painted together with atmospheric conditions.

The following spray losses are common:

Well ventilated but confined space	5%
Outdoors in almost static air	5 – 10%
Outdoors in windy conditions	Over 20% (This figure can be abnormally high if painting is done in unsuitable windy conditions).

Paint wastage: Some wastage is inevitable like paint spill, certain amount remaining in discarded containers and in case of two pack materials mixed paint left beyond its pot life.

The following losses are common:

Single pack materials	Not more than 5%
Two pack materials	5-10%

Spreading rate estimation:

Having given by the paint supplier the theoretical spreading rate and with the preceding loss factors, it is possible to calculate the practical spreading rate, as is illustrated by the following example for guidance.

Example :

Two coats of two pack paint are to be applied by spray in a confined space to a blasted surface of complete structure to yield a DFT of 100 microns per coat. The theoretical spreading rate is 6.0 sq. mtr/ltr. What is the practical spreading rate?

First coat

Required DFT	100 microns
Loss due to surface roughness	10 microns
Loss due to distribution 40% i.e. 100×0.4	40 microns

	150.0 microns
Loss due to application 5% i.e. 150×0.05	7.5 microns

	157.5 microns
Loss due to wastage 10% ie. 157.5×0.1	15.75 microns

	173.25 microns
Extra paint used $(173.25 - 100)$	$= \frac{73.25 \times 100}{100} = 73.3\%$



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Second coat

Required DFT	100 microns
Loss due to surface roughness	Nil
Loss due to distribution 40% i.e. 100×0.4	40 microns

	140 microns
Loss due to application 5% i.e. 140×0.05	7 microns

	147 microns
Loss due to wastage 10% i.e. 147×0.1	14.7 microns

	161.7 microns

$$\text{Extra paint used } (161.7 - 100) = \frac{61.7 \times 100}{100} = 61.7\%$$

$$\text{Total loss for two coats} = \frac{73.3 + 61.7}{2} = 67.5\%$$

In other words, for the two coat of two pack system, 67.5% more paint is required than would be calculated from the theoretical spreading rate.

Loss factors : In the above example the theoretical spreading rate is 6 sq.mtr./ltr. In practice 1.68 ltr. Of paint can be expected to cover 6 sq.mtr.

Therefore, the practical spreading rate is $\frac{6}{1.68} = 3.6 \text{ sq.mtr. /ltr.}$

The loss factor is usually expressed as the difference between the theoretical and practical spreading rates expressed as a percentage of the theoretical spreading rate. In the above example the loss factor is:

$$\frac{6 - 3.6}{6} = 40\%$$

Calculation of Volume Solids :


The volume solid of a paint can be calculated as follows :

$$\% \text{ volume solid} = \frac{\text{DFT(microns)} \times \text{Theoretical coverage(sq.mtr./ltr)}}{10}$$

The volume solids of a paint is an indicator of the mileage it will give at a specified thickness. A service life data published on life of paint with various polymeric medium in different environments is given in Table-II.

1.4 THINNER CONSUMPTION:

This is another important parameter and has to be closely monitored to obtain the desired performance from the paint film. In each Data Sheet a special section is devoted to thinner consumption which should be strictly adhered to. However, it should be noted that the mentioned quantity is only for adding to the paint. The consumption for an optimum environment depends on prevailing temperature, application methods, nature of surface, weather conditions and may require adjustment in thinner volume. The thinner used should be compatible with the paint and corresponds to the same batch of paint.

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Adding a small percentage of extra thinner does not necessarily impair the film properties, but excess thinning increases the quantity of liquid paint without contributing to the solid content. The volume solid, after thinning, should be calculated and the resultant coverage worked out to achieve the recommended film thickness.

Volume solid percentage after thinning = $\frac{\% \text{ Volume solid} \times 100}{\% \text{ thinner added} + 100}$

2.0 SURFACE PREPARATION :

Surface preparation may be carried out as per BHEL STANDARD AA 0674101. However following instructions in general should be adhered to unless otherwise agreed upon

- ◆ Surfaces not to be painted shall be properly masked.
- ◆ Surfaces shall be cleaned by solvent cleaning method to remove oil, grease, dirt, cutting fluids and other contaminants.
- ◆ Surfaces to be coated shall be blast cleaned with suitable abrasive to the required surface finish for operating temperatures above 120° C and a minimum of a commercial blast cleaning for operating temperatures below 120° C.
- ◆ The average maximum blast profile shall be between 3.5 to 6.0 mils. For sand castings, average maximum surface profiles after blasting to be specified.
- ◆ All traces of abrasive and other debris shall be removed by brushing, sweeping, blowing with clean compressed air, and vacuuming before the application of any coating.

3.0 GENERIC PAINT CHARACTERISTICS:

Paint have polymeric resins as binder mediums. These mediums are selected depending on the environment in which it has to operate.

For ease of reference, a generic description of the paint mediums are indicated below together with a specific characterisation of some of their properties.

- ◆ High solids, amine-cured epoxies:
Polyamine-cured epoxies generally have a good resistance to chemicals and solvents.
- ◆ High build, polyamide-cured epoxies :
Polyamide-cured epoxies exhibit a longer pot life, superior flexibility and durability compared with amine-cured epoxies. They possess adequate chemical resistance.
- ◆ High build, aliphatic polyurethanes :
Two component isocyanate-free urethanes produce extremely hard, resistant and durable coatings. Aliphatic urethanes are preferred over aromatic urethanes because of their excellent durability and gloss retention.



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- ◆ Phenolic epoxies :
Two component, high build, amine-cured phenolic epoxy coatings have excellent resistance to a wide range of solvents and (organic) acids.
- ◆ (Alkyl) zinc silicate :
Two component, moisture curing, zinc (alkyl) silicate coating, containing a minimum of 75% metallic zinc, is a hard, abrasion resistant coating that can withstand temperatures up to 400°C.
- ◆ Aluminium pigmented silicate :
One component, (alkyl) silicate, zinc-free coating is suitable for temperatures up to 600°C.
- ◆ Aluminium silicones :
Aluminium pigmented, silicone resin-based paint. Heat resistant up to 600°C. A minimum temperature of 200°C is required for 2 hours to obtain a sufficient cure.
- ◆ Silicone acrylics :
One component, aluminium (or colour) pigmented acrylic-modified silicone resin. Heat resistant up to 350°C. Full cure can be achieved at ambient temperature.
- ◆ Zinc-rich epoxy primer :
Two component, epoxy based primer. Developed to provide sacrificial protection to steel surfaces.
- ◆ Solvent free epoxies :
Two component, amine cured, modified epoxies without solvent. They can be applied as a heavy duty coating up to 28 mil thick.
- ◆ Polysiloxane :
Two component, inorganic polysiloxane. Used for heat resistance (continuous and cyclic) up to 1110°C Current experience with this coating is good but still very limited.
- ◆ Thermally sprayed metal coatings :
Thermally sprayed metal coatings may be used in applications where organic coatings are ineffective or cause product contamination.
- ◆ Black coal tar epoxy :
Generally, Thixotropic amine cured two pack system. Conventional epoxy blended with high purity coal tar to impart flexibility, is mostly recommended for inner sides of water tanks.

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The estimated life of the resin systems for various environments is given in Table-2.

Lead containing paints, should not be used because of the associated health and environmental restrictions that apply unless otherwise insisted upon.

Paints specifically intended for use on austenitic stainless steels or high nickel-chromium alloys shall not contain free chlorides or other halides after curing, although trace amounts in the raw materials is accepted. Chlorides or other halides tied up within the cured resin's chemical molecule are acceptable, unless they are subject to release through ageing within the temperature range specified. Such paint formulations shall also not contain metallic zinc, because of the possibility of inducing liquid metal embrittlement.

Note: It has been shown that zinc oxide or zinc phosphate, which are the more recent non-lead, non-chromate, corrosion inhibitive pigment developments, do not cause embrittlement even at 850°C.

3.1.0 PREPARATION OF THE PAINT AIR DRYING ENAMEL:

3.1.1 Removal of skin from the paint:

Before application, any skin formed on the paint in the container shall be carefully removed, any settled pigment broken up and loosened and the paint thoroughly stirred to ensure complete and uniform mixing of the constituents. Care shall be taken to avoid entering air into the paint while stirring. The paint shall be strained through a muslin cloth or 60 mesh sieve.

3.1.2 Consistency of the paint:

The paint shall be used at an appropriate consistency depending on the mode of application. Table 1 provides the general guidance.

The above consistency shall be adjusted using white spirit or recommended thinner to AA 56701 depending on mode of application.

3.2.0 PREPARATION OF THE PAINT (ETCH PRIMER AND EPOXIDE PAINTS):

3.2.1 Etch primer:

Etch primer, as supplied, consists of two separate ingredients viz., primer base and accelerator. Shortly before use, mix together the primer base and accelerator in the proportions as per the recommendation of the supplier. The paint prepared as above does not require any thinning.

IMPORTANT NOTE:

After mixing, the paint shall be allowed to mature for 30 minutes unless otherwise specified. The mixed paint shall be used within 8 hours.



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3.2.2 COMPOSITION:

The paint shall consist of a two pack system viz., base and accelerator, as per AA 56103.

Generally the base, shall consist of zinc tetroxy chromate pigment dispersed in Polyvinyl butyl resin solution while accelerator shall consists of orthophosphoric acid in suitable solutions like butanol, industrial methylated spirit, etc.

The base shall be in such a condition that uniform and smooth dispersion material is obtained by stirring. There shall not be any tendency for viscosity build up, gelling and pigment settlement throughout the shelf life of the paint.

Etch primer may be applied prior to epoxy paint wherever recommended.

3.2.3 Mixing of the constituents of epoxide paints:

- a) These paints, as supplied, consist of two separate ingredients, namely base and accelerator. Shortly before mixing and use, these shall be thoroughly stirred. The base and the accelerator shall be accurately mixed together in the proportions as per the recommendations of the supplier.

Accelerator should be added to the base but not the base to the accelerator. The paints shall be mixed with continuous stirring until a uniform consistency is obtained.

- b) Consistencies of the paints :
The paints mixed shall be used at an appropriate consistency depending on mode of application. Table 1 provides general guidance.

Important Note:


After mixing, the paint shall be allowed to mature for 30 minutes and the mixed paint shall be used within 8 hours, unless otherwise specified in, by the paint supplier. All other properties should be as per individual specification.

3.2.4 Safety precautions:

Etch primer and epoxy paints are liable to cause irritation to the skin. This may transpire into inflammation, swelling, rash or pustules on the hands, arms and occasionally on the whole body.

Following precautions should be observed while handling these materials:

- i) Work place and storage rooms shall be adequately ventilated.
- ii) Before starting the work, hands should be washed with soap and water and good barrier cream applied.
- iii) Maximum care should be taken to avoid splashes on the skin
- iv) Splashing on the skin should be immediately washed with soap and water.
- v) After the work, hands, arms and face should be washed with soap and water followed by thorough drying with a clean towel.

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3.3.0 PREPARATION OF THE PAINTS (ALUMINUM SILICON):

3.3.1 Mixing of paint material shall be in strict accordance with manufacturer's instructions

3.3.2 Thinning shall only be done if necessary for the workability of the paint and in accordance with manufacturer's instructions. Petroleum or mineral spirits shall be used for thinning and shall not exceed 5% by volume.

3.3.3 Application over ethyl silicate zinc-rich primer:

(a) Underlying inorganic zinc primer shall be completely cured before application of aluminum silicone topcoat.

(b) Apply one coat of aluminum silicone paint to achieve a dry film thickness of 15 - 30 μm . A thin mist coat may be necessary before full coat application to avoid top coat bubbling.

Allow to air dry for 16 hours before direct exposure to operating conditions of the heat or before curing.

All other properties should be as per relevant corporate supplier's standard.

3.4.0 PAINT APPLICATION :

3.4.1 Paint application shall comply with the requirements of individual specification and with the paint manufacturer's printed instruction.

3.4.2 Paint shall be applied at ambient temperatures preferably not below 10° C.

3.4.3 Conventional air spray or airless spray application is acceptable. Brush application is also acceptable for surfaces inaccessible to spray and for touch up coats.

3.4.4 After thorough mixing of the product of two component systems, the maturation time as indicated in the manufacturer's product data sheet is to be allowed before applying the paint.

3.4.5 Short shelf life / two component paint mixture thickens as the time progresses and at the end of the pot life period, the mixture becomes highly viscous and unusable. It is best to consume mixed paint at least one hour before the end of the pot life.

3.4.6 Avoid using excess solvent than the recommended volumes since this leads to reduced dry film thickness, sagging and longer curing time.

3.4.7 Apply Epoxy Primer paint to achieve a dry film thickness of 35-50 microns and a coat of etch primer wherever recommended.

3.4.8 Allow the painted substrate to dry for 16 hrs before direct exposure to outside weather conditions or heat. In case of stoving paints, it is to be stoved at temperature and time specified in a suitable oven.

3.4.9 Apply a coat of finish paint after ensuring removal of dust, dirt and other contaminants from the primed surface. Intermediate coats of paints may be applied wherever recommended.



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3.4.10 All measurements and instrument calibration shall be in accordance with the specification AA 067 41 05 and the data to be recorded in accordance with AA 067 41 06 for each job.

3.5.0 QUALITY CHECKS & INSPECTION:

3.5.1 Following points shall be ensured to achieve overall quality of the job:

- (a) Compressed air used for spray application shall be free from oil, moisture and other contaminants.
- (b) Steel surfaces to be painted shall be free from burrs, sharp edges, lamination, surface imperfections and any other contamination detrimental to paint adhesion finish or appearance.
- (c) All surfaces to be coated have been cleaned in accordance with the requirements of BHEL STANDARD AA 067 4101.
- (d) All surfaces to be coated shall be completely dry before paint application.
- (e) Paint components shall be mixed as prescribed / recommended and mixed paint shall be consumed within specified pot life.
- (f) Drying / curing requirements shall be fully satisfied.
- (g) Damaged paint coating shall be properly touched up before another coating application.
- (h) All paint coating measurements like thickness gloss, finishing and adhesion shall be usable as per AA 067 41 05.

3.5.2 INSPECTION:


a) VISUAL:

The painted surfaces shall be free from spacks of iron, salt or dust. It shall be smooth and uniform and there will be no visible porosity, pot holes, or any other paint coating defects. If runs and sags dry spray and over spray are present these defects shall not be more than 5% in any given area (sq. feet) and cumulatively not more than 2% of total surface area unless otherwise specified.

- b) Dry film thickness DFT:** Dry film thickness should be measured with an appropriate measurement gauge calibrated as per AA 067 41 05. Unless otherwise specified.

c) ADHESION:

The adhesion of the primer to the steel substrate and the intercoat adhesion of the subsequent coat(s) after curing shall be determined by the application of a cross-cut test in accordance with BHEL Standard AA 067 41 05.

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d) Gloss level: As per AA 067 41 05.

e) Finish: as per AA 067 41 05.

f) Shade: As per IS : 5 unless otherwise specified.

g) Coated surfaces are smooth and uniform in coverage.

h) There is no visible porosity or pot holes.

i) Unacceptable defects such as peeling, blistering cracking and damage caused by external sources are clearly marked with a mark-free chalk and with in the specification requirements.

j) Runs and sags, dry spray and over spray are not present in excess of 5% in any given square foot and cumulatively not in excess of 2% of any surface. Unless otherwise specified

k) Drying time/curing time requirements have been satisfied.

l) Holiday / pinhole detection shall be conducted on all conventional thin film thickness, having total DFT 0.5mm or less, by low voltage wet sponge method as per ASTM D5162. This is carried out after top coat applied & fully cured / dried. For tank & vessel internals 100% of the surface shall be tested. Special attention shall be paid to welds, edges & irregular surfaces for holiday / pinhole testing. For external surfaces, random inspection, which shall be representation of entire surface shall be tested. No pinhole is acceptable.

3.6.0 PAINTING SCHEMES:

Selection of painting scheme has to be made on specific operational and environmental requirements. Similarly, selection of colours have to be made suitably unless both are specified by the customer. – BHEL painting scheme for various power equipment and related components is given in annexure - II. However, any deviation from number of coats and thickness specified by customer shall be followed.

Typical painting schedules for various industrial components and painting systems are also given in Annexure III and IV respectively. For general reference.

The list of BHEL Corporate Standards on Paints is enclosed in Annexure-V.



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ANNEXURE-I.

RELATIONSHIP BETWEEN 'DEW POINT', AIR TEMPERATURE AND RELATIVE HUMIDITY.

Air Temp. °C	'Dew Point' in °C at Relative Humidity of								
	50%	55%	60%	65%	70%	75%	80%	85%	90%
5	-5	-3	-2	-1	0	1	2	3	4
6	-3	-3	-1	0	1	2	3	4	4
7	-3	-1	0	1	2	3	4	5	5
8	-2	-1	1	2	3	4	5	6	6
9	-1	0	1	3	4	5	6	7	7
10	0	1	3	4	5	6	7	8	9
11	1	2	4	5	6	7	8	9	9
12	2	3	5	5	7	8	9	9	10
13	3	4	5	6	8	9	10	10	11
14	4	5	6	7	8	10	11	12	12
15	5	6	7	8	9	11	12	12	13
16	5	7	8	9	10	12	12	13	14
17	7	8	9	10	12	12	14	14	15
18	7	9	10	11	12	13	14	15	16
19	8	10	11	12	13	14	15	16	17
20	9	11	12	13	14	15	16	17	18
21	10	12	13	14	15	16	17	18	19
22	11	13	14	15	16	17	18	19	20
23	12	14	15	16	17	18	19	20	21
24	13	14	16	17	18	19	20	21	22
25	14	15	17	18	19	20	21	22	23
26	15	16	18	19	20	21	22	23	24
27	16	17	18	20	21	22	23	24	25
28	17	18	19	21	22	23	24	25	26
29	18	19	20	22	23	24	25	26	27
30	18	20	21	23	24	25	26	27	28

BHEL PAINTING SCHEME FOR PRODUCT Annexure II

Sl. No.	System	Environment (See note 1)	General description	** Painting Scheme reference	Total Dry film Thickness, In μm TDFT	Remarks
1	Power Boiler	Rural	Epoxy Two pack (organic) Zinc rich and Two pack Polyurethane.	1	80	
		Industrial	Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane.	2	180	
		Coastal	Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane	3	180	
		Industrial and coastal	Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane	8	180	
2	HRSG /Industrial Boilers	Rural	Chlorinated Rubber Based, chemical resistant	4	120	
		Industrial	Epoxy Two pack (Organic) Zinc rich and Epoxy Two pack chemical resistant and Two pack Polyurethane	5	155	
		Coastal	Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane	3	180	
		Industrial and Coastal	Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane	8	180	
3	Column, Pressure Vessel, Heat Exchanger	Rural	Epoxy Two pack (organic) Zinc rich and Two pack Polyurethane	1	80	
		Industrial	Epoxy Two pack (organic) Zinc rich, Epoxy Two pack chemical resistant and Two pack Polyurethane	5	155	

**** Refer Annexure - II (a)****Note -1 :** The painting scheme specified provides life to first maintenance of 5 years, under specified environment.

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Sl. No.	System	Environment (See note 1)	General description	** Painting Scheme reference	Total Dry film Thickness, in μm TDFT	Remarks
4	Tankage	Coastal	Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane	3	180	
		Industrial and Coastal	Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane.	8	180	
		Rural	Chlorinated Rubber Based, chemical resistant	4	120	
		Industrial	Epoxy Two pack chemical resistant and Two pack Polyurethane	7	175	
5	Rotating Equipment, Pumps, Compressors	Coastal	Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane	3	180	
		Industrial and coastal	Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane	8	180	
		Rural	Epoxy Two pack (organic) zinc rich and Epoxy Two pack chemical resistant and Two pack Polyurethane	5	155	
		Industrial	Epoxy Two pack chemical resistant and Two pack Polyurethane	7	175	
		Coastal	Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane	3	180	
		Industrial and coastal	Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane	8	180	

** Refer Annexure - II (a)



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II Continued..

Sl. No.	System	Environment (See note 1)	General description	** Painting Scheme reference	Total Dry film Thickness, in μm TDFT	Remarks
6	Piping Valve Fittings	Rural	Chlorinated Rubber based, chemical resistant	4	120	
		Industrial	Epoxy Two pack chemical resistant and Two pack Polyurethane.	7	175	
		Coastal	Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane	3	180	
		Industrial and coastal	Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane	8	180	
7	Transformers Tank conservation Bushing Turact Header, Piping work support structure	Rural	Epoxy Two pack (organic) Zinc rich and Two pack Polyurethane.	1	80	
		Industrial	Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane	2	180	
		Coastal	Epoxy Two pack chemical resistant and Two pack Polyurethane	7	175	
		Industrial and Coastal	Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane	8	180	
8	Control Cubicles	For indoor installation	Epoxy Two pack chemical resistant and Two pack Polyurethane	10	170	appln. Only by spray

**** Refer Annexure -II I (a)**

Note 1: Rural = Exterior, Exposed non-polluted inland atmosphere, operating temperature upto 90° C
Industrial = Exterior, Exposed polluted inland atmosphere, operating temperature upto 90° C
Coastal = Exterior, Exposed non-polluted inland atmosphere, operating temperature upto 90° C
Industrial & Coastal = Exterior, Exposed polluted inland atmosphere, operating temperature upto 90° C

Note 2: For operating temperature 91 - 400 ° C and 401 to 600 ° C, the painting scheme reference no: 6 and no: 9 respectively shall be followed

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CORPORATE STANDARD



BHEL Painting Schemes Details

ANNEXURE - II (a)

Paint reference Scheme	Surface Prepn. Grade/ Surface profile	Primer Coat			Intermediate coat			Finish coat			Total DFT, in µm
		Primer paint	No. of coats	DFT in µm	Intermediate paint	No. of coats	DFT in µm	Finish paint (See note)	No. of coats	DFT in µm	
1	Shot Blasting to Sa 2 1/2 35 to 50 µm	Epoxy zinc rich primer (Two pack) AA 561 14	1	50	--	--	--	Full gloss polyurethane finishing paint AA 561 42	1	30	80
2	Shot Blasting to Sa 2 1/2 35 to 50 µm	Inorganic Ethyl zinc silicate primer AA 561 13	1	75	High build intermediate Epoxy paint AA 561 12	1	75	Full gloss Polyurethane finishing paint AA 561 42	1	30	180



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II (a) Continued....

Note: The shade of finish paint shall be decided based on the option of concerned unit / customer's requirement.

Paint reference Scheme	Surface Prepn. Grade/ Surface profile	Primer Coat			Intermediate coat			Finish coat			Total DFT, in µm
		Primer paint	No. of coats	DFT in µm	Intermediate paint	No. of coats	DFT in µm	Finish paint (See note)	No. of coats	DFT in µm	
3	Shot Blasting to Sa 2 1/2 35 to 50 µm	Inorganic Ethyl zinc silicate primer t AA 561 13	1	75	High build intermediate epoxy paint AA 561 12	1	75	Full gloss Polyurethane finishing paint t AA 561 42	1	30	180
4	Shot Blasting to Sa 2 1/2 35 to 50 µm	Chemical resistant Chlorinated Rubber base priming paint AA 561 07	2	70				Chemical resistant chlorinated rubber based finishing paint AA 561 36	2	50	120

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II (a) Continued....

Paint reference Scheme	Surface Prepn. Grade/ Surface profile	Primer Coat			Intermediate coat			Finish coat			Total DFT, in µm
		Primer paint	No. of coats	DFT in µm	Intermediate paint	No. of coats	DFT in µm	Finish paint (See note)	No. of coats	DFT in µm	
5	Shot Blasting to Sa 2 1/2 35 to 50 µm	Epoxy based zinc rich primer (Two pack) AA 561 14	1	50	High build intermediate Epoxy paint AA 561 12	1	75	Full gloss Polyurethane finishing paint AA 561 42	1	30	155
6	Shot Blasting to Sa 2 1/2 35 to 50 µm	Inorganic Ethyl zinc silicate primer AA 561 13	1	75				Heat resistant air dry Aluminium paint Gr - I AA 561 49	2	40	115
7	Shot Blasting to Sa 2 1/2 35 to 50 µm	Chemical resistant epoxide redoxide zinc phosphate priming paint AA 561 05	2	70	High build intermediate epoxy paint AA 561 12	1	75	Full gloss Polyurethane finishing paint AA 561 42	1	30	175



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II (a) Continued....

Paint reference Scheme	Surface Prepn. Grade/ Surface profile	Primer Coat			Intermediate coat			Finish coat			Total DFT, in µm
		Primer paint	No. of coats	DFT in µm	Intermediate paint	No. of coats	DFT in µm	Finish paint (note See)	No. of coats	DFT in µm	
8	Shot Blasting to Sa 2 1/2 35 to 50 µm	Inorganic Ethyl zinc silicate primer AA 561 13	1	75	High build intermediate epoxy paint AA 561 12	1	75	Full gloss Polyurethane finishing paint AA 561 42	1	30	180
9	Shot Blasting to Sa 2 1/2 35 to 50 µm	Two pack, air drying heat resistant Polysilaxone paint AA 561 43	1	100	--	--	--	--	--	--	100

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II (a) Continued....

Paint referenc e Scheme	Surface Prepn. Grade/ Surface profile	Primer Coat			Intermediate coat			Finish coat			Total DFT, in µm
		Primer paint	No. of coats	DFT in µm	Intermediate paint	No. of coats	DFT in µm	Finish paint (See note)	No. of coats	DFT in µm	
10	Shot Blasting to Sa 2 1/2 35 to 50 µm or Phospha -ting to coating weight of 16.15 gm per sq.m	Chemical resistant epoxide redoxide zinc phosphate priming paint AA 561 05	1	35	High build intermediate epoxy paint AA 561 12	1	75	Full gloss Polyurethane finishing paint AA 561 42	2	60	170



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ANNEXURE-III**TYPICAL PAINTING SCHEDULE**

PIPING, VESSELS, COLUMNS, EXCHANGERS, REACTORS, STRUCTURAL STEEL AND FIRE-FIGHTING SYSTEMS.

ITEM	OPERATING TEMPERATURE (°C)	SUBSTRATE	PAINT SYSTEM No.(Annexure-V)
PIPING, VESSELS, COLUMNS, EXCHANGERS, REACTORS etc.	<120	Carbon steel, low alloy steel	1
	<120	9% Ni steel	2
	120-200	Carbon steel, low alloy steel	3
	200-450	Carbon steel low alloy steel	4
	Ambient – 200	Stainless steel	5
	200-450	Stainless steel	6
	Ambient – 1100	Carbon steel, stainless steel	7*
STRUCTURAL STEEL, LADDERS, GRATINGS etc.	-	Carbon steel, low alloy steel	1
	-	Hot dip galvanized carbon steel	8**
FIRE FIGHTING SYSTEMS(above ground)	<120	Carbon steel	9

* Current experience with this polysiloxane coating is good but still very limited.

** This duplex system shall only be applied to hot dip galvanized steel in cases where access for future maintenance is difficult.



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ANNEXURE-III (continued..)

ITEM		OPERAT-ING TEMPERA- TURE (°C)	SUBSTRATE	PAINT SYSTEM NUMBER (Annexure-V)
CRUDE OIL TANKS BOTTOM and LOWEST SHELL COURSE	INTERNAL Non-corrosive	<80	Carbon steel, low alloy steel	10*
	INTERNAL Corrosive	<80	Carbon steel, low alloy steel	11
CRUDE OIL TANKS ROOF and SHELL	INTERNAL	<80	Carbon steel, low alloy steel	10*
	EXTERNAL	<80	Carbon steel, low alloy steel	1
STORAGE TANKS	INTERNAL	<120	Carbon steel, low alloy steel	10*
	EXTERNAL	<120	Carbon steel Low alloy steel	1
		50-200	Stainless steel	5
	INTERNAL, Chemical Resistant	<60	Carbon steel, Low alloy steel	12
	INTERNAL Industrial water **	<80	Carbon steel, low alloy steel	11
LPG SPHERES and BULLETS	INTERNAL	<120	Carbon steel, low alloy steel	10
	EXTERNAL	<120	Carbon steel, low alloy steel	1
MOUNDED LPG STORAGE ***	EXTERNAL	Ambient	Carbon steel	13

* This treatment is a shop-applied temporary protection only. No further painting is required after construction.

** Primer is optional for use in industrial water tanks

*** For full details about this system, manufacturer's instructions may be followed.

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CORPORATE STANDARD**Annexure-III (Continued...)**

ITEM	OPERATING TEMPERATURE (° C)	SUBSTRATE	PAINT SYSTEM NUMBER (Annexure-V)
FURNACES, STACKS, FLARE STACKS And FLUE DUCTS	<120	Carbon steel, low alloy steel	1
	120-200	Carbon steel, Low alloy steel	3
	200-550	Carbon steel, Low alloy steel	14
	<400	Carbon steel, hot-dip galvanised*	15
	<200	Stainless	5
	200-450	Stainless	6
	Ambient-1100	Carbon steel, stainless steel	7**
OFF SHORE STRUCTURES, TIDAL ZONES	<120	Carbon steel, Low alloy steel	11
TOP SIDE FACILITIES, EQUIPMENT and PIPING	<120	Carbon steel, Low alloy steel	9
	120-200	Carbon steel, Low alloy steel	3

* For long life time service (>20 years) a hot dip galvanised duplex system is preferred.

** Current experience with this polysiloxane coating is good but still very limited.



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ANNEXURE-IV

TYPICAL PAINT SYSTEMS.

SYS. No.	SURFACE PREPARATION	PAINT SYSTEM		
		Primer	Inter-coat	Top-coat
1	Sa 2 ½	Alkyl zinc silicate DFT 75 microns	High build, epoxy sealer DFT 75 microns	High build, aliphatic polyurethane DFT 75 microns
2	Sa 2 ½	High build, polyamide cured, (zinc free) epoxy DFT 100 microns	-	High build, high solids, polyamide- cured epoxy DFT 100 microns
3	Sa 2 ½	Alkyl zinc silicate DFT 75 microns	-	2 coats silicone acrylic TDFT 60 microns
4	Sa 2 ½	Alkyl zinc silicate	-	2coats heat resistant, aluminium silicone TDFT 50 microns
5	Light sweep blast (steam clean if not possible)	Silicone Acrylic DFT 25 mic.	-	Silicone acrylic DFT 25 microns
6	Light sweep blast (steam clean if not possible)	Heat-resistant, Aluminium silicone DFT 25 microns	-	Heat resistant, aluminium silicone DFT 25 microns
7	Carbon steel SA 2 ½ Stainless steel- sweep blast to surface profile of 40 microns		Polysiloxane DFT 125 microns	Polysiloxane DFT 125 microns
8.	Hot dip galvanized after light sweep blast	Zinc-rich epoxy primer DFT 40 mic.	-	High build, aliphatic polyurethane DFT 100 microns
9	Sa 2 ½	Alkyl zinc silicate DFT 75 microns	Polyamide cured, MIO pigmented, Epoxy tie coat DFT 40 mic.	2coats high solids Aluminium-pigmented epoxy TDFT 200 microns

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CORPORATE STANDARD**Annexure-IV (Continued...)**

SYS. No.	SURFACE PREPARATION	PAINT SYSTEM		
		Primer	Inter-coat	Top-coat
10	Sa 2 ½	Zinc-rich epoxy DFT 25 microns	-	-
11	Sa 2 ½	Polyamide-cured epoxy primer DFT 75 microns	-	Solvent-free high solids, amine-cured epoxy DFT 500 microns
12	Sa 2 ½	Amine cured, phenolic epoxy primer DFT 100 microns	Amine adduct-cured, Phenolic epoxy DFT 100 microns	High build, amine adduct-cured epoxy DFT 100 microns
13	Sa 2 ½	-	-	Solvent-free, high solids epoxy (hot applied) DFT 800 microns
14	SA 2 ½	Zinc silicate DFT 75 microns	-	Alkyl silicate Aluminium-pigmented DFT 40 microns
15	Hot dip galvanized (slightly sweep blast if aged)	Zinc-rich epoxy primer DFT 75 microns	Polyamide-cured, MIO pigmented, Epoxy tie coat DFT 40 mic.	High solids, Aluminum-pigmented epoxy DFT 100 microns



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ANNEXURE-V.

LIST OF CORPORATE PAINT SPECIFICATION.

AA 561 01	ANTI-CORROSIVE PRIMING PAINT
AA 561 03	ETCH PRIMER
AA 561 05	CHEMICAL RESISTANT EPOXIDE RED OXIDE ZINC PHOSPHATE PRIMING PAINT
AA 561 07	CHEMICAL RESISTANT CHLORINATED RUBBER BASED PRIMING PAINT.
AA 561 11	ALKYD BASE RED OXIDE ZINC PHOSPHATE ANTI CORROSIVE PRIMING PAINT
AA 561 12	HIGH BUILD INTRMEDIATE EPOXY PAINT
AA 561 13	INORGANIC ETHYL ZINC SILICATE PRIMER
AA 561 14	EPOXY BASED ZINC RICH PRIMER -TWO PACK
AA 561 26	HIGH QUALITY FULL GLOSSY OUTDOOR FINISHING PAINT
AA 561 27	NON-YELLOWING FULL GLOSSY WHITE PAINT
AA 561 28	ALUMINIUM PAINT FOR GENERAL PURPOSES
AA 561 31	CHEMICAL RESISTANT EPOXIDE FINISHING PAINT
AA 561 32	OIL RESISTANT, AIR DRYING, SYNTHETIC ENAMEL
AA 561 34	HEAT RESISTANT AIR DRY ALUMINIUM PAINT - Gr. 2 (TEMPERATURE UPTO 400 ⁰ C)
AA 561 35	HIGH BUILD BLACK COAL TAR EPOXIDE PAINT
AA 561 36	CHEMICAL RESISTANT CHLORINATED RUBBER BASED FINISHING PAINT .
AA 561 40	EXTRA HIGH BUILD BLACK COAL TAR EPOXIDE PAINT
AA 561 42	POLY URETHANE FINISHING PAINT
AA 561 43	TWO PACK, AIR DRYING, HEAT RESISTANT POLYSILOXANE PAINT.
AA 561 49	HEAT RESISTANT AIR DRY ALUMINIUM PAINT - Gr.1 (TEMPERATURE UPTO 600 ⁰ C)
AA 561 59	EPOXY POLYESTER POWDER COATING MATERIAL
AA 561 60	EPOXY POWDER COATING MATERIAL

CORPORATE STANDARD



TABLE - II
Estimated Service Life Years, Before First Maintenance Painting)
of Paint Protective Coating, Galvanizing and Zinc-Rich Systems.

Sl. No.	Number of coats	Coating system	Surf. Prep SSPC *	Minimum DFT mill or microns.	Maint.sched	Sea coast Maint.	Sea coast Heavy Industrial	Caustic	Acid	Fresh water Immersion	Salt water / Brine immersion	Ammonia	Chlorine	Solvents / Gasoline	Mild	Moderate	severe	Dry heat resistance °C
1	2	Alkyd primer/top	2/3	4.0 100	I	1	1	0.5	0.5	N	N	0.5	0.5	0.5	3	2	1	66-94
2	3	Alkyd primer/top	2/3	6.0 150	I	2	2	1	1	N	N	1	1	1	6	4	2	66-94
3	2	Alkyd primer/ silicone alkyd	6	4.0 100	I	2.5	2.5	1	1	N	N	1	1	1	7	5	2.5	149-177
4	2	Universal primer /HB epoxy	2/3	6.0 150	I	4	3	3	2	N	N	3	2	3	7	5	3	121-149
5	3	Universal primer/ HB epoxy/ Acrylic polyurethane	2/3	7.5 180	I	5	3	3	3	N	N	3	3	3	9	6	4	149
6	2	Epoxy primer / HB epoxy	2.3	6.0 150	I	4	3	3	2	N	N	3	2	3	7	5	3	121-149
7	2	Epoxy zinc/ HB epoxy/ Acrylic polyurethane	6	7.0 175	I P	6 9	3 4.5	3 4.5	4 6	N N	N N	3 4.5	4 6	5 7.5	11 16.5	8 12	5 7.5	149
8	3	Epoxy zinc/HB Epoxy / Acr. Ure	10	9.0 225	I P	8 12	6 9	6 9	7 10.5	N N	N N	6 9	7 10.5	6 9	15 19.5	10 15	7 10.5	149

* Rust grades as per SSPC Vis-2 or SSPC D- 610:



CORPORATE PURCHASING SPECIFICATION

AA10108

Rev No. 11

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STRUCTURAL STEEL-STANDARD QUALITY (PLATES, SECTIONS, STRIPS, FLATS & BARS)

(ORDERING DESCRIPTION)

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

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Dt:22-02-2014

Dt:


Year:

51 HPEP, Hyderabad

Corp.R&D

July, 1976

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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

52

	<h1 style="text-align: center;">CORPORATE STANDARD</h1>			AA7111122	
				Rev No.09	
				PAGE 1 of 3	
<h2>BOLTS, HEXAGON HEAD, PRODUCT GRADE 'A' COARSE PITCH, STEEL PROPERTY CLASS 8.8 (M3 - M16)</h2>					
<p>1.0 DESIGNATION: A product Gr.A, hexagon head, steel bolt of nominal diameter 10 mm, length 60 mm, coarse pitch and conforming to property class 8.8 shall be designated as:</p>					
<p>1.1 On Drawings: i) Material specification column : AA7111122 ii) Description Column : BOLT HEX A M10 X 60 – 8.8</p>					
<p>1.2 On Indents: Bolt Hex A M10 X 60 – 8.8: AA7111122</p>					
<p>1.3 For issuing enquiries and on purchase orders: While issuing enquiries and purchase orders delete BHEL standard number from above description and add the information given under clause 2.0</p>					
<p>2.0 COMPLIANCE WITH STANDARDS:</p>					
<p>2.1 Dimensions, Tolerance & General Requirements: As per IS 1364 : Part 1 : 2018</p>					
<p>2.2 Mechanical Properties: To conform to property class 8.8, as specified in Table–3 of IS:1367, Part 3 Permissible hardness 238-350 HB for sizes M6-M10</p>					
<p>2.3 Threads: Pitch-Coarse to IS 4218 : Part 2 Tolerance quality – Medium Tolerance class – 6g</p>					
<p>2.4 Identification Marking: As stated in Clause 10 of IS 1367 : Part 3</p>					
<p>2.5 Surface Discontinuity: As per IS 1367 : Part 9 : Sec 1</p>					
<p>2.6 Finish: Planted as specified in BHEL order.</p>					
Revisions:			APPROVED: INTERPLANT MATERIAL RATIONALISATION COMMITTEE – MRC(F)		
Rev No.09	Amd No.	Reaffirmed	Prepared	Issued	Dt. of 1 st Issue
Dt:20-03-2021	Dt:	Year:	53HEEP, Haridwar	Corp.R&D	January 1977

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3.0 NOTE:

- 3.1** Length and diameter combination (refer Table-1 on page 3 of 3) between the bold lines should only be use
- 3.2** For screw threads, general (Metric) refer to BHEL standard AA0231800
- 3.3** For tolerance grade, position and class refer to BHEL standard AA0230201
- 3.4** Bolts to this standard would be un-plated, divisions wishing to have plated bolts would have to get them plated.
- 3.5** Weights given in this standard are for general reference only and are not meant for commercial transaction.
- 3.6** For product group Gr:A, hexagon head, steel bolts, property class 8.8 (M20 - M24) refer BHEL standard AA7111124
- 3.7** When fasteners are to be tested with in BHEL, the sampling and acceptance plan shall be as per IS:1367, part 17

4.0 REFERRED STANDARDS (Latest publications including amendment):

- | | | |
|-------------------------------------|--------------|---------------------|
| 1) AA0231800 | 2) AA0230201 | 3) AA0231850 |
| 4) IS 1367 : Part 3, 9 : Sec 1 & 17 | 5) AA7111124 | 6) IS 4218 : Part 2 |

EXPLANATORY NOTE

- In Clause 2.1, year of IS updated to 2018
- In Clause 2.4, clause 10 in place clause 9.
- In Clause 2.5, applicable Section of IS added.

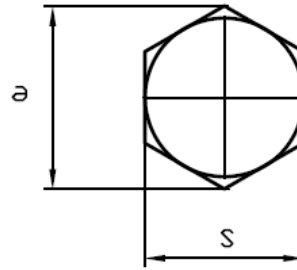
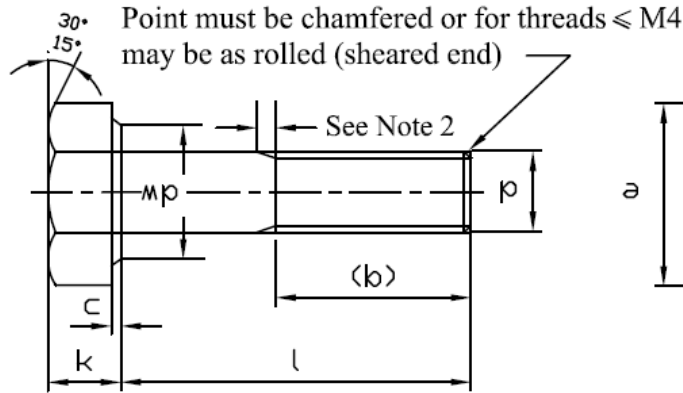


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Note:

- 1) Corporate sub codes are shown in the table.
- 2) For thread runout refer AA0231850
- 3) Weights have been shown in kg per 1000Nos
- 4) Symbol Δ denotes the non-preferred size.

All dimensions are in 'mm'

TABLE - 1

Nom. Size d	Head			Washer		Thread Length b		Nominal Length (l)																		
	Flats s	Crns e	Tkns k	Dia dw	Tkns c	For Nom. Length ≤ 125	For Nom Length >125 & ≤ 200	20	25	30	35	40	45	50	55	60	65	70	80	90	100	110	120	130	140	150
	Max.	Min.	Max.	Min.	Max.			Min.	Sub Code																	
	Min.		Min.						Min.	Weight																
M3	5.5	6.01	2.12	4.6	0.4	12	-																			
	5.32		1.88		0.15																					
M4	7.0	7.66	2.92	5.9	0.4	14	-																			
	6.78		2.68		0.15																					
M5	8.0	8.79	3.65	6.9	0.5	16	-			550			569													
	7.78		3.35		0.15					5.63			7.94													
M6	10.0	11.05	4.15	8.9	0.5	18	-	011 Λ	020*	038	542	356	046													
	9.78		3.85		0.15			7.36	8.47	9.58	10.2	11.8	12.9													
M8	13.0	14.38	5.45	11.6	0.6	22	28		364 Λ	372	054	429	062		380	445		453	577 Λ							
	12.73		5.15		0.15				16.3	18.27	20.3	22.2	24.2		28.15	30.1		34.0	40.0							
M10	16.0	17.77	6.58	14.6	0.6	26	32			070 Λ	089	585	097	593	100	119	399	127	402	135	143	151 Λ				
	15.73		6.22		0.15					32.0	35.1	38.2	41.3	44.4	47.4	50.5	53.6	56.7	59.8	65.9	72.0	78.2				
M12	18.0	20.03	7.68	16.6	0.6	30	36				160*	178	186	194	208	216	607	224	410	470*	488	232	496			
	17.73		7.32		0.15						49.9	54.3	58.7	63.2	67.7	72.1	76.5	74.32	85.4	94.3	103.2	112.0	121.0			
M16	24.0	26.75	10.18	22.5	0.8	38	44					240 Λ	259	267	275	283	291	305	313	321	500*	518	330*	348		
	23.67		9.82		0.2							108.0	115.9	123.7	131.6	139.5	147.4	155.3	171.0	187.0	203.0	218.5	233.0	249.0		



CORPORATE PURCHASING SPECIFICATION

AA10112

Rev No. 07

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BRIGHT STEEL BARS AND SECTIONS (STANDARD QUALITY)

1 GENERAL:

This specification governs the quality requirements of Bright Steel Bars and Sections of standard quality, such as I-beams and equal angles required in very small sections.

2 APPLICATION:

Bars are used in the manufacture of threaded and machined components for general engineering purposes. Sections are used as stator spacer plate vents in generators.

3 CONDITION OF DELIVERY:

3.1 Round Bars - Class 4, surface quality.

Up to 50 mm diameter - Cold drawn.

Above 50mm diameter - Cold drawn or Hot rolled, turned and polished

3.2 Rectangular/Square/Hexagonal Bars - Class 3, surface quality.

All sizes - Cold drawn.

3.3 Sections - Class 4, surface quality.

All sizes - Cold drawn

3.4 Bars and sections shall be straight, with their ends sheared, square and true and shall have a smooth surface.

3.5 The bars and sections shall be given a clear temporary rust preventive (TRP) coating to avoid corrosion during transit and storage.

Black TRP coating is not acceptable.

Clear TRP used shall be free from pungent smell.

The following clear TRP's are suggested:

- Servo RP 150 - M/s Indian Oil Corporation
- HE - 1612 - M/s. BHEL, Bhopal
- Rustilo DW-901 - M/s. Indrol Lubricants and Specialties Ltd.
- Rustpro Special - M/s. Tide water oil co.
- Any other clear TRP conforming to IS: 1154

4 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: 9550-2001 : Bright steel bars

Revisions:

CI 27.2.d of MOM of MRC-S&GPS

APPROVED:

INTERPLANT MATERIAL RATIONALISATION
COMMITTEE – MRC(S&GPS)

Rev No.07

Amd No.

Reaffirmed

Prepared
HEP, Bhopal

Issued
Corp.R&D

Dt. of 1st Issue
September 1976

Dt:15-06-2005


Dt:

Year:2019

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RAS302

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5 DIMENSIONS AND TOLERANCES:

5.1 Sizes:
Bars shall be supplied to the dimensions specified in BHEL order.

5.2 Tolerances:

5.2.1 Rectangular/Square/Hexagonal/Flat Bars:
Unless otherwise specified, tolerances on dimensions shall be as follows:

For drawn round bars and turned bars h10 to table 2 of IS:9550

For hexagonal and square drawn bars upto and including 80mm h11 and above 80mm h12 according to table 2 of IS:9550

For drawn flats in accordance with table 3 and 4 of IS:9550

For ground products in accordance with table 1 and 2 of IS:9550

5.2.2 Sections:
As specified in BHEL order/drawing.

5.3 Length:
Bar and sections shall be supplied in lengths of 2.5 to 4.5 meters with maximum 10% of shorts of not less than 1.5 meters.

5.4 Straightness:
Unless otherwise agreed to, the permissible deviation shall not exceed 1.5mm in any one meter length. Bars and sections shall be free from twists and bends.

6 MATERIAL:
The rolled bars used for purpose of producing the bright bars shall be such, so as to ensure freedom from segregation, piping and other harmful defects.

7 MANUFACTURE:
Steel shall be manufactured by the open-hearth, electric, basic oxygen or a combination of these processes.


8 FREEDOM FROM DEFECTS:
All finished steel bars and section shall be sound and free from internal and surface defects. They shall be bright and clean.


9 SURFACE CONDITION:

9.1 Round Bars and Sections:
Shall be entirely free from cracks and other surface defects.

9.2 Rectangular/Square/Hexagonal Bar-Type '3' Finish:
Shall comply with IS: 9550, Class 3 of table 5.

10 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:

	CORPORATE PURCHASING SPECIFICATION		AA 195 11		
			Rev. No. 09		
			PAGE 1 OF 6		
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 : 36 th MOM of MRC-FCF+HTM			APPROVED : INTERPLANT MATERIAL RATIONALISATION COMMITTEE-MRC (FCF+HTM)		
Rev. No. 09	Amd.No.	Reaffirmed	Prepared	Issued	Dt. of 1st Issue
Dt: 01.10.2005	Dt :	Year;04-11-2011	HYDERABAD	Corp. R&D	MARCH, 1978

AA 195 11	CORPORATE PURCHASING SPECIFICATION	
Rev. No. 09		
PAGE 2 OF 6		

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 COMPOSITION

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

	CORPORATE PURCHASING SPECIFICATION	AA 195 11
		Rev. No. 09
		PAGE 3 OF 6

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
Vanadium	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:

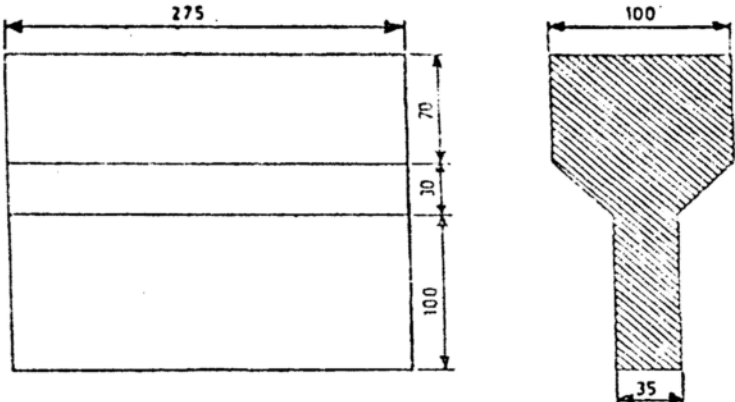
11.2 Unless otherwise specified castings weighing more than 500 kg shall be provided with integrally cast keel block.

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.

AA 195 11	CORPORATE PURCHASING SPECIFICATION	
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DETAIL OF KEEL BLOCK



ALL DIMENSIONS IN mm

12.0 MECHANICAL PROPERTIES:

The test pieces, after being heat treated as per clause CI.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



CORPORATE PURCHASING SPECIFICATION

AA 195 11

Rev. No. 09

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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 |



CORPORATE STANDARD

AA7161001

Rev. No. 04

PAGE 1 of 3

WASHERS, MACHINED, STEEL

1 DESIGNATION

A machined washer of size 8.4 mm made of steel shall be designated as:

1.1 On drawings

- i) Material specification column: AA7161001
- ii) Description column: WASHER MCD 8.4-ST

1.2 On indents

Washer Machined 8.4 – Steel: AA7161001

1.3 For issuing enquiries and on purchase orders

While issuing enquiries and purchase orders, delete BHEL standard number from the above description and add the information given under clause 2.

2 COMPLIANCE WITH STANDARDS

2.1 Dimensions, Tolerances and General requirements

As per IS: 2016-1967, Table-1

2.2 Material

Steel as stated in IS: 2016

2.3 Finish

Plated as specified in BHEL order.

3 NOTE

- 3.1 For machined washers of brass, refer to BHEL standard AA7161002
- 3.2 For machined washers of copper, refer to BHEL standard AA7161004
- 3.3 Washers to this standard would be unplated, divisions wishing to have plated washers would have
- 3.4 For general requirements of washers, refer BHEL standard AA0230408
- 3.5 Weights given in this standard are for general reference only and are not meant for commercial transactions.
- 3.6 When fasteners are to be tested with in BHEL, the following sampling and acceptance plan based on IS: 6821 (Table-2) shall be followed for physical properties.

LOT SIZE	SAMPELE SIZE	ACCEPTANCE NOS.
Up to 1000	5	0
1001-3000	8	0
3003-10000	13	0
10001-35000	20	0
Over 35000	32	1

Revisions: As per clause 29.4 of MOM of WG-F

APPROVED:

INTERPLANT MATERIAL RATIONALISATION
COMMITTEE – MRC (F)

Rev. No. 04	Amd. No.	Reaffirmed	Prepared	Issued	Dt. of 1 st Issue
Dt: 15-04-2011	Dt:	Year: 2019 63	HPEP, Hyderabad	Corp. R&D	01-01-1977

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AA7161001

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CORPORATE STANDARD**4 REFERRED STANDARDS (Latest publications including amendment)**

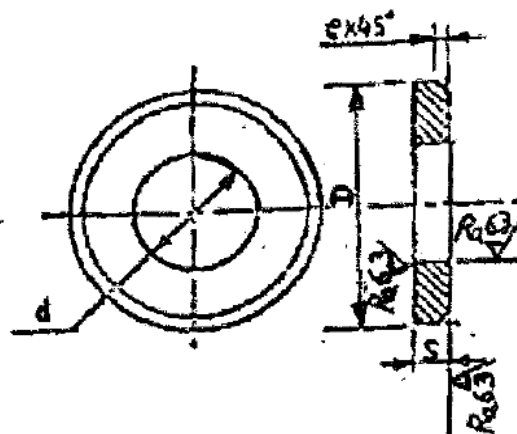
- 1) IS: 6821
- 2) AA0230408
- 3) AA7161002
- 4) AA7161004

EXPLANATORY NOTE

This standard was first issued in January 1977. The standard was based on IS:2016-1967 for dimensions, tolerances and general requirements. Subsequently many changes have been agreed upon at International & IPSC level and were reflected in IS: 2016-1967.

There is no change in IS: 2016-1967. This standard has been reviewed and brought up to date.

- Clause 3.6 “Sampling plan” for washers has been modified in line with IS: 6821
- Clause 4.0 has been modified accordingly.



	CORPORATE STANDARD	AA7161001
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Note:


- 1) Corporate sub codes are shown in Table
- 2) Weights have been shown in kg per 1000 Nos.

Table 1

All dimensions in mm.

Size Nom. d h12	Outside diameter D		Thickness S		e nom	for bolt or screw size	Sub-code	Weight
	Basic	Tol.	Basic	Tol.				
1.7	4	+0 -0.3	0.3	±0.1	0.1	M1.6		
2.2	5	+0 -0.3	0.3	±0.1	0.1	M2	170	
2.7	6.5	+0 -0.3	0.5	±0.1	0.2	M2.5	161	
3.2	7	+0 -0.3	0.5	±0.1	0.2	M3	013	0.11
4.3	9	+0 -0.3	0.8	±0.1	0.3	M4	021	0.29
5.3	10	+0 -0.3	1	±0.1	0.4	M5	030	0.42
6.4	12.5	+0 -0.4	1.6	±0.2	0.6	M6	048	1.08
8.4	17	+0 -0.4	1.6	±0.2	0.6	M8	056	2.07
10.5	21	+0 -0.5	2	±0.2	0.6	M10	064	3.98
13	24	+0 -0.5	2.5	±0.3	0.6	M12	072	6.16
17	30	+0 -0.5	3	±0.3	0.6	M16	080	11.17
21	37	+0 -0.8	3	±0.3	1	M20	099	16.7
25	44	+0 -0.8	4	±0.3	1	M24	102	31.78
31	56	+0 -1.0	4	±0.3	1	M30	110	52.95
37	66	+0 -1.0	5	±0.6	1.6	M36	129	89.99
43	78	+0 -1.0	7	±1	1.6	M42	137	180.3
50	92	+0 -1.5	8	±1	1.6	M48	145	291.26
58	105	+0 -1.5	9	±1	1.6	M56	188	421.8
66	115	+0 -1.5	9	±1	2	M64	153	486.45

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5.0 FINISH:
Material shall have a smooth finish.

6.0 FREEDOM FROM DEFECTS:
All ingredients of the mix shall be free from grit and extraneous matter. The selection and processing of the ingredients shall be such that the vulcanizate is free from surface imperfections, blisters, porosity, voids, inclusions, flow marks, inadequate joint of moulding blank and other defects which would impair satisfactory performance.

7.0 CHEMICAL COMPOSITION:
Sheets, gaskets and moulding shall be made at slow crystallization rate from vulcanizates based on chloroprene polymer reinforced only with carbon black, vulcanized with a metallic oxide and rubber containing at least 2 parts per hundred of a suitable antioxidant.

8.0 IDENTIFICATION:
The material, when identified by infra-red spectra photometer or by any other convenient method shall be of chloroprene copolymer.

9.0 TEST SAMPLES:
Three samples of sheets of the following sizes prepared from the same batch and vulcanized to the same degree as the consignment concerned shall be submitted for testing.
150 x 150 x 2 ± 0.15 mm thickness : two sheets
150 x 150 x 6.3 ± 0.15 mm thickness : one sheets


10.0 PROPERTIES:
When tested in accordance with the Indian standards / British standards shown against each, the test samples shall show the following properties:


10.1 Hardness (BS 903: Part A 26: Method N, 2 Plies, 6.3 mm + 2mm with the thicker ply on top):
60 + 5, - 4 IRHD


10.2 Tensile strength (IS:3400, Part I, Dumb-bell):
13 N/mm², minimum

10.3 Elongation at Break (IS:3400, Part I, Dumb-bell):
250% , minimum

10.4 Compression set at 70⁰C (IS: 3400, Part X):
For 72 hours + 0, - 2, hours: 25%, maximum.

	CORPORATE PURCHASING SPECIFICATION	AA 598 03
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10.5	<p>Ageing in Oil:</p> <p>Two test specimens each of 25 mm wide and of suitable length shall be cut from each sheet in the sample from widely separated positions. The specimens shall be aged in Servo prime 32 of IOC or its equivalent for 72 hours at 70°C.</p>	
10.5.1	<p>Change in Volume: 10%, maximum</p>	
10.5.2	<p>Oil Absorption (Calculated on the Original Weight of the Specimen):</p> <p>15%, maximum</p>	
11.0	<p>TYPE TESTS:</p> <p>Whenever specified, the following type tests shall be conducted as per the test method specified against each and the norms of acceptance shall be as specified below:</p>	
11.1	<p>Volume Change (BS 903: Part A 16: Volumetric Method, Liquid B, 22 Hours At 40°C):</p> <p>70%, maximum.</p>	
11.2	<p>Resistance To Heat Ageing For 168 Hours At 70°C (IS: 3400, Part IV):</p>	
11.2.1	<p>Change In Hardness (BS 903: Part A 26 : Method N):</p> <p>+ 7, IRHD maximum, when measured on 2 plies each of 2 mm thickness before and after ageing.</p>	
11.2.2	<p>Change in Tensile Strength (IS:3400, Part I, Dumb-bell):</p> <p>-12%, maximum of the value obtained at clause 10.2.</p>	
11.2.3	<p>Change In Elongation At Break (IS:3400, Part I, Dumb-bell):</p> <p>-20% , maximum of the value obtained at clause 10.3</p>	
11.3	<p>Adhesion To And Corrosion Of Metals (BS 903: Part A 37: Method A):</p> <p>There shall be no corrosion or pitting of the metals and the material shall not adhere to the metal surface or show any sign of liquid exudation. Discolouration of the metal surfaces shall not be considered to be objectionable.</p>	
12.0	<p>TEST CERTIFICATES:</p> <p>Unless otherwise stated, three copies of test certificates shall be supplied giving the following information:</p> <p>In addition, the supplier shall ensure to enclose one copy of the test certificate along with their despatch documents for quick clearance of the material.</p> <p>AA 598 03, Rev. 03: Chloroprene Rubber Sheets, Gaskets & Mouldings, 60 IRHD BHEL Order No.</p> <p>Manufacturer/s / Supplier/s name and trade mark, if any</p> <p>Batch No</p> <p>Date of manufacture</p> <p>Test results of clauses 4.0, 8.0, 10.0 and 11.0.</p>	

	CORPORATE PURCHASING SPECIFICATION			AA 101 15	
				Rev. No. 09	
				PAGE 1 OF 7	
COLD ROLLED CARBON STEEL SHEET, ANNEALED - DRAWING					
<p>1.0 GENERAL:</p> <p>This specification governs the quality requirements of Cold Rolled Carbon Steel Sheet/Coil of drawing quality, Annealed and skin passed condition. Sheets having thickness of 0.40 to 3.15 mm (both inclusive) and widths upto 1250 mm are covered in this specification.</p> <p>2.0 APPLICATION:</p> <p>Suitable for Drawing/ Welding..</p> <p>3.0 CONDITION OF DELIVERY:</p> <p>Sheets/Coils : 0.40 mm to 3.15 mm thick, cold rolled, descaled and oiled sheet/coil shall be supplied in fully annealed and skin passed condition. The size, weight and packing of the coils/sheets shall be as agreed to between the manufacturer and BHEL for indigenous material. For imported material, it shall comply with clause 14.0.</p> <p>Sheets shall be supplied in straight lengths or in coils as specified in BHEL order.</p> <p>Sheets shall be flat and the edges cleanly sheared and truly squared to the specified dimensions.</p> <p>Oils used for rust prevention shall be free from pungent smell. The following oils are suggested :</p> <p>a) SERVO RP 125 of M/s. IOC.</p> <p>b) RUSTOP 387/388 of M/s. HPC</p> <p>c) Bharat TCPF of M/s. Bharat Petroleum</p> <p>d) Any other TRP conforming to IS : 1154</p> <p>Sheets shall have a matt surface finish and best surface appearance.</p> <p>4.0 COMPLIANCE WITH NATIONAL STANDARDS:</p> <p>4.1 Material shall comply with the requirements of IS:513-1994, Gr:D-Drawing, Temper: SP-Annealed & Skin passed; Quality; killed/semi killed; Surface type - Best; Surface finish : Matt.</p>					
Revisions : CL 27.6.8 OF MOM OF MRC-S&GPS			APPROVED : INTERPLANT MATERIAL RATIONALISATION COMMITTEE-MRC (S&GPS)		
Rev. No. 09	Amd.No.	Reaffirmed	Prepared BHOPAL	Issued Corp. R&D	Dt. of 1st Issue JULY, 1976
Dt: 15.06.2005	Dt :	Year :			

AA 101 15	CORPORATE PURCHASING SPECIFICATION	
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4.2 Material offered to DIN 1623-1983, Part 1, Gr : RRSt-13.03, (Material No. 1.0347) Surface appearance: Best surface - 05, Surface finish : Matt ‘m’, is also acceptable.

4.3 The tolerance on dimensions shall comply with DIN : 1541.

5.0 DIMENSIONS AND TOLERANCES:

5.1 Sizes:

Cold rolled carbon steel sheets/coils shall be supplied to the dimensions specified in BHEL order.

5.2 Tolerances:

The tolerances on sheets and coils shall comply with IS : 513 as detailed below:

5.2.1 Thickness:


Tolerances on thickness of sheets	
Nominal thickness, mm	Tolerance for nominal widths upto 1250 mm
-- 0.40	± 0.04
Above 0.40 up to 0.60	± 0.05
Above 0.60 up to 0.80	± 0.06
Above 0.80 up to 1.00	± 0.08
Above 1.00 up to 1.25	± 0.09
Above 1.25 up to 1.60	± 0.11
Above 1.60 up to 2.00	± 0.12
Above 2.00 up to 2.50	± 0.14
Above 2.50 up to 3.15	± 0.16

5.2.2 Width:

Width	Tolerance
Upto & Incl. 1250 mm	+ 7 mm
	- 0
Above 1250 mm	+ 10 mm
	- 0

5.2.3 Length:

Up to and incld. 2000 mm	+ 15 mm
	- 0
Over 2000 mm	+ 0.75 percent of length
	- 0

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		Rev. No. 09
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5.2.4 Camber:

Camber is the greatest deviation of a side edge from a straight line, the measurement being taken on the concave side with a straight line. Camber tolerances are as specified below:

Coils - 20 mm in any 5000 mm length

Cut lengths - 0.4% x length.

5.2.5 Out-of Square Tolerance (for cut lengths) :

1 percent of the width.

(Out-of squareness is the greatest deviation of an edge from a straight line drawn at a right-angle to the other edge of the sheet, touching one corner and extending to the opposite edge).

6.0 MANUFACTURE :

Steel shall be manufactured by open-hearth, electric, basic oxygen or a combination of these processes.

Material shall be manufactured from semi killed/killed steel, preferably aluminum killed.

Rimmed steel is not acceptable.

7.0 FINISH:

Material shall have a medium or dull finish. Pores, roll marks or scratches which do not impair uniform appearance of the finished product are permissible. The sheets shall be free from waviness and the surface shall be ideal for spray painting.

8.0 HEAT TREATMENT :

Sheets and coils shall be fully annealed and skin passed.


9.0 FREEDOM FROM DEFECTS :

The material shall be free from harmful defects such as scale, rust, blisters, laminations, pitting, cracked edges, etc.

10.0 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	0.12	0.02
Manganese	0.50	0.03
Sulphur	0.040	0.005
Phosphorus	0.040	0.005

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11.0 TEST SAMPLES:

One bend test and hardness test shall be carried out from each lot of 5,000 kg of material or part thereof, per melt per consignment.

Where material of more than one thickness are rolled from the same melt, one additional bend test shall be made for each thickness.

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

12.0 MECHANICAL PROPERTIES :

12.1 Bend Test :

The test piece shall be capable of being bent cold through 180° close without showing sign of cracks or fracture on the outer convex surface.

Bend test shall be carried out in accordance with IS : 1599.

12.2 Hardness (VICKERS) :

When tested as per IS : 1501, the test pieces shall show a Vickers hardness as given below:

Upto & Incl. 1.25 mm, thick	:	115 HV, max.
Above 1.25 mm, thick	:	125 HV, max.

13.0 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:

AA 101 15, Rev 09/IS:513 Gr:D/DIN 1623 Gr: RRSt 13.03 m,
BHEL Order No,
Melt No,
Size and Quantity,
Results of Chemical analysis and Mechanical tests,
Supplier's name,
Identification No
TC No,
Signature of Competent authority, etc..

14.0 PACKING :

14.1 Packing:

Sheets and Coils shall be suitably packed in bundles to prevent corrosion and damage during transit.

Recommended packing for imported material shall be as shown below. However, other methods of packing is also acceptable if prior agreement of BHEL is obtained in writing by the manufacturer.



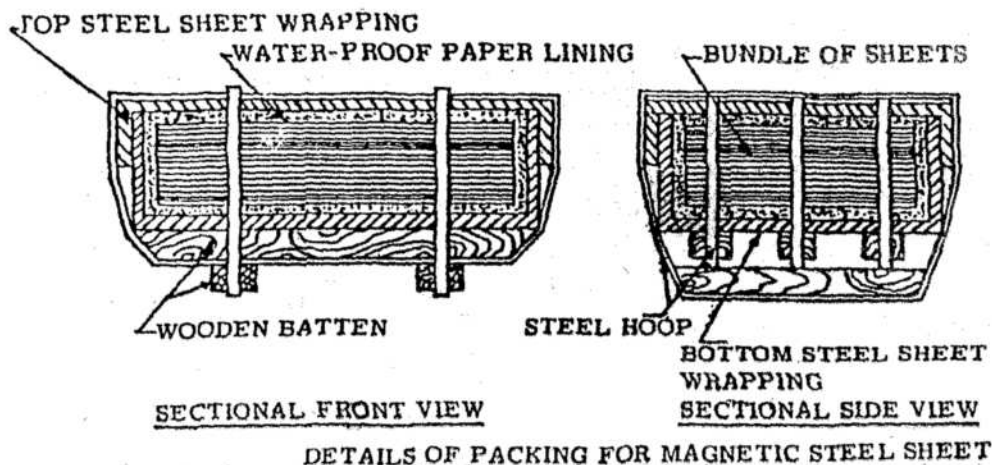
CORPORATE PURCHASING SPECIFICATION

AA 101 15

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14.2

Sheets :Note:

- Water proof paper lining shall be preferably Volatile Corrosion Inhibitor (V.C.I.) Coated Paper with an additional polythene (100 micron) enveloped.
- Approximate weight of each bundle shall be 2 to 3 tonnes. Bundle weighing 2 metric tonnes is however preferred.

14.3

Coils:

The material shall be supplied in coils of continuous strip. The nominal weight of each coil shall be 1800 - 2000 kg.

The nominal internal diameter of coil shall be 500 mm.

Sheet shall be protected to prevent damage and rusting during transit.

Sheet shall be vertically packed according to the instructions and drawings given below:

- An annular protection board shall be placed at either end of the coil.
- The coil should then be wrapped with waterproof anti-rust proof paper by lapping axially all around the circumference.
- The coil shall then be covered by polythylene sheet or anti-rust waterproof paper and the ends sealed properly.
- A galvanized sheet shall be wrapped on the outside of the coil and the top and bottom of the coils. Care shall be taken to ensure that the ends of the top and bottom of the coils extend sufficiently over the inside diameter of the coil.

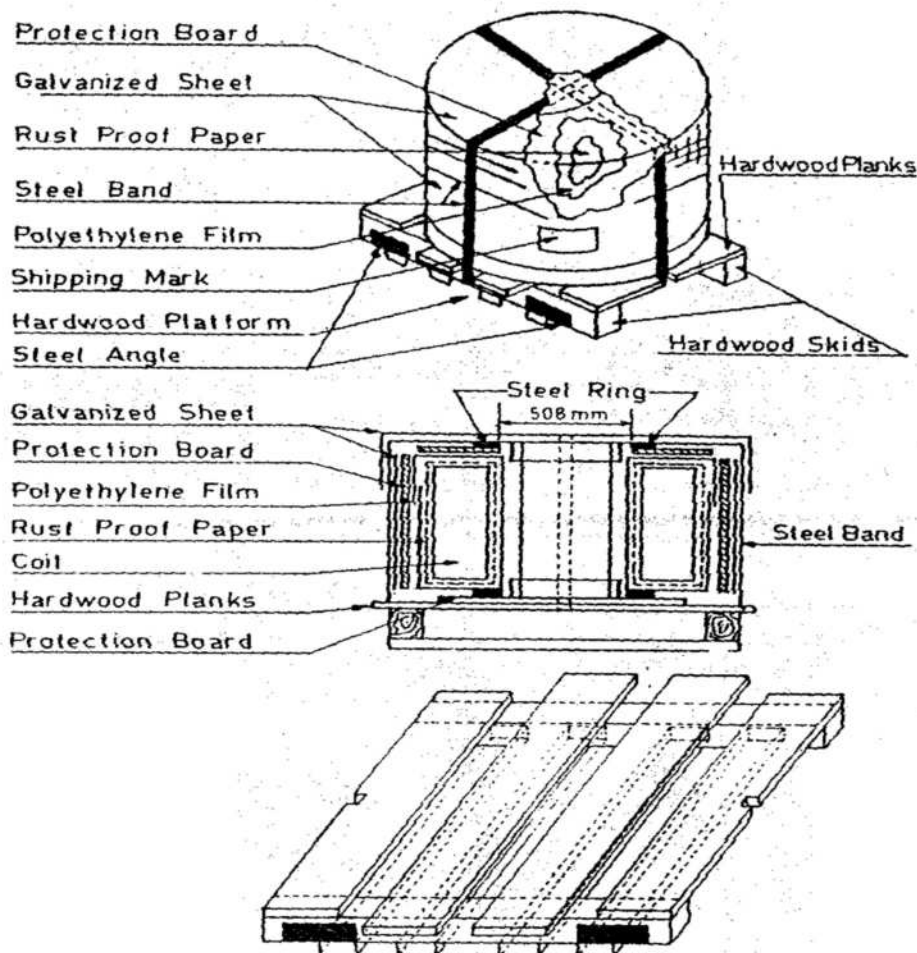
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- e) A galvanized sheet shall be wrapped on the inside of the coil. Care shall be taken that it overlaps sufficiently over the ends of the sheet mentioned in (d) above.
- f) Steel ring made from thick angle sheets shall be placed on the rim of the inner diameter at both ends of the coil. The rings shall be held at either ends at four points by steel bands.
- g) The coil should then be mounted on wooden skids held together by steel bands. Wooden skids must have cutouts to house the steel bands for tight fit and to avoid slippage.
- h) The packing shall ensure that there is no seepage of moisture and the coils reach BHEL in completely rust free condition. It shall be strong enough to withstand handling.
- i) Coils shall be sufficiently tight-wound to prevent collapse to an extent that would preclude their being mounted on a mandrel appropriate to the ordered internal diameter.
- j) Each package should indicate the , Sling Position, for lifting without damage. It is preferable to fix a suitable size of, 'Sheet Steel Angle', at the position where the Sling Rope is to be fitted to avoid slippage/damage/breakage of the wooden skid at four places.

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HOT ROLLED / FORGED CARBON STEEL BARS, Gr: 40 C8-NORMALISED									
<p>1.0 GENERAL</p> <p>This specification governs the quality requirements of Hot Rolled / forged Carbon Steel Bars, Normalised.</p>									
<p>2.0 APPLICATION</p> <p>Production of machined parts for general engineering purposes.</p>									
<p>3.0 CONDITION OF DELIVERY</p> <p>Hot Rolled / forged and Normalised.</p> <p>Note: Sizes upto 100mm in hot rolled >100 to 180mm in hot rolled or forged abov 180mm in forged.</p> <p>Bars shall be supplied in straight lengths with ends square and true.</p>									
<p>4.0 COMPLIANCE WITH NATIONAL STANDARDS:</p> <p>Material shall comply with the requirements of the following National Standards and also meet the requirements of this specification.</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%;">IS : 1570-Part II, Section 1-1979</td> <td style="width: 50%;">: Schedule for wrought Steels-Carbon steels</td> </tr> <tr> <td>Gr:40C8 (C40), Normalised</td> <td>: (Unalloyed Steels)</td> </tr> </table>						IS : 1570-Part II, Section 1-1979	: Schedule for wrought Steels-Carbon steels	Gr:40C8 (C40), Normalised	: (Unalloyed Steels)
IS : 1570-Part II, Section 1-1979	: Schedule for wrought Steels-Carbon steels								
Gr:40C8 (C40), Normalised	: (Unalloyed Steels)								
<p>5.0 DIMENSION AND TOLERANCES</p>									
<p>5.1 Sizes</p> <p>Bars shall be supplied to the dimensions in BHEL order.</p>									
<p>5.2 Length:</p> <p>Unless otherwise specified, hot rolled bars shall be supplied in 3 to 6 metres length and forged bars shall be supplied in lengths of 1.5 to 3 metres</p>									
Revisions : CI 26.6.18 of MOM of MRC-S&GPS			APPROVED : INTERPLANT MATERIAL RATIONALISATION COMMITTEE-MRC (S&GPS)						
Rev. No. 07	Amd.No.	Reaffirmed	Prepared	Issued	Dt. of 1st Issue				
Dt: 15.01.2004	Dt :	Year: 2013	BHOPAL	Corp. R&D	AUGUST, 1976				

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5.2 Tolerances:

5.2.1 For Forged bars: The tolerances shall be as per CI 5.2.2 for bars $\leq 100\text{mm}$.
The tolerances shall be $+8\text{ mm}$ -0 mm for bars $> 100\text{ mm}$

5.2.2 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:

5.2.2.1 Round 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		$\pm 1.6\%$ of diameter or width of side	75 % of total tolerance (+ and -)

5.2.2.2 Flats:

Nominal width, mm		On width	Tolerance, mm		
Over	Up to & Including		On thickness		
			6 to 13	Over 13 to 25 including	Over 25 to 50 including
--	50	± 1.0	± 0.5	± 0.8	± 1.0
50	100	± 2.0	± 0.5	± 1.0	± 1.5
100	150	± 3.0	---	---	± 2.0

5.2.3 Straightness:

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

6.0 MANUFACTURE:

Material shall be manufactured from fully killed steel.



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7.0 FREEDOM FROM 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.

8.0 HEAT TREATMENT :

The bars shall be normalised at a temperature of 830 - 860°C

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 specified below :

Element	<u>Melt analysis, percent</u>		Permissible Variation, percent
	Min.	Max.	
Carbon	0.35	0.45	± 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.

10.3 For ruling section upto & including 40mm, the test piece shall be machined coaxially from the test bars. For ruling section above 40mm the longitudinal axis shall be atleast 12.5 mm from surface of the test bars.

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


11.0 MECHANICAL PROPERTIES (IN NORMALISED CONDITION) :


Mechanical properties of the material shall be as follows:

Tensile strength : 580 - 680 N/mm²

Yield strength : 320 N/mm², min

Elongation on 5.65 √So : 18%, min.

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SPHEROIDAL OR NODULAR GRAPHITE IRON CASTINGS - Gr: 400/15					
<p>1.0 GENERAL</p> <p>This specification governs the quality requirements of Spheroidal or Nodular Graphite Iron Castings having a tensile strength of 400 N/mm², minimum.</p>					
<p>2.0 APPLICATION</p> <p>Suitable for general engineering purpose.</p>					
<p>3.0 CONDITION OF DELIVERY</p> <p>As cast unless otherwise specified on BHEL order/drawing. Castings may be supplied without heat treatment provided the properties are attained without heat treatment.</p> <p>Castings shall not be painted.</p>					
<p>4.0 COMPLIANCE WITH NATIONAL / INTERNATIONAL STANDARD</p> <p>Castings shall comply with the following national standards and also meet the requirements of this specification.</p> <p>IS: 1865-1991 (Reaffirmed 2005) : Iron Castings with Spheroidal or Nodular Graphite Gr: SG 400/15</p>					
<p>5.0 DIMENSION AND TOLERANCES</p> <p>Castings shall be true to the pattern / drawing.</p> <p>Holes for machining up to and including 50mm in diameter are to be cast solid, unless otherwise stated on BHEL order / drawing.</p> <p>Unless otherwise specified on BHEL order/ drawing, untoleranced dimensions for the casings shall be as per tolerance class 4 of BHEL standard AA 023 04 02.</p>					
Revisions : RA as per Cl. 33.2.0 of MRC – FCF+HTM			APPROVED : INTERPLANT MATERIAL RATIONALISATION COMMITTEE-MRC (FC&F+HTM)		
Rev. No. 03	Amd.No.	Reaffirmed	Prepared	Issued	Dt. of 1 st Issue
Dt: 01.05.2008	Dt :	Year : May 2008	CORP R&D	Corp. R&D	DEC., 1977

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6.0 MANUFACTURE

The method of manufacture is left to the discretion of the manufacturer.

7.0 HEAT TREATMENT

Heat treatment, if considered necessary to attain the properties specified, is left to the discretion of the manufacturer. Record of heat treatment of each batch shall, however, be maintained by the manufacturer.

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 inclusions, shrinkage's, 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 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 COMPOSITION

The composition of iron is left to the discretion of the manufacturer. (But in special applications this may be agreed to between BHEL and manufacturer).

11.0 TEST SAMPLES:

Selection of test samples shall be in accordance with clause 10 and 11 of IS: 1865.

12.0 MECHANICAL PROPERTIES:

12.1 Tensile:

When tested in accordance with IS:1608, the test pieces (14 mm gauge diameter and 70 mm gauge length) shall show the following properties:



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Property	Separately cast test sample	Integrally cast test sample, <u>casting thickness, mm</u>	
		30 to 60	61 to 200
Tensile strength, N/mm ² , min.	400	390	370
Proof stress, 0.2% N/mm ² , min.	250	250	240
Elongation, percent, min.	15	15	12

12.2 Hardness (Brinell):

130 to 180 HB

13.0 MICROSTRUCTURE (For information only):

Predominant structural constituent is Ferrite.

14.0 REPAIR OF CASTINGS:

Repair of castings shall not be carried out by the manufacturer without the permission of BHEL.

15.0 TEST CERTIFICATES

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

16.0 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 19721: S.G Iron castings-Gr:400/15.

BHEL Order No.

Consignment/Identification No.

Melt No.

Weight

Supplier's Name

17.0 REFERRED STANDARDS (Latest Publications Including Amendments):

1. IS: 1865

2. AA 023 04 02