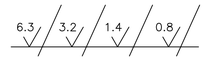
FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

C.C.S.

DRG. NO. 1-61-000-00363

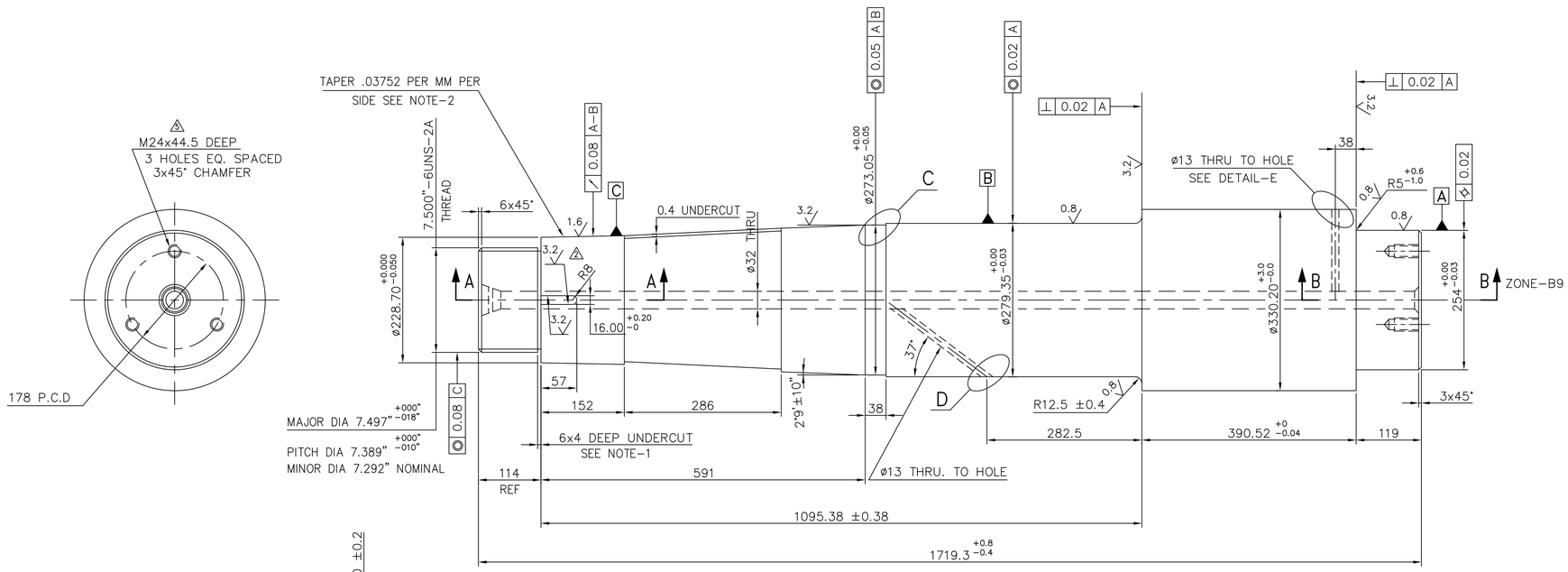


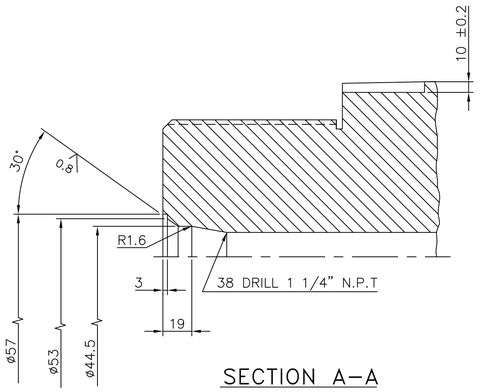
COMPUTER FILE NAME : 16100363.DWG

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

NOTES:-

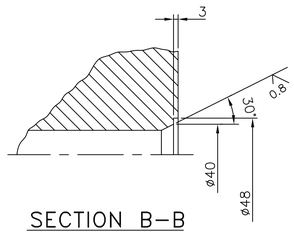
1. BREAK ALL SHARP EDGES AND CORNERS UNLESS OTHERWISE NOTED.
2. SUPPLY AS PER CUSTOMERS APPROVED QUALITY PLAN
3. ATTEST MATERIAL.





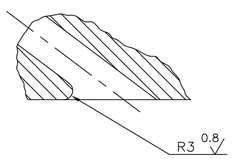
SECTION A-A

SCALE-1:2



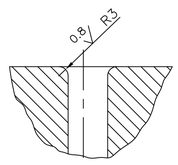
SECTION B-B

SCALE-1:2



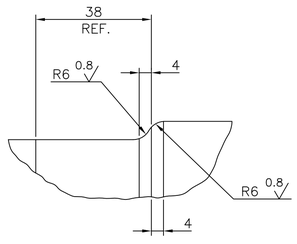
DETAIL-D

SCALE-1:1



DETAIL-E

SCALE-1:1



DETAIL-C

SCALE-1:1

ITEM NO	DESCRIPTION	DRAWING NO.	VAR. NO.	RAW MATERIAL SIZE OR CASTING DRG.NO. OR FORGING DRG.NO.	MATERIAL CODE	NET WT.	GROSS WT.
	FORGING			3-61-000-90173	BA9413253137	790	036
					AA19332		
					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		15.4.99	
CHD.	S.G		15.4.99	
APPD.	K.M.RAO		15.4.99	

DEPT.	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	NO.OF ITEMS
PULV. ENGG	1:5	790.036	C-101-01082/R1 CE-P/N-101-01082		
CODE 446					

TITLE: JOURNAL SHAFT

DRAWING NO. 1-61-000-00363 REV. 07

SHEET NO. | NO OF SHEETS

REV.	DATE	ALTERED	CHECKED	APPD.	ZONE	
07	02.07.03				ZONE	2 DEG 9' ± 10" WAS 2 DEG 9' (REF) SLOT FOR BEARING REMOVAL DELETED BASED ON SHOP FEEDBACK. TOL ON ø279.35 & 254 WAS +0.0/-0.02 NOTES 1-4,6&8 DELETED,RENUMBERED.
06	23.01.99				ZONE	DRG. REVISED ON AUTOCAD
05	11.02.92				ZONE G-11	M24 WAS 1"-8UNC-2 TAP
04	08.08.91				ZONE E-3	U.T. CAT-III WAS CAT-IV NOTE 8 ADDED
03	07.01.91				ZONE	CE MATERIAL SPEC. DELETED
02	20.05.88				ZONE	KEY WAY MACHINING CORRECTED IN DET 'F' SLOT LENGTH INCLUDES MILLING CUTTER RELIEF
01	21.08.87				ZONE	DETAIL-F ADDED SHOWING SLOTS FOR BEARING REMOVAL

FIRST ANGLE PROJECTION

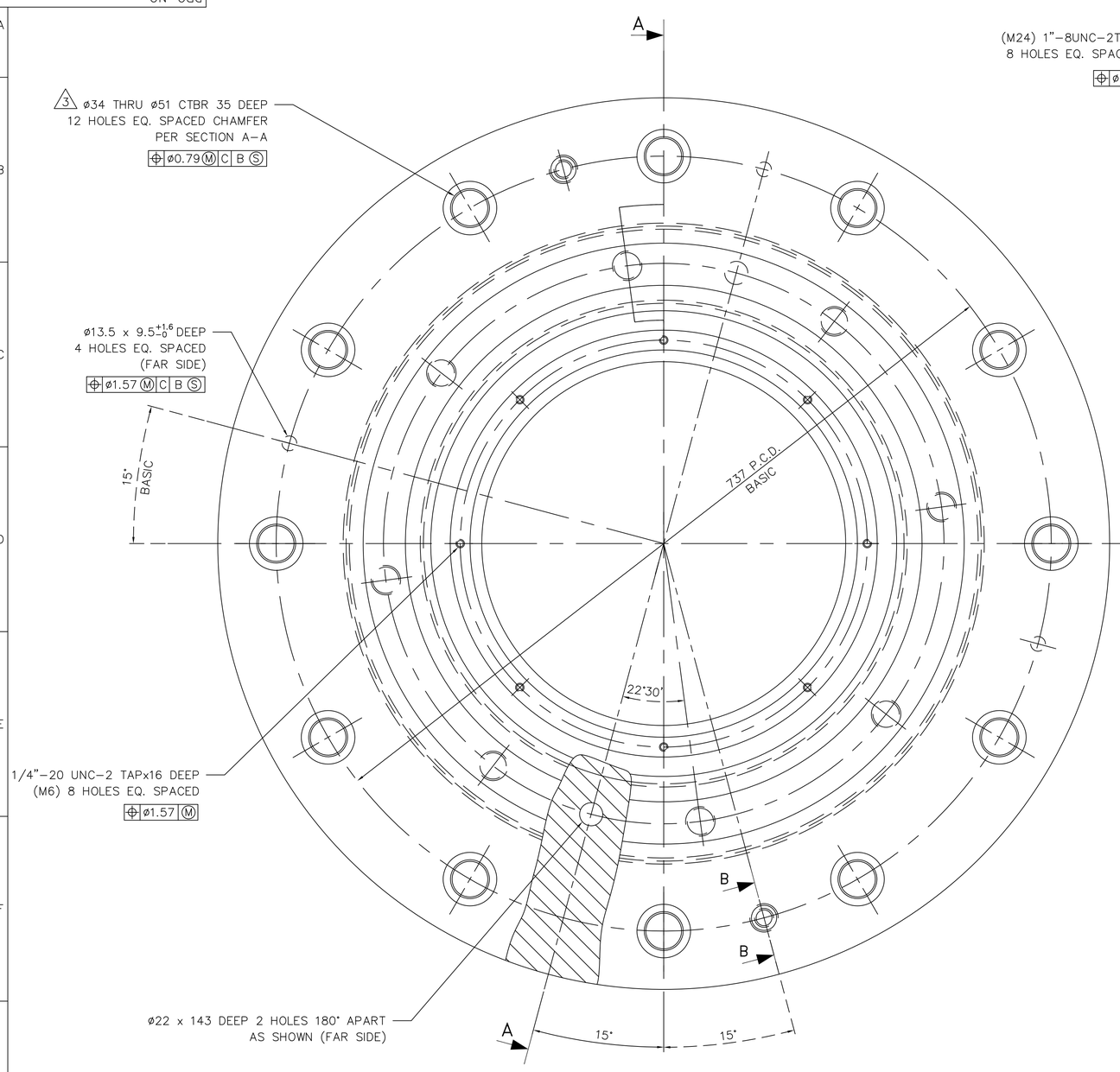
(ALL DIMENSIONS ARE IN mm)

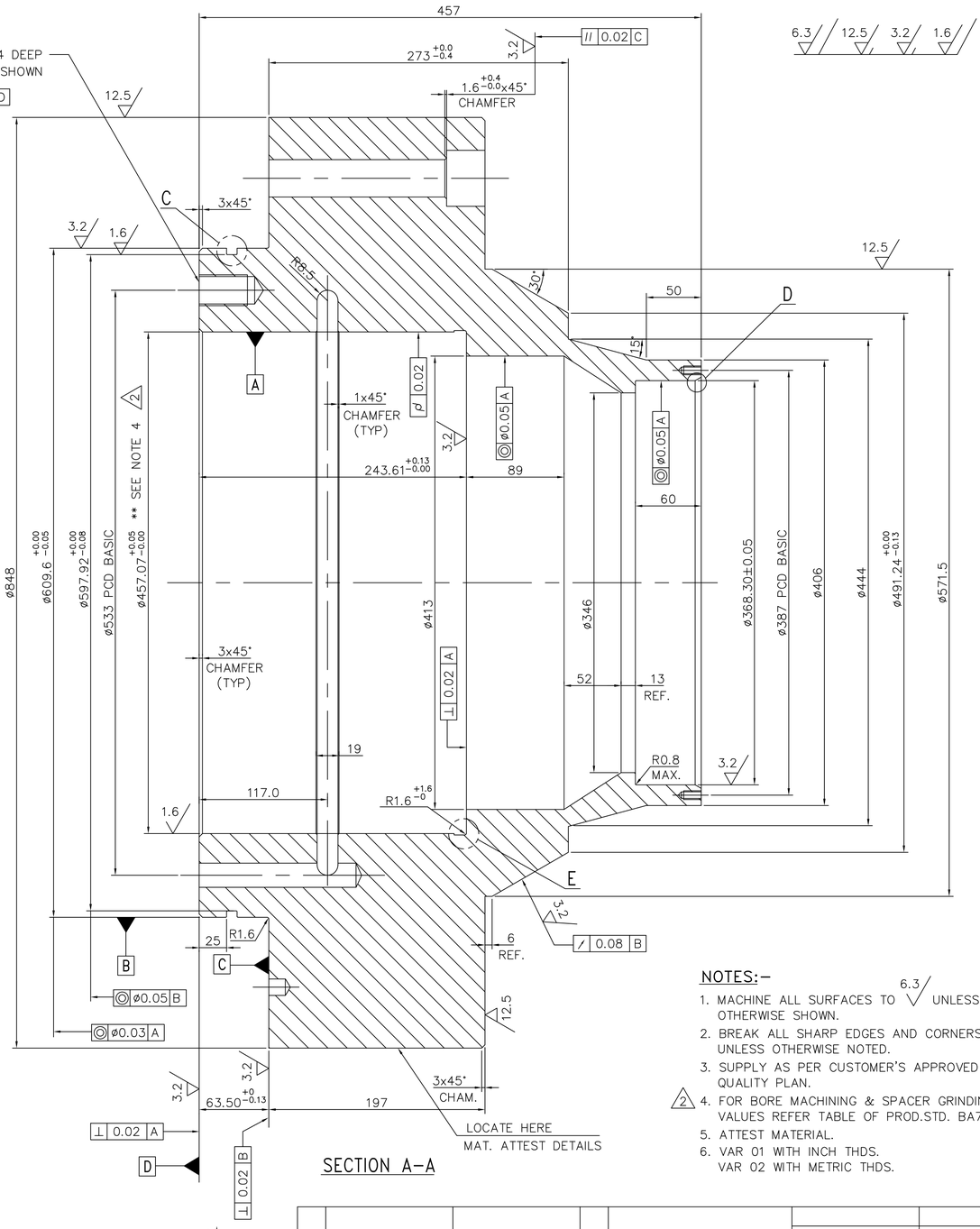
C.C.S.

DRG. NO. 1-61-000-00365

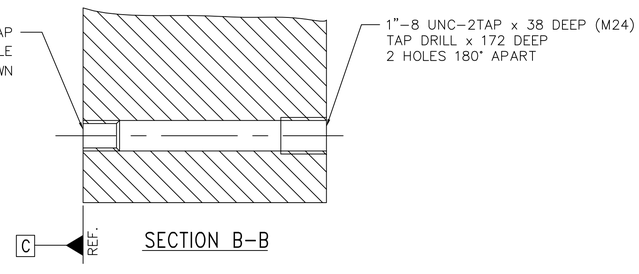
COMPUTER FILE NAME : 16100365.DWG

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

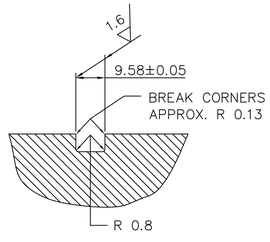




SECTION A-A

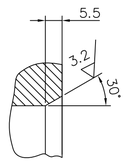


SECTION B-B



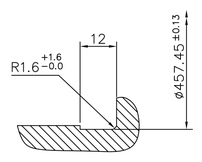
DETAIL-C

SCALE 1:1



DETAIL-D

SCALE 1:1



DETAIL-E

ENLARGED VIEW OPTIONAL MACHINING

NOTES:-

1. MACHINE ALL SURFACES TO 6.3 UNLESS OTHERWISE SHOWN.
2. BREAK ALL SHARP EDGES AND CORNERS UNLESS OTHERWISE NOTED.
3. SUPPLY AS PER CUSTOMER'S APPROVED QUALITY PLAN.
2. 4. FOR BORE MACHINING & SPACER GRINDING VALUES REFER TABLE OF PROD.STD. BA76002.
5. ATTEST MATERIAL.
6. VAR 01 WITH INCH THDS.
   VAR 02 WITH METRIC THDS.

ITEM NO	DESCRIPTION	DRAWING NO.	VAR. NO.	RAW MATERIAL SIZE OR CASTING DRG.NO. OR FORGING DRG.NO.	MATERIAL CODE	NET WT.	GROSS WT.
					BA9413221162	748.767	
01	FORGING ø848 x 457 LONG	3-61-000-90168			AA 19332		
					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		15.4.99	
CHD.	S.G		15.4.99	
APPD.	K.M.RAO		15.4.99	

DEPT.	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	NO.OF ITEMS
PULV. ENGG	1:2.5	748.767	C-101-01081/5		
CODE 446			CE: P/N: 101-01081		

TITLE: UPPER JOURNAL HOUSING

DRAWING NO. 1-61-000-00365 REV. 06

SHEET NO. NO OF SHEETS

REV.	DATE	ALTERED / CHECKED / APPD.	ZONE
06	10.8.01	TOL ON ø609.6 WAS +0.00/-0.03. LOCATION FOR MAT ATTEST INDICATED.	D-7 G-9
05	09.09.2k	SURFACE FINISH 1.6 WAS 0.8	B-7
04	23.01.99	DRAWING REVISED ON AUTOCAD NOTES 5&6 ADDED	
03	07.01.91	C.E.MATERIAL SPECIFICATION DELETED ø34 WAS ø33	C-2 H12
02	03.05.88	NOTE 4 ADDED	
01	07.04.88	19 MM GROOVE PROVIDED & ø19 x 40 DEEP 2 HOLES DELETED	

FIRST ANGLE PROJECTION

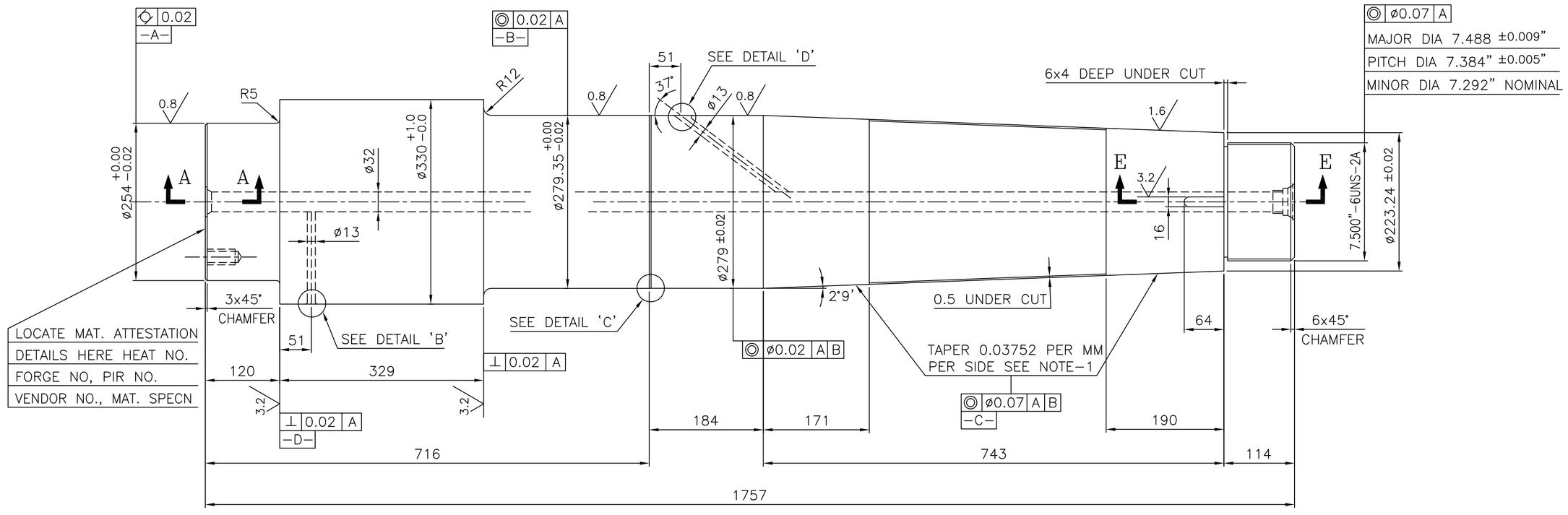
(ALL DIMENSIONS ARE IN mm)

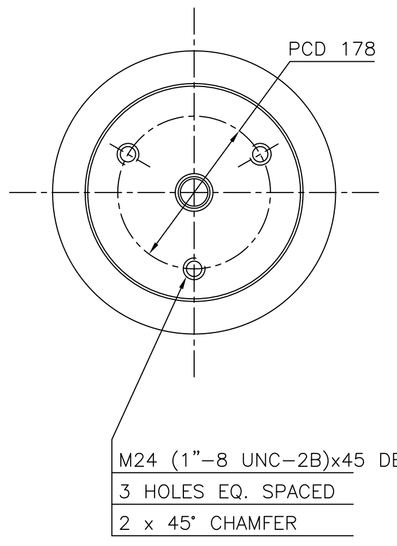
DRG. NO. 1-61-004-01183

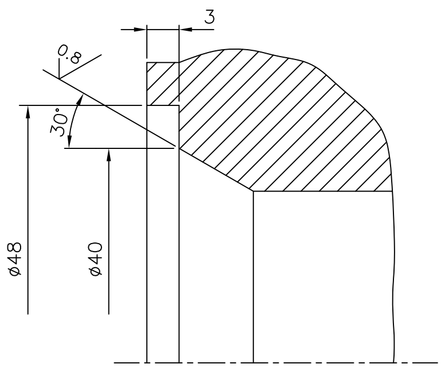
SH. 01 OF 01

COMPUTER FILE NAME 1610183.DWG | REF. DRG. NO. 1-61-004-01190 | SIGN. AND DATE | INVENTORY NO

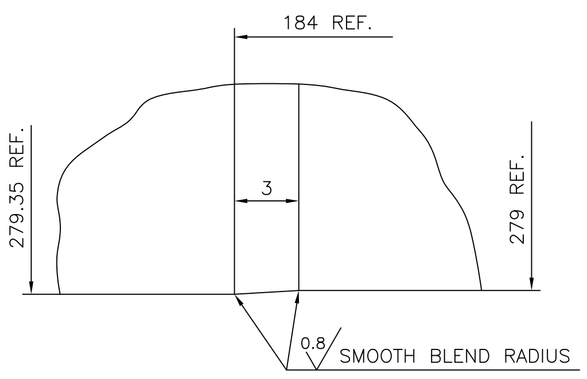
6.3 3.2 1.6 0.8



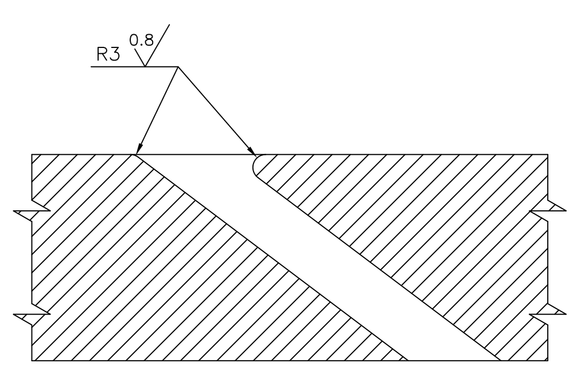




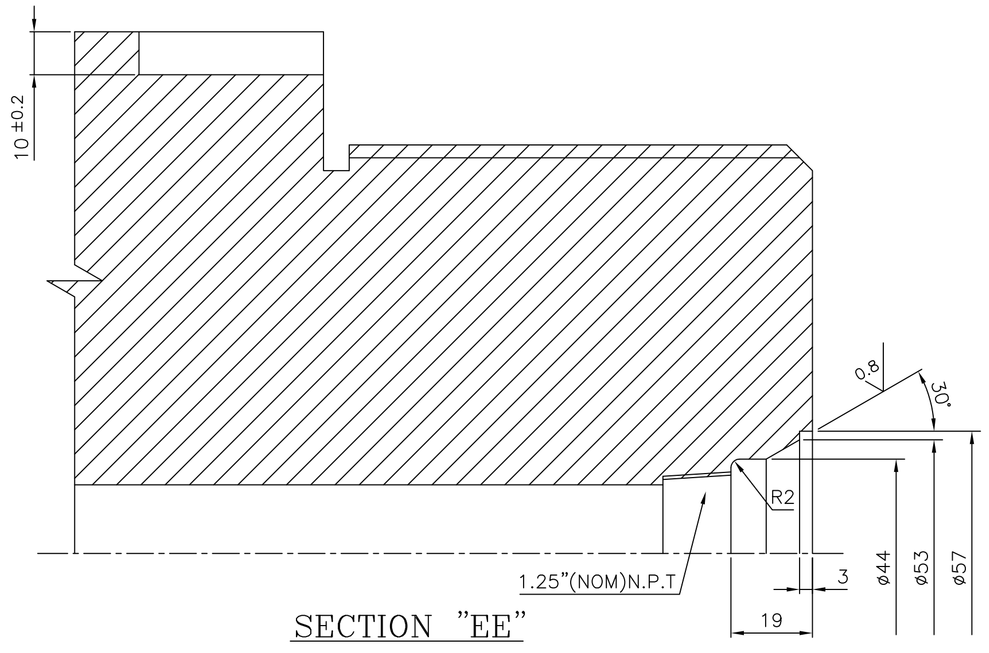
SECTION "AA"



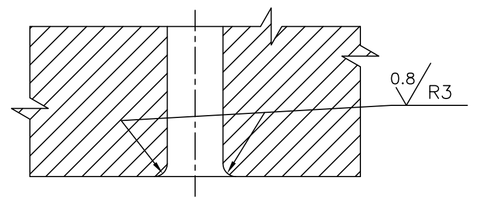
DETAIL "C"



DETAIL "D"



SECTION "EE"



DETAIL "B"

NOTES:–

01. TAPER MUST FIT FULL CONTACT RING GAUGE WITH MIN OF 80% CONTACT BANDS OF NO CONTACT MUST NOT EXCEED 10° OF ARC.
02. ALL DIAMETERS TO BE CONCENTRIC WITH DATUMS A & B WITHIN 0.25 T.I.R UNLESS OTHERWISE SPECIFIED.
03. ALL FILLETS 0.8
04. REFER DRG. No. 3–61–004–90184 FOR ROUGH FORGING.
05 BREAK ALL SHARP EDGES.
06 VAR. 01 METRIC THREADING & VAR. 02 INCH THREADING.

MATERIAL ATTESTATION

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				BA9413253242		799.00
					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
NAME OF CUSTOMER/PROJECT: 1103 XRP BOWL MILL

BHEL BHARAT HEAVY ELECTRICALS LIMITED HYDERABAD

	NAME	SIGN.	DATE	NO.OF VAR.
DRN.	UNIC		10.06.99	–
CHD.	ND.SAMUEL		10.06.99	
APPD.	S.GHATGE		10.06.99	

DEPT.	UNTOL. DIMS. GR.		SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	NO.OF ITEMS
PULV ENGG. CODE 446	∅/M/F		1:5	799.00	1–61–004–01190	09	30

TITLE: JOURNAL SHAFT

CARD CODE | DRAWING NO. 1–61–004–01183 | REV. 02

SHEET NO. 01 | NO OF SHEETS 01

REV.	DATE	ALTD.	APPD.	ZONE
		CHD.		

REV.	DATE	ALTD.	APPD.	ZONE
02	10.06.99	CHD.		

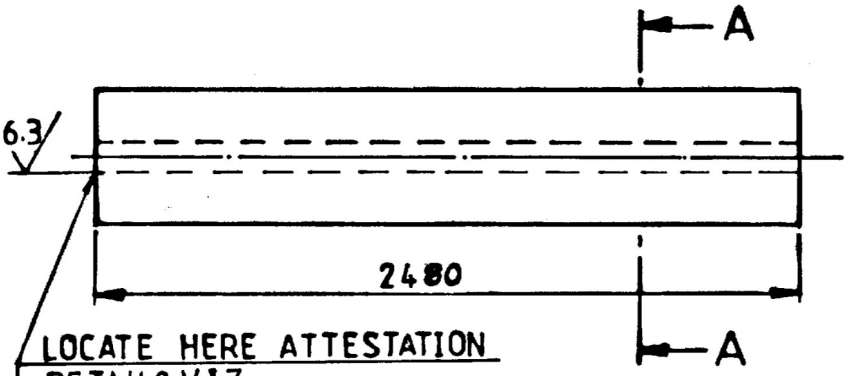
DRG. REDRAWN INCORPORATING THE ALL PREVIOUS REV. VARIANTS ADDED.

REV.	DATE	ALTD.	APPD.	ZONE
01	10.11.93	CHD.		G–12 B–1 H–1

TOLERANCE ADDED FOR ø254 MAT.CODE ADDED, MACHINING SYMBOLS ADDED ON TOP RIGHT CRONER NOTE 5 & MAT. AT TESTATION DETAILS ADDED.

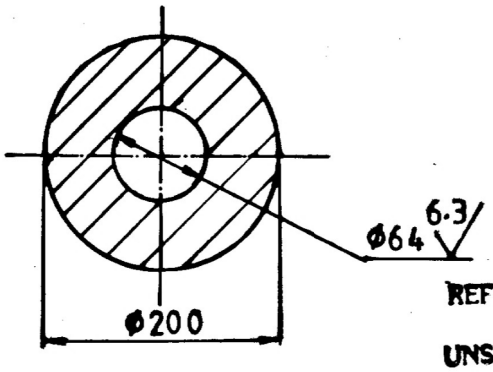
FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN mm)

REV.	DATE	ALTERED / CHECKED	REV.	DATE	ALTERED / CHECKED	REV.	DATE	ALTERED / CHECKED
ZONE			ZONE			ZONE		



12.5 / 6.3

LOCATE HERE ATTESTATION DETAILS VIZ,
SUPPLIERS CODE.
FORGE.NO.
MAT.SPECN
MELT.NO.



SECTION AA

NOTE

1. FORGING TO BE ROUGH MACHINED TO DIMENSIONS INDICATED IN DRG.
2. HOLE Ø64 SHOULD CONCENTRIC WITH CENTRE LINE WITH IN ±1MM
3. TEST ULTRASONICALLY AS PER SPCN. AA0850118 CAT-3.
4. TOLERANCE ON DIAMETERS AND LENGTH ±1MM.
5. FOR FINISH MACHINING REFER DRG. NO. I-61-004-01184

REFER PLANT STANDARD HY 0230261 FOR UNSPECIFIED TOLERANCES

SCANNED

1003×RP BOWL MILL

REF. DRG. NO.

REMARKS (65–75)	ITEM NO. (25 27)	DESCRIPTION (29–58)	STD. (59)	MATL. CODE (34–45) / MATL. SPCN. (46–54)	A/C (55)	UNIT (56–57)	UNIT WT. (58–65) / QTY. (66–71)
		FORGING		BA9413253250 / AA 19332			548·0 / 1
CARD TYPE-3 → 28		28 → CARD TYPE-2		28 → CARD TYPE-1			

SIGN. & DATE

BHARAT HEAVY ELECTRICALS LTD
HYDERABAD

	NAME	SIGN.	DATE
DRN.	D.C.		25-2-93
CHD.	N.D.S		31-3-93
APPD.	Y S L.RAO		3-4-93

NO. OF VAR. (73 74)

INVENTORY NO.

DEPT	GRADE OF TOL. DIM.	SCALE	WEIGHT (Kg)	REF. TO ASSY. DRG.	ITEM NO.	NO. OF ITEMS (75 77)
BMD		NTS	548·0	D-110-00767		
CODE 446						

TITLE: TRUNNION SHAFT (ROUGH FORGING)

CARD CODE (1 3): 7

DRAWING NO. 4-61-004-90249 REV. 00 (22 23 24)

SHEET NO. / NO. OF SHEETS

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

DRG. NO. 2-61-088-02056 SH. 01 OF 01

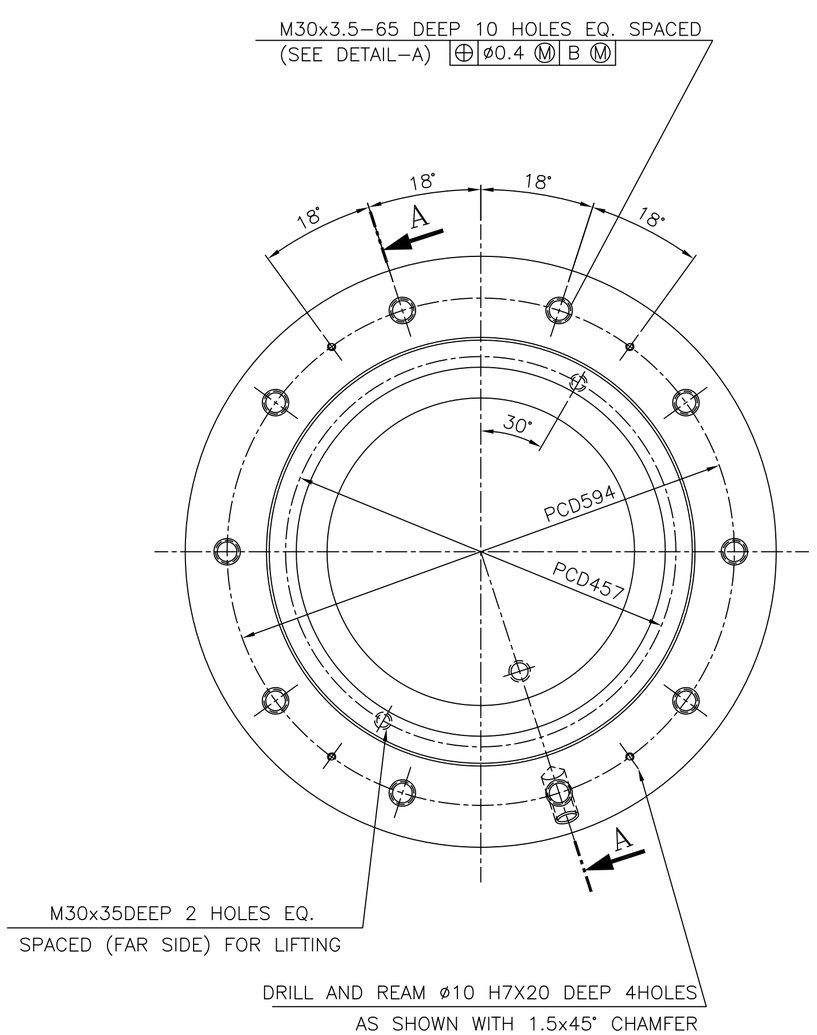
GENERAL DIMENSIONAL LIMITS,FITS & TOLERANCES AS PER HY0230261

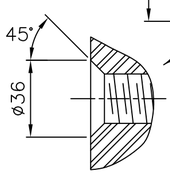
COMPUTER FILE NAME 26102056.DWG

REF. DRG. NO. (C-101-00178A/13)

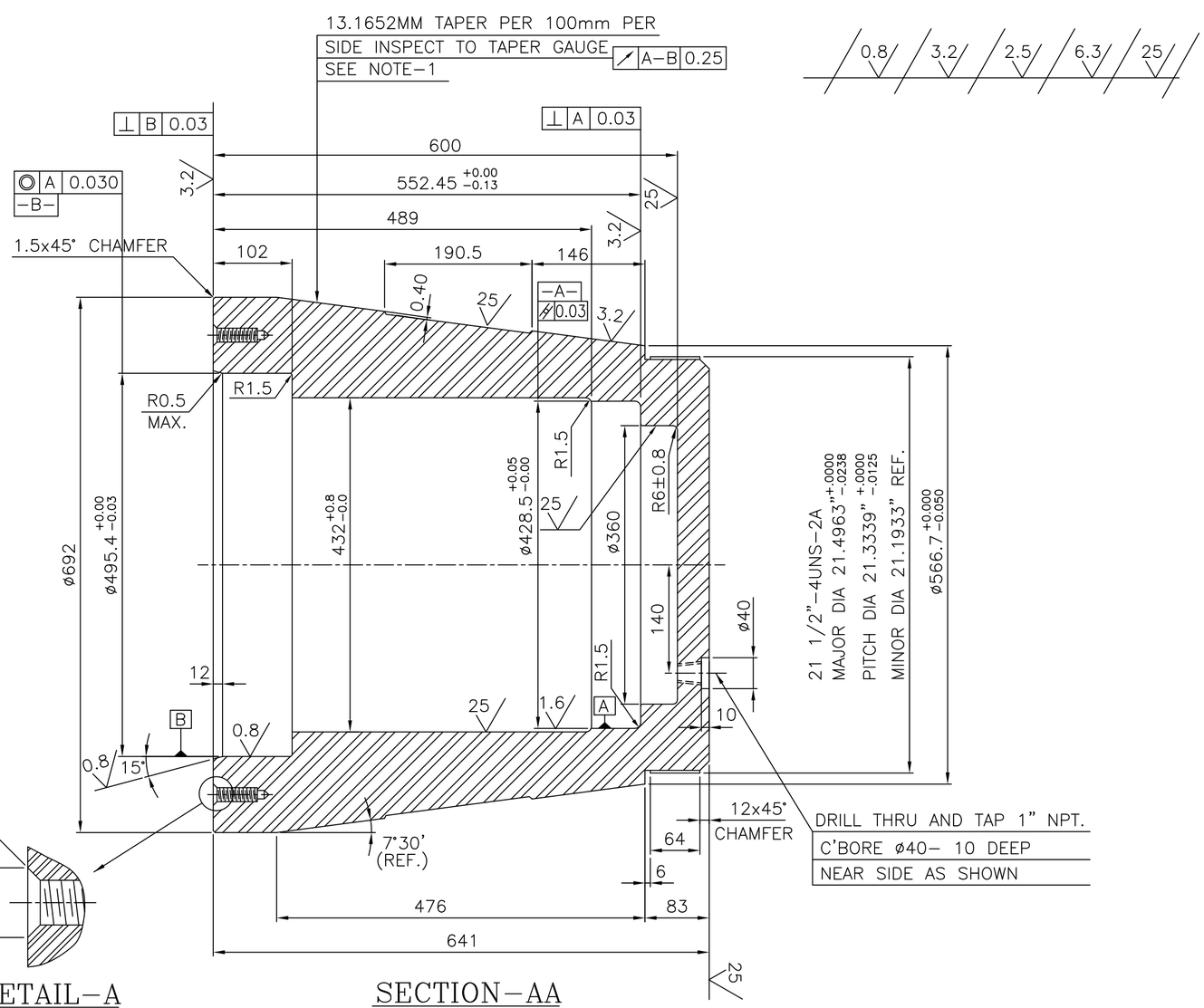
SIGN. AND DATE

INVENTORY NO





DETAIL–A
10 PLACES



SECTION–AA

NOTES:–

1. TAPER MUST BE CHECKED WITH A RING GAUGE AND A MINIMUM OF 80% CONTACT SHALL BE OBTAINED. BANDS OF NO CONTACT MUST NOT EXCEED 10° OF ARC.
2. 100% INSPECTION OF ALL THREADS REQUIRED.
3. BREAK ALL SHARP EDGES & CORNERS UNLESS OTHERWISE NOTED.

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			3–61–088–02392	BA9413221316	840.00	980.00
					AA19332	QUANTITY	1

REV	DATE	ALT	PKP	APPD
07	28.10.14	CHD	CKP	V.KUMAR
ZONE D5	LIFTING HOLE M24X45 REMOVED.			

REV	DATE	ALT	UC	APPD
06	03.12.06	CHD	AMAN	GK
ZONE A2	M30X3.5 WAS M30X2.			

REV.	DATE	ALTERED UC	APPD.
05	03.12.05	CHD.AMAN	GK
ZONE D7	1"NPT WAS 'SQ PIPE PLUG TO FLUSH 2 TURNS.... C'BORE ø40X10 ADDED. STEP TO ø152 DELETED. DIM 600 WAS 622.		

REV.	DATE	ALTERED	APPD.
04	24.8.05	CHD.AMAN	GK
ZONE D1	M30X35 DEEP WAS M20X35 DEEP.		

REV.	DATE	ALTERED	APPD.
03	28.11.03	CHD.G.S.N.M.RAO	
ZONE	DRAWING REDRAWN BY INCORPORATING THE 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 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		14.4.97	
CHD.	G.S.N.M.RAO		28.11.03	
APPD.				

DEPT.	UNTOL. DIMS. GR.	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	NO.OF ITEMS
PULV ENGG. CODE 446	∅/M/F	1:5 1:2	840.00	1.61.088.01019	3	28

TITLE: LOWER JOURNAL HOUSING

CARD CODE U 01

DRAWING NO. 2–61–088–02056 REV. 07

SHEET NO. 01 NO OF SHEETS 01

(ALL DIMENSIONS ARE IN mm)

DRG. NO. 2-61-088-02058

INVENTORY NO | SIGN. AND DATE | REF. DRG. NO. C-94-851 | REF. DRG. NO. 26102058.DWG

DETAIL-E

DETAIL-F

SECTION - JJ

DETAIL-D

VIEW - CC

DETAIL-H

INSPECTION
100% INSPECTION OF ALL THREADS REQUIRED

NOTES: -

1. THIS UNDERCUT IS NOT REQUIRED WHEN MACHINING WITH TRACING EQUIPMENT.
2. MACHINE ALL SURFACES TO 6.3 UNLESS OTHERWISE NOTED.
3. TAPER MUST FIT FULL CONTACT RING GAUGE WITH MINIMUM OF 80% CONTACT BANDS OF NO CONTACT MUST NOT EXCEED 10° OF ARC.
4. SURFACE FINISHES SHOWN ARE MAXIMUM.
5. THIS IS FINISH MACHINED DRG.
6. UT SHALL BE AS PER AA0850118 CAT 3 FOR ROUGH FORGINGS.
7. MPI SHALL BE AS PER AA0820133 REFER -QP FOR ACCEPTANCE LEVEL.

	01	FORGING		3.61.088.02391		BA9413253307			560	662.00		
VAR NO.	ITEM NO.	DESCRIPTION	STD.	DRAWING NO.	IT.NO / VAR.	MATL CODE / MATL SPECN	A/C	UNIT	UNIT WT. / QTY.		GS	ZONE

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: 883XRP BOWL MILL

BHARAT HEAVY ELECTRICALS LTD. HYDERABAD

	NAME	SIGN.	DATE	NO.OF VAR.
DRN.	UNIC		2.7.98	
CHD.	G.S.N.M.RAO		28.11.03	
APPD.				

REF.TO HY0230261 FOR UNSPECIFIED TOLERANCES

REV.	DATE	
05	2.7.98	ALTERED UNIC
		CHECKED G.S.N.M.RAO
		APPROVED
ZONE	DRG REDRAWN.ON AUTOCAD $\phi266.7^{+0.00}_{-0.02}$ WAS $\phi266.7^{+0.00}_{-0.05}$	

DEPT.	GRADE OF TOL.DIM.		SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	NO.OF ITEMS
PULV-ENGG CODE 446	E/M/F		1:5	560KG	1.61.088.01019	01	28

TITLE: JOURNAL SHAFT

CARD CODE

DRAWING NO. 2-61-088-02058 REV. 05

SHEET NO. 01 NO OF SHEETS 01

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

DRG. NO. 2-61-088-02059 SH. 01 OF 01

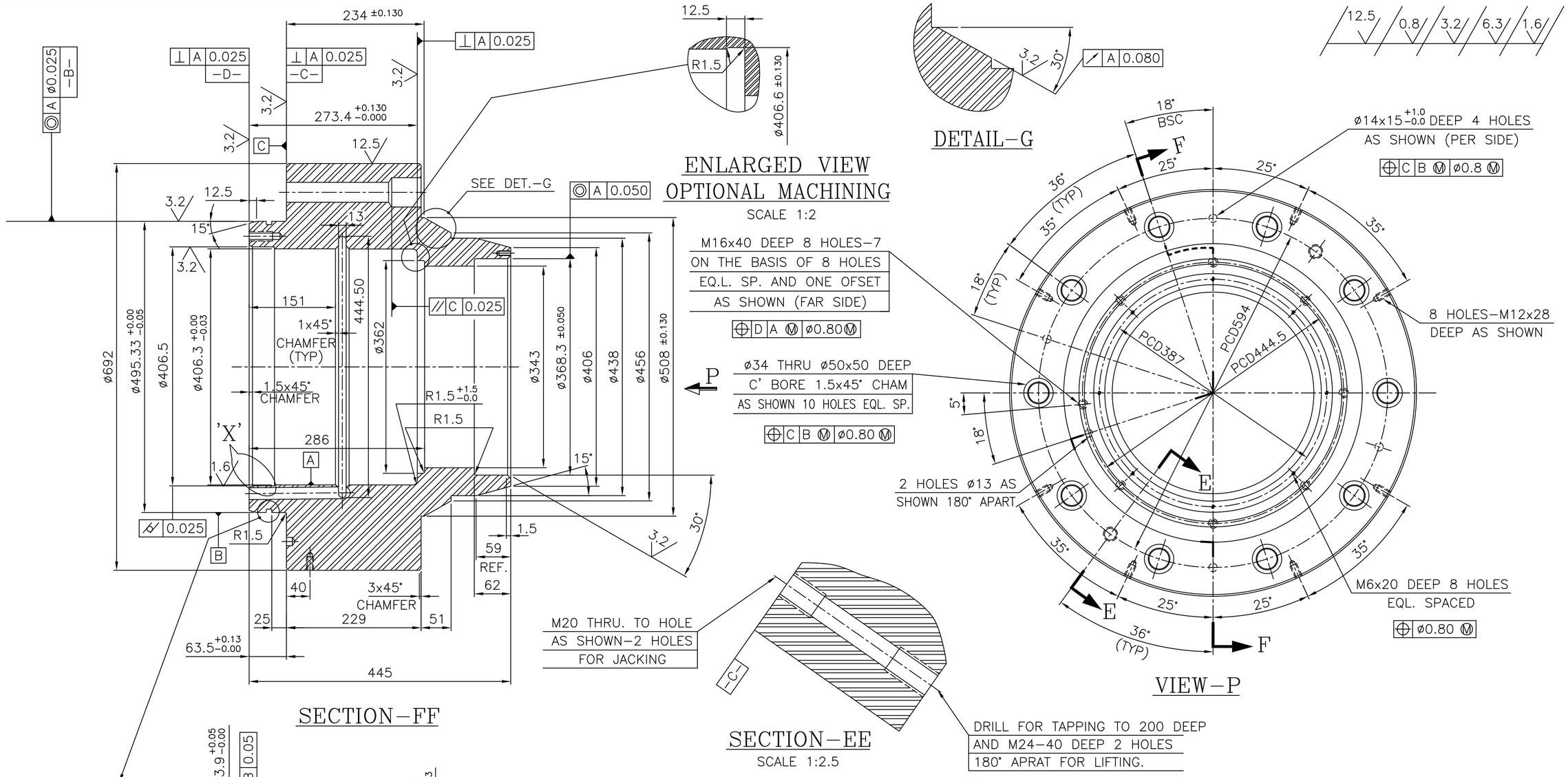
GENERAL DIMENSIONAL LIMITS,FITS & TOLERANCES AS PER HY0230261

COMPUTER FILE NAME 26102059.DWG

REF. DRG. NO. (C-94-852/03)

SIGN. AND DATE

INVENTORY NO



SECTION–FF

ENLARGED VIEW
OPTIONAL MACHINING
SCALE 1:2

DETAIL–G

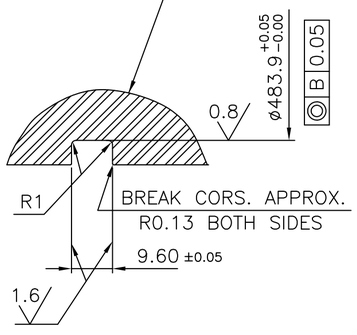
M16x40 DEEP 8 HOLES–7
ON THE BASIS OF 8 HOLES
EQ.L. SP. AND ONE OFSET
AS SHOWN (FAR SIDE)
⊕ D A Ⓜ ø0.80Ⓜ

ø34 THRU ø50x50 DEEP
C' BORE 1.5x45° CHAM
AS SHOWN 10 HOLES EQL. SP.
⊕ C B Ⓜ ø0.80 Ⓜ

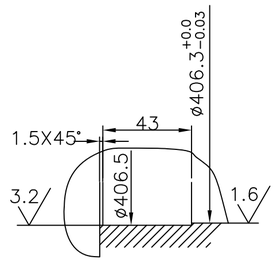
P

VIEW–P

SECTION–EE
SCALE 1:2.5



ENLARGED VIEW
SCALE 1:1



DETAIL–'X'
SCALE 1:2

NOTES:–

1. UNLESS OTHERWISE SPECIFIED: ALL MACHINED SURFACE TO BE 6.3
2. UNLESS OTHERWISE SPECIFIED: ALL COAXIAL FEATURES TO BE CONCENTRIC WITH DATUM 'A' WITHIN 0.250 DIA TIR.
3. BREAK ALL SHARP EDGES & CORNERS UNLESS OTHERWISE NOTED.

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			3-61-088-02393	BA9413221324	540.00	653.00
					AA19332		
					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
NAME OF CUSTOMER/PROJECT
883 XRP BOWL MILL

BHARAT HEAVY ELECTRICALS LIMITED
HYDERABAD

	NAME	SIGN.	DATE	NO.OF VAR.
DRN.	UNIC		16.4.97	
CHD.	G.S.N.M.RAO		28.11.03	
APPD.				

DEPT.	UNTOL. DIMS. GR.	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	NO.OF ITEMS
PULV ENGG. CODE 446	¢/M/F	1:5 1:2&1:2.5	540.000	1.61.088.01019	3	28

TITLE
UPPER JOURNAL HOUSING

CARD CODE U 01

DRAWING NO. 2-61-088-02059 REV. 05

SHEET NO. 01 NO OF SHEETS 01

REV.	DATE	ALTERED	APPD.	REV.	DATE	ALTERED	APPD.	REV.	DATE	ALTERED UC	APPD.
		CHD.				CHD.		05	28.11.03	CHD. G.S.N.M.RAO	
ZONE				ZONE				ZONE	DRAWING REDRAWN BY INCORPORATING THE ALL PREVIOUS REV.		

FIRST ANGLE PROJECTION

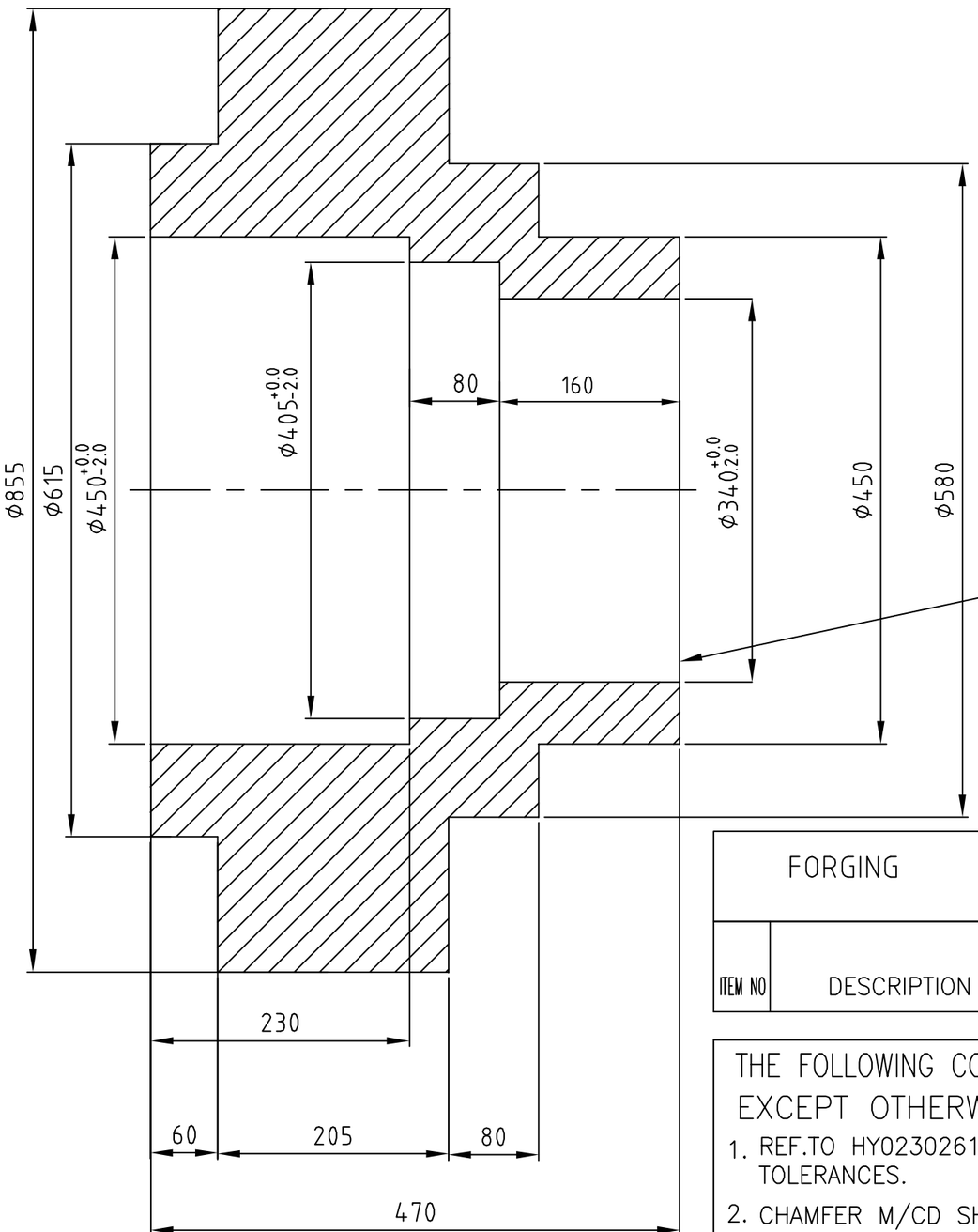
(ALL DIMENSIONS ARE IN mm)

DRG.NO. 3-61-000-90168

FILE NAME

1-61-000-90168 REF.DRG.NO.

INVENTORY NO.



NOTE

1. FORGING TO BE ROUGH MACHINED TO DIMENSIONS INDICATED IN THE DRAWING
2. CHAMFER CORNERS TO R2 & FILLET RADIUS ARE TO BE R3
3. TEST ULTRASONICALLY AS PER SPECIFICATIONS AA0850118 CAT-3
4. FORGING SHOULD BE AS PER SPECIFICATIONS AA19332
5. TOLERENCE ON DIAMETERS AND LENGTHS±1MM
6. FOR FINISH MACHINING REFER 1-61-000-00365

12.5

LOCATE HEAR ATTESTATION DETAILS VIZ

SUPPLIERS CODE

FORGE NO

MAT SPECN

MELT NO

ITEM NO	DESCRIPTION	DRAWING NO.	VAR. NO.	RAW MATERIAL SIZE OR CASTING DRG.NO. OR FORGING DRG.NO.	MATERIAL CODE / MATERIAL SPECN.	NET WT. / QUANTITY	GROSS WT.
	FORGING				BA9413221235 / AA 19332		

REV.	DATE	ALTERED	CHD.	APPD.
ZONE				
01	3.11.03	ALTERED NARAYANA	CHD.N.D.S	APPD.S.G
ZONE		DRAWING DRAWN ON AUTOCAD		

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 KORBA&RAMAGUNDAM 500MW

BHARAT HEAVY ELECTRICALS LTD. HYDERABAD

	NAME	SIGN.	DATE	NO.OF VAR.
DRN.	NARAYANA		3.11.03	
CHD.	N.D.S		3.11.03	
APPD.	S.GHADGE			

DEPT.	CODE	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	NO.OF ITEMS
PULVE.ENGG	446	1:5	854.00	1-61-000-90168		

TITLE: UPPER JOURNAL HOUSING

DRAWING NO. 3-61-000-90168 REV. 01

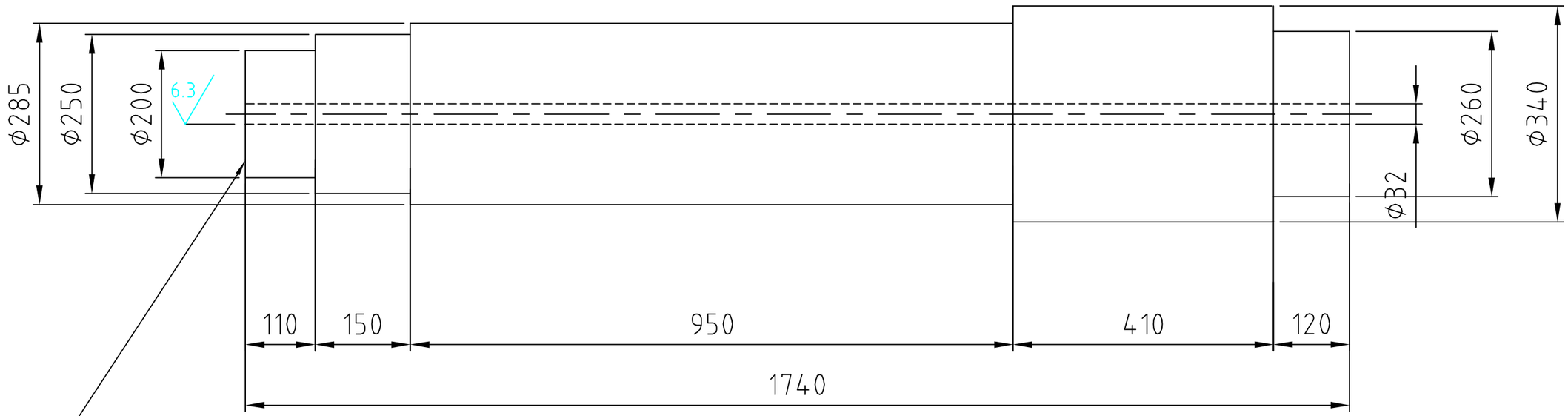
SHEET NO. 01 NO OF SHEETS 01

TD-151/REV. 03 SIZE A3

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

DRG.NO. 3-61-000-90173



LOCATE HARE ATTESTATION DETAILS VIZ.
SUPPLIERS CODE
FORGE No.
MAT. SPECN.
MELT.No.

	FORGING				BA9413253226	876.00	
					AA19332		
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	

NOTE
1. FORGING TO BE MACHINED TO DIMENSIONS INDICATED IN THE DRAWING
2 CHAMFER SHARP CORNERS TO R2 & ALL FILLET RADIUS TO R3
3TEST ULTRASONICALLY AS PER SPECIFICATIONS
AA0850118 CAT-3
4.FORGING SHOULD BE AS PER SPECIFICATIONS AA19332
5. TOLERENCE ON DIAMETERS AND LENGTHS ± 1MM
6. HOLE ϕ32 SHIULD BE CONCENTRIC WITH CENTRE LINE WITH ± 1MM
7. FOR FINISH MACHININING REFER 1-61-000-00363

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 NARAYANA	CHD. N.D.S	APPD. S.GADGA
01	4.11.03			
ZONE	DRAWING DRAWN ON AUTOCAD			

REV.	DATE	ALTERED NARAYANA	CHD. N.D.S	APPD. S.GHATGE
01	4.11.03			
ZONE				

FILE NAME

1-61-000-00363 REF.DRG.NO.

INVENTORY NO.

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: 1003 XRP BOWL MILL KORBA & RAMAGUNDAM 500 MW

BHARAT HEAVY ELECTRICALS LTD.
HYDERABAD

	NAME	SIGN.	DATE	NO.OF VAR.
DRN.	NARAYANA		4.11.04	
CHD.	N.D.S		4.11.03	
APPD.	S.GHATGE			

DEPT.	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	NO.OF ITEMS
PULVE.ENGG	1:10	876.00	1-61-000-00363		
CODE 446					

TITLE: JOURNAL SHAFT
(ROUGH MACHINED)

DRAWING NO. 3-61-000-90173 REV. 01

SHEET NO. 01 NO OF SHEETS 01

TD-151/REV. 03 SIZE A3

FIRST ANGLE PROJECTION

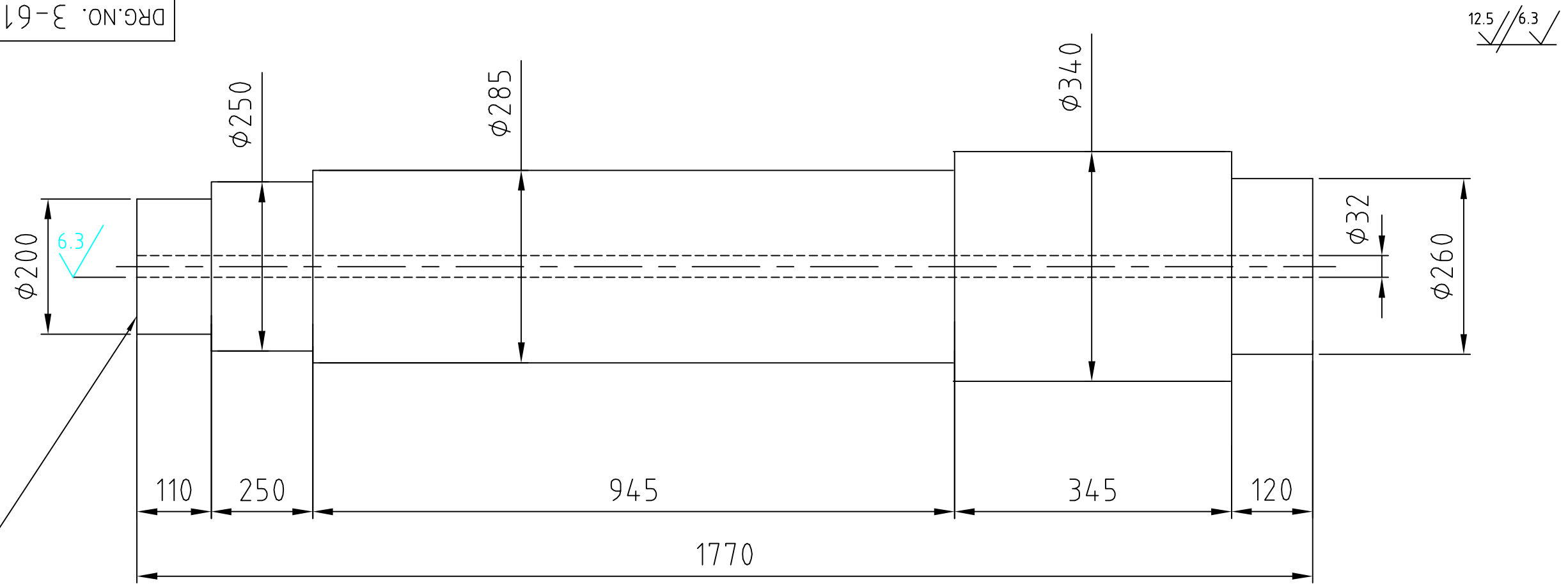
(ALL DIMENSIONS ARE IN mm)

DRG.NO. 3-61-004-90184

36190184.DWG FILE NAME

1-61-004-01183 REF.DRG.NO.

INVENTORY NO.



LOCATE HARE ATTESTATION DETAILS VIZ.
SUPPLIERS CODE
FORGE No.
MAT. SPECN.
MELT.No.

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				BA9413253242	890	
					AA19332		
					MATERIAL SPECN.	QUANTITY	

NOTE
1. FORGING TO BE MACHINED TO DIMENSIONS INDICATED IN THE DRAWING
2. CHAMFER SHARP CORNERS TO R2 & ALL FILLET RADIUS TO R3
3.TEST ULTRASONICALLY AS PER SPECIFICATIONS AA0850118 CAT-3
4. FORGING SHOULD BE AS PER SPECIFICATIONS AA19332
5. TOLERENCE ON DIAMETERS AND LENGTHS ± 1MM
6. HOLE ϕ32 SHIULD BE CONCENTRIC WITH CENTRE LINE WITH ± 1MM
7. FOR FINISH MACHININING REFER 1-61-004-01183

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 PKP	CHD. CKP	APPD. V KUMAR
ZONE					ZONE		DRAWING DRAWN ON AUTOCAD DIM. 120, 945, 250 WERE 105, 950 AND 260 RESPECTIVELY.		
					01	07.11.12			

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: 1043 XRP BOWL MILL CHANDRAPUR 500 MW

BHARAT HEAVY ELECTRICALS LTD.
HYDERABAD

	NAME	SIGN.	DATE	NO.OF VAR.
DRN.	PKP		07.11.12	
CHD.	CKP		07.11.12	
APPD.	V KUMAR		07.11.12	

DEPT.	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	NO.OF ITEMS
PULVE.ENGG	NTS	890.00			
CODE 446					

TITLE: JOURNAL SHAFT
(ROUGH MACHINED)

DRAWING NO. 3-61-004-90184 REV. 01

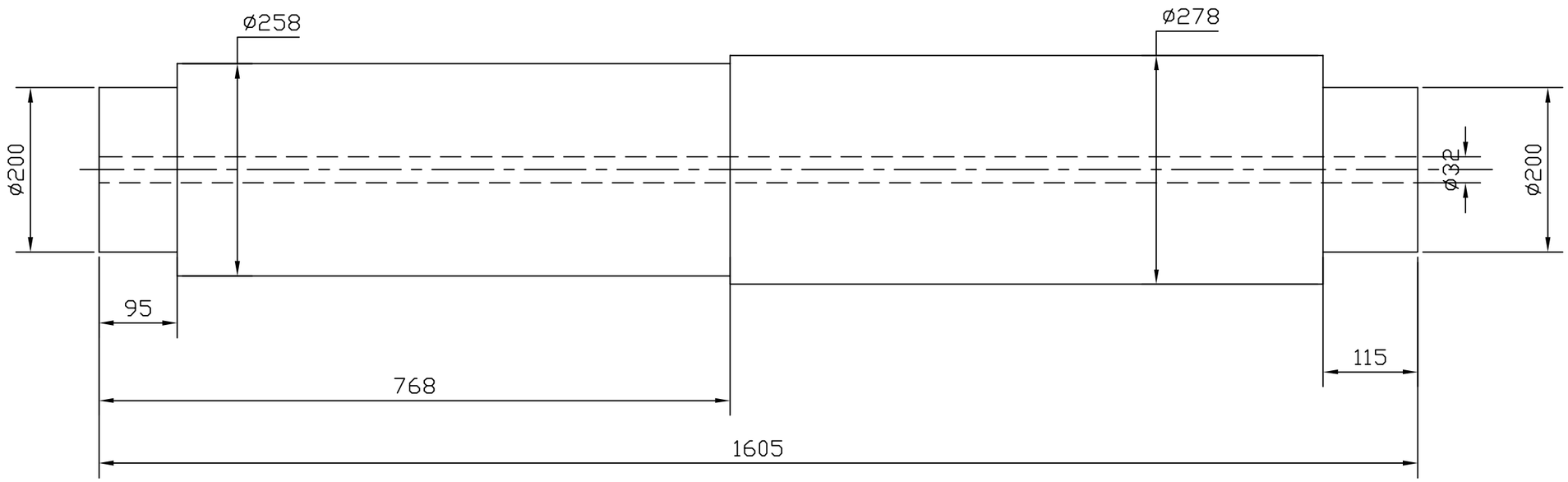
SHEET NO. 01 NO OF SHEETS 01

TD-151/REV. 03 SIZE A3

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

DRG.NO. 3-61-088-02391



1. FORGING SHALL BE ROUGH MACHINED TO DIMENSIONS INDICATED IN THE DRAWING
2. BREAK ALL SHARP EDGES&ALLCORNER RADII TO BE R2
3. FORGING SHALL BELTESTED ULTRASONICALLY AS PER BHEL CORP.STDAA0850118 CAT-2
4. REFER DRG 2-61-088-02058 FOR FINISH MACHINING
5. HOLE ±32 SHOULD BE CONCENTRIC WITH RESPECT TO CENTRE LINE WITH IN 0.5MM

ITEM NO	DESCRIPTION	DRAWING NO.	VAR. NO.	RAW MATERIAL SIZE OR CASTING DRG.NO. OR FORGING DRG.NO.	MATERIAL CODE / MATERIAL SPECN.	NET WT. / QUANTITY	GROSS WT.
	FORGING				BA9516953018 / HY19369,REV,01		

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.
01	15.11.03	NARAYANA	N.D.S	S.G

ZONE

DRAWING DRAWN ON AUTOCAD

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: 883 XRP BOWL MILL

BHARAT HEAVY ELECTRICALS LTD.
HYDERABAD

	NAME	SIGN.	DATE	NO.OF VAR.
DRN.	NARAYANA		15.11.03	
CHD.	N.D.S		15.11.03	
APPD.	S.GADGA			

DEPT.	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	NO.OF ITEMS
PULVE.ENGG	1:5	662	-		
CODE 446					

TITLE: JOURNAL SHAFT (ROUGH MACHINED)

DRAWING NO. 3-61-088-02391 REV. 01

SHEET NO. 01 NO OF SHEETS 01

FILE NAME 02

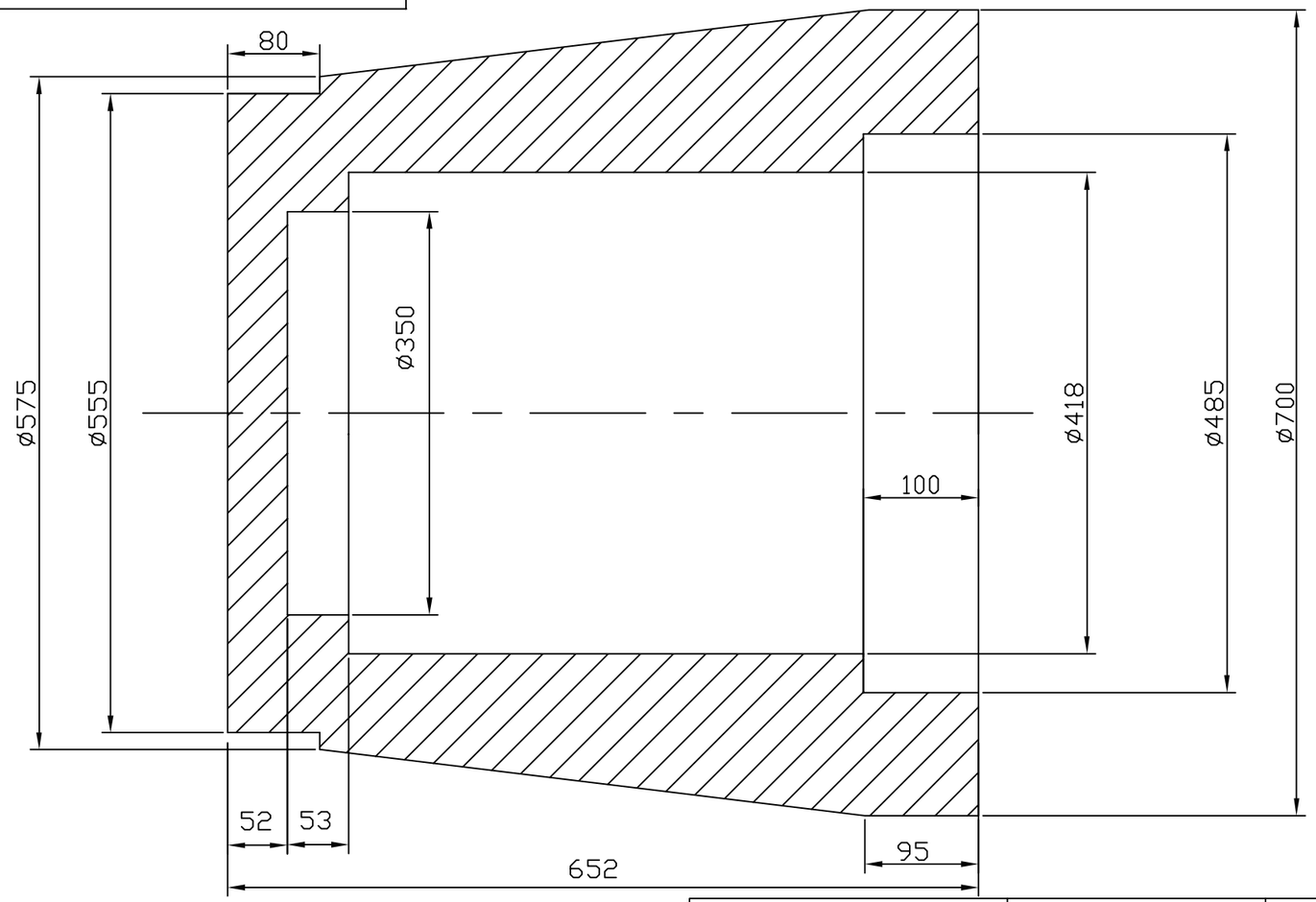
REF.DRG.NO.

INVENTORY NO.

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

DRG.NO. 3-61-088-02392



12.5

NOTE

1. FORGING TO BE ROUGH MACHINED TO DIMENSIONS INDICATED IN THE DRG
2. BREAK ALL SHARP EDGES &ALL CORNER RADII TO BE R2
3. TEST ULTRASONICALLY AS PER SPECIFICATIONS AA0850118 CAT-3
4. FOR FINISH MACHINING REFER 2-61-088-02056

FORGING				BA9413221316	990	
				AA 19332	1	
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.

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: 883 XRP BOWL MILL

BHARAT HEAVY ELECTRICALS LTD.
HYDERABAD

	NAME	SIGN.	DATE	NO.OF VAR.
DRN.	NARAYANA		17.11.03	
CHD.	N.D.S		17.11.03	
APPD.	S.GHATGE		17.11.03	

DEPT.	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	NO.OF ITEMS
PULVE.ENGG	1:5	990	26108802056	1	1
CODE 446					

TITLE: LOWER JOURNAL HOUSING (ROUGH MACHINED)

DRAWING NO. 3-61-088-02392 REV. 03

SHEET NO. 01 NO OF SHEETS 01

REF.DRG.NO.						
03	29.12.08	ALTERED PKP	CHD CKP	APPD VKR.		
ZONE	STEP OF ø 555, 80L ADDED					

INVENTORY NO.						
REV. 02	DATE 4.2.06	ALTERED NARAYANA	CHD N.D.S	APPD S.G		
ZONE	DIM 52 WAS 35.					
REV. 01	DATE 3.11.03	ALTERED NARAYANA	CHD N.D.S	APPD S.G		
ZONE	DRAWING DRAWN ON AUTOCAD					

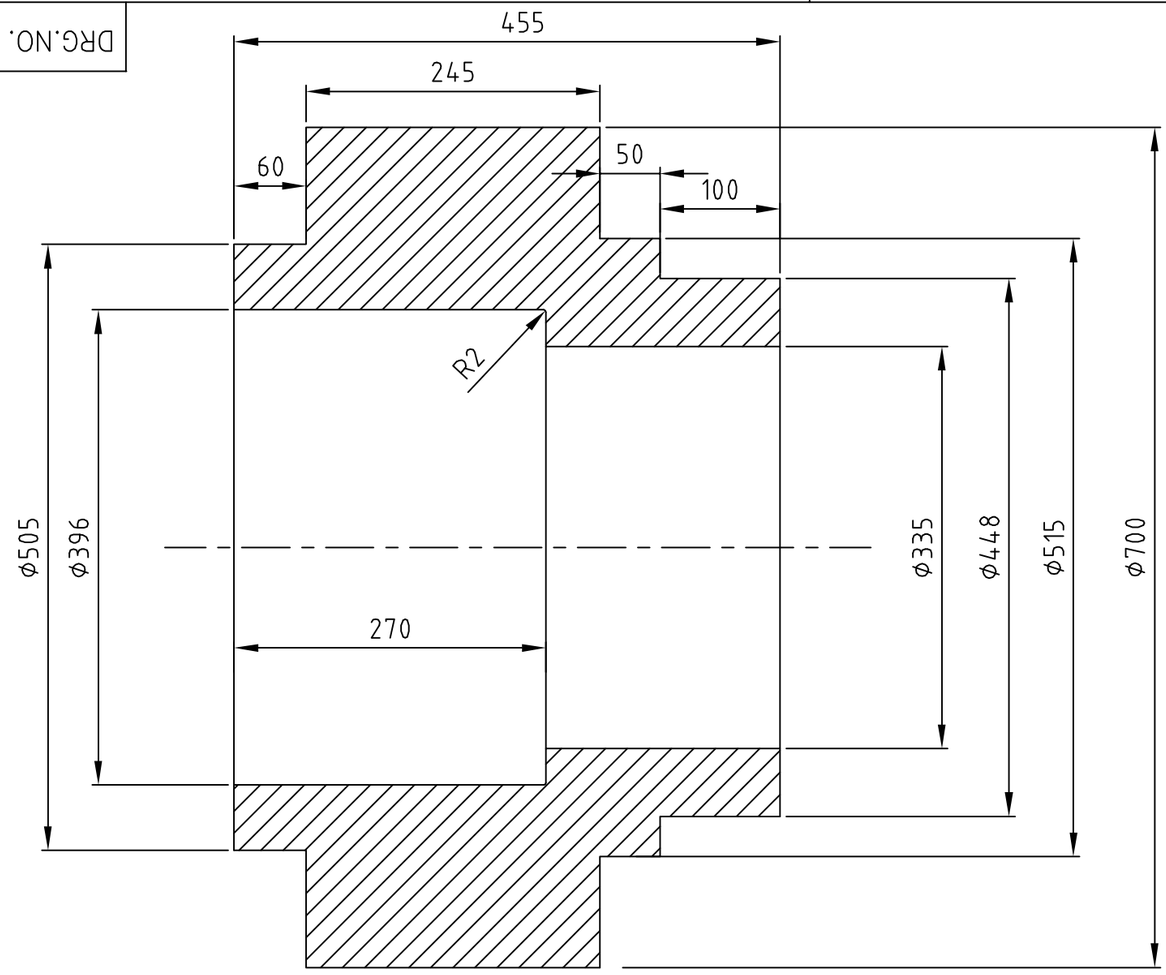
FILE NAME: 36102392.DWG

TD-151/REV. 03 SIZE A3

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

DRG.NO. 3-61-088-02393



12.5

NOTE

1. FORGING TO BE ROUGH MACHINED TO DIMENSIONS INDICATED IN THE DRAWING
2. BREAK ALL SHARP EDGES & ALL CORNER RADII TO BE R2
3. TEST ULTRASONICALLY AS PER SPECIFICATIONS AA0850118 CAT-3
4. FOR FINISH MACHINING REFER 2-61-088-02059

FORGING				BA9413221324	653.0	
				AA 19332		
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.
01	3.11.03	ALTERED NARAYANA	CHD.N.D.S	APPD.S.G
ZONE			ZONE	DRAWING DRAWN ON AUTOCAD

INVENTORY NO.

REF.DRG.NO.

36102393.DWG FILE NAME

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: 883 XRP BOWL MILL

BHARAT HEAVY ELECTRICALS LTD. HYDERABAD

	NAME	SIGN.	DATE	NO.OF VAR.
DRN.	NARAYANA		17.11.03	
CHD.	N.D.S		17.11.03	
APPD.	S.GHATGE		17.11.03	

DEPT.	CODE	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	NO.OF ITEMS
PULVE.ENGG	446	1:5	653	2.61.088.02059	1	1

TITLE: UPPER JOURNAL HOUSING (ROUGH MACHINED)

DRAWING NO. 3-61-088-02393 REV. 01

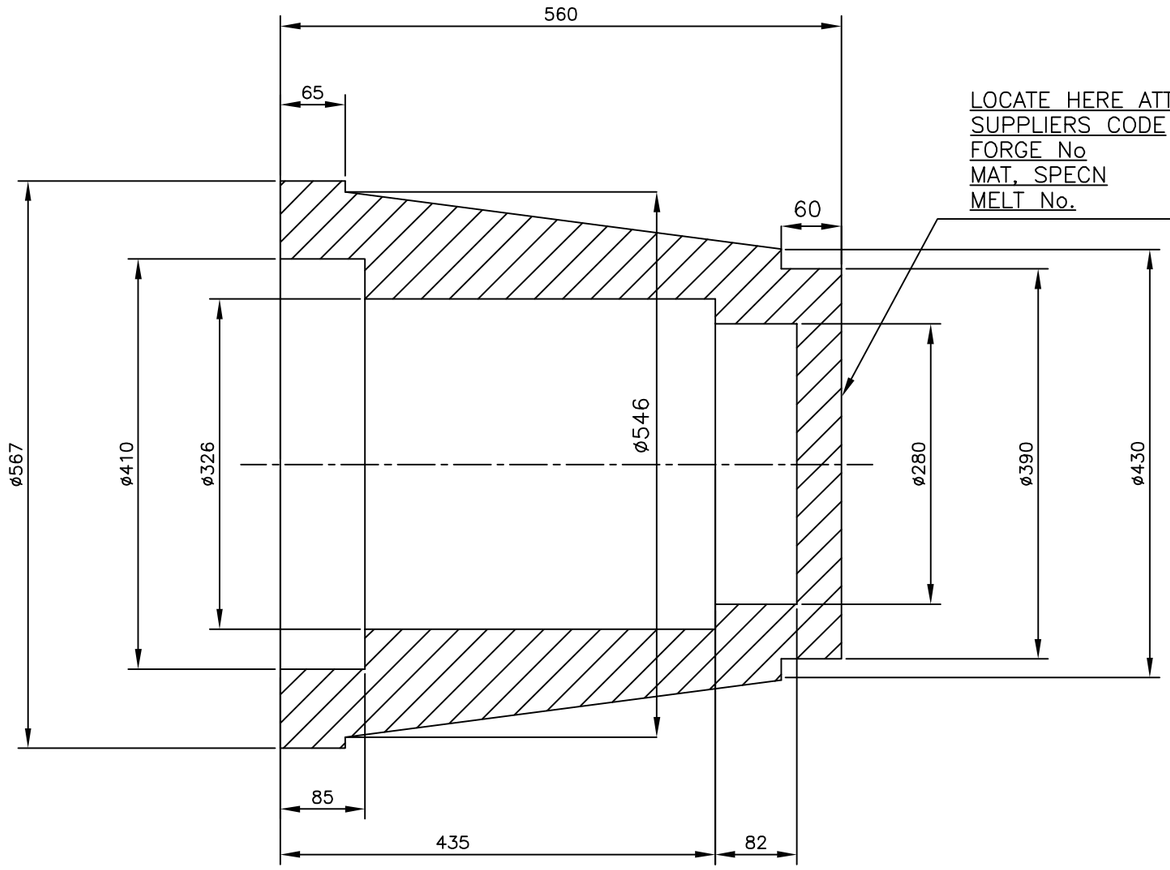
SHEET NO. 01 NO OF SHEETS 01

TD-151/REV. 03 SIZE A3

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

DRG.NO. 3-61-376-90010



12.5

LOCATE HERE ATTESTATION DETAILS VIZ
SUPPLIERS CODE
FORGE No
MAT, SPECN
MELT No.

NOTE:—

1. FORGING TO BE ROUGH MACHINED TO DIMERNSIONS INDICATED IN DRG
2. FIGURE IN DASHED LINE REPRESENTS SHAPE OF FINAL MACHINED COMPONENT
3. CORNER CHAMFERS –R2;FILLET RADIUS–R3.
4. TOLERENCE ON DIAMETERS AND LENGTH ±1MM
5. FORGING SHOULD BE AS PER CPS–AA19332
6. TEST ULTRASONICALLY AS PER CORP ORATION STD AA–085–01–18–CAT–3

	FORGING				BA9413221022		
					AA 19332		
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.

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT

MATERIAL ATTEST
76"BOWL MILL

BHARAT HEAVY ELECTRICALS LTD.
HYDERABAD

	NAME	SIGN.	DATE	NO.OF VAR.
DRN.	NARAYANA		14.11.03	
CHD.	N.D.S		14.11.03	
APPD.	S.GHATGE			

DEPT.	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	NO.OF ITEMS
PULVE.ENGG	N.T.S	480	40–F–002–016		
CODE 446					

TITLE
LOWERJOURNAL HOUSING

DRAWING NO. 3–61–376–90010 REV. 08

SHEET NO. 01 NO OF SHEETS 01

REV.	DATE	ALTERED		ZONE
08	07.10.09	CHD. CKP	APPD. V.KR.	ø280 STEP LENGTH WAS 65 ø326 WAS ø330 WEIGHT CORRECTED.
07	22.10.08	CHD. CKP	APPD. V.KR.	ø 546 STEP ADDED
06	14.11.03	ALTERED NARAYANA CHD. N.D.S	APPD. S.G	DRAWING DRAWN ON AUTOCAD

40–F–002–016 REF.DRG.NO.

FILE NAME

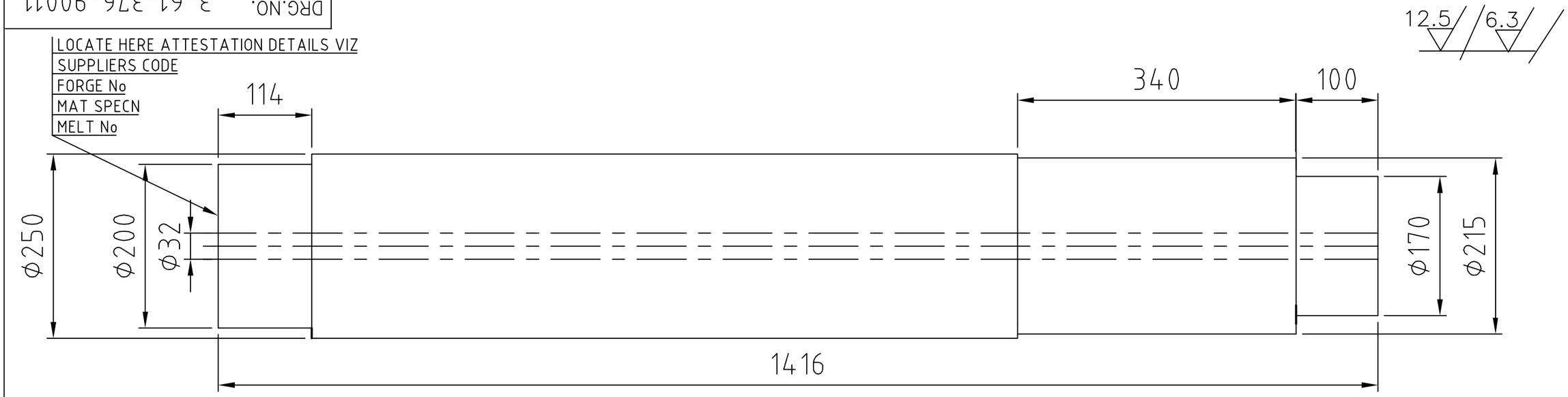
INVENTORY NO.

TD–151/REV. 03 SIZE A3

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

DRG.NO. 3-61-376-90011



NOTE

1. FORGING TO BE ROUGH MACHINED TO DIMENSIONS INDICATED IN THE DRAWING.
2. CHAMFER SHARP CORNERS TO R2 & ALL FILLET RADIUS TO R3.
3. TEST ULTRASONICALLY AS PER SPECIFICATION AA0850118 CAT-2.
4. FORGING SHOULD BE AS PER SPECIFICATION AA19332
5. TOLERENCE ON DIAMETERS AND LENGTHS ± 1 mm.
6. HOLE ϕ32 SHOULD BE CONCENTRIC WITH CENTER LINE WITHIN ± 1mm.

ITEM NO	DESCRIPTION	DRAWING NO.	VAR. NO.	RAW MATERIAL SIZE OR CASTING DRG.NO. OR FORGING DRG.NO.	MATERIAL CODE	NET WT.	GROSS WT.
	FORGING				BA9413253048	463	
					AA19332		
					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.
03	17.11.03	ALTERED NARAYANA	CHD. N.D.S	APPD.S.G

ZONE

DRAWING DRAWN ON AUTOCAD

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: 76"BOWL MILL 'MATERIAL ATTEST'

BHARAT HEAVY ELECTRICALS LTD. HYDERABAD

	NAME	SIGN.	DATE	NO.OF VAR.
DRN.	NARAYANA		17.11.03	
CHD.	N.D.S		17.11.03	
APPD.	S.GHATGE		17.11.03	

DEPT.	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	NO.OF ITEMS
PULVE.ENGG	NTS	463	–		
CODE 446					

TITLE: JOURNAL SHAFT (ROUGH MACHINED)

DRAWING NO. 3-61-376-90011 REV. 03

SHEET NO. 01 NO OF SHEETS 01

TD–151/REV. 03 SIZE A3

FILE NAME

REF.DRG.NO.

INVENTORY NO.

	AMENDMENT - NOTIFICATION	AA 085 01 18 REV. No. 01 PAGE 1 OF 1

AA 085 01 18:ULTRASONIC TESTING CLASSIFICATION AND ACCEPTANCE STANDARDS FOR STEEL FORGINGS, BILLETS AND BLOOMS

1.0 PAGE 1 OF 6; Cl 1.0 SCOPE:
Last sentence of the para is modified as follows:
"This standard does not apply to austenitic steel forgings for which AA 085 01 19 may be referred to."

2.0 Cl 3.2 Sensitivity:
Title of the left hand column of the table is modified as "Frequency, MHz" in place of Frequency range, MHz.

3.0 PAGE 2 OF 6; Cl 5.0 COUPLANT:
Last line is modified as "or water shall be used.

4.0 Cl 6.1: Eight line is modified as follows:
"shall not exceed 150mm/second. The following techniques"

Please see instructions on the reverse.

Ref:	Amd. No.	Approved	Issued	Date	Cum. Sr. No.
Cl:10.2.4 of MOM	01	WG-NDT	CORP. R&D	15.1.96	A 1822

ULTRASONIC TESTING, CLASSIFICATION AND ACCEPTANCE STANDARDS FOR STEEL FORGINGS, BILLETS AND BLOOMS

1.0 SCOPE:

This standard deals with the ultrasonic testing of steel forgings, billets and blooms. The procedure covers pulse echo direct contact manual ultrasonic flaw detection technique. This standard does not apply to austenitic steel forgings.

2.0 PERSONNEL REQUIREMENT:

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

3.0 EQUIPMENT CHARACTERISTICS:

3.1 Frequency range:

The ultrasonic equipment shall be suitable for operating at frequencies within the range of 0.5 to 6 MHz.

3.2 Sensitivity:

The sensitivity of the equipment shall be tested to ensure that the number of full screen back wall echo is not less than that given below, when the appropriate probe is placed on the metalised surface of plastic insert of the Indian Standard reference block (IS:4904)/IIW block.

Frequency range, MHz	Min.No. of full screen back echoes
1	5
2	4
4 to 6	2

3.3 Resolution:

The resolution of the equipment and probe combined shall be such as to show separately indications of the three grooves in the IIW - VI block.

4.0 SURFACE CONDITION:

The test surface shall be free from loose scales, rust and such other extraneous material that would interfere with the ultrasonic energy transmission. In case of machined surface, it is desirable to have a surface finish of 6.25 microns or better. A gramophone record type of finish and tear produced by machining tools shall be avoided since these give rise to spurious echoes and cause probe wear.

5.0 COUPLANT:

To ensure adequate transmission of ultrasonic energy between the probe and the test object, a suitable couplant having good wetting characteristics such as oil, grease, water, glycerine or cellulose paste shall be used.

6.0 TESTING TECHNIQUE:

6.1 Selection of testing technique shall be made after giving due consideration to the method of manufacture and shape of the object tested. Testing technique should be such that each and every part of the object volume is scanned at least once. Successive scans shall overlap a minimum of 15% of the probe width. Uniform contact shall be maintained between probe and object and scanning speed shall not exceed 100 mm/ second. The following techniques are considered to be minimum for providing adequate coverage.

6.2 Scanning Scheme (Solid And Hollow Forgings):
Complete length of the forging shall be scanned radially from sides / cylindrical surface through 360° using longitudinal wave probe. Whenever practicable the forging shall be scanned in axial direction also. Hollow forgings, and when necessary, solid forgings also shall be scanned using appropriate shear wave probes to detect axial and radial cracks. Hollow forgings are the forgings made hollow on the press by punching or ring rolling operation.

6.3 Solid Rectangular Forgings, Billets And Blooms:
Complete length of the object shall be scanned from two adjacent faces and whenever practicable one end face using longitudinal wave probe.

6.4 Radial cracks on round sections which can not be detected by normal testing method may be subjected to other crack detection methods such as MPI.

7.0 SCANNING:

7.1 Probes and Frequency:
Overall scanning shall be done using 2 MHz nominal, 20-25 mm diameter probes except when large grain size and path length make it necessary to use a lower frequency. Smaller probes may be used when necessary. However, for forgings intended for backing material for white metal lined bearings, the examination shall be carried out by 4 MHz probes.

7.2 Time Base Calibration:
The time base shall be calibrated using a calibration block or a known dimension of forging under examination.

7.3 Sensitivity:

7.3.1 When Calibrated Attenuator Is Not Available:

Reference sensitivity of equipment shall be set such that the maximum acceptable defect equivalent flat bottomed hole in the test block is equal to 75% of the full screen height. Testing shall be carried out at the highest sensitivity possible.

7.3.2 When Calibrated Attenuator Is Available:

The sensitivity of the equipment during scanning shall be set 6 dB more than the sensitivity required to give a full screen height echo from the maximum acceptable size of defect.

Note: The above sensitivity level adjustment is purely for scanning purposes. Once a defect is encountered, the sensitivity shall be brought down to estimate the size of defect for evaluation of the material under test.

8.0 ESTIMATION OF FLAW SIZE:

8.1 Large Size Flaws:

The size of large flaws can be estimated by moving the probe in all directions and plotting the midpoint of the probe when echo falls to 50 percent or 6 dB.

8.2 Small Size Flaws:

8.2.1 When Calibrated Attenuator Is Not Available:

8.2.1.1 The size of the flaw may be estimated by comparing with the echoes of the flat bottomed holes at appropriate depths in a test block of ultrasonically similar material.

8.2.1.2 The size of the flaw may also be estimated by moving probe successively in all the four directions at right angles to each other and plotting the mid point of the probe when echo height falls to 50% or 6 dB. Due allowance shall also be made for beam spread, depth and orientation of flaw and diameter of the forging if the scanning is done from the curved surface.

8.2.2 When Calibrated Attenuator Is Provided With The Equipment:

The size of the flaw (smaller than the beam spread) can be estimated accurately in millimetres of equivalent circular flaw with the help of Krautkramer's DGS (Distance - gain - size) diagram. Method of estimating flaw size using a DGS diagram is given in Annexure - A.

9.0 CLASSIFICATION OF FORGINGS, BILLETS AND BLOOMS:

9.1 Forgings, billets and blooms are classified into the following five categories depending upon the defect size admissibility for the purpose of ultrasonic testing:

Category	Unacceptable defects
1	(i) Cracks, flakes, seams & laps. (ii) Defects giving indication larger than that from a 2 mm diameter equivalent flaw. (iii) Groups of defects with maximum indication less than that from a 2 mm diameter equivalent flaw which cannot be separated at testing sensitivity if the back echo is reduced to less than 70%. (iv) Defects giving indications of 1 to 2 mm diameter equivalent flaw separated by a distance less than four times the size of the larger of the adjacent flaws.
2	(i) Cracks, flakes, seams & laps. (ii) Defects giving indication larger than that from a 4 mm diameter equivalent flaw. (iii) Groups of defects with maximum indication less than that from a 4 mm diameter equivalent flaw which cannot be separated at testing sensitivity if the back echo is reduced to less than 50%. (iv) Defects giving indications of 2 to 4 mm diameter equivalent flaw separated by a distance less than four times the size of the larger of the adjacent flaws.
3	(i) Cracks, flakes, seams & laps. (ii) Defects giving indication larger than that from a 6 mm diameter equivalent flaw. (iii) Groups of defects with maximum indication less than that from a 6 mm diameter equivalent flaw which cannot be separated at testing sensitivity if the back echo is reduced to less than 40%. (iv) Defects giving indications of 3 to 6 mm diameter equivalent flaw separated by a distance less than four times the size of the larger of the adjacent flaws.
4	(i) Cracks, flakes, seams & laps. (ii) Defects giving indication larger than that from a 10 mm diameter equivalent flaw. (iii) Groups of defects with maximum indication less than that from a 10 mm diameter equivalent flaw which cannot be separated at testing sensitivity if the back echo is reduced to less than 20%.

(iv) Defects giving indications of 5 to 10 mm diameter equivalent flaw separated by a distance less than four times the size of the larger of the adjacent flaws.

5 (i) Cracks, flakes, seams & laps.
(ii) Defects giving indication larger than that from a 15 mm diameter equivalent flaw.
(iii) Groups of defects with maximum indication less than that from a 15 mm diameter equivalent flaw which cannot be separated at testing sensitivity if the back echo is reduced to less than 10%.

Note: Loss of back wall echo not attributable to the presence of defects or geometry and exceeding the limits mentioned in item (iii) of each category of unacceptable defects shall be a cause for rejection.

ANNEXURE - A

The equivalent flaw size curves of the DGS diagram is prepared by plotting the amplitude in decibels from a series of circular reflectors with increasing distance from the probe in water and so the graph incorporates only the loss in water. When it is found that the attenuation in the material under test is more (this can be checked using back echo curve of DGS diagram), this shall be taken into account while calculating the flaw size. Corrections will not be required for majority of heat treated forgings when tested with 2-4 MHz probes.
A step by step method of estimating flaw size using universal DGS diagram is given below:

(a) Adjust the depth range of the equipment to the required depth.

(b) Adjust the back echo to 70% of screen height from a defect free area parallel wall of the material under test or ultrasonically similar test block and note the dB value (A) on the calibrated gain control.

(c) Mark on the back echo curve of the diagram, the back wall of the distance in terms of near field in millimetres in the case of universal DGS diagram.

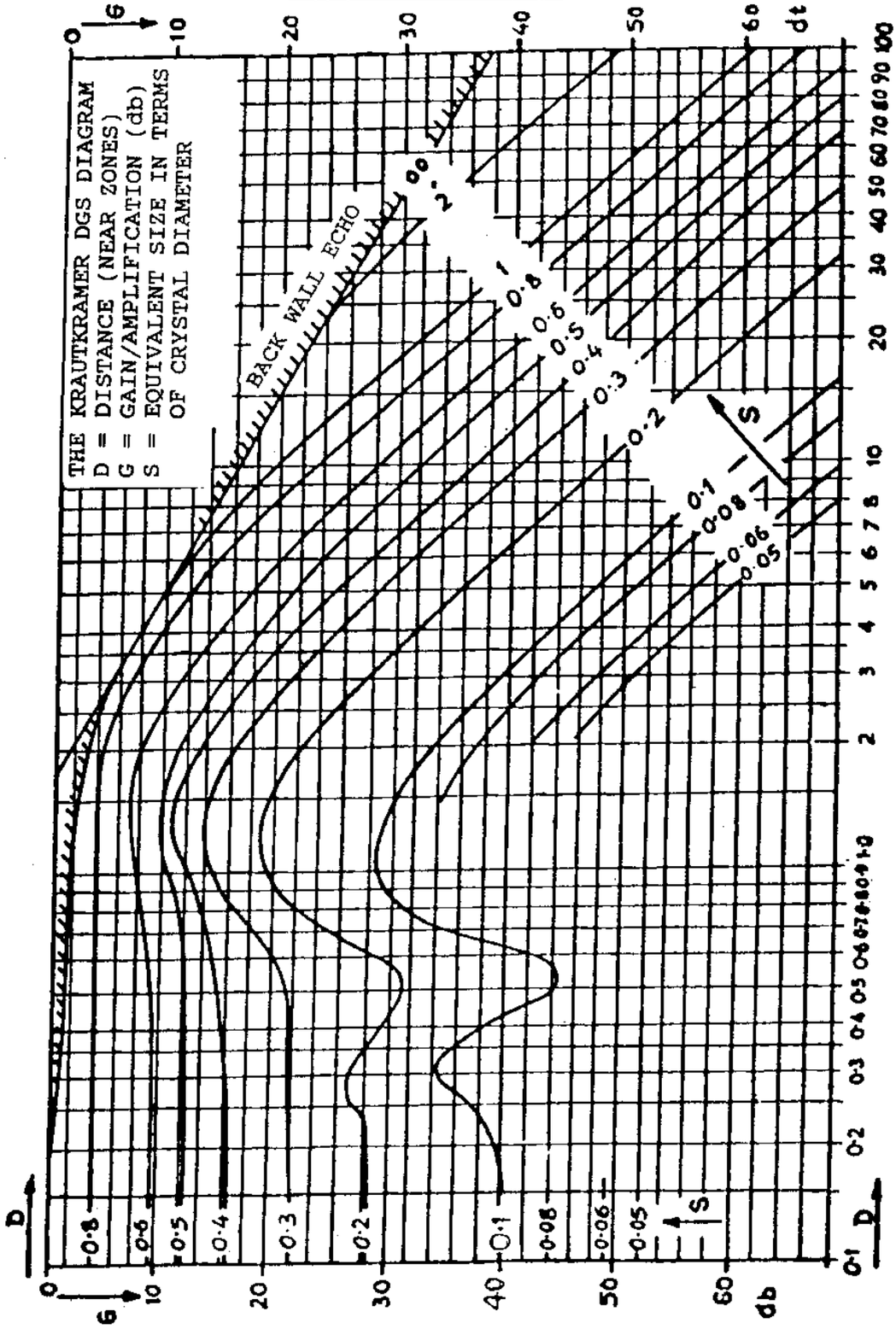
(d) Move the probe to the defective area and get the maximum defect echo. Read off the flaw depth. Increase the gain with the calibrated gain control until echo height reaches 70% of screen height. Note the attenuator reading in dB (B).

(e) Calculate the gain (G) in dB by subtracting 'A' from 'B'. Count off the gain 'G' downwards from the marked point on the back echo curve, and then move horizontally to intersect the vertical line from the base line corresponding to the flaw depth 'D' in terms of near field in the case of universal diagram.

(f) Note the equivalent flaw size curve passing through the above point. Multiply the reduced flaw dimension (S) of the curve by the probe diameter to give the equivalent flaw size in millimetres.

ANNEXURE - A

KRAUTKRAMER'S DGS DIAGRAM



PROCEDURE FOR MAGNETIC PARTICLE EXAMINATION

1.0 SCOPE:

1.1 This standard outlines the procedure for magnetic particle examination of ferro-magnetic materials.

1.2 Typical surface and subsurface discontinuities detectable by this method are cracks, seams, laps, cold shut, inclusions, etc.

1.3 This shall be applied to all forms of ferromagnetic material as formed and semiformal as well as, finished state, such as welds, forgings, castings, etc.

1 .4 This standard is generally based on ASTM E 709.

2. 0 PERSONNEL REQUIREMENT:

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

3.0 TEST METHOD:

- 4

Finely divided magnetic particles are applied to the surface of a part which has been suitably magnetised. The particles are attracted to regions of magnetic non-uniformity associated with defects and discontinuities, thus producing indications which are observed visually. The magnetic particle is applied either as dry powder or in a wet suspension in a liquid medium.

4.0 SURFACE CONDITION/PREPARATION:

The surface being inspected shall be clean and dry. It shall be free from dirt, oil, grease, sand, rust or loose scale. As cast or as welded surfaces are generally satisfactory if clean. A pressure blast is useful for this purpose. Thin paint does not interfere with the formation of indications but must be removed at points where electrical contact is to be made. If the surface is unusually rough, such as with burned in sand or very rough weld bead, interpretation may be difficult because the particle is being trapped mechanically. In case of doubt, light grinding may be necessary to determine if actual indications are present..

5 .0 SEQUENCE OF OPERATION:

5.1 Method Of Examination:

Examination shall be generally carried out by the continuous method, i.e., the magetising current remains on, while the examination medium is being applied and excess being removed.

5.2 Magnetisation:

Any suitable and appropriate means for establishing the necessary magnetic flux may be employed, such as passing current through the material (e.g. 'Prod' method) using magnetic yoke, or wrapping the part with a coil through which a magnetising current is passed.

5.3 Examination Medium:

5.3.1 The finely divided ferromagnetic particles used for detection of discontinuities shall be of fine grain and the same shall be of high permeability and low retentivity. It shall be of dry powders (Fluorescent and nonfluoresent) ready for use, as supplied or powder concentrates (Fluorescent and non-fluoresent) for dispersion in water or suspending light petroleum distillates.

5.3.2 Dry Particles:

When dry particles are used, they shall be sprayed either by a low pressure pneumatic instrument or hand operated bulb blower. Colour of the powder shall be such as to provide adequate visual contrast with the back ground of the surface being examined. The temperature of the surface of the part under examination shall not exceed 315℃ (600*F). Adequate lighting should be provided for easy observation of the indication. Some coloured organic coatings applied to dry particles to improve contrast lose their colour at higher temperatures- Fluorescent dry particles shall not be used at this high temperature. Manufacturer's recommendations for temperature limitation shall be followed.

5.3.3 Wet Particles:

When wet particles are used, the solid magnetic particles shall be suspended in a suitable liquid medium. The concentration of the particles in the"liquid medium shall be 0.2 to 0.4 ml in a 100ml sample for fluorescent particles and from 1.2 to 2.4 ml in a 100 ml for non-fluorescent particles unless otherwise specified by the particle manufacturer.

5. 3 .4 Florescent Particlaes

5. 4. 3. 1 The fluorescent particle examination shall be performed using a black light in a darkned area.

•

5. 3. 4. 2 The black light used for fluorescent particle testing shall be capable of developing the wave length of 365mm; in any case the wave length should be in the range of 330 to 390nm. with an intensity of not less than 1000 uw/cra^2 on t surface of the part.

5. 3. 4. 3 The black light shall be allowed to warm up for a minimum of 5 min. prior to its use or measurement of the intensity of the ultraviolet light emissio**n.**

5. .3. 4. 4 The examiner shall be in the darkened area for atleast 5 min. prior to examining the parts using black light so that his eyes will adopt to dark viewing. Photochromic or permanently tinted lenses shall not be worn during examination.

5. 3. 4. 5 The black light intensity shall be measured with a black light meter at least once every 8 hours and whenever the work station is changed.

5. 4 Orientation of Discontinuities And Examination Coverage:

Examination shall be conducted with sufficient overlap to ensure cent percent coverage at established test sensivity. To ensure most effective detection of discontinuities each area shall be examined at least twice with the lines of flux approximately perpendicular to each other.

5. 5 Demagnetisation:

Demagnetisation following examination shall be carried out where residual magnetism can interfere with subsequent process or usage. Demagnetisation is not normally required on the type of parts where the dry powder Prod magnetisation is used.

6 . 0 METHODS OF MAGNETISATION:

6 . 1 Prod Method:

6 . 1 . 1 Magnetising Technique:

6. 1. 1. 1 Magnetisation shall be accomplished by portable Prod type electrical contacts pressed against the surface in the area to be examined. To avoid arcing, a remote control switch may be provided to permit the current to be turned on after the prods have been properly positioned and turned off before they are removed.

6 . 1 . 2 Prod Spacing:

Prod Spacing shall be maximum of 200 mm. Shorter spacing may be used to meet the limitation of geometry or dimensions of the area being examined, or to increase the sensitivity, but prod spacing less than 75 mm usually is not recommended owing to banding of the particles around the prods

6. 1. 3 **Magnetising Current:**

Alternating, direct or rectified magnetising current shall be used. The current shall be 90 to 110 A per 25mm. of prod spacing for sections less than 19mm. thick and 110 to 125 A per 25mm. prod spacing for sections 19mm. and greater.'

6. 1. 4 Prod shall be kept free of iron pick up by frequent filing. Local areas of metal being tested which have been subjected to arcing shall be ground to clean metal wherever necessary.

6. 2 Coil Method:

6. 2 .1 Magnetising Technique:

Magnetisation shall be accomplished by pressing current thought a nultiturn coil looped around the part or section of the part to be examined to produce a magnetic field paralled to the axis of the coil.

6. 2. .2 Magnetising Current:

6. 2 .2 .1 Encircling Coils:

There are four empirial longitudinal magnetization formulas for using encircling coils , the formulas to be used depending on the fills factor.

6. 2.. 2.. 1 .1 Low Fill Factor Coils: In this case , the cross sectional area of the fixed encircling coil greatly exceed the cross sectional area of the part (Less than 10% coil inside diameter). The part shall be placed well within the coils ans close to the inside wall of the coil. For parts with length over diameter ratio (L/D) between 3and 15 is calculated from the following equations.

(1) **Parts with low fill factor positioned closed to the inside wall of the coil in the center of the coil;**

$$= \frac{45{,}000}{L/D} \text{ Ampere Turns } (\pm 10\%)$$

(2) Parts with a low fill factor positioned in the center of the coils:

$$= \frac{43{,}000 \times R}{(6L/D) - 5} \text{ Ampere Turns } (\pm 10\%)$$

6. 2. 2. 1.2 Intermediate Fill Factor Coils:

When the cross section of the coil is greater than twice and less than ten times the cross section of part being examined.

= (Nl) hf (10-4) + (Nl) If (4 -2)/8

Where

NIhf = Value calculated for high fill factor coils using

$$\frac{35000}{(L/D) + 2} \quad (10\%)$$

Nllf = Value Calculated for low fill factor coils using

$$\frac{43/000 \times R}{(L/D) - 5} \quad (10\%)$$

Where R = Coil Radius
Y = Ratio of the cross sectional area of the coil to the cross section of the part.

For example if the coil has an inside diameter of 24 cm. and part (a bar) has outside diameter of 12 cm.

$$Y = \frac{n(12)^2 \ ^{=}4}{n(6)2}$$

6. 2. 2 .1 .3 **High Fill Factor Coils:**

In this case, when fixed coils or cable wraps used and the cross sectional area of the coil is less than twice the cross sectional area (Including hollow portions) of the part, the coil has a high fill factor.

For parts with in a high fill factor positional coil and for parts with L/D ratio equal or greater than 3.

$$= \frac{35,000}{(L/D)+2} \text{ Ampere turns } (+ 10\%)$$

L/D ratio for a hallow piece: When calculating L/D ratio for a hollow piece, D shall be replaced with an effective diameter Deff. Calculated using.

Deff. = [(At - Ah)/n]^.

Where
At = Total cross section area of part
Ah = Cross sectional area of hollow portion(s) of the part.

For a cylindrical piece this is equivalent to
Deff. = $[(OD)^2 - (ID)^2]$^

Where
OD = Outside diameter of cylinder
ID = Inside diameter of cylinder.

6.2.2.2 Through Coils:

For through coils the current specified in para 6.3.2 divided by number of turns shall be used.

6.3 Direct Contact Method:

6.3.1 Magnetising Technique:

Magnetising shall be accomplished by passing current end to end through the part to be tested to produce a circular magnetic field perpendicular to the current "flow through the part.

6.3.2 Magnetising Current :

Direct or rectified current shall be used at 280 to 360 amperes per centimeter of part for diameter upto 125 mm; 200 to 280 amperes per centimeter of part for diameter grater than 250mm.
(Note: A different means of magnetisng shall be used for the second examination to fulfill the requirements specified in Cl.5.4).

6.4 Yoke Method:

6.4.1 Application:

This method shall be used only to detect surface discontinuities which actually come to the surface.

6.4.2 Magnetising Technique:

6.4.2.1 Alternating current electromagnetic yoke shall be used to magnetise, provided the yoke has a lifting power of at least 4.5 Kg and a pole spacing of 75 to 150 mm.

6.4.2.2 Alternatively direct current electromagnetic or permanent magnetic yoke shall be used to magnetise, provided the yoke has a lifting power of at least18 kg and a pole spacing of 75 to 150 mm.

6.5 Threading Bar and Coil Technique:

6.5.1 If the part is hollow, flaws in a longitudinal direction may be detected by passing the magnetising current through a bar or cable held within the bore of the part. Alternatively a threading coil may be used.

6.5.2 The current strength shall be equivalent to not less than 10500 ampere turns (a.c; r.m.s value) or 15000 ampere turns (d.c.) per metre of the maximum distance of the bar cable from the surface of the bore of the part.

6. 5. 3 Because of limitations of the equipment, it m<^ be necessary to magnetise the part at several positions within the bore, with the bar or cable lying on the bore surface, in which case the distance between spacing of the conductor or coil for successive checks shall not be grater than 100 mm.

Note: Magnetising particle field indicator shall be used to establish adequacy of the magnetic field.

7. 0 CALIBRATION:

Calibration of the ammeter shall be done as per BHEL Standard AA 085 01 59.

8.0 EVALUATION OP INDICATIONS & INTERPRETATION:

8.1 If the indication is caused by the surface discontinuity the particles are usually tightly held to the surface by a relatively strong magnetic leakage field. The line of particles will be sharp and well defined.

8.2 If the indication is caused by surface discontinuity, the particles are held in a board fuz2y accumulation rather than being sharp and well-defined.

8.3 Non-relevant indications are caused by distortion of magnetic field resulting from magnetic writing, cold working, hard and soft spots, boundaries of heat affected zone, abrupt change of section, etc. Care shall be taken to identify and eliminate them as they may mask the actual defect.

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

9.0 REFERRED STANDARDS (Latest Publication Including Amendments):

1. ASTM E 70
2. BHEL CS AA 085 01 59

ACCEPTANCE STANDARDS FOR INDICATIONS REVEALED DURING MAGNETIC PARTICLE EXAMINATION OF STEEL FORGINGS

1.0 SCOPE:

This standard gives the acceptance norms for indications revealed during the magnetic particle inspection of steel forgings used for general applications.

2.0 PROCEDURE:

The procedure, requirement of equipment, consumables and personnel shall be as per BHEL standard AA 085 01 33 which is generally based on ASTM E 709.

3.0 ACCEPTANCE NORMS:

Following defects are unacceptable.

Category I:

i) Any cracks/linear indication.

ii) Rounded indication larger than 3mm size.

iii) Groups of rounded indications with individual size of 3mm or less and separated by a distance of less than 2 times the largest defect.

Category II:

i) Any cracks/linear indication.

ii) Rounded indication larger than 6mm size.

iii) Groups of rounded indications with individual size of 6mm or less and separated by a distance of less than 2 times the largest defect.

4.0 REFERRED STANDARDS(Latest Publications Including Amendments):

1. BHEL CS AA 085 01 33
2. ASTM E 709

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:

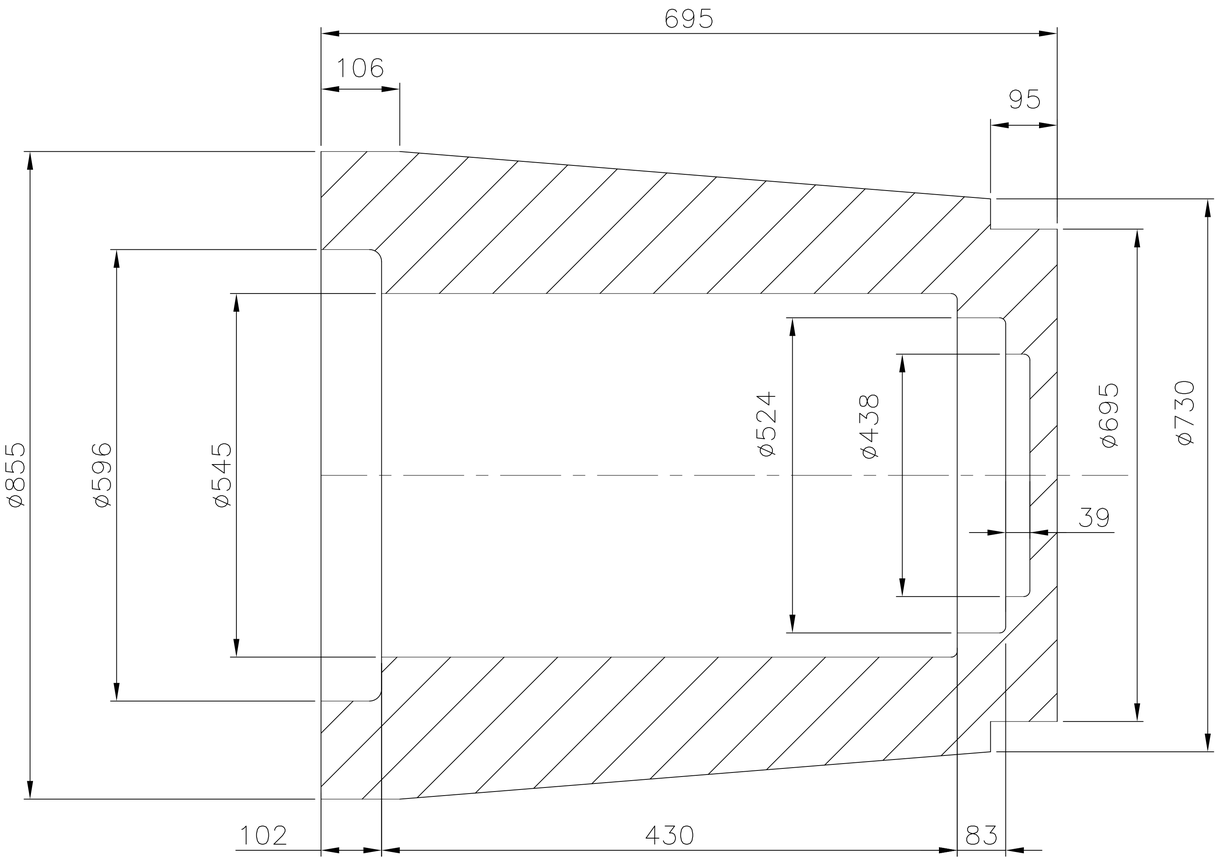
INSTRUCTIONS

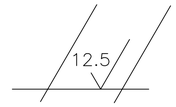
a) Details of all heat treatment processes carried out should be furnished sequentially in 17.
b) Test certificates are to be furnished as per Purchase order and specification, in A4 size preferably in transparent paper.
c) All the entries including signature should be in block colour ink.
d) If testing 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.

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

DRG.NO. HY-312.A.02.F





NOTES:-

1. FORGING SHOULD BE AS PER SPECN. AA19332
2. CHAMFER SHARP CORNERS TO R2 & FILLET RADIUS TO R3
3. TOLERANCE ON DIAMETER AND LENGTH ±1 mm
4. TEST ULTRASONICALLY AS PER SPEC AA 0850118 CAT2

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				AA19332	1475	
					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: XRP-1003 MILL KORBA & RAMAGUNDEM

BHARAT HEAVY ELECTRICALS LTD. VARANASI

	NAME	SIGN.	DATE	NO.OF VAR.
DRN.	D.BASAK		2.07.04	/
CHD.	S.TEWARI		2.07.04	
APPD.	V.KUMAR		2.07.04	

DEPT.	SCALE	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO.	NO.OF ITEMS
PULV ENGG. CODE 446	1:4	1475	16100000375	/	/

TITLE: L.J.HOUSING R/MCD FORGING

DRAWING NO. HY-312.A.02.F — REV. 00

SHEET NO. 01 — NO OF SHEETS 01

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

INVENTORY NO. | HERP MADE DRG LOCATION: | HY-312.A.02.F FILE NAME

TD-151/REV. 03 SIZE A3

ALLOY STEEL FORGINGS –H &T
GRADE : 40 Ni Cr Mo 65

1.0 GENERAL:

This specification governs the quality requirements of alloy steel forgings of grade 40 Ni Cr Mo 65.

2.0 APPLICATION:

Forgings are suitable for main vertical shaft and general engineering purposes requiring high tensile strength and good ductility.

3.0 CONDITION OF DELIVERY:

The forgings shall be supplied in hardened & tempered condition. Final stress relieving shall be performed if mentioned in the drawing. Forgings shall be rough machined unless otherwise specified.

4.0 COMPLIANCE WITH NATIONAL STANDARDS:

The forgings shall in general comply with the requirements of BS PD – 970: 2001, Gr. 817 M40.

5.0 DIMENSIONS AND TOLERANCES:

The dimensions shall be as per the ordering drawing and tolerances shall be as follows.

a) For finish machined component drawings the extra allowance of 3 mm/ surface shall be provided for finish machining at BHEL.

b) For rough machined forging drawings necessary finish machining allowance is included in the dimensions. Extra allowance is not required.

c) The tolerance on rough machined surface shall be ± 1mm dimension, unless otherwise specified in the drawing.

6.0 MANUFACTURE:

The method of steel manufacture shall be at the discretion of the supplier. However, mixed air open hearth & bessemer processes are not permitted.

The steel shall be fully killed. Sufficient discard shall be made from the ingot, if used as forging stock, to ensure freedom from piping, segregation and other defects.

The amount of hot working shall be sufficient to ensure uniform working throughout the cross-section.

Reduction ratio shall be minimum 4:1 for ingots and 1.5:1 for rolled /forged stock.

7.0 HEAT TREATMENT:

The forgings shall be heat-treated to attain the mechanical properties specified.

The recommended heat-treatment shall be as given below. Hardening in oil at a temperature of 820-850°C. Tempering at the temperature upto 700°C max.

However tempering between 280-500°C shall be avoided as it leads to temper embrittlement.

8.0 FINISH:

Surface finish of the forgings shall be 6.3 microns (r.m.s) to carryout ultrasonic test.

9.0 FREEDOM FROM DEFECTS:

Forgings shall be free-from cracks, flakes, seams segregation and other defects which may affect the utility of the forgings.

10.0 CHEMICAL COMPOSITION:

The melt analysis of the steel shall be as follows:

Element		C	Si	Mn	Ni	Cr	Mo	S	P
Melt Analysis	% Min.	0.36	0.10	0.45	1.30	1.00	0.20	-	-
	% Max.	0.44	0.40	0.70	1.70	1.40	0.35	0.040	0.030
Permissible variation in product Analysis		±0.02	±0.03	±0.03	±0.05	+0.05 -0.04	±0.02	+0.003	+0.003

11.0 TEST SAMPLES:

11.1 Test coupons shall be taken from each melt and each heat treatment batch/size unless integral test coupons are called for in the drawing/purchase order.

The test coupons shall be heat treated along with the forgings. In case of integral test coupons, the test pieces shall be cut from the forgings only after heat treatment. However the remaining integral test coupon after at supplier's end shall be kept integral with the forging and sent to BHEL.

Sufficient test material shall be sent to BHEL for cross-check where necessary.

11.2 Test samples shall be cut at as given unless other wise specified in the ordering drawing.

a) For Solid forgings: Distance of 1/3 radius or 1/6 diagonal from the outer surface.

b) For hollow forgings: Midway between the inner and outer surface of the wall thickness.

12.0 MECHANICAL PROPERTIES:

The test pieces shall have the following mechanical properties.

Ruling section min	Tensile Strength N/mm^2 Min	0.2% proof Strength N/mm^2 Min	% Elongation (L=5d) Min		Charpy Impact Strength (ISO-V) J, min	
			L	T	L	T
150	850-1000	680	13	10	50	37
>150-250	850-1000	650	13	10	35	26
>250-450	775-925	585	11	8	20	15

NOTE: a) Mechanical tests shall be performed preferably on tangential test samples. If the forging configuration does not allow for taking tangential test samples, longitudinal ones shall be used. L&T in the above table indicate values for longitudinal and transverse samples.

b) Tensile test shall be performed as per IS :1608 or any reputed National Standard.

c) The charpy impact test shall be performed on a 2mm ISO V-Notch, as per IS:1757 or any reputed National Standard.

The impact values indicated above are average of 3 values. All the 3 values shall be reported. Only one value can be lower than the minimum specified value but not less than 2/3 of the same.

13.0 NON-DESTRUCTIVE TESTS:

The following test shall be conducted on the forgings.

13.1 Ultrasonic test: Shall be performed as per AA0850118 with both longitudinal and shear waves and following shall be unacceptable defects, unless otherwise specified in the drawing.

i) Cracks, flaks, seams and laps

ii) Defects giving indications larger than that from a 4mm diameter equivalent flaw.

iii) Groups of defects with maximum indication less than that from a 4mm diameter equivalent flaw which cannot be separated at testing sensitivity if the back echo is reduced to less than 50%.

iv) Defects giving indication of 2 to 4mm diameter equivalent flaw separated by a distance less than four times the size of the larger of the adjacent flaws.

13.2 Magnetic particle test: MPI shall be conducted as per ASTM-A275:

Cracks and laps are not acceptable.

14.0 RETESTS:

If any of the selected test specimens fail to meet the specified requirement due to some mechanical reasons, another specimen may be taken for testing.

In the event of failure due to material heat-treatment, two more reheat-treatments shall be permitted. However, retempering is not considered as reheat-treatment.

15.0 INSPECTION AT SUPPLIER'S WORKS:

BHEL representative shall have free entry & access to all the areas of the where the manufacture of the forgings is carried out. All reasonable facilities shall be extended to him including labour wherever necessary.

BHEL representative shall be given sufficient advance intimation shall be given to the representative to witness the various process, tests etc. Punching & Identification of test coupons & forging and execution of various tests shall be done in the presence of BHEL representative.

16.0 TEST CERTIFICATE:

16.1 The supplier shall furnish three copies of the test certificate (English) with containing the following details.

1. HY 19369 Rev.04
2. BHEL Order No.
3. Item Description
4. Drawing No.
5. Supplier's Name.
6. Melt No.
7. Serial No. of the forging.
8. Heat treatment Details
9. Result of all test stipulated in this specification.

16.2 The test certificate shall be attested by the chief of Inspection /Chief Metallurgist of the Supplier and also by BHEL representative.

17.0 MARKING AND PACKING:

17.1 The following details shall be punched clearly on each forging and the same shall be encircled by paint:

1) HY 19369 Rev.04
2) BHEL Order No.
3) Melt No.
4) Serial No. of the forging
5) Drawing No.
6) BHEL Inspector's stamp
7) Supplier's Name.

The forgings shall be suitably packed to prevent damage and corrosion during transit. In the case of overseas supplies, the packing shall be seaworthy.

18.0 REJECTION AND REPLACEMENT:

In the event of the forging proving defective in the course of further processing at BHEL, the same shall be rejected not withstanding any previous acceptance.

The supplier shall replace the rejected forgings at his own cost, and the rejected forgings shall be returned after all the commercial conditions are satisfied.

BHEL-HERP,VARANASI
QUALITY PLAN

AA-19332

Rough Machined Forging

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	Ingot/Billet/Blooms	I. Material Identification	Visual	100%	----	----	I.R.	3	-	-	
		ii. Composition	i. Chemical Analysis	1 Sample per melt	AA19332	AA19332	T.C.	3	-	2	Review of Mill TC
2	Forging	i. Heat Treatment	H.T.Chart	1 Sample per H.T.batch	AA19332	AA19332	HT Chart	3	-	2	
		ii. Test Piece Marking (Integral Test Piece)	Transfer of Marking	-do-	----	----	Q.C.Record	3	2	-	
		iii. (a) Mechanical Properties	Mechanical Test on identified test piece	-do-	AA19332	AA19332	T.C.	3	2	-	
		(b) Composition	Chemical Analysis	-do-	-do-	-do-	-do-	3	-	2	
3	In Process (After Rough Machining)	i. Dimensions	Measurement	100%	Drawing	Drawing	D.R.	3	-	2	
		ii. Soundness of Forging after skin cut	Ultrasonic Testing	100% (Refer Remark)	Tech.Spec. AA0850118	Tech.Spec. AA0850118	U.T.Report	3/2	2	-	100% UT as per Cat.2 to be witnessed for Critical forging like UJ Housing, LJ Housing, Journal Shaft and Trunnion shaft. In case of Shafts, UST to be carried out before Centre thru hole drilling. Rest of the other forging, random 10% UT as per Cat.2 to be witnessed by BHEL representative.
		iii. Surface / Sub surface cracks	M.P.I.	100% (Refer Remark)	Tech.Spec. AA0850133	AA0850136 CAT-II	I.R.	3/2	2	-	100% MPI to be witnessed for Critical forging like UJ Housing, LJ Housing, Journal Shaft and Trunnion shaft. Rest of the other forging, random 10% MPI to be witnessed by BHEL representative.
4	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/21 Rev.10	Approved by	PK Prajapati	Approved by	SK Tiwari
Date	06-04-2019	Signature & Date		Signature & Date	
Page No.	1 of 1				

Legend
P=Perform
W=Witness
V=Verify
3=Vendor/Supplier

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

2=Inspection Agency nominated by BHEL HERP

P.K. Prajapati 06/04/19
प्रदीप कुमार प्रजापति
उप० प्रबंधक (अ०एवं वि०)/Dy. Manager (E&M)
भारत हेवी इलेक्ट्रिकल्स लि०/ BHEL-HERP
तरना, शिवपुर, वाराणसी /Tarna, Shivpur, Varanasi

Rev-08 BHEL approved sources and Review of Mill TC added for Ingot/Billet/Blooms
Rev-09 clause for UST test of Shaft to be done before centre thru hole drilling added
Rev-10 BHEL approved sources for Ingot/Billet/Blooms deleted and remark of UT and MPI modified.