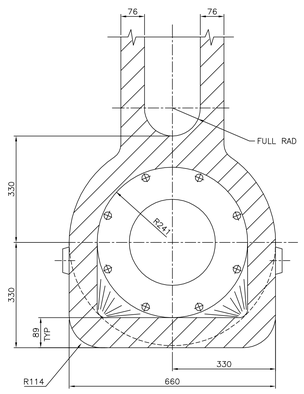
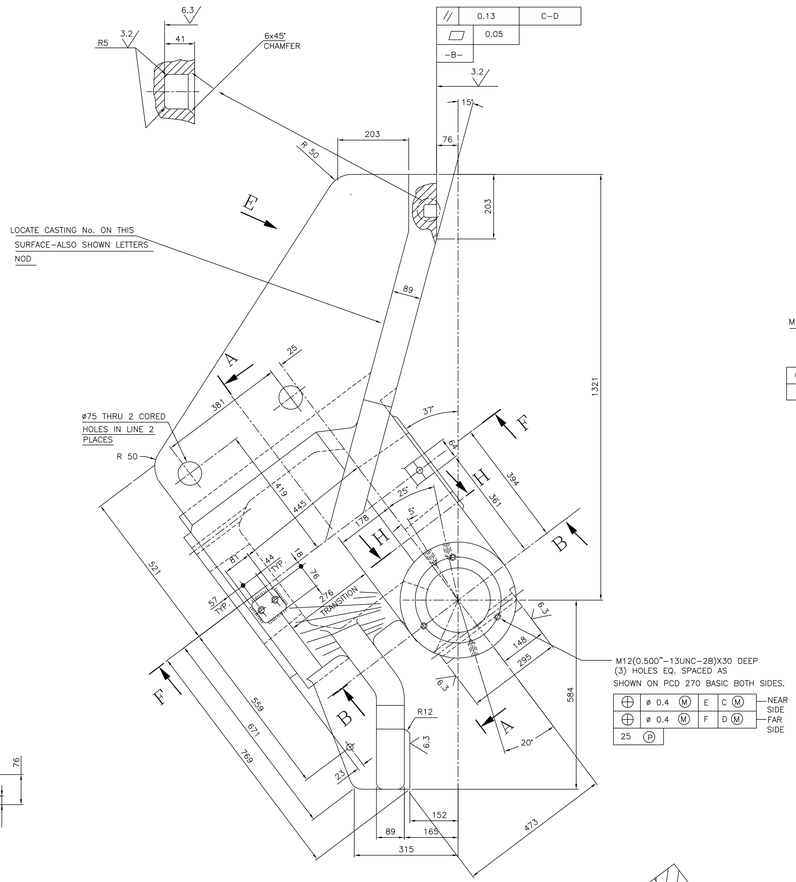
FIRST ANGLE PROJECTION

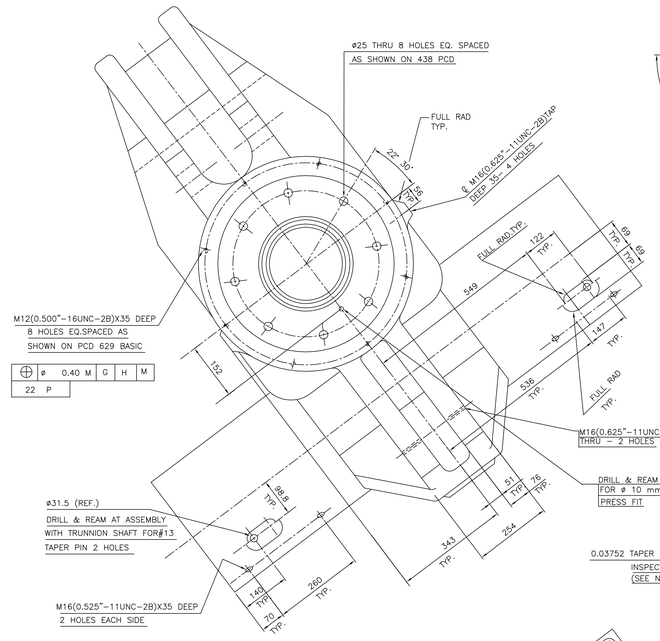
(ALL DIMENSIONS ARE IN mm)

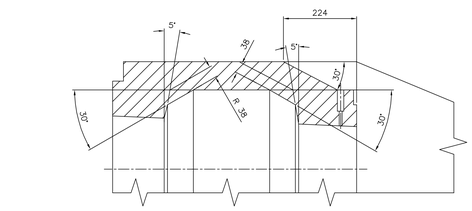
DRG. NO. 0-61-004-00569



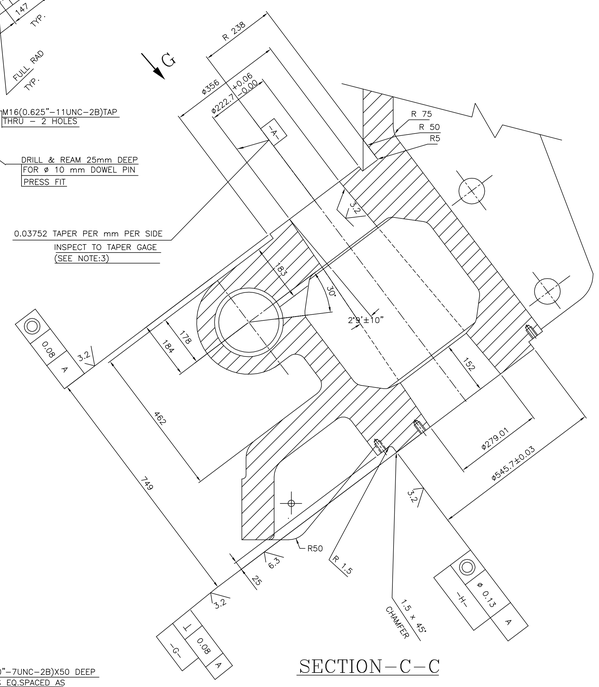
SECTION–A–A



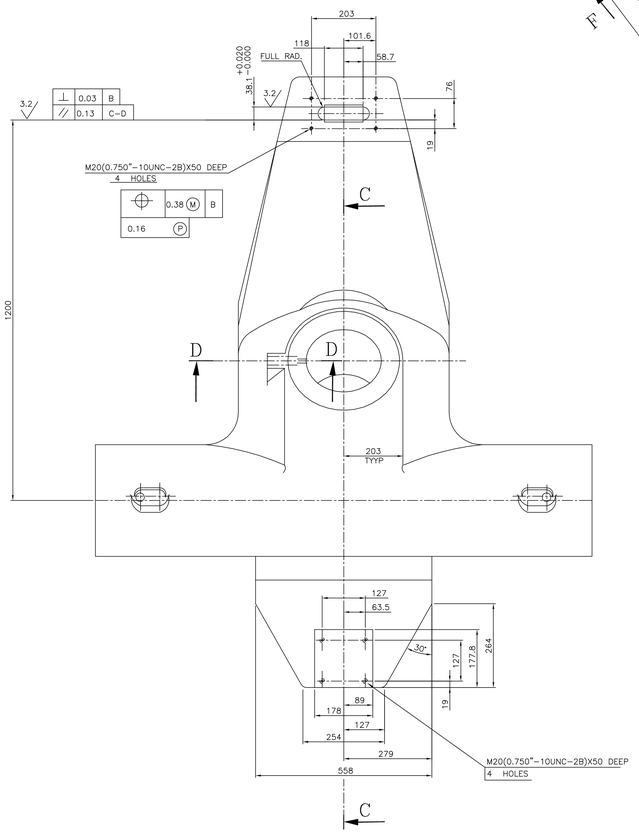


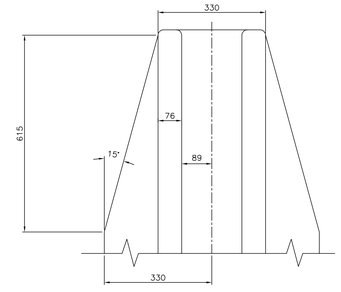


SECTION–F–F

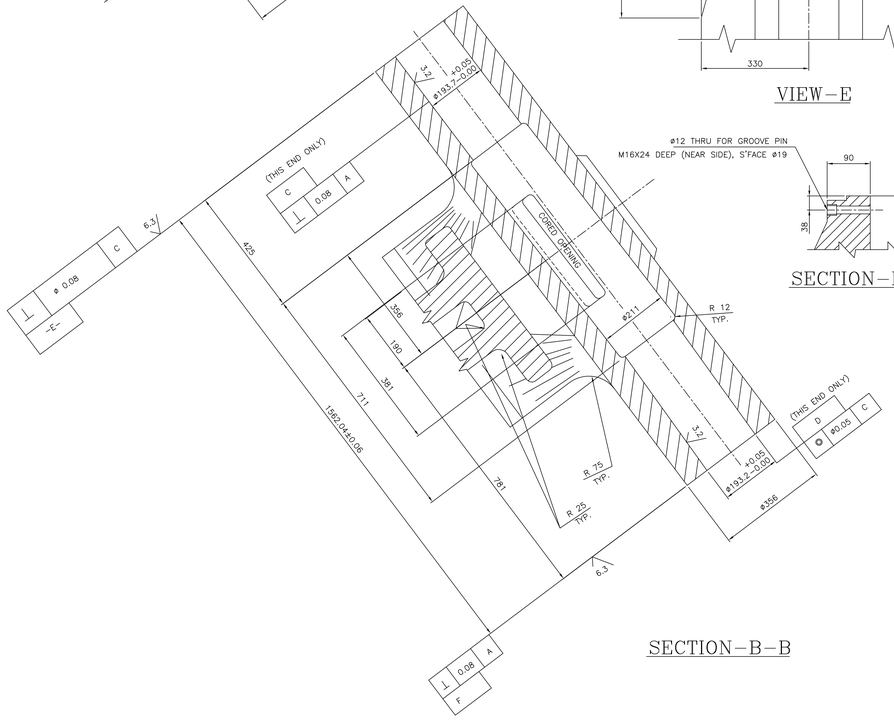


SECTION–C–C

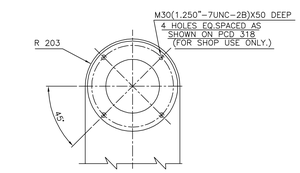




VIEW–E

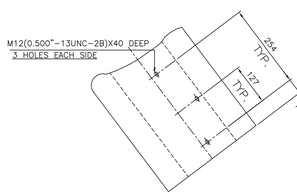


SECTION–B–B



SECTION–DD

VIEW–G



SECTION–H–H

NOTE :

1. BREAK ALL SHARP EDGES AND CORNERS UNLESS OTHERWISE SPECIFIED.
2. UNLESS OTHERWISE SPECIFIED.
   a) ALL INSIDE FILLETS TO BE R25
   b) ALL RADII TO BE R12
3. TAPPER MUST FIT FULL CONTACT MALE GAGE WITH A MINIMUM 80% CONTACT. BANDS OF NO CONTACT MUST NOT EXCEED 10° OF ARC.
4. VAR. 01 – METRIC THREADS
   VAR. 02 – INCH THREADS

ITEM NO.	DESCRIPTION	DRAWING NO.	VAR. NO.	RAW MATERIAL SIZE OR CASTING DRG. NO. OR FORGING DRG. NO.		
01	CASTING				BA9211122104	4000.00
					AA19511	1
					MATERIAL CODE	NET WT. / GROSS WT.
					MATERIAL SPECN.	QUANTITY

THE FOLLOWING CONDITIONS APPLY EXCEPT OTHERWISE STATED.

1. REF. TO HY0230261 FOR UNSPECIFIED TOLERANCES.
2. CHAMFER M/CD. SHARP EDGES 1.2 TO 1.0 AT 45°.
3. INTERNAL M/CD. CORNER RADII 1 TO 0.7
4. THE SURFACE ROUGHNESS WHERE–EVER NOT SHOWN SHALL BE TAKEN FROM THE SURFACE ROUGHNESS SHOWN OUT SIDE THE BACK SLASH GIVEN OR THE TOP MOST RIGHT CORNER OF THE DRG.

TYPE OF PRODUCT 1043 XRP BOWL MILL

NAME OF CUSTOMER/PROJECT CHANDRAPUR – 500MW

BHARAT HEAVY ELECTRICALS LIMITED HYDERABAD

	NAME	SIGN.	DATE	NO.OF VAR.
DRN.	SCS/ACAD		13.7.99	
CHD.	N.D.S		13.7.99	
APPD.	K.M.RAO		13.7.99	

DEPT.	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	NO.OF ITEMS
4460	N.T.S	4000.000	0-61-004-00571	02	32
CODE					REV.
PUDV. ENGG.			DRAWING NO. 0-61-004-00569		03.1

TITLE JOURNAL HEAD

SHEET NO. 01 | NO OF SHEETS 01

REV.	DATE	ALTERED	CHECKED	APPROVED	ZONE
03.1	02.04.18	SUSHANT	PKP	V.KUMAR	

TOLERANCE ADDED IN KEYWAY WIDTH KEYWAY WIDTH WAS 38 MM

REV.	DATE	ALTERED	CHECKED	APPROVED	ZONE
03	25.6.04		N.D.S	S.G.	

DIM. 90 SHOWN AND DIM. 241 DELETED IN SEC. D–D.

REV.	DATE	ALTERED	CHECKED	APPROVED	ZONE
02	18.6.04		N.D.S	S.G.	

M16X 24 DEEP WAS C'BORE ø13X80 DEEP. S'FACE ø19 ADDED.

REV.	DATE	ALTERED	CHECKED	APPROVED	ZONE
01	13.07.99	SCS	N.D.S	K.M.R	

DRAWING REDRAWN IN ACAD. VARIANTS ADDED

COMP. FILE NAME 06100569.DWG

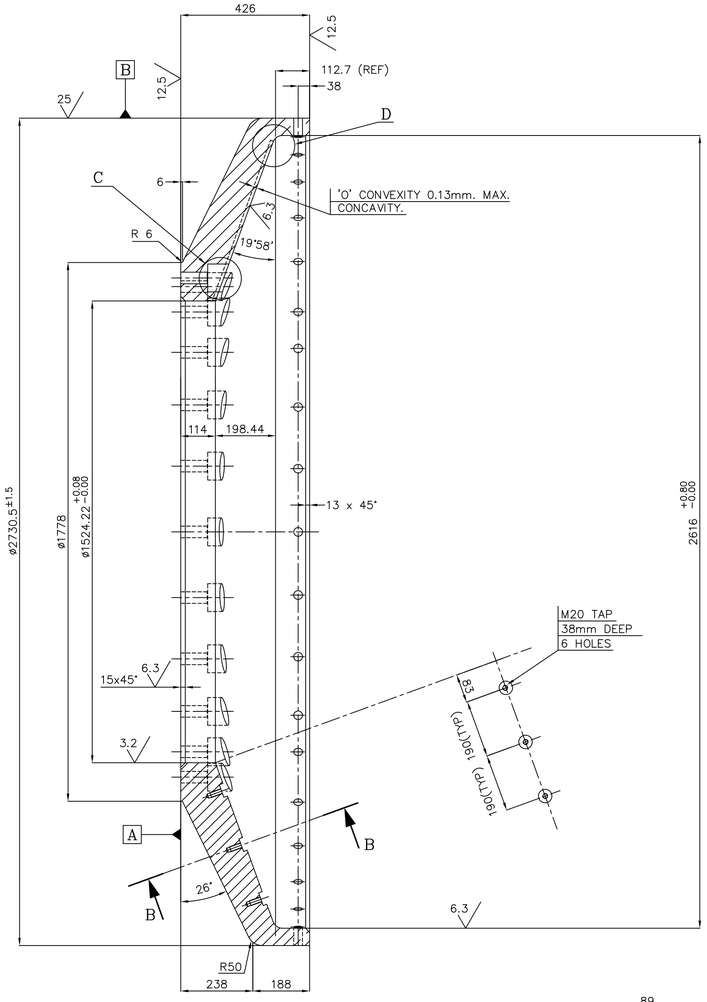
REF. DRG. NO.

INVENTORY NO

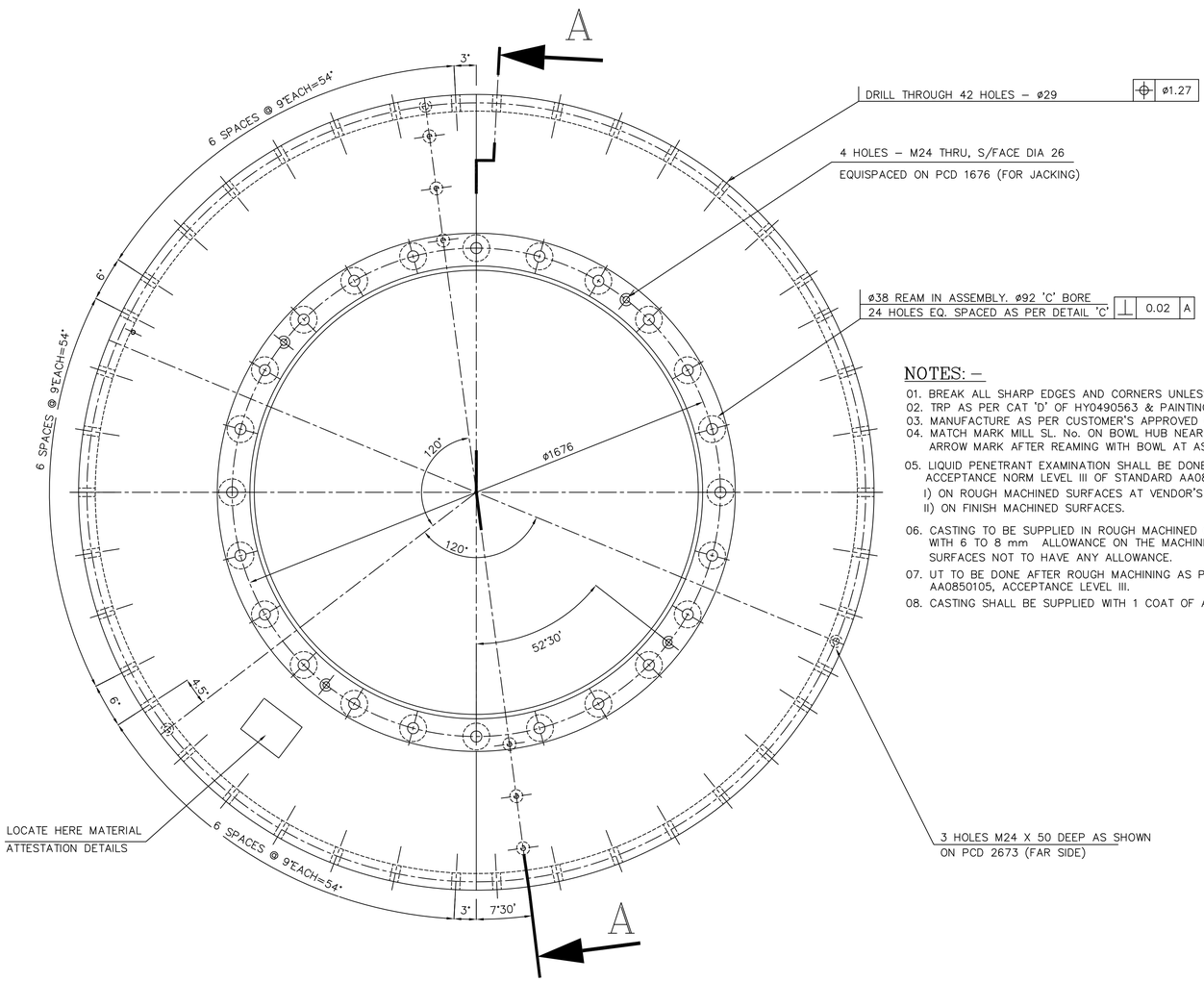
FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

DRG. NO. 1-61-100-01457

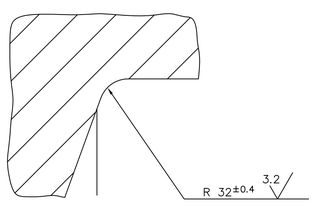


SECTION – AA

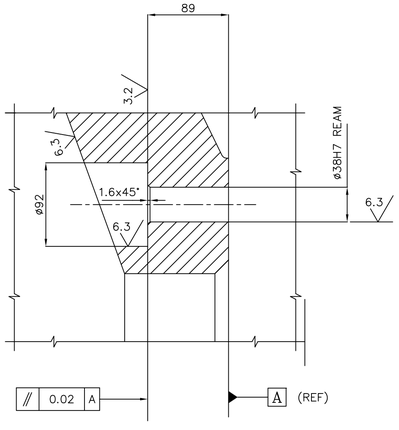


NOTES: –

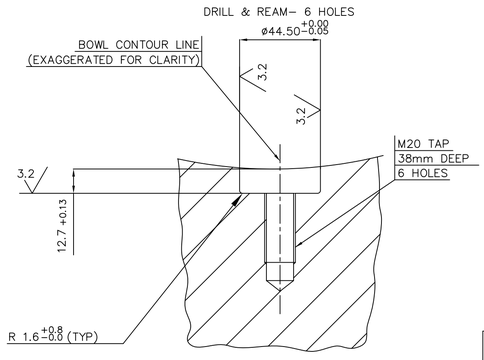
01. BREAK ALL SHARP EDGES AND CORNERS UNLESS OTHERWISE NOTED
02. TRP AS PER CAT 'D' OF HY0490563 & PAINTING AS PER APPROVED PAINTING SCHEDULE.
03. MANUFACTURE AS PER CUSTOMER'S APPROVED QUALITY PLAN
04. MATCH MARK MILL SL. No. ON BOWL HUB NEAR THE PUNCHED ARROW MARK AFTER REAMING WITH BOWL AT ASSEMBLY.(REF.ZONE.) E12)
05. LIQUID PENETRANT EXAMINATION SHALL BE DONE AS PER AA0850131, ACCEPTANCE NORM LEVEL III OF STANDARD AA0850132,
    I) ON ROUGH MACHINED SURFACES AT VENDOR'S WORKS
    II) ON FINISH MACHINED SURFACES.
06. CASTING TO BE SUPPLIED IN ROUGH MACHINED CONDITION WITH 6 TO 8 mm ALLOWANCE ON THE MACHINED SURFACES. OTHER SURFACES NOT TO HAVE ANY ALLOWANCE.
07. UT TO BE DONE AFTER ROUGH MACHINING AS PER AA0850105, ACCEPTANCE LEVEL III.
08. CASTING SHALL BE SUPPLIED WITH 1 COAT OF ALKYD BASED ZINC PHOSPHATE PRIMER.



DETAIL–D



DETAIL–C



SECTION–BB

"MATERIAL ATTESTATION"

01	CASTING.		BA9211103584	5227.00
			AA19511	1
ITEM NO.	ITEM DESCRIPTION	DRAWING NO.	MATL. CODE	NET.WT.
			MATL. SPCN.	QTY.

THE FOLLOWING CONDITIONS APPLY EXCEPT OTHERWISE STATED.

1. REF. TO HY0230261 FOR UNSPECIFIED TOLERANCES.
2. CHAMFER M/CD. SHARP EDGES 1.2 TO 1.0 AT 45°.
3. INTERNAL M/CD. CORNER RADII 1 TO 0.7
4. THE SURFACE ROUGHNESS WHERE-EVER NOT SHOWN SHALL BE TAKEN FROM THE SURFACE ROUGHNESS SHOWN OUT SIDE THE SLASH GIVEN OR THE TOP MOST CORNER OF THE DRG.

TYPE OF PRODUCT 1003 XRP BOWL MILL

NAME OF CUSTOMER/PROJECT

BHARAT HEAVY ELECTRICALS LIMITED HYDERABAD

	NAME	SIGN.	DATE	NO.OF VAR.
DRN.			19.05.07	01
CHD.	AMAN SURIN		19.05.07	
APPD.	S.GHATGE		19.05.07	

DEPT. 446	UNTOL. DIMS. GR. ¢/M/f		SCALE 1 : 10	WEIGHT (KG) 5227.0	REF. TO ASSY DRG. ----------	ITEM NO. --	NO.OF ITEMS 01
CODE PUL.							

TITLE: BOWL

CARD CODE: NA

DRAWING NO. 1-61-100-01457 REV. 00

SHEET NO. 01 NO OF SHEETS 01

COMPUTER FILE NAME: 16100284.DWG/1047

REF. DRG. NO.

SIGN. AND DATE

INVENTORY NO

REV.	DATE	ALTERED	CHECKED	APPROVED	REV.	DATE	ALTERED	CHECKED	APPROVED	REV.	DATE	ALTERED	CHECKED	APPROVED	REV.	DATE	ALTERED	CHECKED	APPROVED	REV.	DATE	ALTERED	CHECKED	APPROVED	REV.	DATE	ALTERED	CHECKED	APPROVED
ZONE					ZONE					ZONE					ZONE					ZONE					ZONE				

PERMISSIBLE DEVIATIONS FOR UNTOLERANCED DIMENSIONS OF CASTINGS

1.0 SCOPE:

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

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

2.0 NOMENCLATURE:

2.1 Nominal Dimensions:

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

2.2 Actual Dimension:

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

2.3 Governing Dimensions:

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

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

2.4 Allowable Dimensional Deviations:

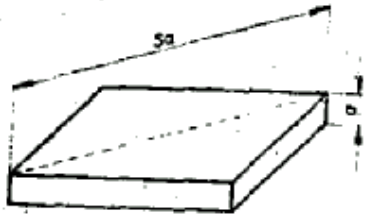
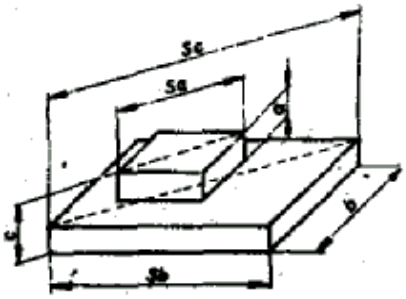
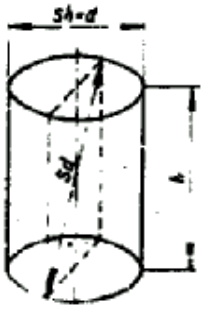
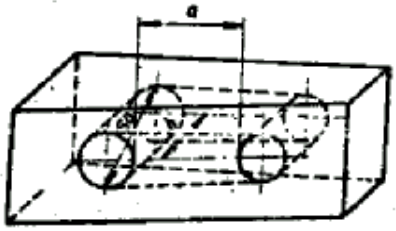
a) Upper allowable deviation:

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

b) Lower allowable deviation:

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

TABLE –1: GOVERNING DIMENSIONS (S)

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

3.0 TOLERANCE CLASSES:

3.1 General:

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

3.2 Tolerance class 1:

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

TABLE 2: TOLERANCE CLASS 1

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

3.3 Tolerance class 2:

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

TABLE 3: TOLERANCE CLASS 2

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

3.4 Tolerance class 3:

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

TABLE 4: TOLERANCE CLASS 3

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

3.5 Tolerance class 4:

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

TABLE 5: TOLERANCE CLASS 4

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

3.6 Tolerance class 5:

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

TABLE 6: TOLERANCE CLASS 5

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

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

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

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

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

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

5.0 GUIDELINES FOR SELECTION OF TOLERANCE CLASS:

Given in Table 8 for information.

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

6.0 SPECIFYING OF TOLERANCE CLASS:

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

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

AA 085 01 05 : ULTRASONIC EXAMINATION, ACCEPTANCE STANDARDS AND CLASSIFICATION OF STEEL CASTINGS FOR HYDRO-TURBINES, HYDRO-GERERATORS & MOTORS

PAGE 4 OF 7; Cl 10.0 ACCEPTANCE STANDARD :
The following table along with Note is added at the end of Page (i.e below Cl 10.4)

Table 1

Ultrasonic testing Quality level	Area in ^{2} (cm^2)	Max Length in (mm)
1	0.8 (5)	1.5 (40)
2	1.5 (10)	2.2 (55)
3	3.0 (20)	3.0 (75)
4	5.0 (30)	3.9 (100)
5	8.0 (50)	4.8 (120)
6	12.0 (80)	6.0 (150)
7	16.0 (100)	6.9 (175)

Ref :	Amd. No.	Approved	Issued	Date	Cum.Sr.No.
TSD / SM / 762 dt 04.01.99 from Bhopal	01	WG NDT	Corp.R&D	1.2.99	A 2505

Note :

1. The areas in the table refer to the surface area on the casting over which a continuous indication exceeding the amplitude reference line of a continuous loss of back reflection of 75 % or greater is maintained.

2. Areas shall be measured from the centre of the search unit.

3. In certain castings, because of very long test distances or curvature of the test surface, the casting surface area over which a given discontinuity is detected may be considerably larger or smaller than the actual areas of the discontinuity in the casting, in such cases a graphic plot that incorporates the consideration of beam spread should be used for realistic evaluation of the discontinuity.

ULTRASONIC EXAMINATION, ACCEPTANCE STANDARDS AND CLASSIFICATION OF STEEL CASTINGS FOR HYDRO-TURBINES, HYDRO-GENERATORS & MOTORS

1.0 SCOPE:

This standard deals with the ultrasonic testing procedure, acceptance standards and classification of steel castings for hydro-turbines, hydro-generator and electrical motors.

This standard is not applicable for Austenitic castings.

2.0 STAGE OF EXAMINATION:

Ultrasonic examination shall be generally carried out after heat treatment and rough machining of the castings, as called for in the order/drawing. Ultrasonic examination shall be repeated after weld rectification, if any.

3.0 SURFACE PREPARATION:

Smooth "as cast" surface free from adhered or fused sand and irregularities is adequate for ultrasonic examination. Loose scales and excessive surface irregularities such as that caused by removal of runner and riser shall be ground off. While grinding care shall be taken to avoid surface undulations which would interfere with probe contact. To improve coupling efficiency of as cast surfaces or to remove rust or paint, shot blasting or sand-blasting may be carried out. Rough machined surfaces should have a minimum surface finish of 6.2 microns.

4.0 PERSONNEL REQUIREMENT:

Personnel performing the non-destructive examination and evaluation shall be qualified to the recommended practice SNT - TC - 1A or any other recognised practice.

5.0 EQUIPMENT CHARACTERISTICS:

5.1 Frequency range:
The equipment shall be capable of operating over a frequency range of at least 0.5 to 6 MHz.

5.2 CRT Screen Presentation:
"A" scan presentation shall be used. The trace shall be well defined, easy to read and associated with permanent graticule scale marking for both range and amplitude.

5.3 Screen Height Linearity:
The amplifier shall be linear within ± 5% upto at least 75% of full screen height and any deviation above this should be known to the operator. Suppression affects linearity and the effect of suppression over full range should be recorded.

5.4 Amplitude Control Linearity:
The equipment shall contain a signal attenuator or calibrated gain control that shall be accurate over its useful range to ± 20% of the useful range(20% to 80% of screen height)

5.5 Linearity Of Time Base:
The time base shall be linear as far as possible and non-linearity should not exceed 2% of the full scale graticule reading.

5.6 Resolution:
The resolution of probe and flaw detection apparatus shall be such as to show separately the indication from three reflecting surfaces of the vertical grooves in the IIW 'V1' block.

5.7 Sensitivity of the Equipment:
The sensitivity of the equipment shall be checked with the longitudinal wave probe used by placing the probe on the metalised surface of the plastic insert of IS 4904/ IIW test block. The minimum number of multiple echoes from the plastic insert at full gain setting shall be as given below:

Frequency range, MHz	Number of multiple echoes
1	5
2	4
4 to 6	2

6.0 COUPLANT:

To ensure adequate transmission of ultrasonic energy between probe and casting, a suitable couplant having good wetting characteristics shall be used. Oil, glycerin or polycell paste may be used. For better adoption of cast surfaces, a thin protective plastic cover over the longitudinal probe is recommended.

7.0 SEARCH UNIT:

7.1 Longitudinal wave internally grounded having a 1/2 to 1 in (13 to 25 mm) diameter or 1 in (25 mm) square piezo-electric elements. Based on the signal to noise ratio of the response pattern of the casting a frequency in the range from 1 to 5 MHz shall be used. The back ground noise shall not exceed 25% of the distance amplitude correction curve (DAC). Transducers shall be utilized at their rated frequencies.

7.2 Dual-Element, 4 MHz 1/2 by 1 in (13 by 25 mm), 12° included angle search units are recommended for sections 1 in (25mm) and under.

7.3 Other frequencies and sizes of search units may be used for evaluating and pin pointing indications.

8.0 TESTING PROCEDURE:

8.1 Selection of Probes:

For all ultrasonic examinations, the highest frequency compatible with the size, metallurgical condition and thickness of the casting shall be used.

8.2 Testing Techniques:

While selecting testing technique the following factors must taken into account:

i. Type, orientation, position and incidence of defects likely to be encountered in the casting under consideration.

ii. Thickness and profile of the section.

iii. Structural condition.

All parts of the casting surface where a contact probe can be used, shall be tested by overlapping scans 15% with normal beam probes, irrespective of casting geometry and availability of reference back echo. Normal beam probe of 1 to 5 MHz frequency shall be used.

9.0 EQUIPMENT CALIBRATION:

9.1 Depth Range:
The depth range of the equipment shall be adjusted for normal and shear wave probes using known thickness of the casting or standard calibration block. When latter is used, velocity difference, if any, should be taken into account.

9.2 Sensitivity:

The scanning sensitivity of the apparatus shall be adjusted using either DGS diagram or standard test block with flat bottomed hole so that maximum acceptable equivalent defect will give an indication height of 75% of screen height +6 db. When test block is used for sensitivity calibration, distance amplitude curve shall be plotted on CRT screen to facilitate correct defect size assessment. While estimating the size of the defect compensation shall also be made for the difference in the surface condition and attenuation in the test block and casting.

10.0 ACCEPTANCE STANDARD:

Following reference blocks shall be used for ultrasonic examination.

A. Calibration block as indicated in Fig.1 shall be used for normal beam scanning.

B. Calibration block as indicated in Fig.2 shall be used for double crystal probe scanning.

C. Calibration block as indicated in Fig.3 shall be used for angle beam scanning.

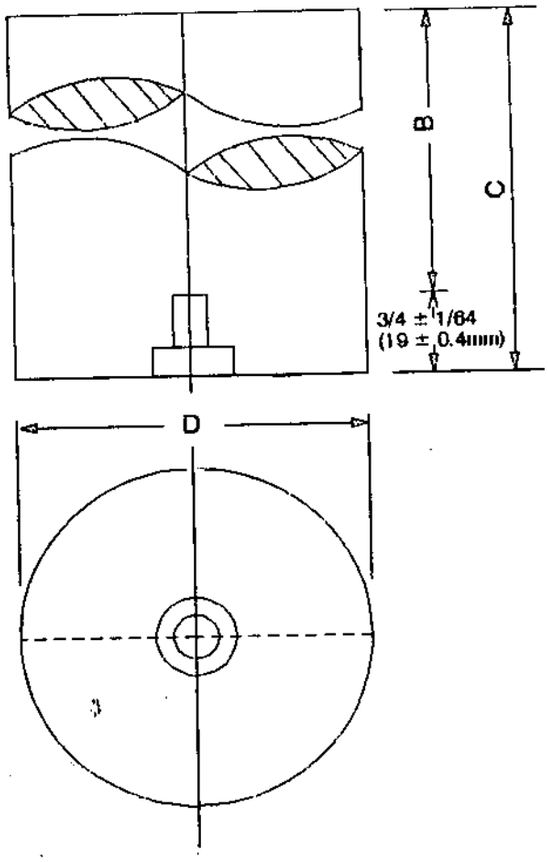
10.1 Acceptance criterion for quality levels are specified in the table given below. Applicable quality level/ levels shall be specified in the drawing or the purchase order. Applicable quality level for weld zones, bearing seating areas, deep machining zones, etc., shall be clearly specified in the drawing.

10.2 No indication equal to or greater than DAC over an area specified for applicable quality level of Table 1.

10.3 Indications producing a continuous response equal to or greater than DAC with a dimension exceeding a maximum length shown for the applicable quality level shall be unacceptable.

10.4 No reduction of back reflection of 75% or greater that has been determined to be caused by a discontinuity over an area specified for the applicable quality level of Table.1

FIG. 1 Ultrasonic Standard Reference Block



Notes:

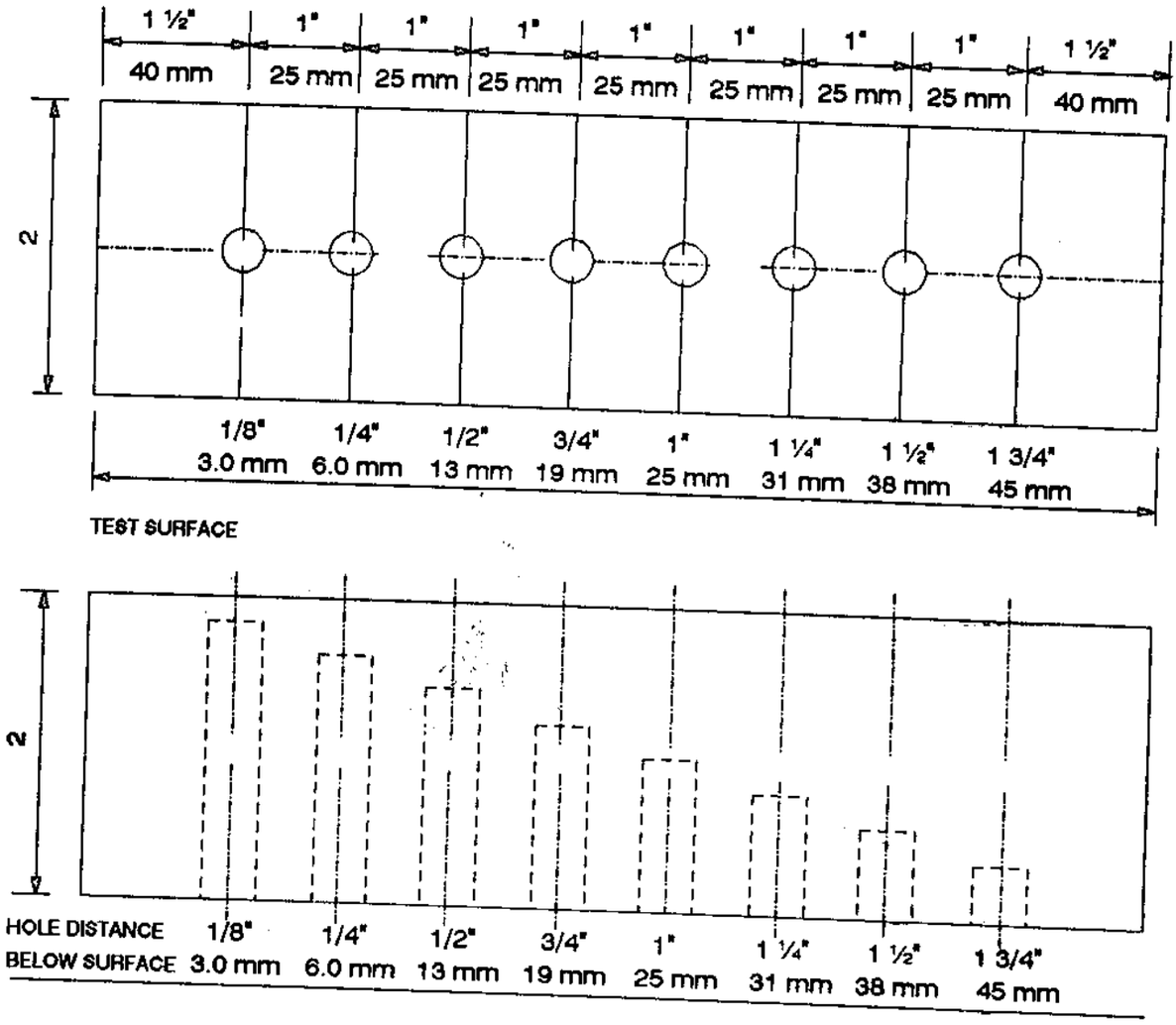
1. Opposite ends of reference block shall be flat and parallel within 0.001 in (0.025 mm)
2. Bottom of flat-bottom hole shall be flat within 0.002 in (0.050 mm) and the finished diameter shall be 1/4 + 0.002 in (6.4 + 0.050 mm)
3. Hole shall be straight and perpendicular to entry surface within 0°, 30 min. and located within 1/32 in. (0.80 mm) of longitudinal axis.
4. Counter bore shall be 1/2 in. (13mm) diameter by 1/8 in (3 mm) deep.

Dimensions and Indentification of Reference blocks in the basic set (See Fig. 1)

Hole diameter, in 1/64 ths. in. (mm)	Metal distance (B) [A] in. (mm)	Overall length C in. (mm)	Width or diameter D min. in. (mm)	Block Identification number
16(6.30)	1(25)	1 3/4(45)	2(50)	16-0100
16(6.30)	2(50)	2 3/4(70)	2(50)	16-0200
16(6.30)	3(75)	3 3/4(95)	2(50)	16-0300
16(6.30)	6(150)	6 3/4(170)	3(75)	16-0600
16(6.30)	10(255)	10 3/4(275)	4(100)	16-1000
16(6.30)	B	B + 3/4 (B + 20)	5(125)	16-B00 [B]

A - Tolerance ± 1/8 in. (3 mm)
B - Additional supplemental blocks for testing thickness greater than 10in. (250 mm).

FIG. 2 Ultrasonic Standard Reference Block for Dual-Search Unit Calibration



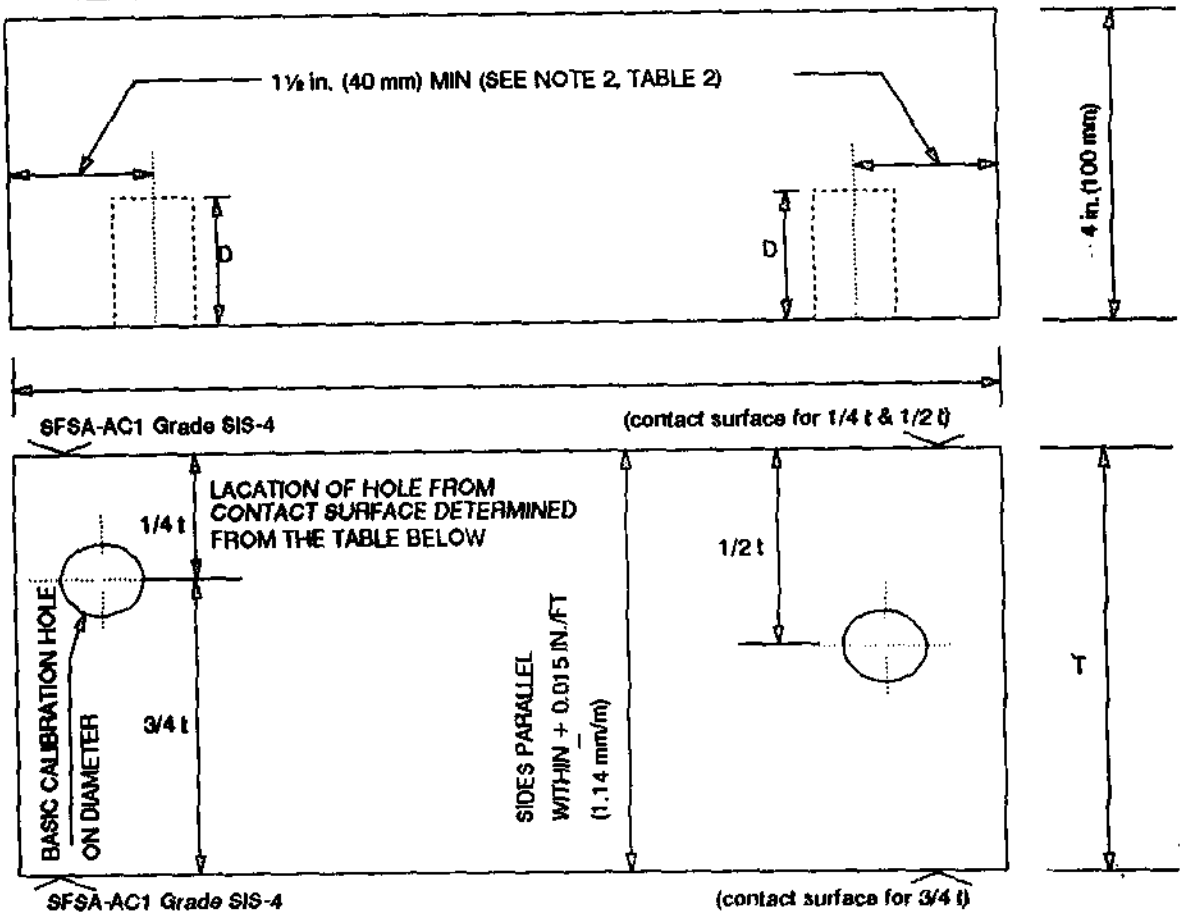
Note 1: Entrant surface shall be 250 μin. (6.3 μm) or finer.

Note 2: The 3/32 in. (2.4 mm) flat bottom hole must be flat within 0.002 in. (0.050 mm). Diameter must be with in +0.005 in. (0.13 mm) of the required diameter. Hole axis must be perpendicular to the block and within an angle of 0°, 30 min.

Note 3: Hole shall be plugged following checking for ultrasonic response.

in.	(mm)	in.	(mm)
1/8	(3)	1 1/4	(32)
1/4	(6)	1 1/2	(38)
1/2	(13)	1 3/4	(44)
3/4	(19)	2	(50)
1	(25)	10	(254)

FIG. 3 Basic Calibration Block for Angle Beam Examination



L = Length of block determined by the angle of search unit and the vee-path used
T = Thickness of basic calibration block (see table 2)
D = Depth of the side drilled hole (see table 2)
d = Diameter of the side drilled hole (see table 2)
t = nominal production material thickness.

TABLE 2: Dimensions of Calibration Blocks for Angle-Beam Examination

Note 1: For each increase in thickness of 2 in. (50 mm) or a fraction thereof the hole diamter shall increase 1/25 in.(1.0 mm)

Note 2: For block size over 3 in.(75 mm) in thickness, 'T', the distance from the hole to the end of he block shall be 1/2 T min. to prevent coincident reflections from the hole and the corner. Block fabricated with a 2 in. (50 mm) min. dimension need not be modified if the corner and hole indications can be easily resolved.

Nominal production material thickness (t), in.(mm)	Basic Calibration Block thickness (T) in.(mm)	Hole Diameter (d) in.1.002 (mm ± 0.05)	Minimum depth (D) in. (mm)
Upto 1 (25) incl.	1 (25) or t	3/32 (2.4)	1 1/2 (40)
Over 1 to 2 (25-50)	2 (50) or t	1/8 (3.2)	1 1/2 (40)
over 2 to 4 (50-100)	4 (100) or t	3/16 (4.8)	1 1/2 (40)
over 4 to 6 (100-150)	6 (150) or t	1/4 (6.3)	1 1/2 (40)
over 6 to 8 (150-200)	8 (200) or t	5/16 (7.9)	1 1/2 (40)
over 8 to 10 (200-250)	10 (250) or t	3/8 (9.5)	1 1/2 (40)
over 10 (250)	t	See Note 1	1 1/2 (40)

PROCEDURE FOR LIQUID PENETRANT EXAMINATION

1.0 **SCOPE:**

1.1 This standard details the procedure for liquid penetrant examination of non-porous ferrous and non-ferrous and non-metallic materials such as ceramics, plastics, glass, etc.

1.2 Typical surface discontinuities detectable by this method are cracks, seams, laps, cold shuts, porosity, laminations, etc.

1.3 This standard conforms substantially with ASTM E 165 ~~—1980 (Reapproved 1988)~~ and ASME code section V, Article 6. (01)

2.0 **PERSONNEL REQUIREMENT:**

Personnel performig non-destructive examination and evaluation shall be qualified to the recommended practice SNT-TC-1A or any other recognised practice.

3.0 **DESCRIPTION:**

In principle a liquid penetrant is applied to the surface to be examined and allowed to enter discontinuities, excess penetrant removed, the part dried and a developer applied. The developer functions both as a blotter to absorb penetrant that has been trapped in discontinuities and as a contrasting back ground to enhance the visibility of penetrant indications.

4.0 **APPROVED METHODS & MATERIALS:**

4.1 Either a colour contrast or fluorescent penetrant method may be used. Any one of the following penetrants shall be used:

(a) Solvent Removable
(b) Post Emulsifying
(c) Water Washable

4.2 For nickel base alloys and/or for stainless steel materials used in nuclear components the penetrant materials, cleaner, penetrant developer, etc., used shall not contain sulphur or halogen above 1% by weight.

4.3 Selection of liquid penetrant material shall be from the same family (brand). Inter-mixing of family of liquid penetrant materials is not allowed.

5.0 **PROCEDURE:**

5.1 **Surface Preparation:**

5.1.1 Surface preparation by grinding or machining or other method may be employed where surface irregularities may mask indications of unacceptable discontinuities.

5.1.2 The surface to be examined and all adjacent areas within at least 25 mm shall be dry and free from any dirt, lint, scale, rust, welding flux, weld spatter, grease, oil or other extraneous matter that could obscure surface openings or otherwise interfere with examination.

5.1.3 The surface to be examined shall be cleaned with detergents, organic solvents, descaling solutions or paint removers. Degreasing and ultrasonic cleaning may be employed to increase cleaning efficiency. Cleaning method employed is an important part of the examination procedure. Cleaning solvents shall meet the requirements of Cl.4.2

Caution: Blasting with shot or dull sand, rotofinishing, buffing, wire brusing the soft material or machining with dull tools shall not be used as they may peen the discontinuities at the surface.

5.2 **Drying:**

Drying, after cleaning the surface to be examined, shall be accomplished by normal evaporation or with forced hot air, as appropriate. A minimum period of time shall be established to ensure that the cleaning solution has evaporated prior to application of the penetrant.

5.3 **Application Of Penetrants:**

5.3.1 The penetrant shall be applied by dipping, brushing or spraying. If the penetrant is applied by spraying using compressed air type apparatus, filters shall be placed at the air inlet to preclude contamination of penetrant by oil, water or dirt sediment that may have collected in the lines. Spraying should only be performed in a booth equipped with exhaust system.

5.3.2 The length of penetration time is critical and depends upon the material being inspected, the process through which it has passed and the type of discontinuities expected. The recommended penetration time is given in Table 1.

5.3.3 The temperature of the penetrant and the surface of the part to be examined shall not be below 10°C(50°F) nor above 50°C(125°F) throughout the examination period. Local heating or cooling is permitted provided the temperatures remain in the range of 10 to 50°C during the examination. Where it is not practical to comply with these temperature limitations, other temperatures and times shall be used provided the procedures are qualified as described in Annexure-I.

5.4 **Removal Of Excess Penetrant:**

After the penetration time specified in the procedure has elapsed, any penetrant remaining on the surface shall be removed, taking care to minimise removal of penetrant from discontinuities.

5.4.1 **Postemulsifying Penetrants:**

The emulsifier shall be applied by spraying or dipping. The emulsifying time shall not exceed 5 minutes. After emulsification, the mixture shall be removed by water spray.

5.4.2 **Solvent Removable Penetrants:**

Excess penetrant shall be removed by wiping with a cloth or absorbent paper repeating the operation until most tracesof penetrants have been removed. The remaining traces shall be removed by wiping the surface lightly with cloth or absorbent paper moistened with solvent.

Caution: Care shall be taken to avoid excess solvent as this may remove penetrants from discontinuities. Flushing the surface with solvent following the application of the penetrant and prior to developing is prohibited.

5.4.3 **Water Washable Penetrants:**

Excess water washable penetrant shall be removed with a water spray. The water pressure shall not exceed 0.35 N/mm² (50 Psi) and the water temperature shall not exceed 43.3°C (110°F).

5.5 **Drying:**

Surface shall be dried before the application of developer.

5.5.1 a) If postemulsifying or water washable method is used, the surface shall be dried by blotting with clean materials or by using circulating warm air, provided the temperature of the surface is not raised above 50°C (125°F).

b) For solvent removable method, the surface may be dried by normal evaporation, blotting, wiping or forced air.

5.6 **Application Of Developer:**

The developer shall be applied as soon as possible after the removal of the excess penetrant. Two types of developer, dry or wet,shall be used with fluorescent penetrant. With colour contrast penetrants, only wet developer shall be used.

5.6.1 **Application Of Dry Developer:**

Dry developer shall be applied by a soft brush, a hand operated powder bulb or a powder gun or other means provided the powder is dusted evenly over the entire surface being examined.

5.6.2 **Application Of Wet Developer**

Prior to applying suspension type wet developer to the surface, the developer must be thoroughly agitated to ensure adequate dispersion of suspended particles.

(a) **Aqueous Developer Application:**

Aqueous developer may be applied to either a wet or dry surface. It shall be applied by dipping, spraying or other means provided a thin coating is obtained over the entire surface being examined. Drying time may be decreased by using warm air, provided the surface temperature of the part is not raised above 50°C.

(b) **Non-aqueous Developer Application:**

Non-aqueous developer shall be applied only on a dry surface. It shall be applied by spraying, except where safety or restricted access preclude it. Under such conditions developer may be applied by brushing. Drying shall be by normal evaporation.

6.0 **EXAMINATION:**

Observe the surface during the application of the developer to detect nature of any indications which tend to bleed out profusely. Final examination shall be done between 7 minutes at the earliest and 30 minutes at the latest after application of the developer. The nature of discontinuities corresponding to the indications shall be defined depending upon the method of setting, appearance, direction, shape and dimensions of the same. If the bleed out does not alter the examination results, longer periods are permitted. If the surface to be examined is large enough to preclude complete examination within the prescribed time the surface shall be examined in increments.

6.1 **Colour Contrast Penetrants (Visible Dye Penetrants):**

6.1.1 With colour contrast penetrants the developer forms a reasonably uniform coating. Surface discontinuities are indicated by bleeding out of the penetrant which is normally of a deep red colour. Indication with a light pink colour may indicate excessive cleaning. Inadequate cleaning may leave an excessive background making interpretation difficult.

6.1.2 Adequate illumination is required to ensure no loss of the sensitivity in the examination. Examination shall be done under natural or suitable light (illumination level shall be in the order of 500 LUX).

6.2 **Fluorescent Penetrants:**

Examination of the surface shall be carried out with a high intensity black light in a darkened area or booth. Black light shall have a wave length of 3650 A°. The bulbs shall be allowed to warm up for not less than 5 minutes prior to use in the examination. The black light intensity shall be at least of 800 uW/cm^2 on the surface of the part being examined and the light source being kept at a distance of at least 375 mm from the surface being examined. The operator should allow his eyes to become accustomed to the darkness of the inspection booth for at least 5 minutes before inspecting the parts. He should avoid looking directly into the black light and also avoid going from the darkness to

the light and back again without allowing sufficient time for his eyes to adjust to the darkness. The intensity shall be measured at least once every 8 hours and whenever the work station is changed.

7.0 EVALUATION OF INDICATIONS & INTERPRETATION:

7.1 As the developer dries to a smooth, even white coating, indications will appear at the locations of discontinuities. Depth of surface discontinuities may be correlated with the richness of colour and speed of bleeding out. However, localised surface imperfections such as may occur from machining marks or surface conditions may produce similar indications which are non-relevant.

7.2 Usually, a crack or similar opening will show a line and light cracks or partially welded lap will show a broken line. Gross porosity may produce large indications covering an entire area. Very fine porosity is indicated by random dots.

7.3 Any non-relevant indication shall be regarded as a defect until the indication is either eliminated by surface conditioning or it is Proved non-relevant by other NDT methods.

7.4 Linear indications are those indications in which the length is more than three times the width. Rounded indications are indications which are circular or elliptical with the length less than three times the width.

7.5 All indications shall be evaluated in terms of the acceptance standards of the referencing documents.

8.0 ACCEPTANCE STANDARDS:

8.1 For castings - Refer Corporate Standard AA 085 01 32.

8.2 For Austenitic Forgings - Refer Corporate Standard AA 085 01 30.

8.3 For Welds - Refer Corporate Standard AA 085 01 29.

9.0 POST EXAMINATION CLEANING:

Surfaces examined shall be cleaned after evaluation of the test with dry cotton rag with or without water rinse.

TABLE - 1 (Clause 5.3.2)

Suggested Penetration Time For Post-emulsified And Solvent Removable Penetrants

Material	Form	Type of discontinuity	*Penetration time (min.)
Aluminium	Castings	Porosity	5
		Cold shut	5
	Extrusions & Forgings	Laps	10
		Lack of fusion	5
	Welds	Porosity	5
	All forms	Cracks	10

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CORPORATE STANDARD

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TABLE - 1 (Clause 5.3.2) Contd.

Material	Form	Type of discontinuity	*Penetration time (min.)
Magnesium	Castings	Porosity	5
		Cold shut	5
	Extrusions & Forgings	Laps	10
		Lack of fusion	10
	Welds	Porosity	10
	All forms	Cracks	10
Steel	Castings	Porosity	10
		Cold shut	10
	Extrusions & Forgings	Laps	10
		Lack of fusion	20
	Welds	Porosity	20
	All forms	Cracks	20
Brass & Bronze	Castings	Porosity	5
		Cold shut	5
	Extrusions & Forgings	Laps	10
		Lack of fusion	10
	Brazed parts	Porosity	10
	All forms	Cracks	10
Plastics	All forms	Cracks	5
Glass	All forms	Cracks	5
Carbide tipped tools	All forms	Lack of fusion	5
		Porosity	5
		Crack	20
Titanium & high temperature alloys	All forms		20 to 30
Ceramic	All forms	Cracks	5
		Porosity	5

* For lower temperatures, penetration time should be increased.

ANNEXURE - 1 (Clause 5.3.3)

PROCEDURE FOR NON-STANDARD TEMPERATURES

A.1 **General:**

When it is not practical to conduct a liquid penetrant examination within the temperature range of 15.6 to 51.6°C (60 to 125°F), the examination procedure at the proposed lower or higher temperature range requires qualification. This shall require the use of a quench cracked aluminium block, which is designated as 'Liquid Penetrant Comparator Block'.

A.2 **Liquid Penetrant Comparator Block:**

The liquid penetrant comparator block shall be made of aluminum, ASTM B209, Type 2024 or SB-211. Type 2024, 10 mm (3/8 in.) thick, and shall have approximate face dimensions of 50 mm x 75 mm (2 in. x 3 in.). At the centre of each face, an area approximately 25 mm in diameter shall be marked with a 510°C (950°F) temperature indicating crayon or paint. The marked area shall be heated with a blow torch, a Bunsen burner or similar device to a temperature between 510°C (950°F) and 524°C (975°F). The specimen shall then be immediately quenched in cold water which produces a network of the fine cracks on each face. The block shall then be dried by heating to approximately 149°C (300°F). After cooling, the block shall be cut into two halves. One half of the specimen shall be designated block 'A' and the other block 'B' for identification in subsequent processing. Figure 1 illustrates the comparator blocks "A" and "B". As an alternate to cutting the block in half to make blocks "A" and "B", separate blocks 50 mm x 75 mm (2 in. x 3 in.) can be made using the heating and quenching technique as described above. Two comparator blocks with closely matched crack patterns may be used. The blocks shall be marked "A" and "B".

A.3 **Comparator Application:**

(a) If it is desired to qualify a liquid penetrant examination procedure at a temperature of less than 15.6°C (60°F) the proposed procedure shall be applied to block "B" after the block and all materials have been cooled and held at the proposed examination temperature until the comparison is completed. A standard procedure which has previously been demonstrated as suitable for use shall be applied to block "A" in the 15.6 to 51.6°C (60 to 125°F) temperature range. The indications of cracks shall be compared between blocks "A" and "B". If the indications obtained under the proposed condition on block "B" are essentially the same as obtained on block "A" during examination at 15.6 to 51.6°C (60 to 125°F), the proposed procedure shall be considered qualified for use.

(b) If the proposed temperature for the examination is above 51.6°C (125°F), block "B" shall be held at this temperature throughout the examination. The indication of cracks shall be compared as described in T-647.3(a) while block "B" is at the proposed temperature and block "A" is at the 15.6 to 51.6°C (60 to 125°F) temperature range.

(c) A procedure qualified at a temperature lower than 15.6°C (60°F) shall be qualified from that temperature to 15.6°C (60°F).

(d) To qualify a Procedure for temperatures above 51.6°C (125°F), the upper and lower temperature limits shall be established and the procedure qualified at these temperatures.

(e) As an alternate to the requirements of (a) and (b) when using color contrast penetrants, it is permissible to use a single comparator block for the standard and non-standard temperatures and to make the comparison by photography.

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(f) When the single comparator block and photographic technique is used, the processing details (as applicable) described in (a) and (b) above shall apply. The block shall be thoroughly cleaned between the two processing steps. Photographs shall be taken after processing at the nonstandard temperature and then after processing at the standard temperature. The indication of cracks shall be compared between the two photographs. The same criteria for qualification as (a) above shall apply.

(g) Identical photographic techniques shall be used to make the comparison photographs.

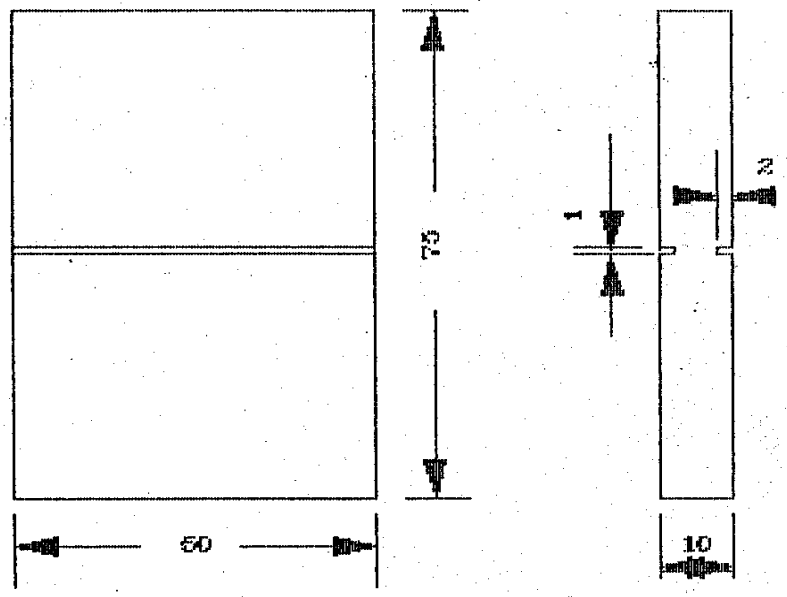


FIGURE: 1-LIQUID PENETRANT COMPARATOR BLOCK

EVALUATION AND ACCEPTANCE STANDARD FOR LIQUID PENETRANT EXAMINATION OF CASTINGS

1.0 SCOPE:

1.1 This standard is applicable for Liquid Penetrant examination of castings.

1.2 The procedure adopted for this examination is as per Corporate Standard AA 085 01 31

2.0 DEFINITION OF INDICATIONS:

2.1 Circular indications are those, more or less elliptical with major axis not more than three times the minor axis.

2.2 Linear indications are those, having length in excess of three times the average width.

2.3 In-line indications are those, in group of three or more indications aligned side by side in line with intervening gaps of less than 2mm measured edge to edge.

3.0 EVALUATION OF INDICATIONS:

3.1 Defects which occur as mechanical discontinuities at the surface will be indicated by the bleeding out of the penetrant, however, localised surface imperfections such as may occur from machining marks or surface conditions may produce similar indications which are not relevant to the detection of defects.

3.2 Any indication which is suspected to be non-relevant is to be considered relevant till it is proved otherwise.

3.3 Relevant indications are those which result from mechanical discontinuities. Linear indications are those indications in which the length is more than three times the width. Rounded indications are those indications which are circular or elliptical with the length less than three times the width.

3.4 Indications measuring less than 1.5mm across shall not be taken into consideration unless they are clustered in group of more than 4 Nos. with intervening gap of less than the largest dimensions of adjacent flaws. Such clusters shall be evaluated as single defect.

4.0 ACCEPTANCE STANDARDS:

Castings are classified into four levels, as details below, according to the size and number of flaws permissible.

(01)

Level	No. of acceptable indications per 100 sq. cm. surface area of length not exceeding 25cm.	~~Unacceptable~~ Linear defects.
I	2 Nos. of 3mm circular indication.	Crack and hot tears.
II	3 Nos. of 3mm circular indication. One 5mm circular or linear indication.	-do-
III	3 Nos. of 3mm circular indication. 2 Nos. of 4mm circular indication. One 6mm circular or linear indication. One in-line indication of 10mm maximum length.	-do-
IV	4 Nos. of 3mm circular indication. 3 Nos. of 4mm circular indication. 2 Nos. of 8mm circular or linear indication. One in-line indication of 15mm maximum length.	-do-

Note: The minimum permissible distance between any two or more acceptable individual flaws shall not be less than the major dimension of the larger flaw.

CS-0345

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.

6.0 MANUFACTURE

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

The steel shall be fully killed.

7.0 HEAT TREATMENT

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

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

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

8.0 FINISH

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

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

9.0 FREEDOM FROM DEFECTS

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

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

10.0 CHEMICAL COMPOSITIION

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

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

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

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

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

11.0 TEST SAMPLES

Manufacturers shall carryout mechanical testing as per following sampling plan.

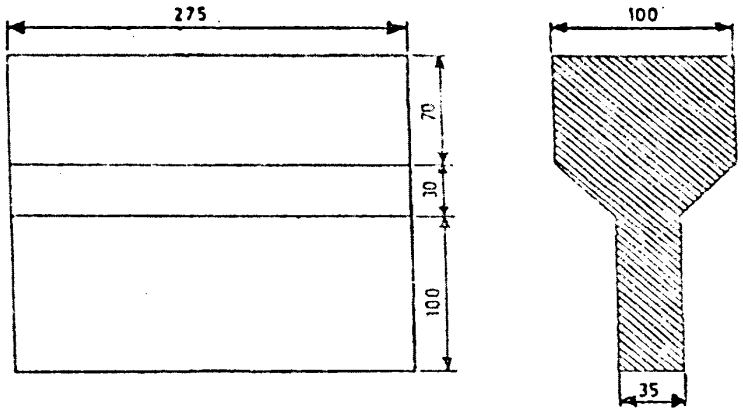
11.1 Unless otherwise specified for castings weighting up to 500 kg. piece weight one keel block, separately cast per melt per heat treatment batch shall be supplied according to the sketch given below:

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

11.3 Retests shall be carried out as per IS : 8800

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

DETAIL OF KEEL BLOCK



ALL DIMENSIONS IN mm

12.0 MECHANICAL PROPERTIES:

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

12.1 Tensile

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

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

12.2 Hardness (Brinell): for information only:

150 - 205 HB.

13.0 NON-DESTRUCTIVE TESTS:

The following tests shall be conducted:

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

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

14.0 REPAIR OF CASTINGS

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

15.0 SCOPE OF THIRD PARTY INSPECTION:

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

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

16.0 TEST CERTIFICATES

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

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

The test certificate shall bear the following information:

i) Dimensional inspection.

ii) Detail of heat treatment

iii) Chemical composition & unspecified alloying elements whenever called for

iv) Results of mechanical tests

v) Results of NDT tests.

17.0 PACKING AND MARKING

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

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

18.0 REFERRED STANDARDS (Latest Publications Including Amendments):

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

ANNEXURE 1 - RECOMMENDED TEST CERTIFICATE FORMAT FOR CASTINGS

SUPPLIERS'S NAME AND ADDRESS

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

II. CASTING COVERED BY T.C.

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

12. CHEMICAL COMPOSITION (PERCENT)

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

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

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

14. MECHANICAL PROPERTIES

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

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

17.NON-DESTRUCTIVE TESTS

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

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

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

Signature & Seal of the Inspecting Officer (Purchase Representative)

Date :

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

Date :

INSTRUCTION:

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

TDC FOR CRITICAL STEEL CASTINGS OF BOWL MILLS

1. **GENERAL** :

1.1 SCOPE AND FIELD OF APPLICATION

The purpose of this specification is to define the required quality and the general manufacturing and inspection conditions for critical steel castings of bowl mills.

2. CHEMICAL ANALYSIS AND MECH. PROPERTIES

The Chemical composition and Mechanical properties should be as per AA19511. (Latest Edition)

NOTE:

- The dimensions and number of test ingots shall be sufficient to allow specimens to be taken for test, retests and, if necessary, reworking.
- For each unsatisfactory test, 2 retests shall be performed. In the event that one of the retests is not satisfactory, reworking by new heat treatment is possible.

3. GENERAL MANUFACTURING CONDITIONS:

3.1 GENERAL

Execution of the items shall be in compliance with drawings and bills of material and with this specification.

To meet the dimensional accuracy, soundness and surface condition requirements for the items, pouring shall be done in a rigid mould.

The temperatures and durations of these treatments shall be recorded and the recordings shall include the references of the items to ensure their traceability.

3.2 REPAIRS

a) SURFACE DEFECTS

Surface defects detected on the items in the rough machined state during the non destructive inspections (visual examination, magnetic particle inspection) can be eliminated by grinding within the limit of the dimensional tolerances indicated on the drawings.

There shall be a gradual transition between these excavations and the surrounding surface. A magnetic particle or liquid penetrant inspection shall be performed to demonstrate the accordance with the same criteria as for the initial inspections (see annexure A). No surface excavation after final machining is accepted.

b) REPAIR WELDING:

Other defects outside the criteria can be repaired by welding to bring the items into compliance with the inspection criteria.

A qualified repair welding procedure must previously have been drawn, up in accordance with ASME IX.

A map of major defects as per Annexure B shall be drawn up.

Repaired and neighboring zones shall be given the same inspection as before (see Annexure A), together with an ultrasonic inspection with separate angle probe and transceptor (or with a suitable close field) to detect any planar defect.

c) POST WELD STRESS – RELIEVING TREATMENT:

After welding, the items shall be given stress relieving heat treatment in the oven for all major and minor excavations as defined in Annexure B. The temperature of this heat treatment shall be less than the quality heat treatment one (less than 20 º C)
Repairs after surface excavations (see Annexure B) can be locally stress relieved provided that no minor or major excavations has been performed on that item, only for the heads welded on the shell.

3.3. MARKING:

The material attestation details shall be hard punched with 10 mm punch (min) at a place remaining as-cast unless otherwise specified in the drawing.

The following indications shall be included:

a) Pattern or drawing number.
b) BHEL vendor code.
c) Heat number (to be quoted on all inspection documents)
d) Material specification BA75020+AA19511 REV...
e) Manufacturer monogram/initials shall not be cast on the casting.

The marking shall be surrounded by yellow paint to make it clearly visible.

4. GENERAL INSPECTION CONDITIONS:

4.1 GENERAL

The first time a type of item is made, the first casting shall be considered a prototype, but it will not be necessary to wait for the results of the inspections at the rough-machined stage before continuing with the manufacture of the other item.

The Quality Control Plan or manufacturing and associated inspection programme shall be drawn up. It shall indicate all the manufacturing operations in chronological order and all the inspections.

4.2 TESTS AND INSPECTIONS

The tests and inspections to be performed on the castings are defined in Annexure A.

5**. DOCUMENTS**:

To be submitted to BHEL after manufacture and before shipment:

a. Chemical analysis certificates
b. Mechanical test certificates
c. Heat treatment certificates
d. Map of major excavations
e. Dimensional records
f. Non-destructive inspection certificates.

All of these documents shall be gathered together to form the constructor file, with a table of contents and cover pages.

6. ENCLOSED.

The following Annexure's are enclosed to this specification:

Annexure A - Test & Inspection
Annexure B - Cut out- defect diagrams
Annexure C - Magnetic particle test criteria
Annexure D - Liquid penetration test criteria

7. PACKING AND TRANSPORT

The castings shall be packed suitably and transported to avoid transit damage

ANNEXURE –A

TEST AND INSPECTION

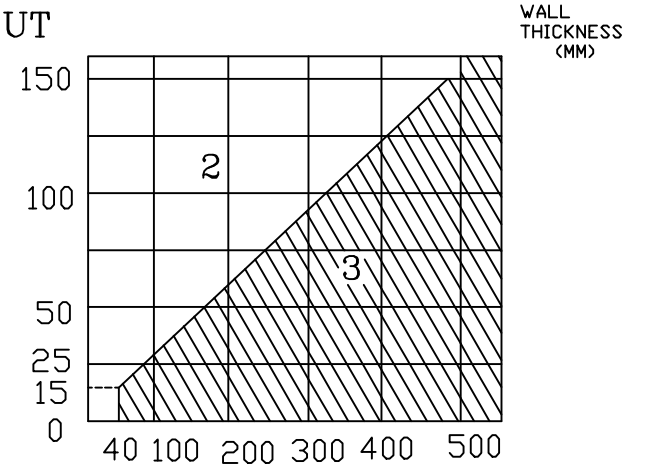
Type of Inspection	Ref	Method of Inspection	Acceptance Level/Criteria	Inspection Frequency	Support Document
a.Dimensions	IS	Dimensional	1.As per drg.	Each casting	Dimensional report
b. Surface		Visual	The surface shall be free from the defects like cracks or other defects detrimental to the item.	Each casting	
c. Chemical analysis	AA19511	Standard	The result shall comply the spec	Each item	Certificates
d. Mechanical	AA19511	Standard	The result shall comply the spec.	Each item	Certificates
e. Ultrasonic (Rough machined condition)	AA08501 04	AA085010 4	Level II	Each item	Certificates
f. MPI (In rough machined condition)	AA08501 33	AA085013 4	1.Transition radii linear & aligned defect level 01 2. Non-linear defect level 2 3. All rest level 2 4. Planar defects after repair by welding are not permissible	Each casting -do-	Certificate -do-
g.Liquid penetration test (For heads delivered with fully machined condition)	AA08501 31	Annexure D AA085013 1	Defect level 01 of Annexure D.	Each head on zone shown	Certificate

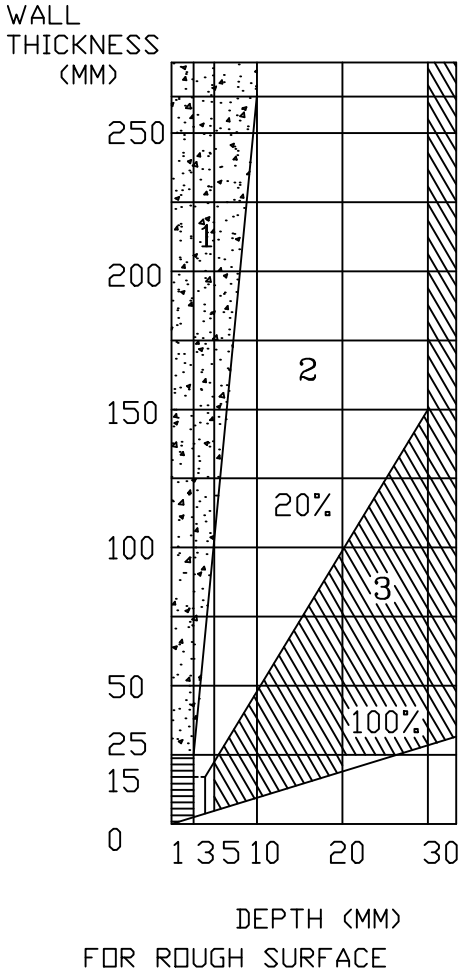
ANNEXURE B
CUT OUT

1 ZONE
SUPERFICIAL CUT-OUTS

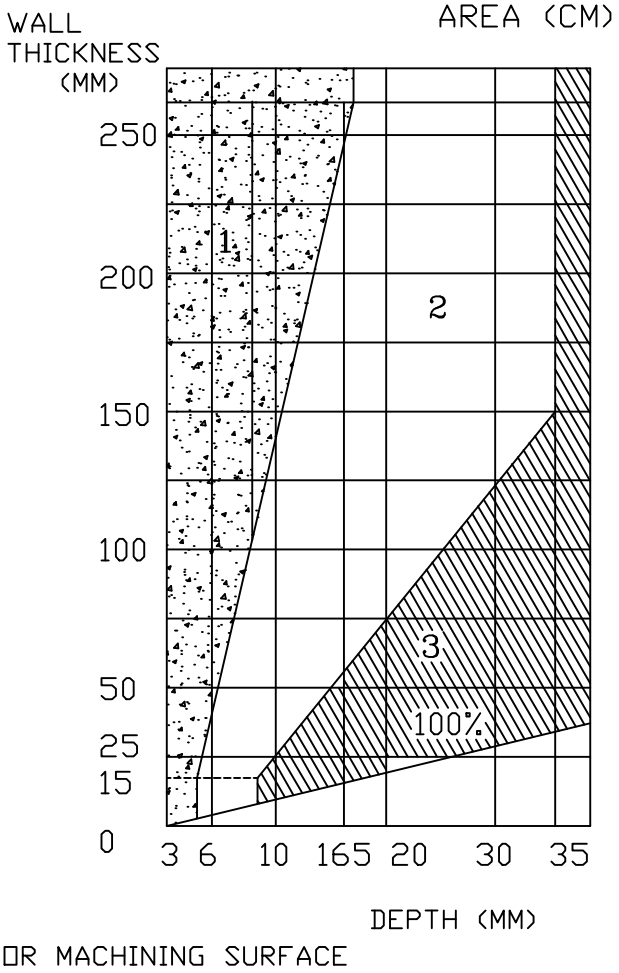
2 ZONE
MINOR CUT-OUTS

3 ZONE EDS
MAJOR CUT-OUTS





FOR ROUGH SURFACE



FOR MACHINING SURFACE

ANNEXURE C (MAGNETIC PARTICLE TEST CRITERIA –STEEL CASTINGS

Equivalence ASTM E 125					1		2		3		4		5	
LEVEL			001	01	1		2		3		4		5	
Size of the indication taken into account			0.3		1.5		2		3		4		5	
SM (2) Non-linear indications		(1) Maximal whole area (sq. mm)			10		35		70		200		500	
		Maximal individual size (mm)	1	1	2 (4)		4 (4)		6 (4)		10 (4)		16 (4)	
LM (2)		Ordering of indications	Isolated or cumulated		Isolated	Cumulated	Isolated	Cumulated	Isolated	Cumulated	Isolated	Cumulated	Isolated	Cumulated
AM (2) Liner and aligned indications	Maximal lengths of indications (mm) (1)	"a" (3) thickness $t \leq 16$ mm	0	1	2	4	4	6	6	10	10	16	16	25
		"b" (3) thickness $16 < t \leq 50$ mm	0	1	3	6	6	10	10	16	16	25	25	40
		"c" (3) thickness $t > 50$ mm	0	2	5	10	10	16	16	25	25	40	40	63

(1) In a frame of 105 x 148 mm .
(2) The indication is liner if $L \geq 3\ I$ with L : length and 1: width of the indication.
The indications are aligned if numbering of 3 or more and if the distance between them is less than 2 mm- non linear –or if less than the greatest of the indications. The length taken into account is the distance between the beginning of the first indication and the end of the last one.
(3) Thickness of the casting (4) 2 Indications Max. for this size

ANNEXURE D (LIQUID PENETRANT TEST CRITERIA (STEEL CASTINGS) IN ACCORDANCE WITH ASTM E433

LEVELS			001	01	1		2		3		4		5	
Size of the indication taken into account (mm)			0.3		15		2						3	
SR (2) Non linear indications	(1) Maximal number of indications			5	8		8		12		16		20	
	Maximal size of indication (mm)			1	3		5		8		12		16	
AR (2) Linear and aligned indications	Ordering of indications		Isolated or cumulated		Isolated	Cumulated	Isolated	Cumulated	Isolated	Cumulated	Isolated	Cumulated	Isolated	Cumulated
	(1) Maximal lengths of indications (mm)	"a" (3) thickness $t \leq 16$ mm	0	1	2	4	4	6	6	10	10	16	16	25
		"b" (3) thickness $16 < t \leq 50$ mm	0	1	3	6	6	10	10	16	16	25	25	40
		"c" (3) thickness $t > 50$ mm	0	2	5	10	10	16	16	25	25	40	40	63

1. In a frame of 105 x 148 mm .
2. The indication is liner if $L \geq 3\ I$ with L : length and 1: width of the indication.
   The indications are aligned if numbering of 3 or more and if the distance between them is less than 2 mm- non linear –or if less than the greatest of the indications. The length taken into account is the distance between the beginning of the first indication and the end of the last one.
3. Thickness of the casting .

PRODUCT STANDARD
PULVERISERS
HYDERABAD

RECORD OF REVISIONS

REV. NO	DATE	REVISION DETAILS	REVISED	APPROVED
01	18.8.06	Common clauses with AA19511 deleted.	AMAN	SG
02	27.06.07	For MPI ref.- AA0850133 And Method of Inspection- AA0850134 were ASTM E-125 and Annexure-C of ASTM E-125 respectively in Annexure-A	AMAN	SG

TRP APPLICATION ON FERROUS COMPONENTS OF DIFFERENT PRODUCTS

1. SCOPE:

1.1 The standard covers the selection and applications of Temporary Rust Preventives (TRP) for different products & their components during production, before despatch and at site.

1.2 This standard supersedes the old company standard and other Product Standards/ documents made on the subject.

2. GENERAL:

The effectiveness of TRP depends on the following aspects:

2.1 Selection of proper TRP.

2.2 Proper preparation of the surface to be protected. Refer plant standard HY 067 41 66.

2.3 Application of TRP – Under normal atmospheric conditions, corrosion of machined surfaces starts as soon as they are accessible to moisture, air etc. Hence it is necessary to apply rust preventive immediately after the machining of surfaces.

2.4 TRP – Reference on manufacturing & erection instructions/drgs. wherever necessary by Engg.

3. SELECTION OF TRPs:

The list of rationalized TRPs, is given in Annexure - I. This covers various types, method of application, durability of protection, equivalent brands etc.

4. SURFACE PREPARATION: (For details refer plant std HY0674166)

Before application of TRPs, it is necessary to ensure that the surfaces are free from rust, dust, dirt, grease, oil etc. The effectiveness of TRP depends on the cleanliness of the surface.

5. TRP APPLICATION:

5.1 The application of TRPs is classified in Annexure II keeping in view the finish and the extent of protection required.

5.2 The details of components against each category of application are given productwise in the Annexure III.

6. PRECAUTIONS FOR APPLICATION:

6.1 The TRP shall be stirred well in the original container so as to make a homogenous mixture of its constituents.

6.2 The container, brush, cloth to be used for application of TRP shall be clean. The container and the brush shall be washed with white spirit, for the next operation.

6.3 Preservative shall be applied in closed premises not later than 3-5 hours after cleaning and degreasing. Application shall not be done in humid atmosphere and during sharp changes in temperature, which may cause sweating.

6.4 Care shall be taken to see that the preservative coating is uniform and without overflow or gaps, bald spots, and flows in. Each subsequent layer shall be coated after the preceding one dries up completely.

6.5 The quality of preservative layer shall be checked by visual inspection for uniform coat. Any defect observed shall be immediately rectified.

7. DURABILITY OF PRESERVATION:

The durability of preservation varies from 6 months to 1 year depending on the category of TRP application refer Annexure–I. After this period, it is necessary to inspect the preserved parts and if necessary carry out re-preservation after cleaning and making the surfaces free from corrosion, if any.

8. DETAILS OF REPRESERVATION TECHNIQUES:

8.1 The earlier coating shall be removed by using white spirit.

8.2 Rust if any shall be removed with fine emery paper. Care shall be taken to see that precision machined surfaces like Journal surfaces shall not be damaged during this operation.

8.3 Surfaces prepared for re-preservation shall not be touched by hand.

8.4 The duration of re-preservation shall be as per the durability of protection specified in Annexure I. After drying, re-preservation shall be carried out in accordance with clause 6

9. DEPRESERVATION BEFORE ASSEMBLY / ERECTION:

9.1 Depreservation of the various parts shall be done during Assembly/erection period as and when necessary.

9.2 Depreservation of parts consists of removal of TRP coatings from all the machined surfaces with white spirit.

9.3 Degreasing or cleaning of any forged components like rotors, blades, shafts etc., shall not be done with Chlorinated Solvents like Carbon Tetrachloride.

Preservative Instruction to Site:

1. This standard on preservation of different products and components shall be followed.
2. As soon as the components are received at site, they should be examined for rupture of TRP film, VCI paper and development of rust, if any. Patch work wherever necessary should be done with the TRP system.
3. The components should be stored in such a way that TRP film does not get damaged.
4. The surface of TRP coated components shall be examined for damage and corrosion spots regularly.
5. Represervation shall be followed as per the Tag attached to the component.
6. Inspect coated and wrapped surfaces. If coating or wrapping appears to have been removed during shipping clean and re-wrap or coat as applicable.
7. Inspect shafts for adequate preservative and add a heavy film of valvoline TECTYL 894 or Equivalent as necessary.
8. Rotate the Rotors a few revolutions every month and ensure that the bearings are packed with grease.

RECOMMENDED TYPES OF TRPs

(Clause – 3) **ANNEXURE-I**

Type of TRP	Description of TRP/SPEC. No.	Method of Application	Durability of Protection	Equivalent Brands
Hard Film Solvent deposited	Rust Preventive Hard Film Black AA55154	Dipping, Spraying, Brushing	6 months	HE 1710 (Bhopal)
	Rust Preventive Hard Film Yellow AA55155	Dipping, Spraying, Brushing	1 year	HE 1706 (Bhopal)
Soft Film deposited	Rust preventive solution, clear (TRP) AA55152	-Do-	6 months	HE 1709 (Bhopal)
	Rust solution, Steam washable (TRP) AA55151		3 months	HE 1712 (Bhopal)
Grease	Temporary Corrosion Preservative Grease IS:958	Smearing Brushing	6 months	IOC Multi-Purpose Grease No.2
Oil	Rust inhibitive oil (TRP) AA55153	Dipping, Rinsing, Spraying,	3 weeks	HE 1711 (Bhopal)
	Temporary corrosion Preventive Fluid IS:1153		6 months	ESSO: RUST BAN 394
Powder/ Tablet	Volatile Corrosive inhibitor (VCI) powder/tablet IS:5730	Sprinklin	3 months	
Paper	VCI paper IS:6263	Wrapping	3 months	
Gas	Nitrogen Blanketing	Filling	3 months	
Crystal	Silica-jel	Inserting	3 months	

TRP APPLICATION CATEGORIES

(Clause – 5) **ANNEXURE-II**

TRP Appli-cation Category	Application Details	Guide Lines for Selection
A	Apply 1 Coat of Rust Preventive Hard Film yellow (HE 1706) / AA55155 and 1 Coat of Rust Preventive Hard Film Black (AA55154)/HE1710. Wrap the surfaces with Volatile Corrosive inhibitive (VCI) paper with its active side facing the surfaces. Fix the ends with adhesive tape. Wrap the surfaces with rubber sheet and then with aluminium foil of thickness 0.05 to 0.1 mm. Fix the adhesive tape.	Longer duration of protection before despatch to site. Suitable for precision machined surfaces with simple profiles, eg. Rotor Journal Surfaces
B	Apply 1 Coat of Rust Preventive Hard Film yellow (HE 1706) /AA55155 and 1 Coat of Rust Preventive Hard Film Black (AA55154)/ HE1710.	Longer duration of protection before despatch to site. Suitable for precision machined surfaces like parting plane suraces, covers, couplings, base plates, machined cross around pipes etc.
C	Apply 2 Coats of Anti Rust solution, steam washable (TRP) (AA55151) / HE1712	Steam Turbine components of complicated profiles where steam washing facility is available eg. Steam Turbine rotor components.
D	Apply 2 Coats of Rust Preventive solution, Clear (TRP) (AA55152) / HE1709	Steam Turbine components of complicated profiles where there is no facility for steam washing.
E	Apply 2 Coats of TRP fluid (IS:1153)	Steam Turbine components of complicated profiles. The TRP is with brown Pigment.
F	Apply 1 Coat of Rust inhibitive oil (TRP) (AA55153) / HE1711	Machined components during the process, Storage on shop floor over 1 month upto 3 months.
G	Apply Temporary Corrosion Preventive Grease IS:958 liberally and wrap in polythene sheet/bag and tie it with a thread	Suitable for Fasteners, chains, Gear Wheels etc.
H	Wrap with 2 layers of VCI paper IS:6263 and one layer of Polythene Sheet.	Suitable for commutator of Armature, Bushings.
I	Sprinkle VCI powder/tablets IS:5730 inside pipe. Close the ends by plastic caps and adhesive tape.	Inside oil pipes.

ANNEXURE – II

TRP Appli-cation Category	Application Details	Guide Lines for Selection
J	Draining after Hydro Test drying with hot air, evacuation of the vessel and Nitrogen blanketing.	Suitable for the water chamber and the shell side of Heat Exchanger
K	Keep silica-jel bag inside suction and discharge branches, close all opening close all tapped holes with red plastic caps (HY7242375 for G threads, HY7242579 for NPT threads). Close all flanged openings with suitable metal covers (HY7790963).	Suitable for all exposed tapped holes and flanged openings on the pumps and Tubings.

PRODUCT COMPONENTS – TRP CATEGORIES
(CLAUSE –5.2)

ANNEXURE –III

DETAILS OF COMPONENTS	TRP APPLICATION CATEGORY
STEAM TURBINE AND COMPRESSORS HP,LP and other rotors. Rotor Journals, Thrust Collars	A
Base plate machined.	B
Crossed around pipes, machined	B
Bearing pedestals with assembled parts and bearing housings Outer machined surfaces	B
HP turbine outer casings Outer machined	B
HP, LP and other rotors. Rotor coupling flange faces, coupling bolt holes	B
Welded low pressure Turbine components Longitudinal Grider and front Outer machined	
LP upper part outer machined surface	B
LP inner outer casings outer machined surface	B
LP Inner, inner casings outer machined surface	B
Fasteners of Threaded portions Unthreaded portions (M64 and above)	B
HP Exhaust Elbow outer machined surface	B
Shaft lifting and clearance measuring device, machined surface	B
Assembly fixtures for HP Turbine, machined surface	B
Turning over device for HP Turbine, machined surface	B
Transportation device for HP Turbine, machined surface	B
Oil tank Outer machined surface	B
Injector Nb. 300 Outer machined surface	B
Main steam and re-heat strainer body Outer	B
Cast exhaust hood Outer machined surface	B

ANNEXURE –III

DETAILS OF COMPONENTS	TRP APPLICATION CATEGORY
Cross around pipes, inner	C
Valves-casings and covers	
Inner un-machined surface	C
Bearing pedestals with assembled parts and bearing housings	
Outer un-machined surface	C
HP and outer turbine outer casing-	
Inner	C
HP and IP inner casing and diaphram-carrier and guide blade carrier-	
Outer	C
Inner	C
HP, LP and other rotors.	
All surfaces except journals, Thrust collars	
Flange cases and coupling bolt holes	C
STEAM TURBINE AND COMPRESSORS	
Welded low pressure Turbine components -	
Logitudinal Girder and front valves	
Inner	C
LP upper part,	
Inner	C
LP Inner, outer casings	C
Inner including blades	C
Outer un-machined	C
LP Inner, inner casings	
Inner including blades	C
Outer un-machined	C
Cover for shaft sealing casing	
Inner	C
Steam inlet and extraction connections	
Inner and outer	C
HP Exhaust elbow	
Inner	C
Handling Barring Gear and hydraulic Gear oil tank	
Inner	C
Injector Nb.300	
Inner	C
Main steam and re-heat strainer body	
Inner	C

ANNEXURE –III

DETAILS OF COMPONENTS	TRP APPLICATION CATEGORY
Blanking arrangement for strainer body	C
Oil strainer	C
Main steam and reheat strainer handling device, machined	C
Oil throttle valve, inner	C
Oil stripper journal	C
Cast exhaust hood	
Inner	C
Compressor Rotor	D/E
Bearings, Oil seals, couplings, spare blades, gland ring	G
Lifting beams and clamps machined	G
Valves – casings and covers	
Inner machined	G
Spindles	G
Fasteners of Threaded portions	
Unthreaded portions	G
Emergency Governor	G
Piping of governing and LP bypass central rack and supply unit for valves, inner	G
Suspension arrangement for ESU and interceptor valve	
Machined surfaces and springs	G
Tools and tackles for governing equipment, machined	G
Oil pipeline outside the governing equipment	I
Other pipings	I
ELECTRICAL MACHINES	A
Rotor Journals, Slip rings, Journals of Armature	
Stator End Flanges, machined flanges, Machined surfaces of Foundation Frames, Base plates.	B
Machined components, Base plates, Machined surfaces of Oil cooler, Air cooler, Accessories	B
Rotor coupling face, threaded holes of exposed surfaces, bearing shells. Fasteners, internal/external threaded surfaces	G
Commutator of Armature, Bushings	H

ANNEXURE –III

DETAILS OF COMPONENTS	TRP APPLICATION CATEGORY
SWITCHGEAR Hydraulic pistons	A
Operating mechanisms after testing and before shipment HLD Base frame, Machined Flange surfaces and mechanism housing, Terminal butting surfaces.	D/E
Machined Ferrous components like shafts, pins, gears Springs, links and levers, castings, machined surfaces of fabricated housings, catches, latches, rollers protective pipe flanges.	F
Chains and bearings, pull rod (threaded portion), Base frame Tapped holes, external/internal threaded surfaces, fasteners.	G
HEAT EXCHANGERS inside condenser shells, inside deaerator shells, machined surfaces of flanges and drilled tube sheets/ support plates	D/E
Inside of Rectangular and very large condensers. Machined surfaces of condenser, tube sheets.	G
Inside water chamber and shell side of feed water heaters	J
OIL FIELD EQUIPMENT Rig instrumentation Valves and disconnectors dampers for gauges, indicating instruments. Mud Agitators Machined surfaces of mud system Hoisting and rotating equipment Rotory, Swivel, travelling block, Hydra Hooks Mud system Centrifugal pump, external surfaces of mud agitators Mud pump external surfaces, loose parts of mud pump. Mud pump internal surfaces with oil contact.	 G G G G
Centrifugal pump, mud pump internal surfaces with liquid contact. (Except Oil)	L

ANNEXURE – III

DETAILS OF COMPONENTS	TRP APPLICATION CATEGORY
BOWL MILLS Machined surfaces	D/E
Inside Gear case assembly	F
Bearings, Drive couplings, fastener, external/internal threaded surfaces	G
PUMPS Journal Bearings, bearing surfaces and exposed portion of shafts.	A
Exposed machined surfaces of ferrous components like thrust collar large fabricated frames, foundation frames, pump discharge covers, tubular cooler, catridge, keyway blocks of pump casings, Head gears, Canisters, Foundation Rings, elements, CWP parts.	B
Ferrous components stored in assembly shop, freshly machined surfaces with more than 1 to 3 months gap between one operation to another	F
Spare parts, fasteners, external/internal threaded joints	G
All exposed tapped holes and flanged openings on the pumps and tubings	K
GAS TURBINES Journal & Thrust Bearings, Rotor journals & Thrust collars	A
Ferrous components stored in assembly shop, freshly machined surfaces with more than one month gap between operations	F
All exposed tapped holes and flanged openings on the pumps	K
Exposed machined surfaces/parting planes of all ferrous fabricated frames including base plates, couplings	B
Fasteners, External/Internal threaded joints	G
Oil pipes when stored for long periods or when despatched loose	I
Torque converter – fill with lube oil, plug all openings If storage and/or despatch period together exceeds 3 months	
Fuel pump and flow dividers-fill with HSD, plug all openings, if storage and/or despatch period together exceeds 3 months	

ANNEXURE – A

LIST OF SUPPLIERS OF TRP

M/S. BHEL, Bhopal - Rust preventive oil

M/S. Ceturion coatings, Madras - Rust preventive compound (proprietary)

M/S. Agromore Ltd., Bangalore - Rust preventive Agents

M/S. Mascot chemical works, Bangalore - - ‘’-

M/S. Chembond chemicals Pvt. Ltd., Bombay - - “ -

M/S. Pradeep Metal Treatment Chemical Pvt. Ltd., Thane - - “ -

M/S. Surendra Enterprises, Hyderabad - - “ -

M/S. Canning Mithra phomics Ltd., Bombay - - “ -

M/S. Grawer & Weil (Ind) Ltd., Bombay - - “ -

M/S. Metrit Industries, Bombay - - “ -

M/S. Electro chemicals, Calcutta - - “ -

M/S. CMF Systems, Secunderabad - - “ -

M/S. Peddainton chemicals Industries (Ind), Bombay - - “ -

M/S. Protochem Industries, Bombay - - “ -

M/S. Suprabha protective, Products, Pune - Rust Poliq – N (Proprietary)

M/S. OKS, 5/9, Primorse Road, Bangalore - 560025 - 1) OKS – 240 Anti – seize compound
2) OKS – 1140 High Temperature Silicone grease
3) OKS – 410 Mos 2 High performance long life grease
4) OKS – 300 Mos 2 Mineral oil concentrate (Additive)
5) OKS – VCI : 368 N
6) OKS - VCI : 369 N
7) OKS - 2140
8) OKS - 2160
9) OKS - 2201

M/S. Prosol Chemicals Pvt. Ltd. - 1) Rustex - 221

M/S. Futech chemicals (P), Secundeabad - 1) Futech - AR (LT)

BHEL-HERP,VARANASI

QUALITY PLAN

Rough M/cd Carbon Steel Casting as per AA19511/09
(With UT, DP AND MPI Test)

Sl.No.	Component/ Operation	Characteristic Checked	Type/Method of Check	Extent of Check	Reference Documents	Acceptance Norm	Format of Record	Agency P	Agency W	Agency V	Remarks
1.0	Material	i. Composition	Chemical Analysis	1 Sample per melt	AA19511/09	AA19511/09	T.C.	3	-	2	
		ii. Heat Treatment	H.T.Chart	1 Sample per H.T.Batch	AA19511/09	AA19511/09	HT Chart/	3	-	2	
		iii. Mechanical Properties	Mechanical Test	1 Sample per H.T.Batch	AA19511/09	AA19511/09	T.C.	3	-	2	
2.0	After rough machining	i. Soundness of casting	Ultrasonic test	100%	BA75020/02 Annexure-A	BA75020/02 Annexure-A	T.C.	3	2	-	100% UT , MPI and DP test to be witnessed by BHEL / Nominated Inspection Agency
		ii. Surface defects	D.P.Test	100%	BA75020/02 Annexure-A	BA75020/02 Annexure-A	T.C.	3	2	-	
		iii. Surface Cracks	M.P.I.Test	100%	BA75020/02 Annexure-A	BA75020/02 Annexure-A	T.C.	3	2	-	
		iv. Dimensions	Measurement	10% by BHEL, 100% by Vendor	Drawing	Drawing	Dimension Report	3	2	-	
3.0	Final Inspection	I. Cleanliness	Visual	100%	----	----	I.R.	3	2	-	
		ii. Identification & Marking	Punching Heat No.Inspector Seal	100%	----	----	I.R.	3	2	-	
		iii. Prevention (from rust)	Visual	100%	----	----	I.R.	3	2	-	
Q.P.No.	RV/C&F/102 Rev.00	Approved by	V.Kumar								
Date	12/12/2007	Signature & Date									
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Legend

P=Perform
W=Witness
V=Verify
2=BHEL
3=Vendor/Supplier

TC=Test Certificate
HT=Heat Tratment
DR=Dimension Report
IR=Inspection Report