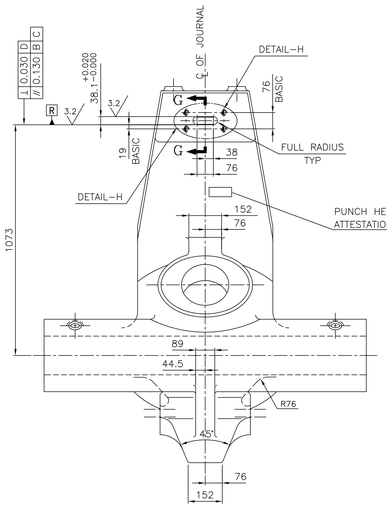
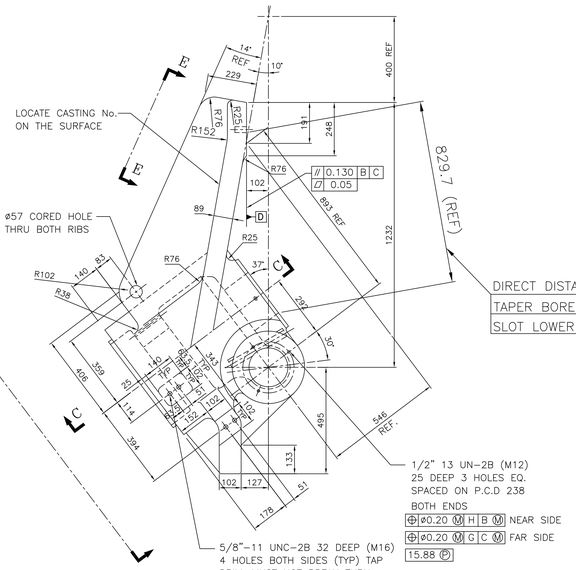
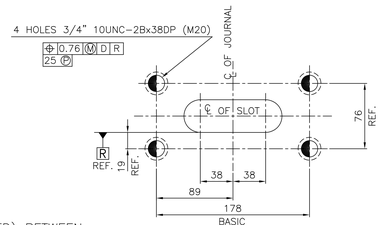
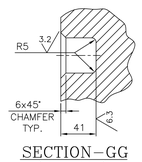


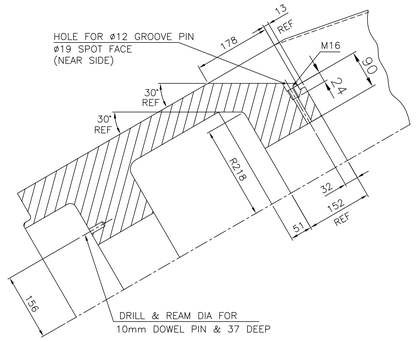




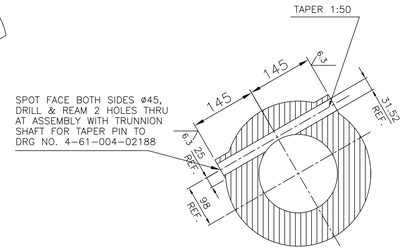
DETAIL–H
(SCALE–1:2.5)



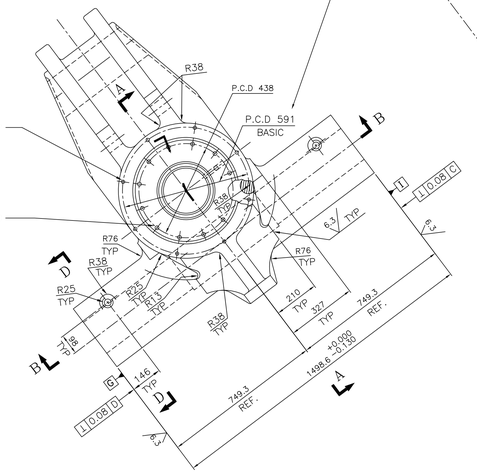
SECTION–GG
(SCALE–1:2.5)

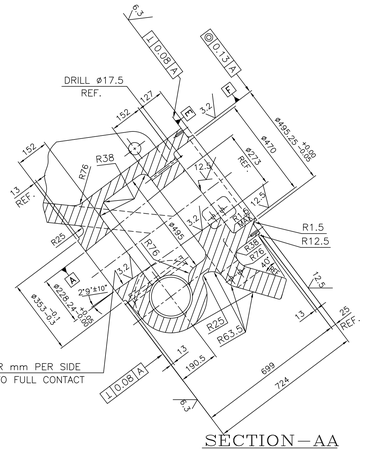


SECTION–CC
(SCALE–1:5)

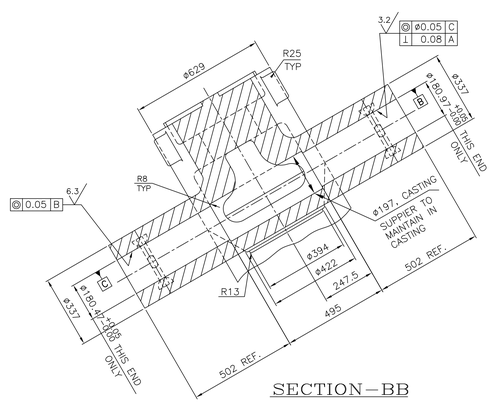


SECTION–DD
(SCALE–1:5)

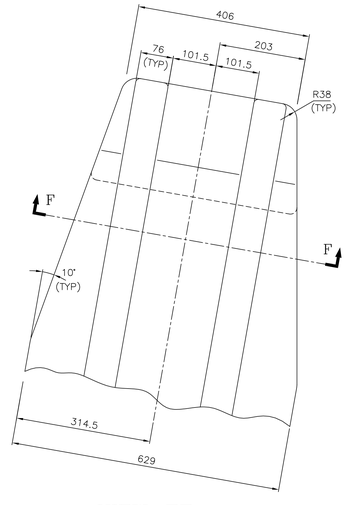




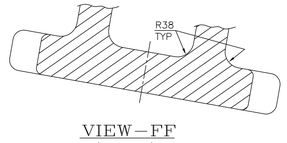
SECTION–AA



SECTION–BB



VIEW–EE
(SCALE 1:5)



VIEW–FF
(SCALE 1:5)

NOTES:–

02. UNLESS OTHERWISE MOTED
    A) ALL FILLLETS TO BE R25.
    B) ALL RADII TO BE R12.
03. SUPPLY AS PER CUSTOMERS APPROVED QUALITY PLAN.
04. VAR–01 WITH INCH THDS.
    VAR–02 WITH METRIC THDS.
05. SUPPLY AS PER TDC–BA75020.

ITEM NO	DESCRIPTION	DRAWING NO.	VAR. NO.	RAW MATERIAL SIZE OR CASTING DRG.NO. OR FORGING DRG.NO.	MATERIAL CODE	NET WT.	GROSS WT.
	CASTING				BA9211122120	2200.00	
					AA19511		
					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 WHEREVER NOT SHOWN SHALL BE TAKEN FROM THE SURFACE ROUGHNESS SHOWN OUT SIDE BACK SLASHES GIVEN AT THE TOP MOST RIGHT CORNER OF THE DRG.

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: 1003 XRP BOWL MILL

BHARAT HEAVY ELECTRICALS LTD. HYDERABAD

	NAME	SIGN.	DATE	NO.OF VAR.
DRN.	N.D.S		22.01.00	
CHD.	S.G		22.01.00	NA
APPD.	K.M.RAO		22.01.00	

DEPT.	CODE	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	NO.OF ITEMS
PULV. ENGG	446	1:10 1:5, 1:2.5	2200.00	E-101-01312/1 101-1312-A	NA	NA

TITLE: JOURNAL HEAD

DRAWING NO. 0-61-000-00169 REV. 11

SHEET NO. 01 NO OF SHEETS 01

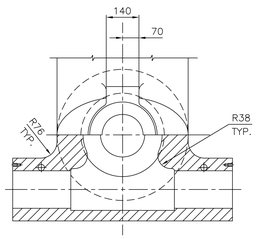
REV.	DATE	ALTERED	CHECKED	APPD.	ZONE	
11	19.6.07	NOTE 05 ADDED.				
10	28.1.06	MATERIAL ATTESTATION LOCATION SHOWN.				
09	25.6.04	DIM. 90 SHOWN.			D14	
08	3.1.2003	"ø197 CASTING SUPPLIER TO MAINTAIN IN CASTING" ADDED.			H11	
07	25.06.01	DIMN ø353 −0.1 −0.2 WAS ø353 −0.08 −0.08			B 10	
06	00.04.20	DIMN 829.7 ADDED			B 10	
05	22.03.2K	BOSS FOR TAPER PIN ADDED. MAT CODE WAS BA9211122058. NOTE FOR TAPER PIN MODIFIED. TAPER PIN WAS 36108802145.			E15	
04	28.01.00	DRAWING IS REDRAWN IN ACAD.				
03	31.05.99	NOTE–1 CANCLLED NOTE–4 ADDED. DUCTILE IRON DELETED.				
02	08.08.91	M16x24 DEEP ADDED IN SECTION–CC				
01	02.12.87	KEYWAY LENGTH SHORTENED TO SUIT THE REVISED KEY.				

INVENTORY NO | SIGN. AND DATE | REF. DRG. NO. | COMPUTER FILE NAME: 0610169.DWG

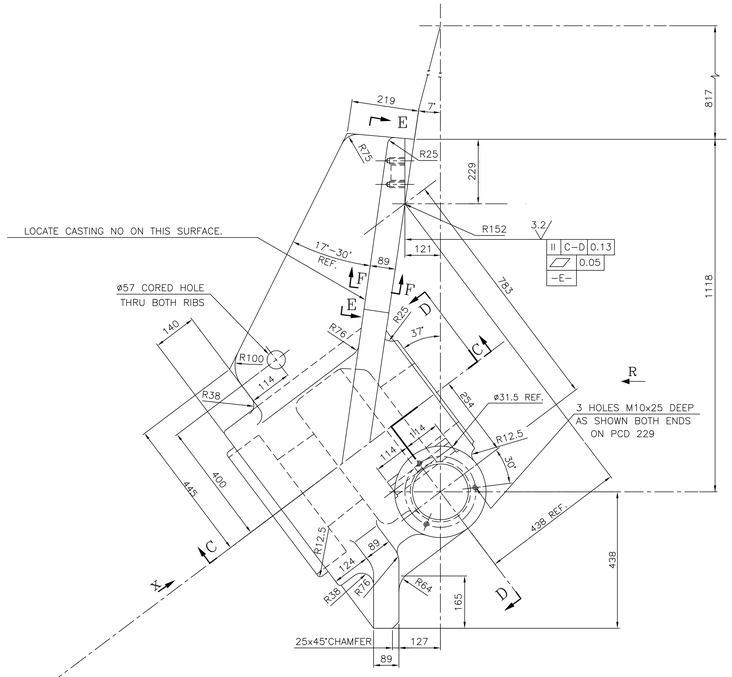
FIRST ANGLE PROJECTION

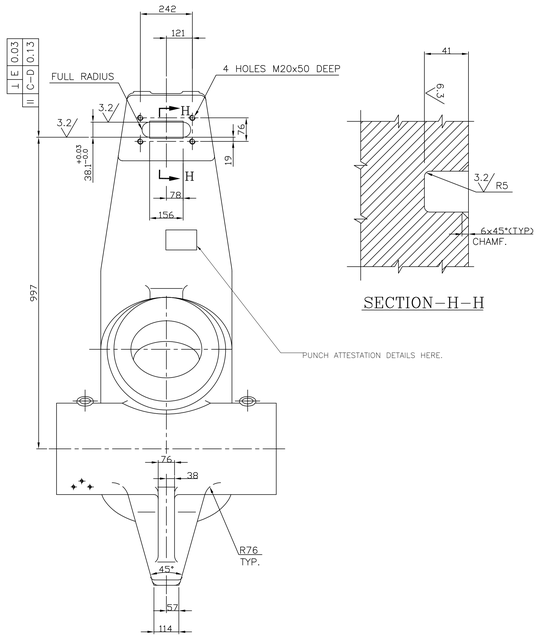
(ALL DIMENSIONS ARE IN mm)

DRG. NO. 0-61-088-00525 SH. 01 OF 01



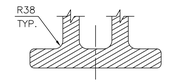
PARTIAL SECTION D–D



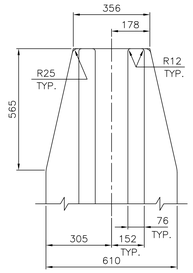


VIEW–R

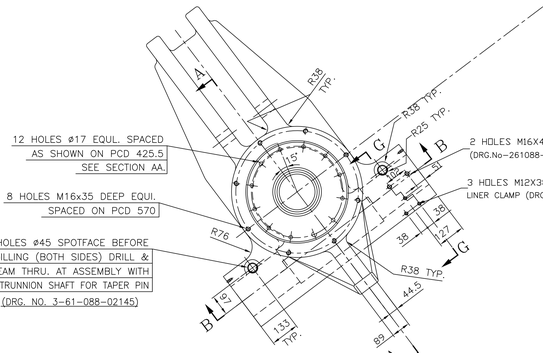
SECTION–H–H



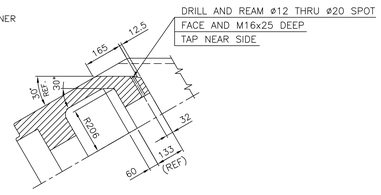
SECTION–F–F



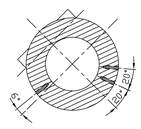
VIEW–E–E



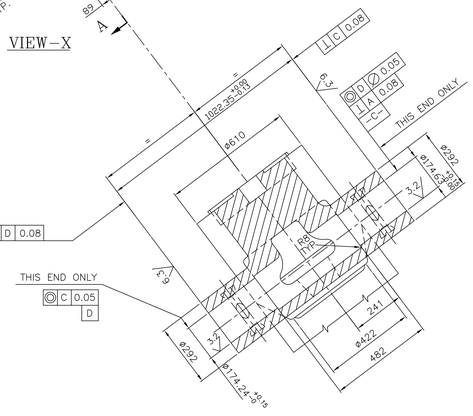
VIEW–X



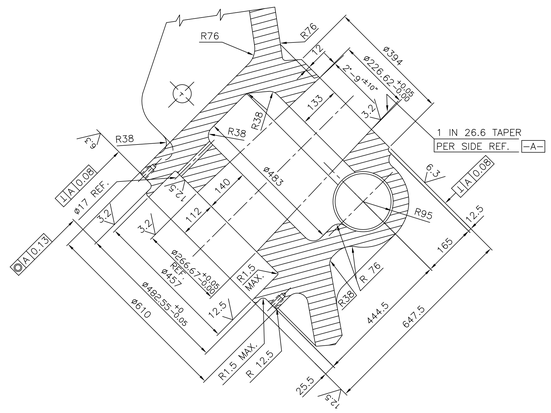
SECTION–"CC""



SECTION G–G



PARTIAL SECTION "B–B"



SECTION "A–A"

NOTES:–

01. THIS IS A FINISH MACHINED DRAWING. CASTING SHALL BE SUPPLIED IN STRESS RELIEVED AND ROUGH MACHINED CONDITION WITH 5mm ALLOWANCE ON ALL MACHINED SURFACES.

02 UNLESS OTHERWISE NOTED:
A) ALL FILLETS TO BE R25
B) ALL RADII TO BE R12.

03. 2 HOLES M16X40 & 3 HOLES M12X38 ARE TO BE DONE AFTER MARKING WITH JOURNAL HEAD LINER & LINER CLAMP ASSEMBLY REFER DRG.2–61–088–02067C FOR JOURNAL HEAD LINER ASSEMBLY.

04. SUPPLY AS PER TDC–BA75020.

ITEM NO.	DESCRIPTION	DRAWING NO.	VAR NO.	RAW MATERIAL SIZE OR CASTING DRG. NO. OR FORGING DRG. NO.	MATERIAL CODE	UNIT WT.	GROSS WT.
					MATERIAL SPECN.	QUANTITY	
01	CASTING				BA9211122040		1800.00
					AA19511		1

THE FOLLOWING CONDITIONS APPLY EXCEPT OTHERWISE STATED.

1. REF. TO HYD230261 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: 883 XRP BOWL MILL
NAME OF CUSTOMER/PROJECT

BHARAT HEAVY ELECTRICALS LIMITED
HYDERABAD

	NAME	SIGN.	DATE	NO.OF VAR.
DRN.	UNIC		7.12.98	
CHD.	SG		7.12.98	
APPD.	KMR		7.12.98	

DEPT.	GRADE OF TOL.DIM	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	NO.OF ITEMS
BMD		1:10	1800.000	1.61.088.01022	01	
CODE 446						

TITLE: JOURNAL HEAD

CARD CODE U 01 | DRAWING NO. 0-61-088-00525 | REV. 06 | SHEET NO. 01 | NO OF SHEETS 01

REV.	DATE	ALTERED UNIC	APPD.
06	19.6.07	CHD. AMAN	SG
ZONE	NOTE 4 ADDED.		
05	28.1.06	CHD. SG	KMR
D2	MATERIAL ATTESTATION LOCATION SHOWN, 'NOD' REMOVED FROM CASATING DETAILS.		
04	7.12.98	CHD. SG	KMR
D2	NOTE 3 ADDED M16X40 AND M12X38 DEEP HOLES WERE M16X32 AND M12X32 DEEP RESPECTIVELY.		
04	7.12.98	CHD. SG	KMR
B12 & D11	DIMNS DIA174.24+0.15–0.00&DIA174.63 +0.15–0.00 WERE DIA174.24 +0.05–0.00&DIA174.625+0.05–0.00 RESPECTIVELY.		
03	31.5.97	CHD.	
	DRAWING REDRAWN BY INCORPORATING ALL PREVIOUS REV.		

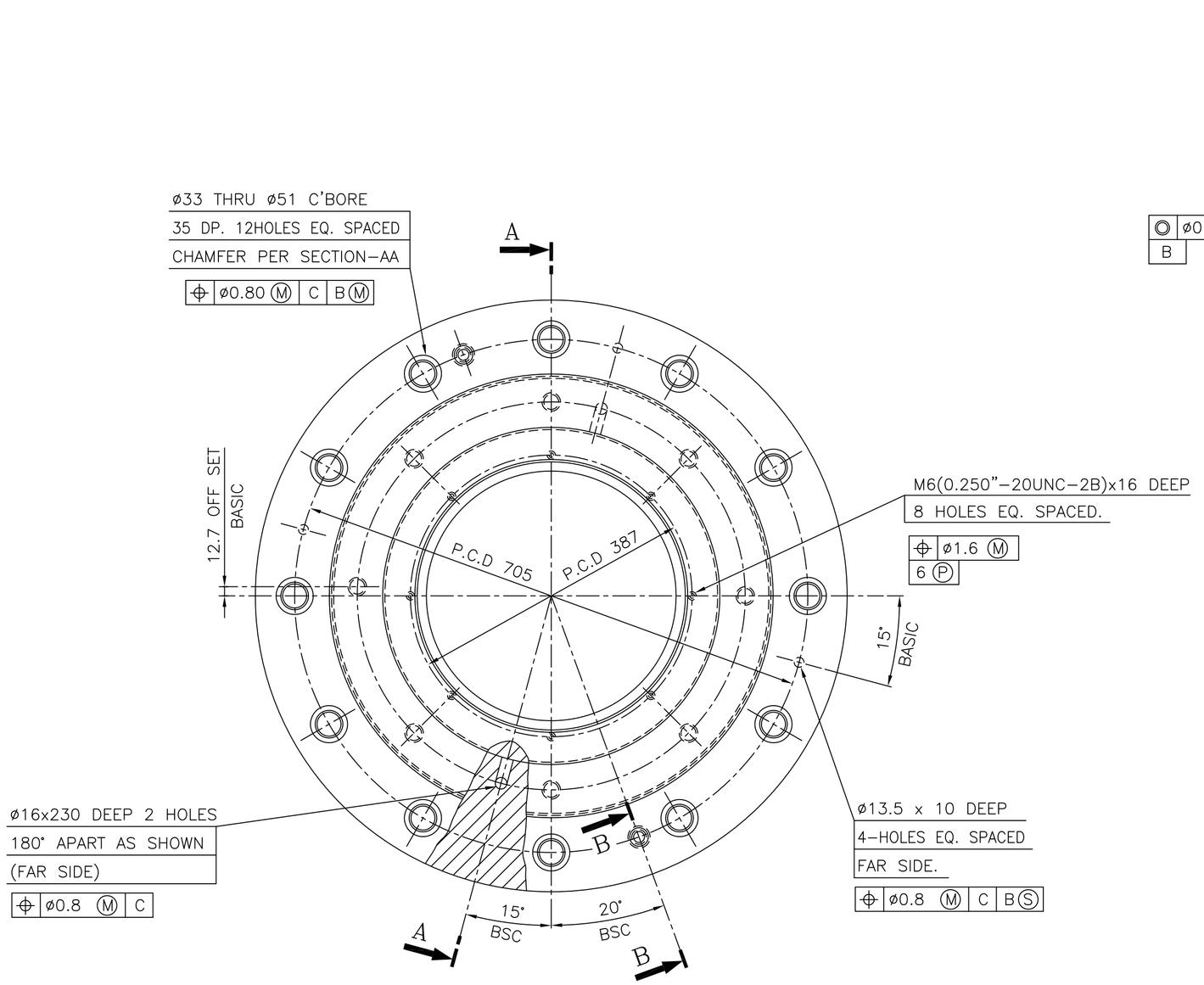
INVENTORY NO SIGN AND DATE | REF. DRG. NO. (E–94–647/S) | COMP. FILE NAME 06100525.DWG

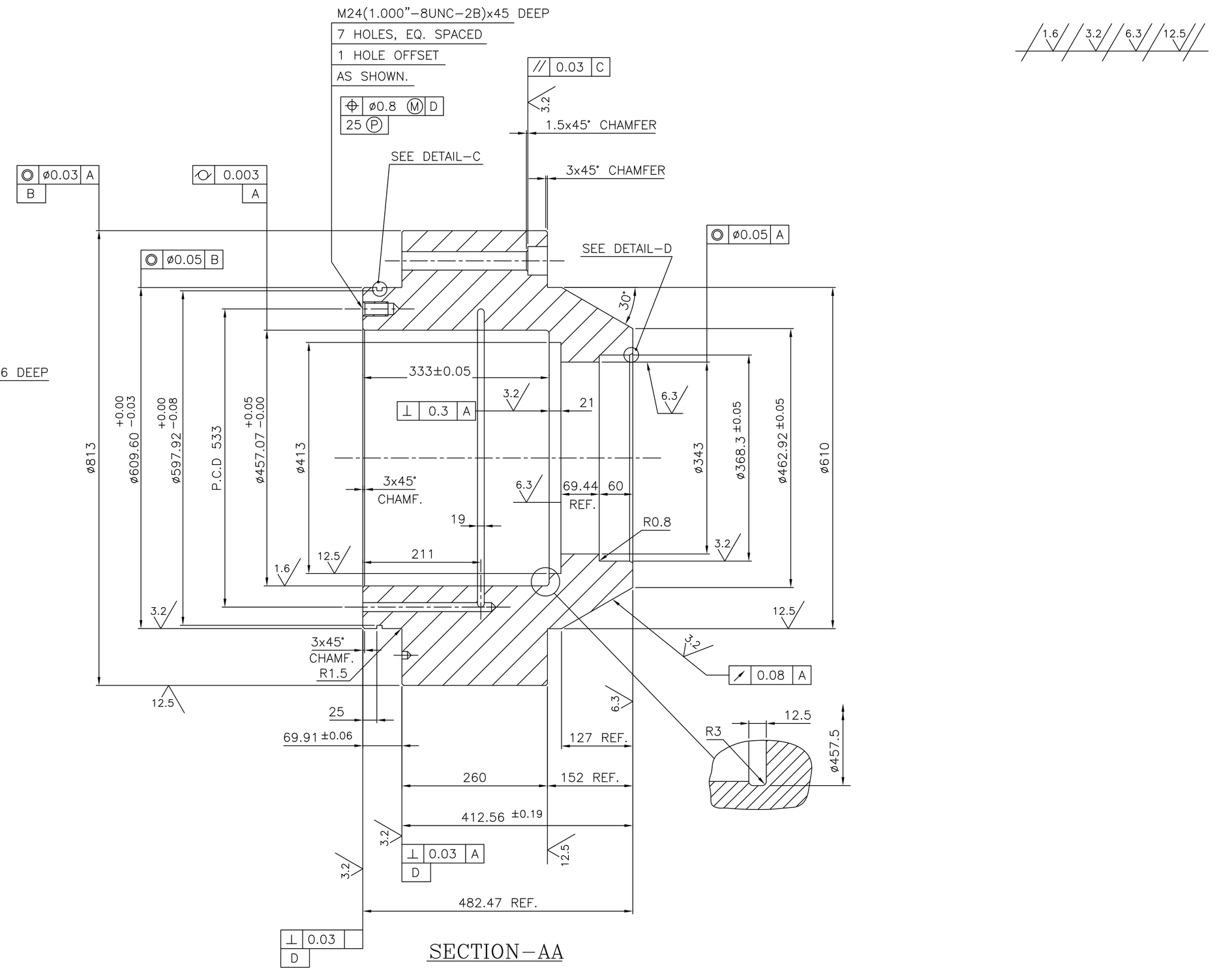
FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

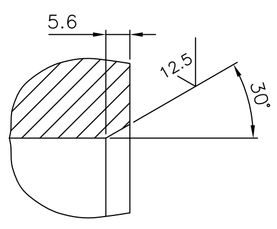
DRG. NO. 1-61-004-01186

SH. 01 OF 01

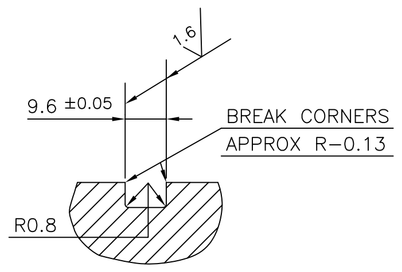




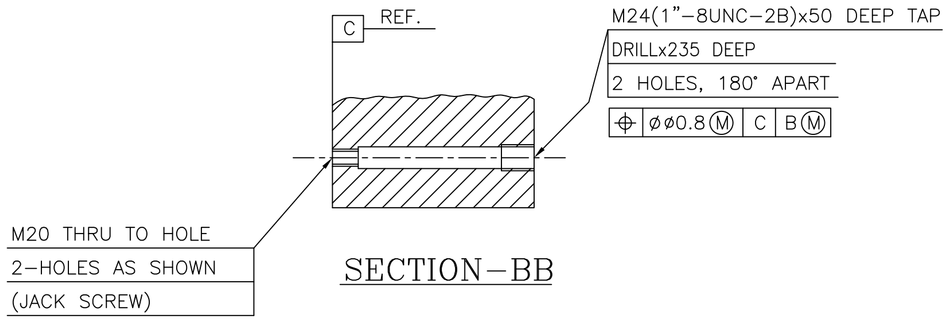
SECTION–AA



DETAIL–D



DETAIL–C



SECTION–BB

NOTES:–

01. FOR ROUGH FORGING REFER DRG. NO. 3–61–004–90188
02. BREAK ALL SHARP EDGES AND CORNERS UNLESS OTHERWISE NOTED.
03. TOLERANCES UNLESS OTHERWISE NOTED.
    FORGING ±1.6
    ANGULAR ±0.1°
04. VAR. 01 – METRIC THREADS
    VAR. 02 – INCHE THREADS

ITEM NO.	DESCRIPTION	DRAWING NO.	VAR NO.	RAW MATERIAL SIZE OR CASTING DRG. NO. OR FORGING DRG. NO.	MATERIAL CODE	NET WT.	GROSS WT
01	FORGING				BA9413221260		958.000
					AA19332		1
					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 ON THE TOP MOST RIGHT CORNER OF THE DRG.

TYPE OF PRODUCT BHEL 280/1043 BOWL MILL

NAME OF CUSTOMER/PROJECT

BHARAT HEAVY ELECTRICALS LIMITED
HYDERABAD

	NAME	SIGN.	DATE	NO.OF VAR.
DRN.	UNIC		12.06.99	–
CHD.	N.D.SAMUEL		12.06.99	
APPD.	S.GHATGE		12.06.99	

DEPT.	UNTOL DIMS. GR.	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	NO.OF ITEMS
PULV ENGG. CODE 446	℄/M/F	1:5	958.000	1–61–004–01190	03	30

TITLE: UPPER JOURNAL HOUSING

CARD CODE

DRAWING NO. 1–61–004–01186 REV. 04

SHEET NO. 01 NO OF SHEETS 01

COMPUTER FILE NAME 161011186.DWG

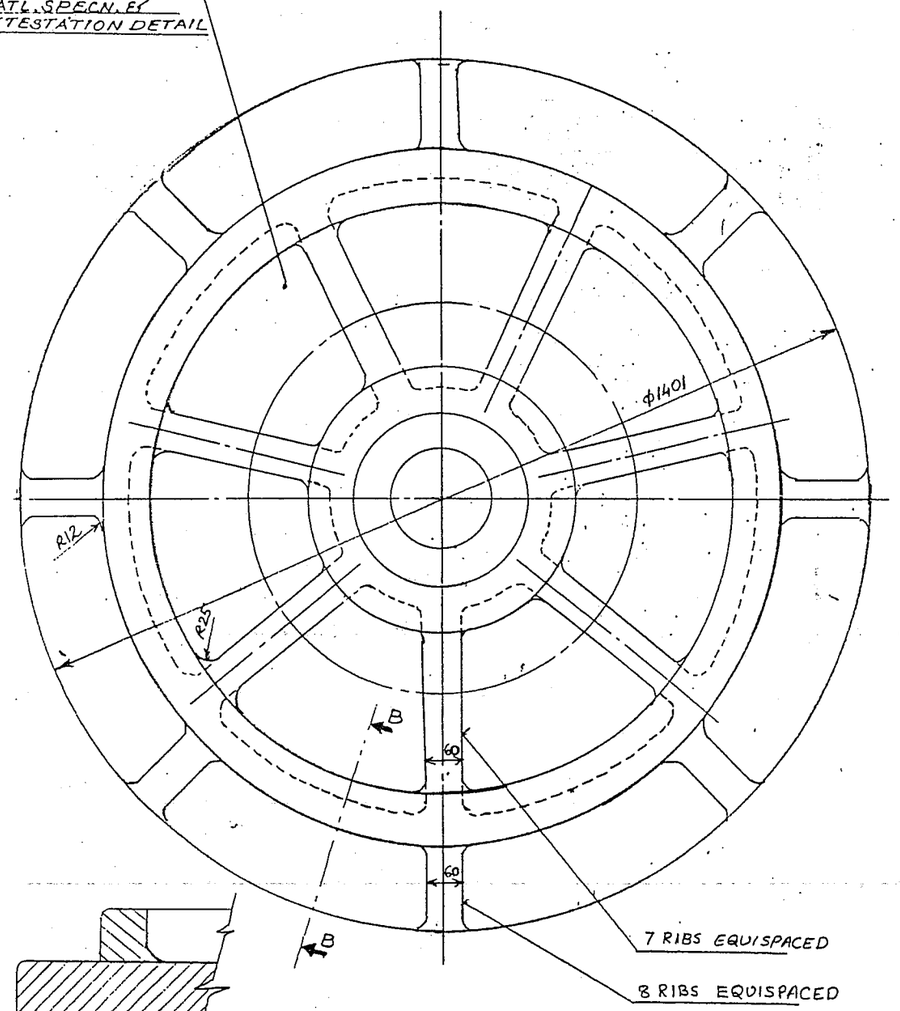
REF. DRG. NO. 1–61–004–01190

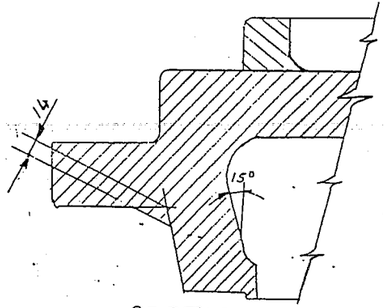
SIGN. AND DATE

INVENTORY NO

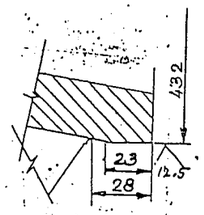
REV	DATE	ALTD.	APPD.	ZONE	DESCRIPTION
04	11.6.03	CHD.			2 HOLE–ø12–180° APART REMOVED. 457.07 +0.05/–0.0 597.92–0.08/+0.0, 609.6–0.03 WERE 457.10±0.03, 597.89±0.03 609.59–0.03. SLOT ADDED.
03	12.06.99	CHD.		D–5	DRG. REDRAWN INCORPORATING THE ALL PREVIOUS REV. VARIANTS ADDED
02	05.02.97	CHD.			DIM 482.47 REF WAS 482
01	09.11.93	CHD.		E–6 F–9 F–10 E–11 C–6	1.6 R3 WAS R2.3 ADDED FOR ø457,PCDS WERE 387.4&704.9, ø16 HOLE DEPTH 230 WAS 23, 1"–8UNC–2B WAS M24 TOLERANCE ADDED FOR ø609.59

LOCATE HERE
SUPPLIER'S CODE
MELT NO.
MATL. SPECN. &
ATTESTATION DETAIL

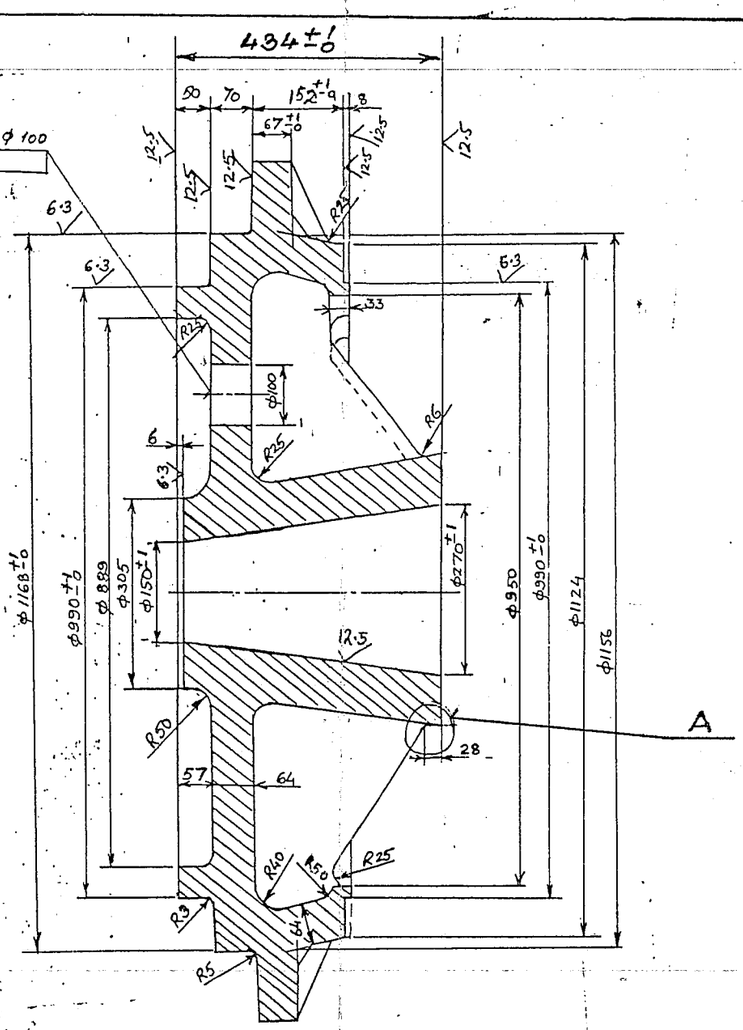




SECTION-BB



DETAIL-A



01		CASTING (ROUGH MACHINED)		AA 19511		1430.0 1		
SL.NO.		DESCRIPTION		MATERIAL CODE / MATERIAL SPECN.		UNIT WT.(KG) / QTY.		DRG.NO.

NOTE:-

01. BREAK ALL SHARP EDGES & CORNERS UNLESS OTHER WISE SPECIFIED.
02. SHOT BLAST ALL SURFACES AT FOUNDARY. INSIDE SURFACES MUST BE 100% FREE FROM SAND & SCALE.
03. ALL MACHINED DIAMETERS SHALL BE CONCENTRIT WITHIN ± 0.50 m.m.

BHARAT HEAVY ELECTRICALS LTD.
HERP, TARNA, SHIVPUR, VARANASI.

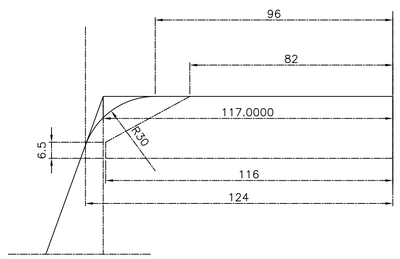
FIRST ANGLE	SCALE	DRAWN	D.BASAK	WEIGHT(KG.)	1430.0
		CHECKED			
		APPROVED	S.C.RAI		
ALL DIMN.'S ARE IN mm		DATED	03.08.2001		

TITLE

BOWL HUB
(ROUGH MACHINED)

DRG.NO.	REV.
1-61-176-00007M	00

—MASTER COPY—

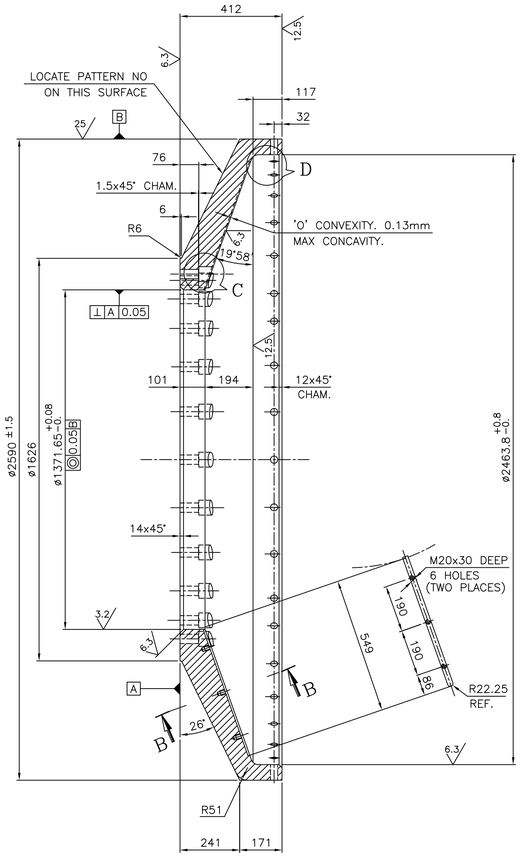


FIRST ANGLE PROJECTION

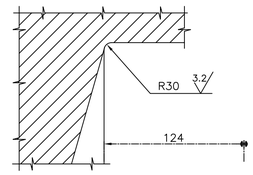
(ALL DIMENSIONS ARE IN mm)

DRG. NO. 1-61-188-01028 SH. 01 OF 01

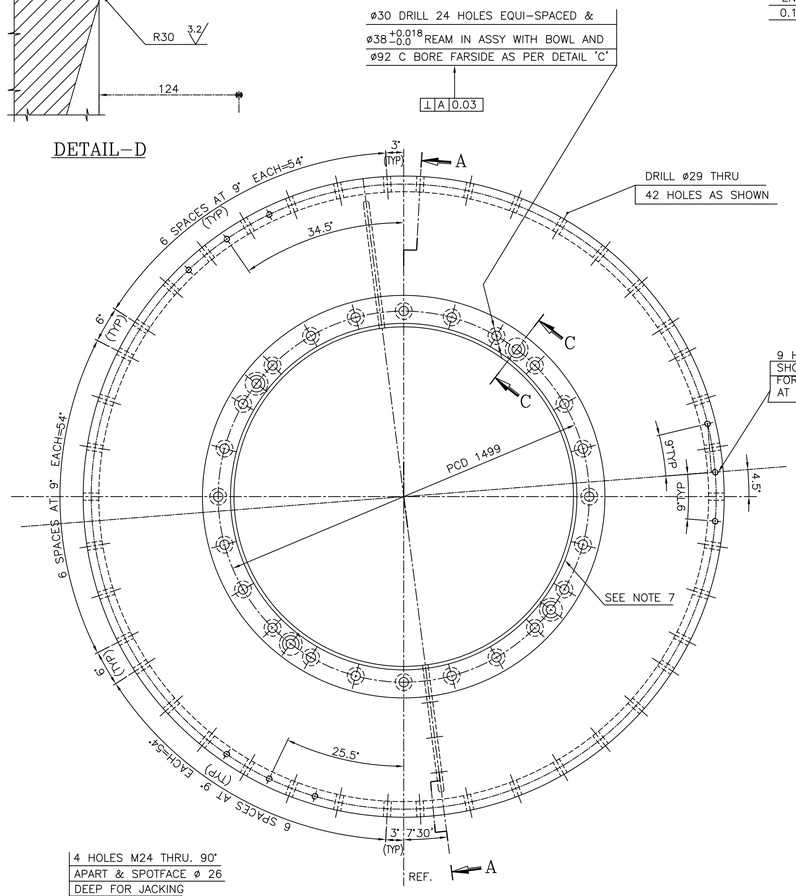
COMPUTER FILE NAME 1610102B.DWG | REF. DRG. NO. | SIGN. AND DATE | INVENTORY NO

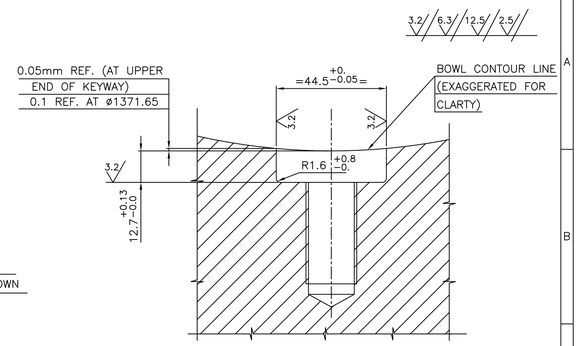


SECTION A–A

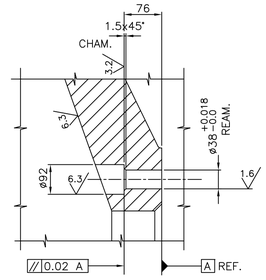


DETAIL–D

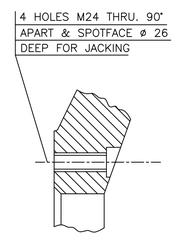




SECTION–BB



DETAIL–C



SECTION–'CC'

NOTES

01. CASTING TOL. SHOULD BE WITHIN $^{+0.0}_{-1.6}$; ANGULAR 0° 6'
02. PATTERN No. 1–61–188–01028.
03. BREAK ALL SHARP CORNERS & EDGES UNLESS OTHERWISE NOTED.
~~04. ANNEAL AS PER DRG. No. 4–61–196–00493~~
05. TRP AS PER CAT D OF HY0490563.
06. MANUFACTURE AS PER CUSTOMERS APPROVED QUALITY PLAN.
07. MATCH MARK MILL SL No. ON BOWL & BOWL HUB NEAR THE PUNCHED ARROW MARK (FAR SIDE).
08. THIS DRAWING SHEET 01 OF 02 IS FOR ROUGH MACHINED CASTING

ITEM NO.	DESCRIPTION	DRAWING NO.	VAR NO.	RAW MATERIAL SIZE OR CASTING DRG. NO. OR FORGING DRG. NO.	MATERIAL CODE	NET WT.	GROSS WT
01	CASTING				BA9211103576	3500.00	
					AA19511	1	
					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 AT THE TOP MOST RIGHT CORNER OF THE DRG.

TYPE OF PRODUCT
NAME OF CUSTOMER/PROJECT — 883 XRP BM

BHARAT HEAVY ELECTRICALS LIMITED
HYDERABAD

	NAME	SIGN.	DATE	NO.OF VAR.
DRN.	B.N.R		8.7.04	
CHD.	N.D.S		8.7.04	NA
APPD.	G.K		8.7.04	

DEPT. PULV ENGG. CODE 446	UNTOL DIMS. GR.	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	NO.OF ITEMS
	∅/M/F	1:5 1:10	3500.00	0–61–188–0501 (CE.DRG No. D94–116/6)	72	NA

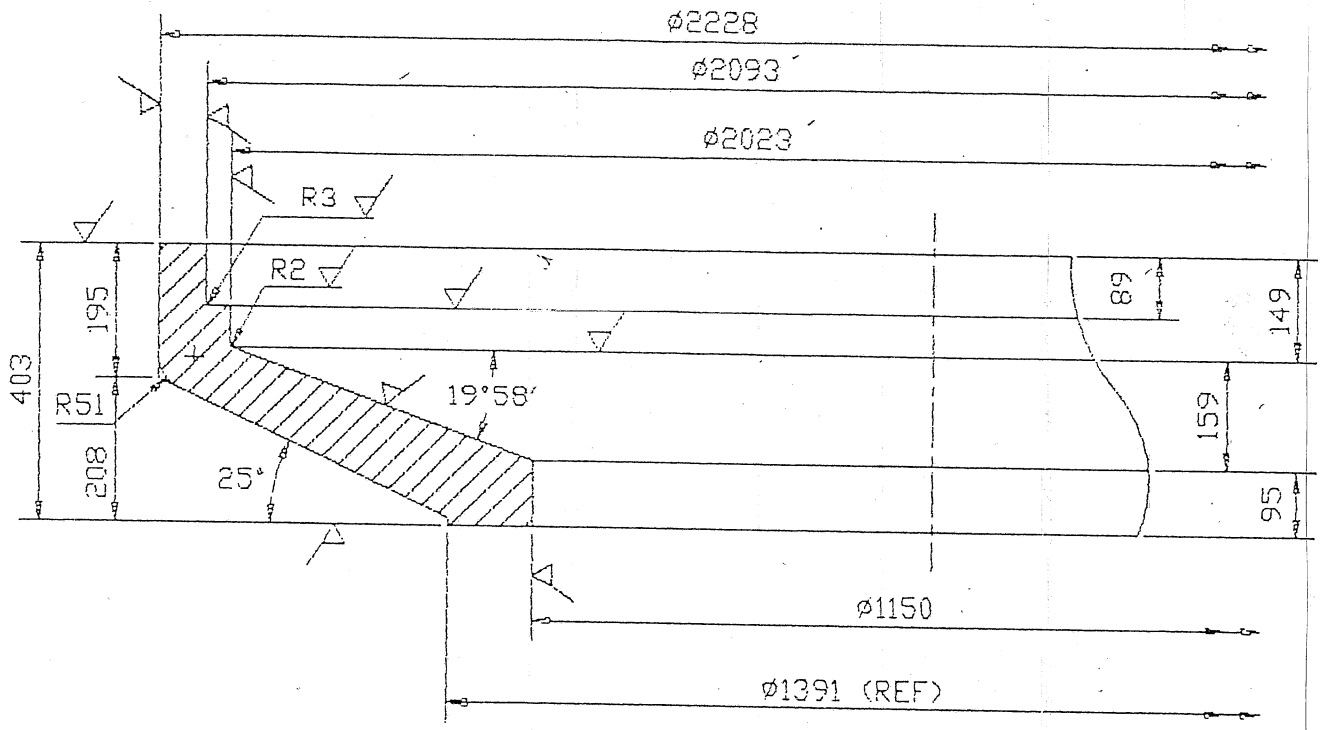
TITLE: BOWL FINISH MACHINED

CARD CODE — DRAWING NO. 1–61–188–01028 — REV. 5.1

SHEET NO. 02 | NO OF SHEETS 02

REV.	DATE	ALTERED PKP	APPD.
5.1	12.10.09	CHD. CKP	V.KUMAR
ZONE	SHEET 1 OF 2 REVISED. ø 2454 was ø2463.8		
05	7.12.05	CHD.	
ZONE	9 HOLES M24X 50 WERE 4 HOLES M24 X 50, APPLICABLE FOR PLANETARY GEAR BOX.		
04	28.2.97	CHD.	
ZONE	DRAWING IS REDRAWN BY INCORPOTATING ALL PREVIOUS REVISIONS & NOTE 04 DELETED.		

(2)



NOTE:-

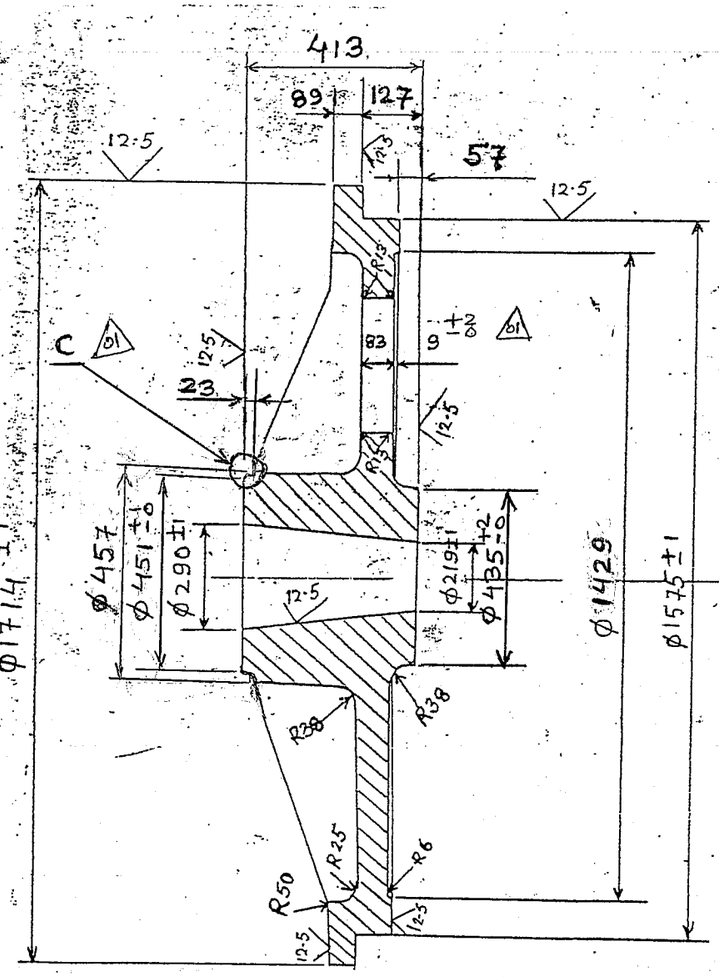
1. CASTING TO BE ROUGH MACHINED TO DRG. DIMENSIONS ON ALL THE SURFACES MARKED ▽ TO THE SURFACE FINISH OF 6.3 MICRONS AND TO THE TOLERANCE OF ±1 , UNLESS STATED OTHERWISE.

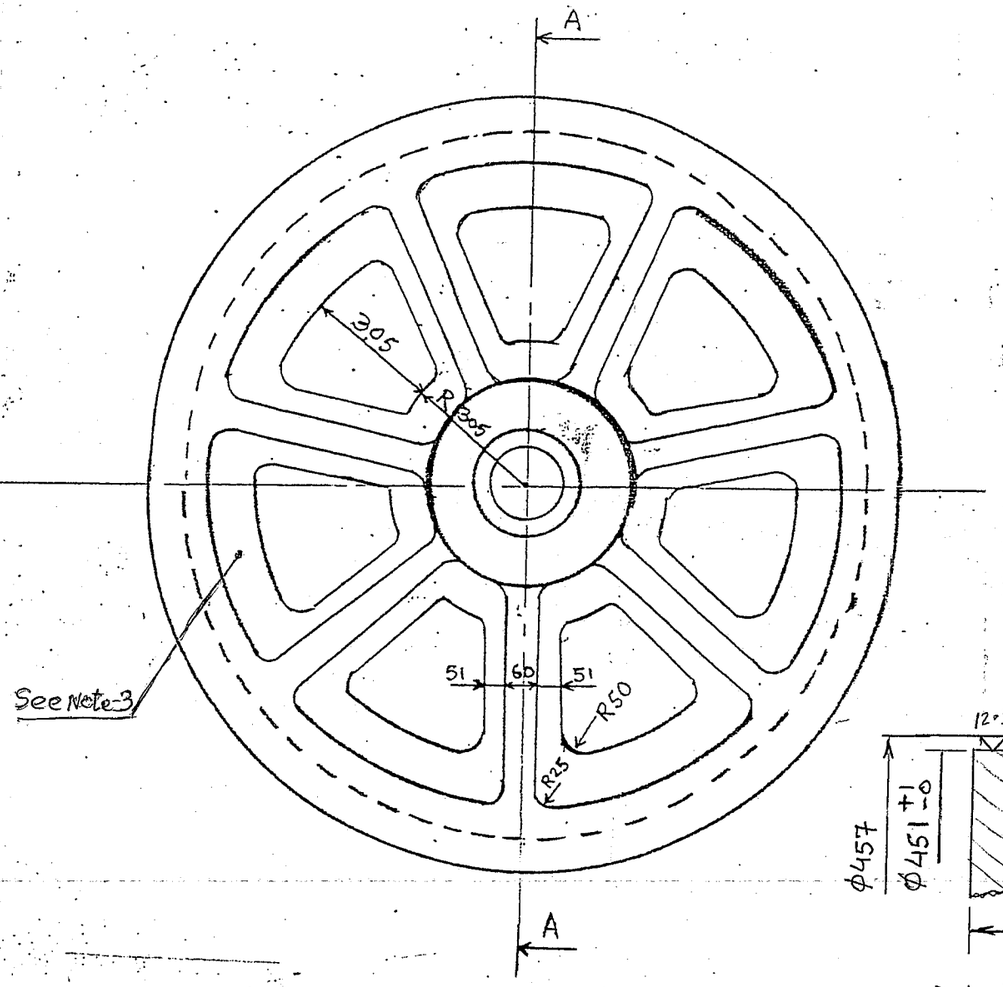
2. THIS DRG. IS ISSUED FOR THE PURPOSE OF ROUGH MACHINING ONLY. FOR ALL OTHER DETAILS PLEASE REF. COMPONENT DRG. NO. 2-61-176-00018 REV.-07

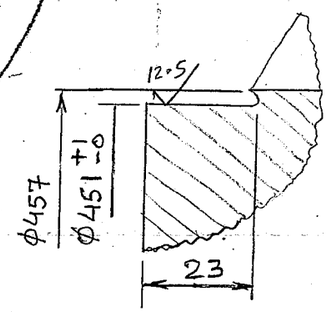
BHARAT HEAVY ELECTRICALS. LTD.
CENTRAL FOUNDRY FORGE PLANT
RANIPUR HARDWAR

DEPTT. FDY.TECH.	SCALE N.T.S.	WEIGHT IN Kgs 2550.00	ACAD/GC159.DWG	
TITLE ROUGH MACHINING DRG. FOR BOWL			DRN GYANCHAND	25-7-98
			WKD A.K.JHA	30/9/98
			CHD Y.N.V.RAO	9/10/98
			APPD N.KHAN	12/10/98
PROJECT AND CUSTOMER NAME BHEL – HYD (BOWL MILL)	TECHNOLOGY NO 37033	DRAWING NO.- 2-61-176-00018/M		
		SHEET NO.- 1	NO. OFF SHEETS- 1	

Rev	Date		
Rev 01	Date: 20.06.01	V.K. Kumar	DETAIL 'C' ADDED TOL. ON STEP DEPTH 9 ADDED
Rev 02	DTD.17.08.17 BY V.KUMAR		Wt. 1475 Kg. CORRECTED TO 1850 Kg.
Rev 03			







NOTES:~

01. BREAK ALL SHARP EDGES AND CORNERS UNLESS OTHERWISE SPECIFIED.

02. SHOT BLAST ALL SURFACES AT FOUNDRY. INSIDE SURFACES MUST BE 100% FREE FROM SCALE & SAND. ALL INSIDE UNMACHINED SURFACES TO BE COATED WITH ARM-STRONG WHITE CRANK CASE SEALER (SY-N-THETIC CASTING SEALER) OTHER SURFACES ARE TO BE PAINTED WITH RED-OXIDE.

03. LOCATE HERE
- SUPPLIERS CODE
- MELT. NO.
- MATL. SPECN.
- ATTESTATION DETAIN

04. ALL MACHINED DIAMETERS SHALL BE CONCENTRIT WITHIN ±0.50 m.m.

SL.NO.	DESCRIPTION	MATERIAL CODE	UNIT WT.(KG)	DRG.NO.
		MATERIAL SPECN.	QTY.	
01	CASTING	AA 19511	1	1850

BHARAT HEAVY ELECTRICALS LTD.
HERP, TARNA, SHIVPUR, VARANASI.

FIRST ANGLE	SCALE			WEIGHT(KG.)
	NTS	DRAWN	D. BASAK	1850
		CHECKED	V. KUMAR	
		APPROVED	B.P. SINGH	
ALL DIMN'S ARE IN mm		DATED	23.07.2001	

TITLE: WORM GEAR HUB (ROUGH MACHINED)

DRG. NO. 2-61-176-00009 M

REV. 02

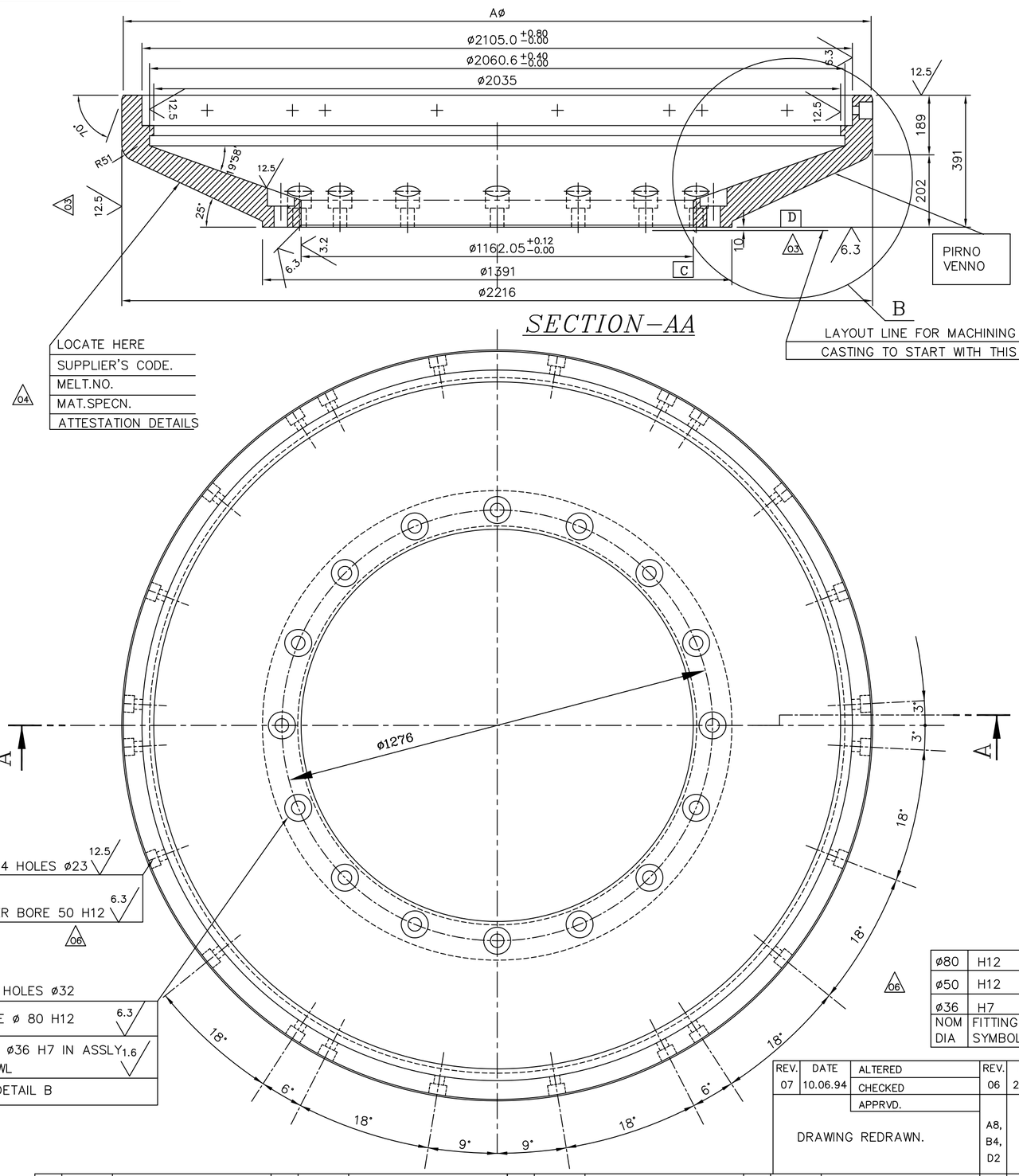
— MASTER COPY —

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

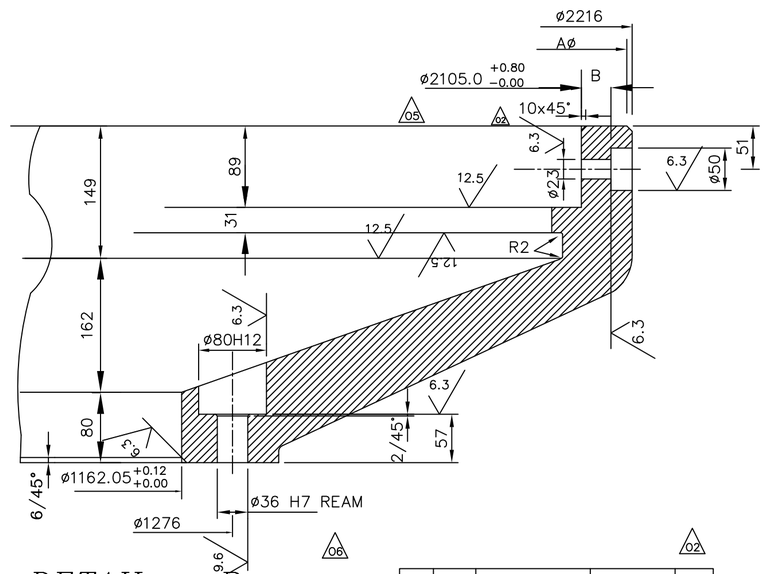
DRG. NO. 2-61-176-00018

COMP. FILE NAME BH018.DWG | REF. DRG. NO. | SIGN. AND DATE | INVENTORY NO



SECTION–AA

△04 LOCATE HERE
SUPPLIER'S CODE.
MELT.NO.
MAT.SPECN.
ATTESTATION DETAILS



DETAIL – B
1:5

GENERAL DIMENSIONS, LIMITS, FITS & TOLERANCES AS PER PS. HY 0230261

△02

803	03	2160	2178	15
783	02	2185	2203	29
763	01	2210	2220	37
MILL	VAR NO.	Aø	WEIGHT Kg	B

△03 SURFACE [D] TO BE SURFACE TO DIA [C] WITH IN 0.005 T.I.R.

REMOVE ALL SHARP EDGES

CASTING DRG NO : 30–FC–002–002/B

	STYLE NO.	ITEM NO.	BPS	REF.DRG./BPS No.				COMP. GROUP	UNIT WT. (Kg.) / NO. OFF	BMI	DI	DESCRIPTION REMARKS
△03	03	01			RVN	BA9211103525	A		2178			CASTING(803)
						AA19511						
△03	02	01			RVN	BA9211103525	A		2203			CASTING(783)
						AA19511						
△03	01	01			RVN	BAS311103525	A		2220			CASTING(763)
						AA19511						

ø80	H12	+0,300	0,000
ø50	H12	+0,250	0,000
ø36	H7	+0,025	0,000
NOM DIA	FITTING SYMBOL	UPPER TOLERANCE	LOWER TOLERANCE

△06

REV.	DATE	ALTERED / CHECKED / APPRVD.	ZONE	
07	10.06.94	DRAWING REDRAWN.	A8, B4, D2	
06	23.3.85	H7 WAS G6		
05	13.3.84	AA19511 WAS A216 WCB M.C. WAS 92/005/339 CHAMFER 10x45° ADDED.	D–8	
04	13.9.80	NOTE ADDED. MATL. ATTEST NOTE ADDED.	E1	
03	18.7.80	MATL. SPEC. ASTM A216–Gr. WCB WAS NI–60–45–10 NOTES ADDED ON SQUARENESS 12.5 WAS 25	D1	
02	2.1.80	1)DIMN 'B' ADDED IN PLACE OF DIMN '37'. 2)DIMN 'B' ADDED IN STYLE CHART.		
01	27.2.76	CASTING DRG. NO. INCORPORATED		

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT

△04 MATERIAL ATTEST

76" BOWL MILL

BHARAT HEAVY ELECTRICALS LTD. HYDERABAD

	NAME	SIGN.	DATE
DRN.	IIC		
CHD.	G.K		
APPD.	Y.S.B		

NO.OF VAR.

DEPT. B.M | CODE 446 | UNTOL.DIMS.GR. E/M/F | SCALE 1:10 1:5 | WEIGHT (KG) | REF. TO ASSY DRG. | ITEM NO. | NO.OF ITEM

TITLE: BOWL

CARD CODE U01

DRAWING NO. 2–61–176–00018 REV. 07

SHEET NO. | NO OF SHEETS

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

DRG. NO. 2-61-176-90019 SH. 01 OF 01

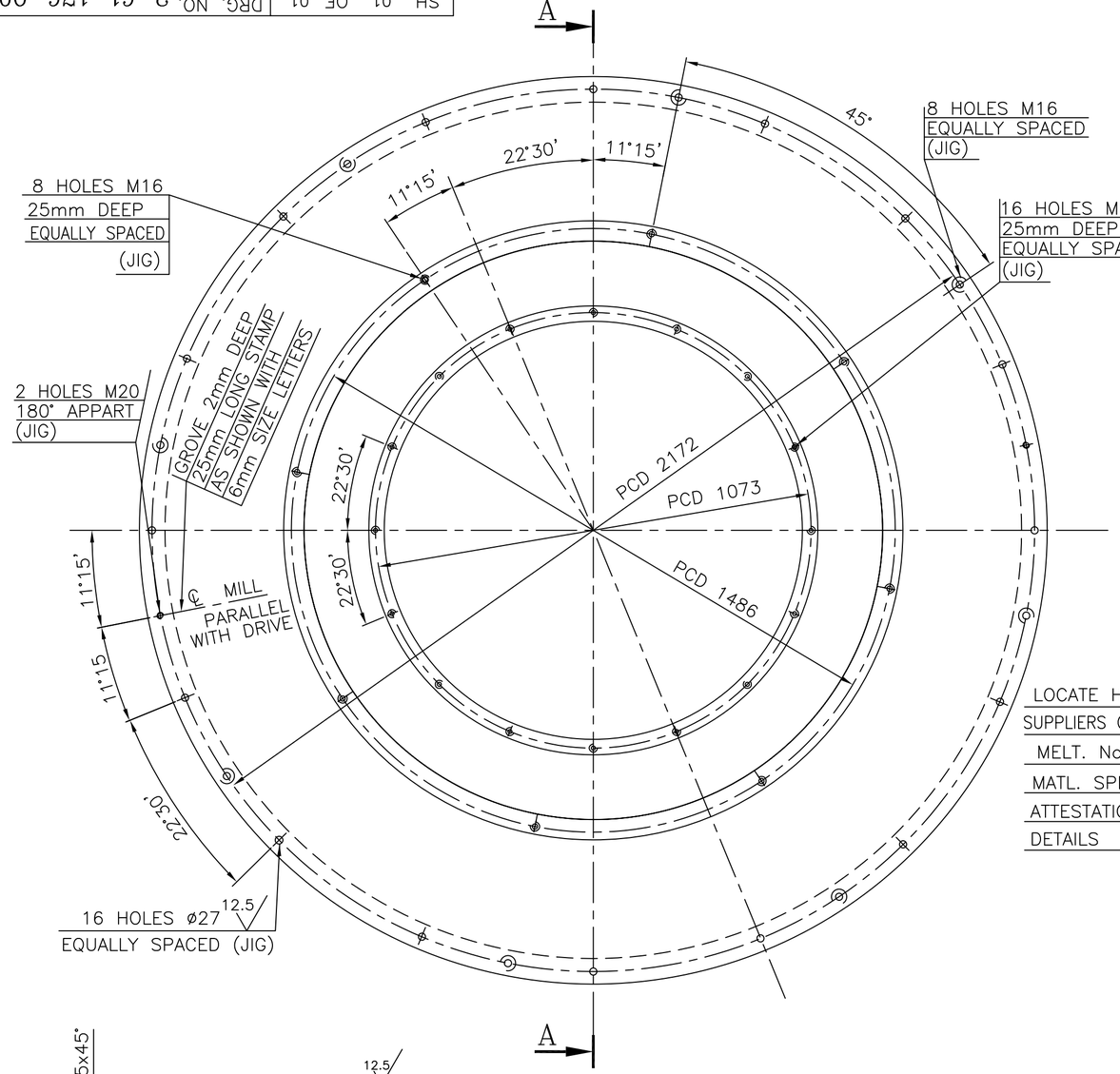
COMPUTER FILE NAME 26190019.DWG

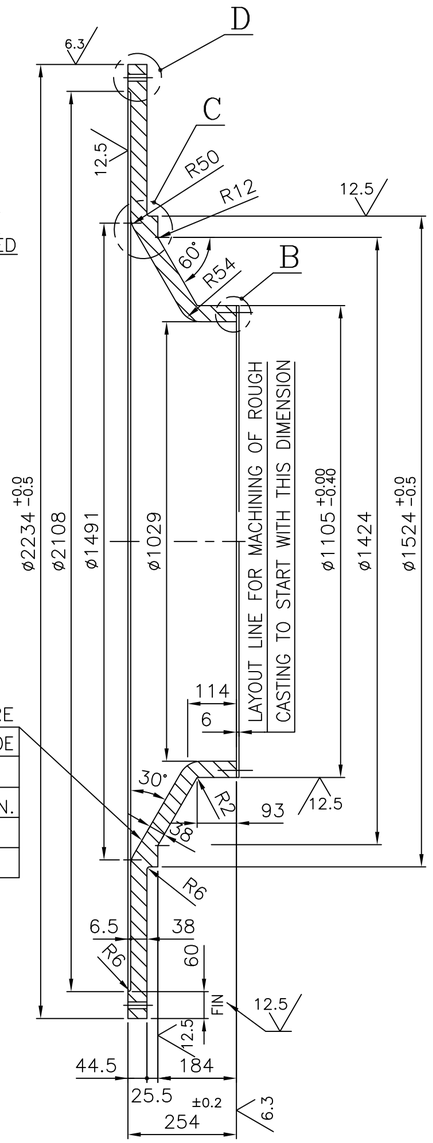
REF. DRG. NO.

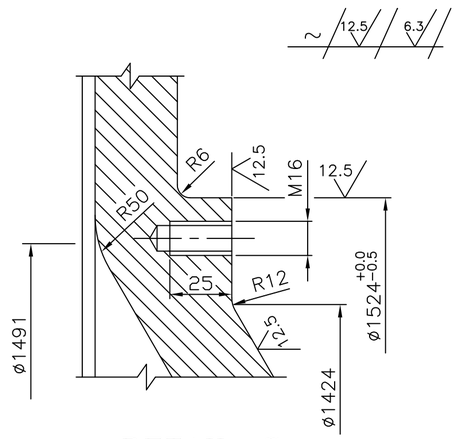
SIGN. AND DATE

INVENTORY NO

GENERAL DIMENSIONAL LIMITS,FITS & TOLERANCES AS PER HY0230261

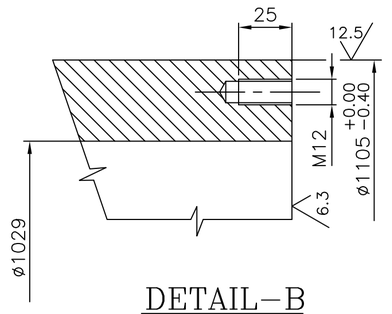






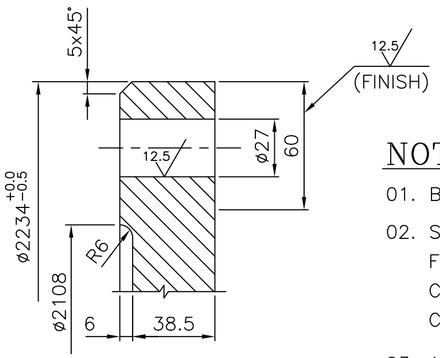
DETAIL–C

SCALE 1:2



DETAIL–B

SCALE 1:2



DETAIL–D

NOTES:–

01. BREAK ALL SHARP EDGES AND CORNERS UNLESS OTHERWISE SPECIFIED.
02. SHOT BLAST ALL SURFACES AT FOUNDRY. INSIDE SURFACES MUST BE 100% FREE FROM SCALE & SAND. ALL INSIDE UNMACHINED SURFACES TO BE COATED WITH ARM–STRONG WHITE CRANK CASE SEALER. (SY–N THETIC CASTING SEALER) OTHER SURFACES ARE TO BE PAINTED WITH RED–OXIDE.
03. ALL ANGULAR TOLERANCES OF HOLES TO BE WITHIN ±7.5'ANGULAR TOLERANCE

LOCATE HERE
SUPPLIERS CODE
MELT. No.
MATL. SPECN.
ATTESTATION
DETAILS

MATERIAL ATTEST

ITEM NO.	DESCRIPTION	DRAWING NO.	VAR. NO.	RAW MATERIAL SIZE OR CASTING DRG. NO. OR FORGING DRG. NO.	MATERIAL CODE	NET WT.	GROSS WT.
	CASTING				BA9211104017	1178.00	
					AA19511		
					MATERIAL SPECN.	QUANTITY	

REV.	DATE	ALTERED	APPD.
		CHD.	
ZONE			

REV.	DATE	ALTERED	APPD.
05	5.8.98	CHD.	
ZONE	DIM 254 ±0.2 WAS 254 NOTE 3 ADDED		

REV.	DATE	ALTERED UC	APPD.
03	19.02.97	CHD.	
ZONE	DRG. REDRAWN BY INCORPORATING ALL PREVIOUS REV.		

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 ON THE TOP MOST RIGHT CORNER OF THE DRG.

TYPE OF PRODUCT

NAME OF CUSTOMER/PROJECT 763 XRP BOWL MILL

BHARAT HEAVY ELECTRICALS LIMITED
HYDERABAD

	NAME	SIGN.	DATE	NO.OF VAR.
DRN.	UNIC			
CHD.	NDS		07.10.97	
APPD.	S GHATGE		07.10.97	

DEPT.	UNTOL. DIMS. GR.	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	NO.OF ITEMS
PULV ENGG CODE 446	¢/M/₱	1:2 1:10	1178.00	1–61–180–90027	32	

TITLE

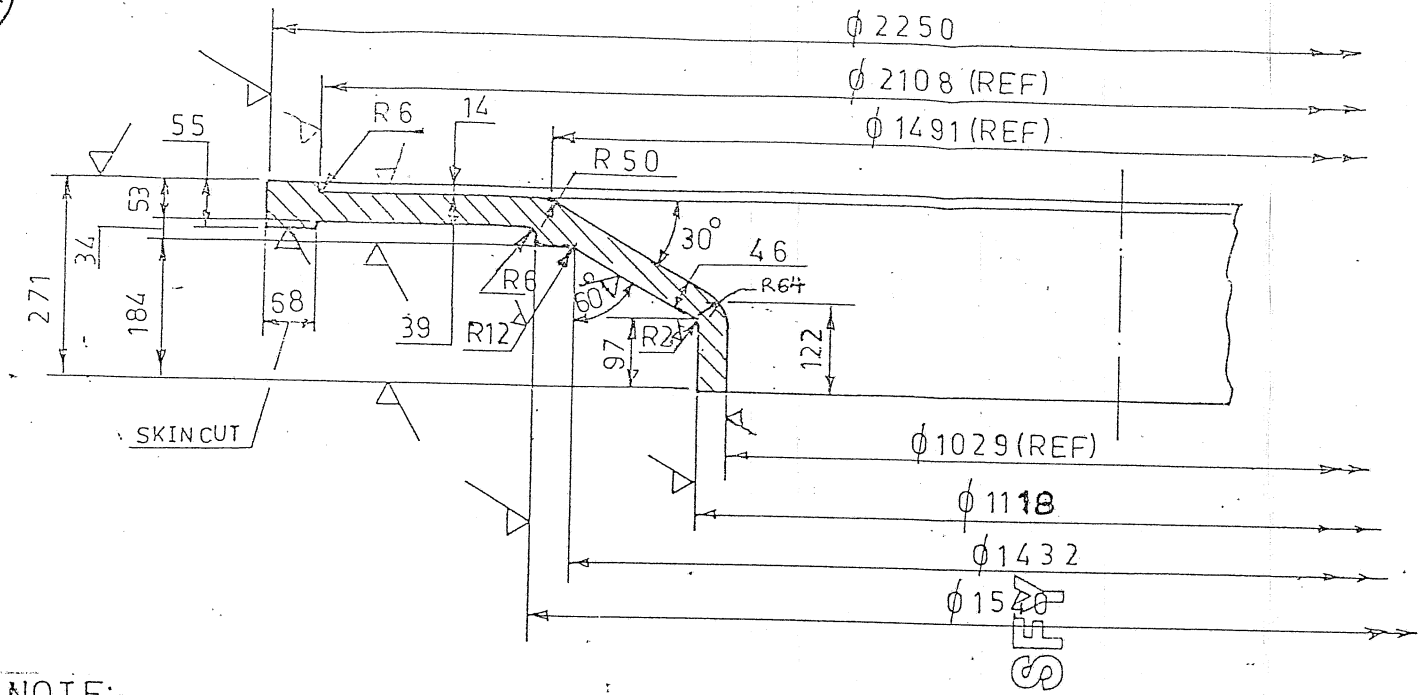
MILL BOTTOM

CARD CODE U 01

DRAWING NO. 2–61–176–90019 REV. 05

SHEET NO. 01 NO OF SHEETS 01

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN mm)



NOTE:—

1. CASTING TO BE ROUGH MACHINED ON ALL SURFACES MARKED ▽ TO THE DRG DIMENSIONS TO A SURFACE FINISH 12·5 MICRONS AND TOLERANCE ±1 mm UNLESS STATED OTHERWISE
2. THIS DRG IS ISSUED FOR THE PURPOSE OF ROUGH-MACHINING ONLY. FOR ALL OTHER DETAILS PLEASE REFER TO COMPONENT DRG NO. 2-61-176-90019 REV-05 @

REV	DATE	ALTD	CHD
@	28-7-2000		

1. COM REV 05 INCORPORATED IN DRG

FT/M/2000-24

BHARAT HEAVY ELECTRICALS LTD.
UNIT : CENTRAL FOUNDRY FORGE PLANT.
HARDWAR.

DEPTT. FDY. TECHY | SCALE N.T.S | WEIGHT (KGS.) 1200.00

TITLE ROUGH MACHINING DRG FOR MILL BOTTOM

	NAME	SIGN.	DATE
DRAWN	GYAN CHAND		
WORKED	S K GUPTA		4/9/155
CHECKED	Y N V RAO		5/9/96
APPROVED	N KHAN		

NAME OF CUSTOMER / PROJ: BHEL-HYD BOWL MILL

TECHY NO. 37040

DRAWING NO. 2-61-176-90019 / M

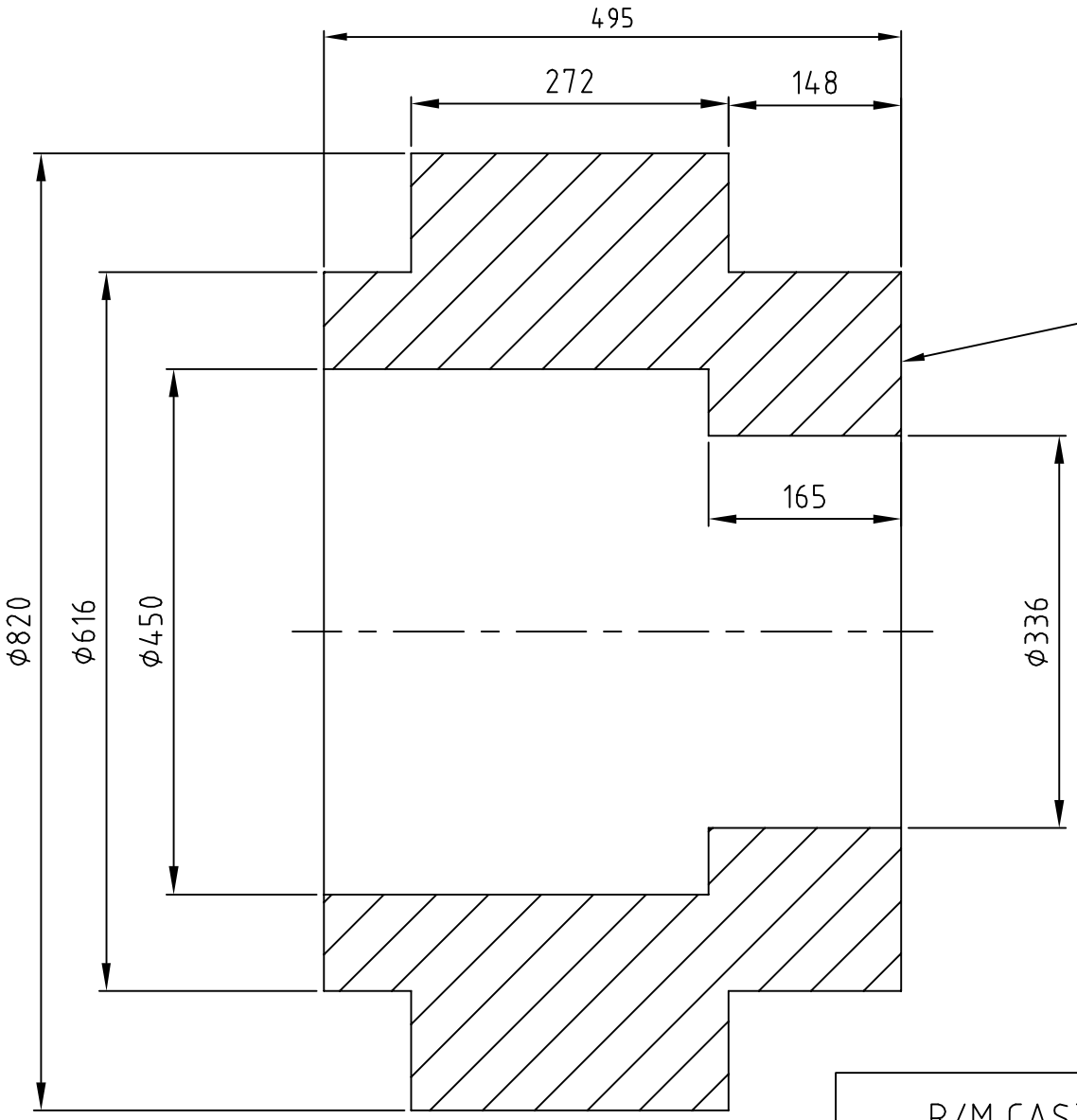
SHEET NO. 1 | NO OF SHEETS 1

SIZE - A3

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

DRG.NO. 3-61-004-03151



LOCATE HEAR ATTESTATION DETAILS VIZ

SUPPLIERS CODE

MAT SPECN

MELT NO

12.5

NOTE

1. CASTING TO BE ROUGH MACHINED TO DIMENSIONS INDICATED IN THE DRAWING
2. CHAMFER CORNERS TO R2 & FILLET RADIUS ARE TO BE R3.
3. UT, MPI & LPI TO BE CARRIED OUT AFTER R/MC TO BA75020 ACCEPTANCE LEVEL II.
4. TOLERENCE ON DIAMETERS AND LENGTHS±1MM
5. FOR FINISH MACHINING REFER 1-61-004-01186

R/M CASTING				BA9211123259	1122	
				AA 19511		
ITEM NO	DESCRIPTION	DRAWING NO.	VAR. NO.	RAW MATERIAL SIZE OR CASTING DRG.NO. OR FORGING DRG.NO.	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 WHEREVER NOT SHOWN SHALL BE TAKEN FROM THE SURFACE ROUGHNESS SHOWN OUT SIDE BACK SLASHES GIVEN AT THE TOP MOST RIGHT CORNER OF THE DRG.

REV.	DATE	ALTERED	CHD.	APPD.	REV.	DATE	ALTERED	CHD.	APPD.
ZONE					ZONE				

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: 1043/1103 XRP BOWL MILL

BHARAT HEAVY ELECTRICALS LTD. HYDERABAD

	NAME	SIGN.	DATE	NO.OF VAR.
DRN.	NARAYANA			
CHD.	AMAN SURIN		11/7/07	
APPD.	S.GHATGE		11/7/07	

DEPT.	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	NO.OF ITEMS
PULVE.ENGG	1:5	1122.0	1-61-004-01190		
CODE 446					

TITLE: UPPER JOURNAL HOUSING

DRAWING NO. 3-61-004-03151 REV. 00

SHEET NO. 01 NO OF SHEETS 01

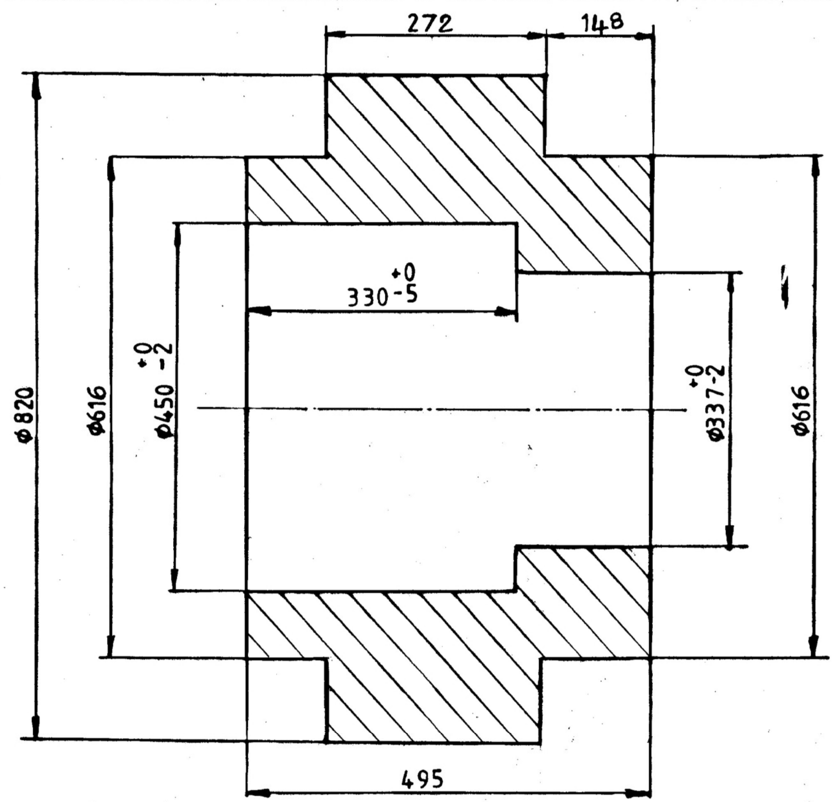
INVENTORY NO. | REF.DRG.NO. 36103151.DWG | FILE NAME

TD-151/REV. 03 SIZE A3

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

DRG. NO. 3-61-004-90188



12.5

NOTE

1. CHAMFER CORNERS TO R2 AND FILLET RADIUS TO R3
2. TEST ULTRASONICALLY AS SPEC. AA0850118 CAT-3
3. FOR FINISH MACHINING REFER - DRG 1-61-004-01186

SCANNED

THE INFORMATION ON THIS DOCUMENT IS THE PROPERTY OF BHARAT HEAVY ELECTRICALS LIMITED IT MUST NOT BE USED DIRECTLY OR INDIRECTLY IN ANY WAY DETRIMENTAL TO THE INTEREST OF THE COMPANY

VAR. OO	REMARKS	VAR. NO	ITEM NO.	DESCRIPTION	STD.	DRAWING NO.	IT. NO / VAR.	MATL. CODE / MATL. SPCN.	A/C	UNIT	UNIT WT. / QTY.	GS	ZONE
				FORGING				BA9413221260 / AA19332			1120.0		

28 → CARD TYPE-3 | 28 → CARD TYPE-2 | 28 → CARD TYPE-1

ADDITIONAL INFORMATION

STATUS OF DRAWING

DISTRIBUTION OF PRINTS

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: 1043 R.P BOWL MILL CHANDRAPUR T.P.S 500 M.W

M F

BHARAT HEAVY ELECTRICALS LTD.
HYDERABAD

	NAME	SIGN	DATE
DRN.	D C		
CHD.	N. D. SAMUEL	[signature]	31-3-93
APPD.	Y.S.B.L. RAO	[signature]	3-4-93

NO OF VAR.

REV.	DATE	ALTERED / CHECKED	REV.	DATE	ALTERED / CHECKED	REV.	DATE	ALTERED / CHECKED
						01	15.3.97	APP.
ZONE			ZONE			ZONE		Wt was 1100.00

DEPT	GRADE OF TOL. DIM.		SCALE	WEIGHT (Kg)	REF. TO ASSY. DRG.	ITEM NO.	NO. OF ITEMS
PULVENG / CODE 446	d/M/R		1:6	1100.00	D-110-00760/1		

TITLE: UPPER JOURNAL HOUSING (ROUGH FORGING)

CARD CODE

DRAWING NO. 3-61-004-90188

REV. 01

SHEET NO. | NO. OF SHEETS

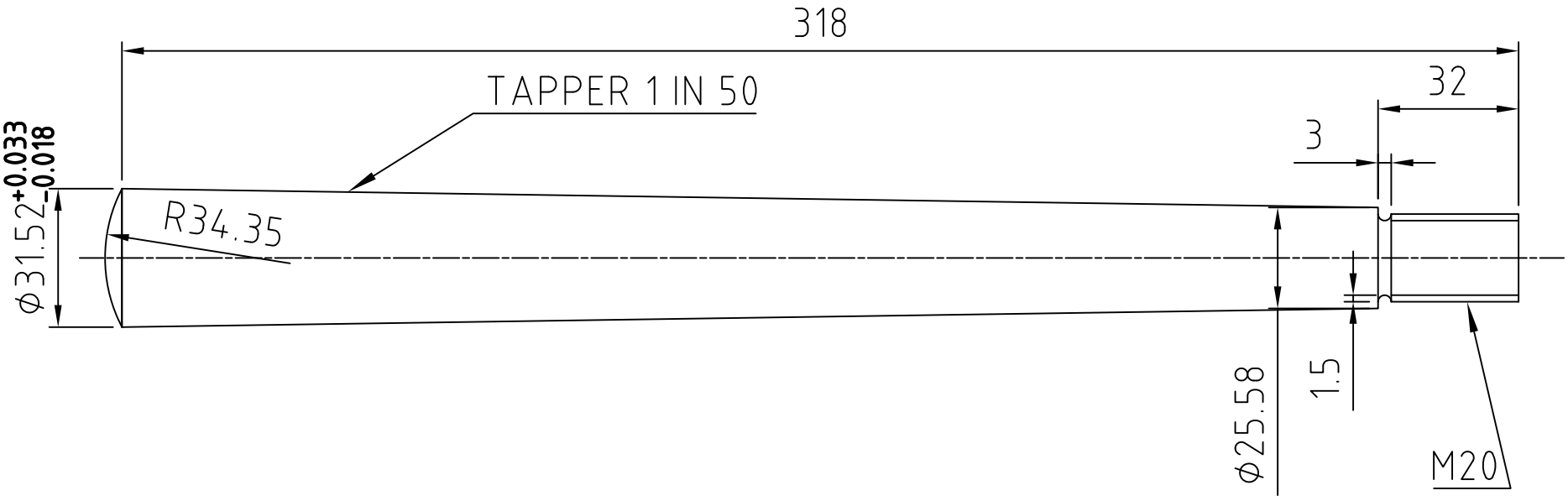
INVENTORY NO. | SIGN & DATE | REF. DRG. NO.

TD-151. REV. NO. 2

SIZE A3

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN mm)

REV.	DATE	ALTERED E.M.ASHOK	APPD	REV.	DATE	ALTERED	APPD	ADDITIONAL INFORMATION
02	15-03-03	CHECKED				CHECKED		STATUS OF DRAWING
DRG. REDRAWN								DISTRIBUTION OF PRINTS



NOTES:
TOLERANCES UNLESS OTHERWISE NOTED
CASTING FRACTIONAL ± 0.4

GENERAL DIMENSIONS,LIMITS,FITS
& TOLERENCES AS PER PS HY 0230261.

ITEM NO	DESCRIPTION	DRAWING NO.	MATL. CODE / MATL. SPEN.	UNIT Wt. / QTY.
01	ROUND ø36 X 325 LG.		AA1020208155 / AA10208	0.300 / 01

BHARAT HEAVY ELECTRICALS LTD.
HYDERABAD

	NAME	SIGN.	DATE	NO.OF VAR.
DRN.	E.M.ASHOK		15.03.03	/
CHD.	N.D.S		15.03.03	
APPD.	S.G		15.03.03	

DEPT.	GRADE OF TOL.DIM.		SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	NO.OF ITEMS
PULV.ENGG	¢/M/F		1:2	0.300	0-61-004-00571	12	32
CODE 446							

TITLE: TAPER PIN

CARD CODE

DRAWING NO. 4-61-004-02188 REV. 02

SHEET NO. 01 NO OF SHEETS 01

REF. DRG. NO.

COMP.FILE NAME 46102188

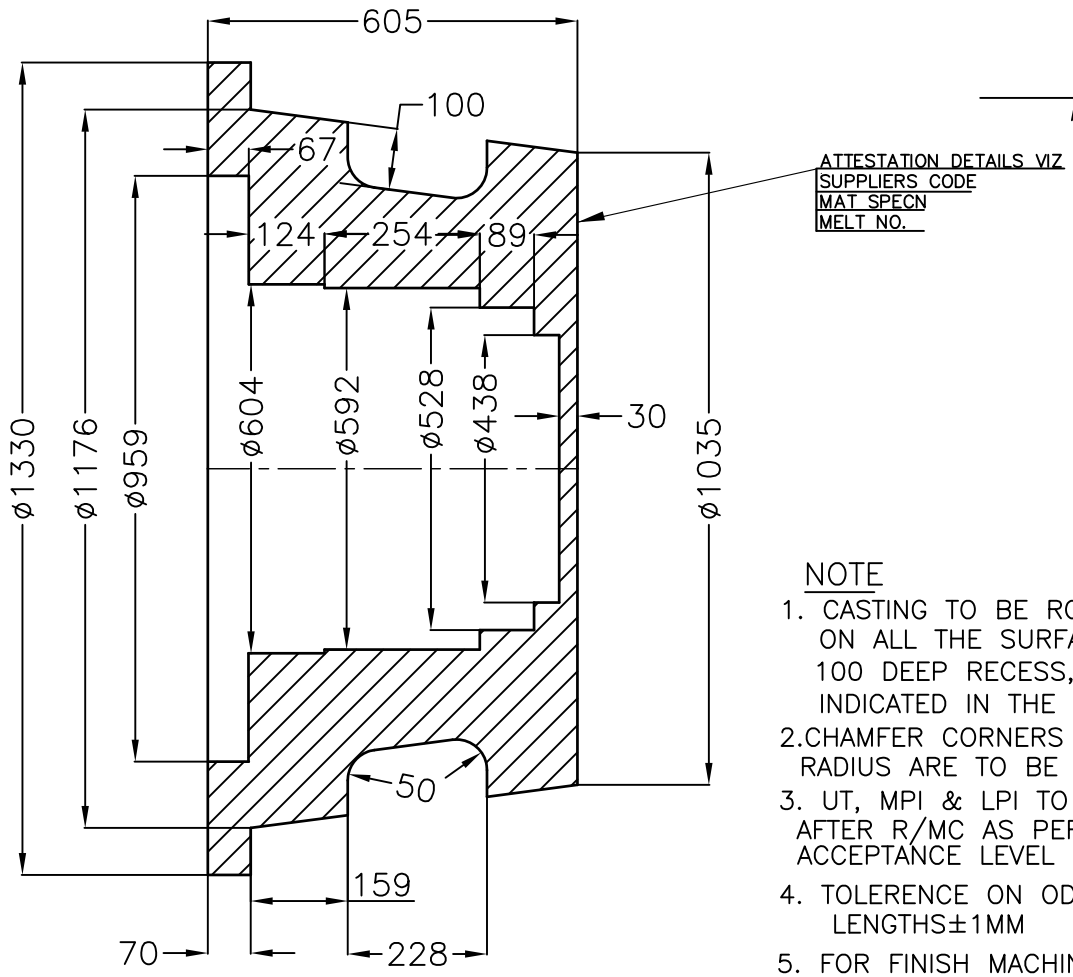
INVENTORY NO

FIRST ANGLE PROJECTION

ALL DIMENSIONS ARE IN mm.

REV.	DATE	ALTERED	REV.	DATE	ALTERED	REV.	DATE	ALTERED
01	17.6.08	CHECKED			CHECKED			CHECKED
		APPROVED			APPROVED			APPROVED

REVISED TO HAVE 3 MM ALLOWANCE ON TOOL POINT.



NOTE

1. CASTING TO BE ROUGH MACHINED ON ALL THE SURFACES EXCEPT 100 DEEP RECESS,TO DIMENSIONS INDICATED IN THE DRAWING
2. CHAMFER CORNERS TO R2 & FILLET RADIUS ARE TO BE R3.
3. UT, MPI & LPI TO BE CARRIED OUT AFTER R/MC AS PER BA75020 ACCEPTANCE LEVEL II.
4. TOLERENCE ON OD +1, ID −1 & LENGTHS±1MM
5. FOR FINISH MACHINING REFER DRG.NO.1−61−004−01480
6. DIAMETERS TO BE CONCENTRIC WITHIN ±0.50

R/M CASTING			BA9211123240	3160	
			AA19511		
DESCRIPTION & DRG.NO.	VAR NO.	RAW MATERIAL SIZE OR CASTING DRG.NO. OR FORGING DRG.NO.	MATL. CODE	NET.WT.	GROSS WT
			MATL. SPECN.	QTY.	

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT

BHARAT HEAVY ELECTRICALS LTD. HYDERABAD

	NAME	SIGN	DATE	NO.OF VAR.
DRN.	E.M.ASHOK		13.7.07	
CKD.	N D S		13.7.07	
APPD.	S.GHATGE		13.7.07	

DEPT. PULV. ENGG		SCALE	WEIGHT(K.G.)	REF.TO ASSY.DRG.	ITEM NO.	NO.OF ITEM
CODE 446		1:12	3160.0			

TITLE: LOWER JOURNAL HOUSING

DRAWING NO. 4−61−004−02756 REV. 01

SHT.NO. 1 NO.OF SHT. 1

REF. TO HY0230261 FOR UNSPECIFIED TOLERANCES.

SIGN. & DATE

REF. DRG. NO.

COMPUTER NO. 46102540

INVENTORY NO.

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:

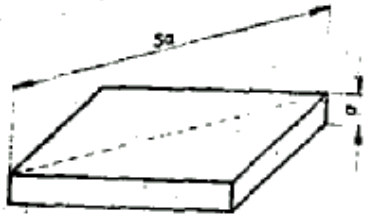
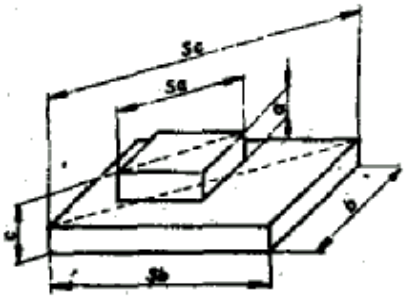
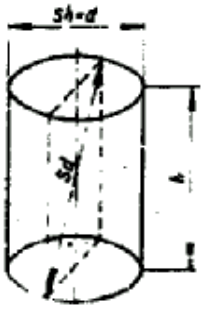
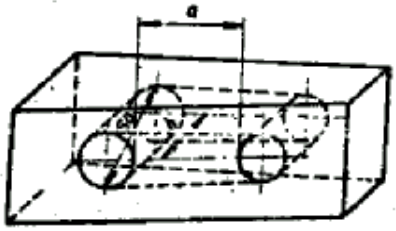
a) Upper allowable deviation:

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.

STRUCTURAL STEEL - WELDABLE QUALITY
(PLATES, SECTIONS, STRIPS, FLATS AND BARS)

ORDERING DESCRIPTION

1.0 GENERAL:

The material shall conform to IS 2062 – 2011, E250-Gr.BR (with mandatory Impact Test) or DIN EN 10025-2:2005, Gr. S275JR and comply with following additional requirements.

2.0 APPLICATION:

For general engineering purposes, suitable for welding.

3.0 CONDITION OF DELIVERY:

3.1 Bars & Sections shall be supplied in Hot rolled in straight lengths without twists and bends.

3.2 The material shall be supplied as per IS: 2062 – 2011, E250 Gr.BR (with mandatory Impact Test) or as per DIN EN 10025-2:2005 Gr. 275JR.

3.3 Any other additional requirement as per BHEL Purchase order.

4.0 DIMENSIONS AND TOLERANCES:

4.1 Sizes:

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

4.2 Tolerances:

The tolerances on hot rolled material shall comply with IS: 1852 or any other equivalent national standard.

4.3 Straightness for hot rolled bars:

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

5.0 TEST SAMPLES:

The selection of test pieces for all tests like Chemical, Mechanical etc. shall be as per IS: 2062, E250-Gr.BR or DIN EN 10025-2, Gr. S275JR.

CORPORATE PURCHASING SPECIFICATION

6.0 ULTRASONIC EXAMINATION:

Plates shall be ultrasonically examined in accordance with BHEL standard AA0850120 (or ASTM-A435) as detailed below and shall comply with the acceptance standards specified therein.

6.1 For plates above 40 mm thick:

Shall be ultrasonically examined unless when otherwise specified in order.

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:

AA10119 - Rev.No.15/ IS: 2062-Gr: BR (with mandatory Impact test) or DIN EN 10025-2, Gr. S275JR,

BHEL order No.

Melt No, Size & Quantity, Batch No with heat treatment details, Results of Chemical analysis,

Mechanical tests & NDT, 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.

Each plate shall be marked with Melt No. Material grade and specification, BHEL Order No, Supplier's Name Identification No, Size & weight, on any one corner and encircled with paint preferably of white colour.

9.0 REJECTION AND REPLACEMENT

If the material does not comply with the requirements of this specification during receipt inspection at BHEL or if any defect is found during further processing of material, BHEL reserves the right to reject the whole consignment and the supplier shall replace the material free of cost. The rejected material shall be taken back by the supplier after fulfilling the commercial terms and conditions.

10.0 REFERRED STANDARDS (Latest publications including amendments):

1) IS: 1852 2) ASTM - A435 3) AA0850120

26/6/14

CS-721

HOT ROLLED / FORGED CARBON STEEL BARS, Gr: 40 C8-NORMALISED

1.0 GENERAL

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

2.0 APPLICATION

Production of machined parts for general engineering purposes.

3.0 CONDITION OF DELIVERY

Hot Rolled / forged and Normalised.

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

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

4.0 COMPLIANCE WITH NATIONAL STANDARDS:

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

IS : 1570-Part II, Section 1-1979 : Schedule for wrought Steels-Carbon steels
Gr:40C8 (C40), Normalised : (Unalloyed Steels)

5.0 DIMENSION AND TOLERANCES

5.1 Sizes

Bars shall be supplied to the dimensions in BHEL order.

5.2 Length:

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

5.2 Tolerances:

5.2.1 For Forged bars: The tolerances shall be as per Cl 5.2.2 for bars ≤100mm.
The tolerances shall be +8 mm -0 mm for bars > 100 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		± 1.6% of diameter or width of side	75 % of total tolerance (+ and -)

5.2.2.2 Flats:

Nominal width, mm			Tolerance, mm		
Over	Up to & Including	On width	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.

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^{0}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	Melt analysis, percnt		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/mm^2

Yield strength : 320 N/mm^2, min

Elongation on 5.65 √So : 18%, min.

12.0 ULTRASONIC TEST:

12.1 Each bar above 100 mm shall be tested ultrasonically in accordance with BHEL standard AA 085 01 18 to ensure freedom from internal defects. The norms of acceptance shall be as per category 2 of the above standard.

12.2 **Optional tests:** If specified on order, each bar > 40 to 100mm shall be tested ultrasonically in accordance with BHEL standard AA 085 01 18 to ensure freedom from internal defects and the norms of acceptance shall be as per category 2.

13.0 TEST CERTIFICATES :

Three copies of test certificates shall be supplied, unless otherwise stated on the order.
In addition, the supplier shall ensure to enclose one copy of the test certificate along with their despatch documents to facilitate quick clearance of the material.

The test certificate shall bear the following information :

AA 102 08; Rev. No. 07: Hot rolled /forged carbon steel bars, Gr.:40 Normalised
BHEL order No,
Supplier's Reference :
Name
Identification No.
Melt No.
Details of heat treatment.
Results of Tests :
Results of Dimensional inspection.
Results of chemical analysis, mechanical tests & Ultrasonic test.

14.0 PACKING AND MARKING :

The material shall be suitably packed in bundles-hessian wrapped to prevent sagging, corrosion and damage during transit. A suitable clear temporary rust preventive shall be applied on all the bars. Each bar of 50 mm and above shall be stamped with AA 102 08, melt no, BHEL order no, at one end or on the end face.

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

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

AA 102 08 : Hot Rolled / Forged Carbon Steel Bars, 40C8-Normalised.
BHEL Order No.
Consignment/Identification No.
Melt No.
Size and Weight.
Supplier's Name.

15.0 REFERRED STANDARDS (Latest Publications Including amendments):

1. IS : 1570 Part II 2. IS : 1608 3. IS : 3739 4. AA 085 01 18

CARBON STEEL FORGINGS, CLASS-3 Î

1.0 GENERAL:

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

2.0 APPLICATION:

Suitable for general engineering purposes.

3.0 CONDITION OF DELIVERY:

Normalised/Normalised and tempered.

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

4.0 COMPLIANCE WITH NATIONAL STANDARDS:

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

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

Gr: 3 (30C8), } Purposes. Î

5.0 DIMENSIONS AND TOLERANCES:

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

For finish machined drawings : 3 ± 1 mm

For rough machined drawings : ± 1 mm

6.0 **MANUFACTURE:**

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

Steel shall be fully killed.

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

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

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

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

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

7.0 HEAT TREATMENT:

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

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

8.0 FINISH:

As mentioned in the drawing.

9.0 FREEDOM FROM DEFECTS:

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

10.0 CHEMICAL COMPOSITION:

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

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

Notes:

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

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

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

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

11.0 TEST SAMPLES:

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

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

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

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

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

12.0 MECHANICAL PROPERTIES:

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

12.1 Tensile test : IS:1608

12.2 Hardness test (Brinell) : IS:1500

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

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

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

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

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

13.0 ULTRASONIC TESTS: Î

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

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

14.0 ADDITIONAL TESTS:

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

14.1 Bend Test (Longitudinal):

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

14.2 Magnetic particle test.

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

15.0 SCOPE OF THIRD PARTY INSPECTION:

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

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

16.0 TEST CERTIFICATE:

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

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

The following details shall be furnished in the test certificate:

i) Reduction ratio

ii) Dimensional Inspection.

iii) Chemical composition including trace elements.

iv) Results of mechanical tests.

v) Results of Ultrasonic test

vi) Details of heat treatment

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

17.0 PACKING & MARKING:

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

Machined surfaces shall be properly protected with anticorrosive compounds.

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

AA 193 32 : Carbon Steel Forgings, Class 3 Î

BHEL Order No.

Suppliers Name

Consignment/ Identification No.

Batch No.

Weight.

18.0 REFERRED STANDARDS (Latest publications Including Amendments):

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

ANNEXURE-I: RECOMMENDED TEST CERTIFICATE FORMAT FOR FORGINGS

SUPPLIER'S NAME AND ADDRESS

TEST CERTIFICATE FOR FORGINGS

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

15. FORGINGS COVERED BY TEST CERTIFICATE

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

16. CHEMICAL COMPOSITION (PERCENT)

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

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

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

18. MECHANICAL PROPERTIES

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

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

20. DIMENSIONAL INSPECTION

21. NON-DESTRUCTIVE TESTS

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

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

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

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

24. IDENTIFICATION OF FORGINGS AS PER PURCHASE .SPEC.

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

SIGNATURE, NAME & SEAL OF THE INSPECTING OFFICER
DATE:

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

INSTRUCTIONS

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

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.

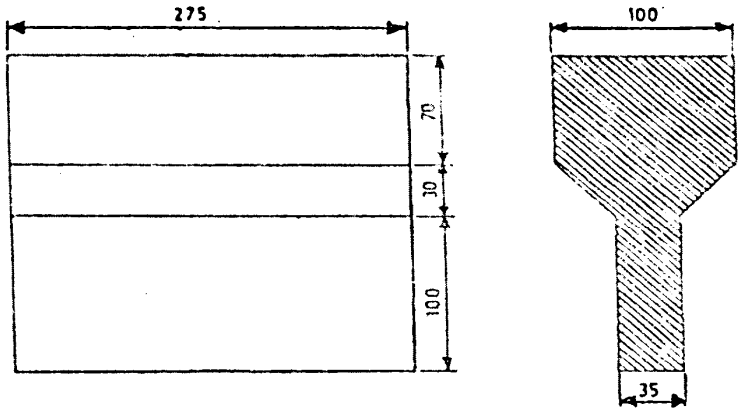
11.1 Unless otherwise specified for castings weighting up to 500 kg. piece weight one keel block, separately cast per melt per heat treatment batch shall be supplied according to the sketch given below:

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

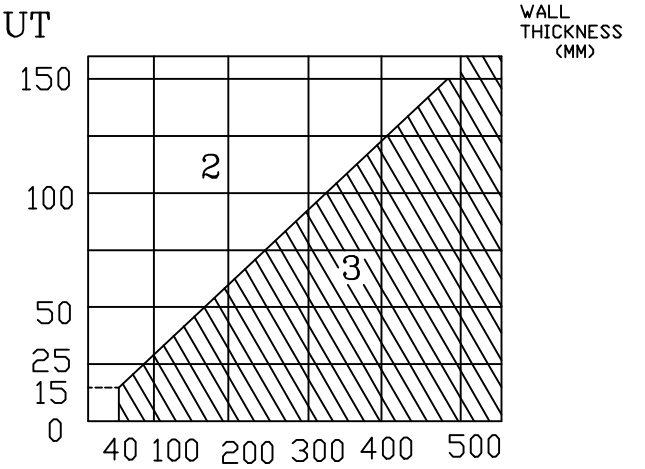
Type of Inspection	Ref	Method of Inspection	Acceptance Level/Criteria	Inspection Frequency	Support Document
a.Dimensions	IS	Dimensional	1.As per drg.	Each casting	Dimensional report
b. Surface		Visual	The surface shall be free from the defects like cracks or other defects detrimental to the item.	Each 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

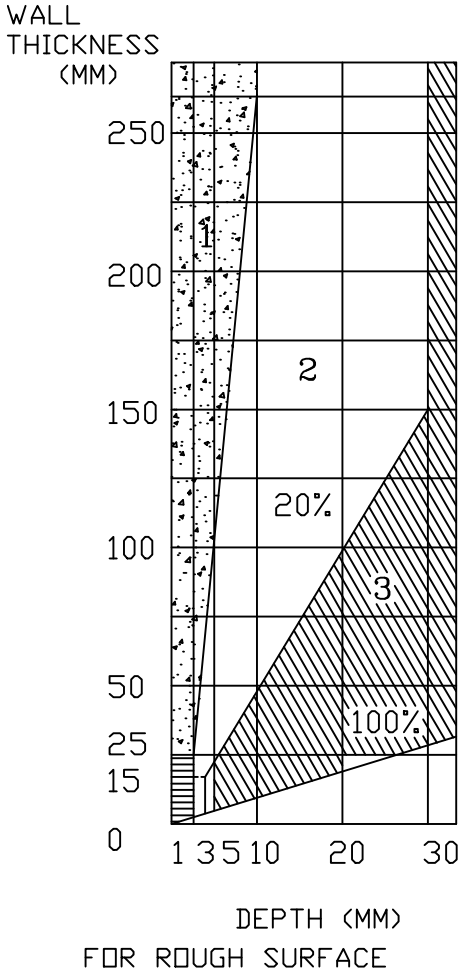
ANNEXURE B
CUT OUT

1 ZONE
SUPERFICIAL CUT-OUTS

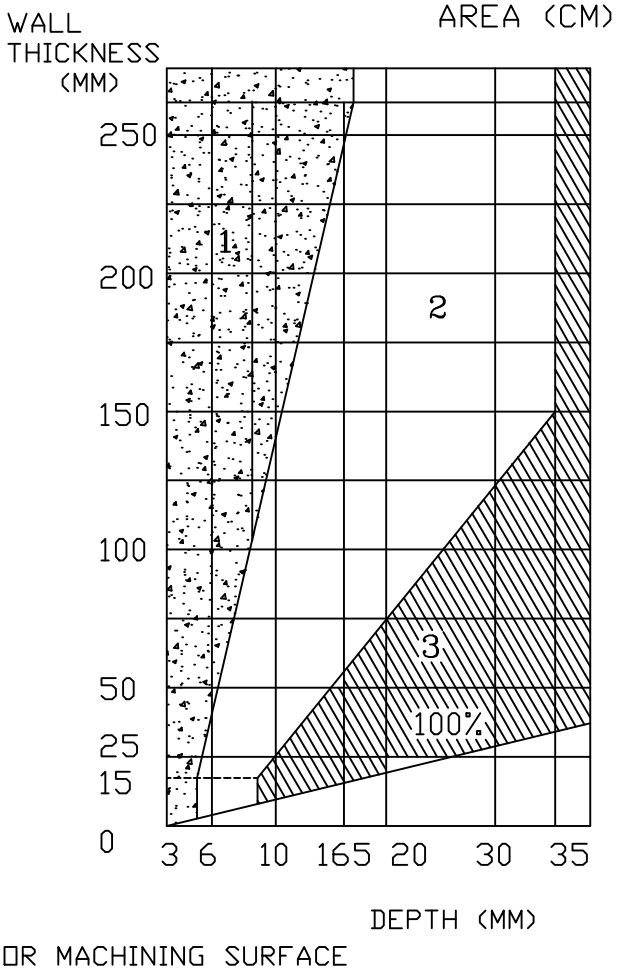
2 ZONE
MINOR CUT-OUTS

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

LIST OF APPLICABLE STANDARDS ON LIMITS, FITS AND TOLERANCES

1.0 SCOPE:

The standard covers the list of applicable standards on Limits, Fits and Tolerances. These standards are applicable unless or otherwise specified.

2.0 LIST OF APPLICABLE STANDARDS:

SL. NO.	STANDARD NO.		TITLE
1.	AA0230201	-	Limits and Fits (Tolerance grade, Position and Class).
2.	AA0230202	-	Limits and sizes for commercial bolts and nuts.
3.	AA0230204	-	Guide for selection of Fits.
4.	AA0230206	-	Standard limits for Shafts (upto 500 mm).
5.	AA0230207	-	Standard limits for Shafts (above 500 mm and upto 3150 mm).
6.	AA0230208	-	Allowable deviations for dimensions without specified tolerances (linear and angular).
7.	AA0230402	-	Permissible deviations for untoleranced dimensions of castings.
8.	AA0230403	-	Tolerancing system ISO Metric Screw Threads
9.	AA0621101	-	Tolerances and Machining allowances for Flame cutting.
10.	AA0621104	-	General tolerances for welding constructions for length and angles.
11.	AA0621105	-	General tolerances for welded structures – form and position.

NOTE:

1) AA 023 02 08

Medium class of deviation is applicable, if the same is not mentioned on the drgs./specs.

2) AA 023 04 02

Tolerance class 5 is applicable, if the same is not mentioned on the drgs./specs.

3) AA 062 11 04

Accuracy class A is applicable if the same is not mentioned on the drgs.

4) AA 062 11 05

Accuracy class E is applicable, if the same is not applicable on drgs.

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									
Page No.	1 of 1	BHEL									

Legend

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

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