An ISO 9001
Company

Bharat Heavy Electricals Limited
(High Pressure Boiler Plant**)**
Tiruchirappalli – 620014, TAMIL NADU, INDIA
MATERIALS MANAGEMENT

PROCUREMENT OF FORGINGS AS PER THE SPECIFICATION 20MnMoNi55 AND PB-M-90	Phone: **+91 431 2577480** Fax : **+91 431 252 07 19** Email : **tkr@bheltry.co.in**

	Reference Number: Enquiry 1401000037	**Enquiry Date: 25.02.2010**	**Due date for submission of quotation: 05.04.2010**
You are requested to quote the Enquiry number date and due date in all your correspondences. This is only a request for quotation and not an order			

Sub: Requirement of additional sources for supply of 20MnMoNi Forgings.

BHEL/Trichy is looking for empanelment of new vendors for supply of forgings as per annexure A. Kindly note that

1. Material supply/sourcing in any form from Chinese suppliers is not acceptable.
2. Only vendors with prior experience of supply to Nuclear Power Corporation of India Ltd or any other nuclear power station are asked to submit their offers.

BHEL commercial terms & conditions, other additional conditions for submission of offers and all annexure can be downloaded from BHEL web site http://www.bhel.com under enquiry reference "**1401000037** "

Tenders should reach us before 14:00 hours on the due date Technical bid will be opened at 14:30 hours on the due date Tenders would be opened in presence of the tenderers who have submitted their offers and who may like to be present.	Yours faithfully, For **Bharath Heavy Electricals Limited** Manager / Purchase (C&F)

BHARAT HEAVY ELECTRICALS LIMITED

ENQUIRY

(A Government of India Undertaking)
HIGH PRESSURE BOILER PLANT
PURCHASE DEPARTMENT - FOSSIL BOILERS
THIRUCHIRAPALLI - 620014
TAMILNADU (INDIA)

PHONE : 2577480
GRAMS : BHARATELEC
FAX NO: 2520719
E-mail: tkr@bheltry.co.in
Web:

Enquiry No	Enquiry Date	Due Date for Quotation
1401000037	25.02.2010	05.04.2010

Please quote Enquiry No, Date and due date in all correspondences.
This is only a request for quotation and not an order.

Item	Description	Unit	Quantity	Delivery Schedule Quantity	Delivery Schedule Date
10	D13530101161 LIFTING SUP. GUSSET: FPL 40x240x470.	NO	32.000	32.00	26.11.10
20	D13530101165 LIFTING SUP.PLATE: FPL 70x247x350.	NO	16.000	16.00	26.11.10
30	D13530101167 SNUBBER LUG-1: FPL 110x460x250.	NO	32.000	32.00	26.11.10
40	D13530101168 PLATE FOR SUPPORT : FPL 160x750x1110.	NO	8.000	8.00	26.11.10
50	D13530101170 TUBE SHEET TEST COUPANS mentioned in Drg 2-93-170-05110/02: FPL 430x700x700 - 1 NO.(Material code D13530101264, D13530101265, D13530101266,D13530201328,D13530201329,D13530201330 and D13530101170 shall be from same melt.)	NO	1.000	1.00	26.11.10
60	D13530101264 TUBE SHEET as per Drg.2-93-170-05110/02 (Material code D13530101264 , D13530101265 and D13530101266 shall be from same Melt.)	NO	4.000	4.00	26.11.10
70	D13530101265 TUBE SHEET TEST PLATE MENTIONED IN THE DRG.2-93-170-05110/02 - FPL 56x250x1000. (Material code D13530101264 , D13530101265 and D13530101266 shall be from same Melt.)	NO	4.000	4.00	26.11.10
80	D13530101266 TUBE SHEET TEST PLATE MENTIONED IN THE DRG.2-93-170-05110/02- FPL 150x200x200. (Material code D13530101264 , D13530101265 and D13530101266 shall be from same Melt.)	NO	8.000	8.00	26.11.10
90	D13530101267	NO	4.000	4.00	26.11.10

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Late tenders are liable to be rejected.

Yours faithfully,
For **BHARAT HEAVY ELECTRICALS LIMITED**

MANAGER / PURCHASE
(FOSSIL BOILERS)

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1401000037 / 25.02.2010

	SHELL-1 as per Drg.-2-93-170-05111/02. (Material code D13530101267 and D13530101268 shall be from same Melt.)				
100	D13530101268 SHELL-1 and 2 TEST PLATE MENTIONED IN THE DRG.2-93-170-05111/02.- FPL 56x250x2500. (Material code D13530101267 and D13530101268 shall be from same Melt.)	NO	4.000	4.00	26.11.10
110	D13530101269 SHELL-2 as per Drg. 2-93-170-05111/02.	NO	4.000	4.00	26.11.10
120	D13530101271 HAND HOLE NOZZLE as per Drg.: 3-93-170-05165/02.	NO	16.000	16.00	26.11.10
130	D13530101272 SHELL-IV as per Drg.-2-93-170-05113/02.(Material code D13530101272 and D13530101273 shall be from same Melt.)	NO	4.000	4.00	26.11.10
140	D13530101273 SHELL-4 TEST PLATE MENTIONED IN THE DRG.2-93-170-05113/02.- FPL 70x250x2500.(Material code D13530101272 and D13530101273 shall be from same Melt.)	NO	4.000	4.00	26.11.10
150	D13530101274 TORISPHERICAL HEAD as per Drg.-2-93-170-05114/03.(Material code D13530101274 and D13530101275 shall be from same Melt.)	NO	4.000	4.00	26.11.10
160	D13530101275 TORI HEAD TEST PLATE MENTIONED IN THE DRG.2-93-170-05114/03.- FPL 70x250x2500.	NO	4.000	4.00	26.11.10
170	D13530101276 SECONDARY MAN WAY NOZZLE as per Drg.-2-93-170-05123/02.	NO	4.000	4.00	26.11.10
180	D13530101281 FEED WATER NOZZLE as per Drg. 3-93-170-05166/02.	NO	8.000	8.00	26.11.10
190	D13530101282 STEAM OUTLET NOZZLE as per Drg. 3-93-170-05167/02.	NO	4.000	4.00	26.11.10

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1401000037 / 25.02.2010

200	D13530101283 SHELL-VI as per Drg.: 2-93-170-05196/02.	NO	4.000	4.00	26.11.10
210	D13530101288 HAND HOLE COVER(Hh) as per Drg.- 2-93-170-05175/02.	NO	16.000	16.00	26.11.10
220	D13530101317 PDHRS NOZZLE: as per Drg. 3-93-170-05231/02.	NO	4.000	4.00	26.11.10
230	D13530101318 LIFTING SUPPORT PLATE-2: FPL 40x250x250.	NO	32.000	32.00	26.11.10
240	D13530101319 RIB FOR SUPPORT: FPL 100x260x585.	NO	32.000	32.00	26.11.10
250	D13530201328 TUBE SHEET TEST COUPANS mentioned in Drg 2-93-170-05110/02: FPL 86x250x2500 - 4 NOs.(Material code D13530101264, D13530101265, D1353 0101266,D13530201328,D13530201329,D135 30201330 and D13530101170 shall be from same melt.)	KG	1687.750	1,687.75	26.11.10
260	D13530201329 TUBE SHEET TEST COUPANS mentioned in Drg 2-93-170-05110/02: FPL 56x250x2500 - 4 NOs.(Material code D13530101264, D13530101265, D1353 0101266,D13530201328,D13530201329,D135 30201330 and D13530101170 shall be from same melt.)	KG	1099.600	1,099.60	26.11.10
270	D13530201330 TUBE SHEET TEST COUPANS mentioned in Drg 2-93-170-05110/02: FPL 130x700x3000 - 4 NOs.(Material code D13530101264, D13530101265, D135 30101266,D13530201328,D13530201329,D13 530201330 and D13530101170 shall be from same melt.)	KG	8572.200	8,572.20	26.11.10
280	D13530501326 PLATE FOR SUPPORT : FPL 160x630x690 - 8 NOs.	KG	4367.840	4,367.84	26.11.10
290	D13530501327 SNUBBER LUG-2 : FPL 100x430x450 - 16 NOs.	KG	2430.400	2,430.40	26.11.10

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MANAGER / PURCHASE
(FOSSIL BOILERS)
Yours faithfully,

BHARAT HEAVY ELECTRICALS LIMITED

(A Government of India Undertaking)
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1401000037 / 25.02.2010

General Note:

1. Supply of approximately 456 MT of forgings to the specification 20MnMoNi55 and TDC PB-M-90/Rev01. The supplier to read the notes given in the drawings and the specification (TDC: PB-M-90/Rev01) carefully and clause by clause confirmation to be specifically indicated in their technical offer.
2. Inspection by any authorized third party for imports. For indigenous supplies, BHEL/any authorized agency.
3. Tender will be opened as two part bid. Vendors are to submit their offers in two seperate covers, one for the technical bid and the other for the priced bid.
4. The offers should be submitted before 2 P.M on 05.04.2010.
5. 5 sets of additional dialets containing Test Certificates, copies of approved procedures DCR, Drawings etc apart from contractual requirements like raw material TC, work TC and UT reports shall be submitted along with supplies.
6. Actual production of materials is permitted only after review/approval of manufacturing/testing/inspection drawing/documents and Quality assurance plans (QAP)by BHEL,Trichy.
7. Material supply / sourcing from chinese suppliers in any form is not acceptable.
8.a. Materials pertaining to mtl codes D13130101264, D13130101265, D13130101266, D13130101170, D13130201328, D13130201329 & D13130201330 shall be from the same melt no.
8.b. Materials pertaining to D13130101267 & D13130101268 shall be from the same melt no.
8.c. Materials pertaining to D13130101272 & D13130101273 shall be from the same melt no.
8.d. Materials pertaining to D13130101274 & D13130101275 shall be from the same melt no.
9. The above forgingsd are required for RAPP 7&8 (700 MWe) and end user certificates will not be provided by BHEL.
10. Wherever FTC requirement is mentioned in the component drawing, FTC materials shall also be supplied along with components.
11. Test coupons mentioned in the drawings are covered as seperate items. However, the respective test coupons shall be made from the same melt of the corresponding component.
12.a. Supplier should have supplied atleast one set to Nuclear Power Corporation of India Ltd., or any other nuclear power station and submit proof for the same.
12.b. Also, supplier has to furnish test certificates for the similar major components.
13. Please note that for serial nos. 10, 40, 50, 70, 80, 190, 220, 230, 240, 280 & 290, size (width and length) and quantity may be finalised at the time of placement of order. Hence, prices for these items shall be offered in rate per kg ALSO.
14. BHEL will finalise all the above 29 items as a group and will procure all items from a single source.

"LD clause has to be confirmed without fail."

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Yours faithfully,
For **BHARAT HEAVY ELECTRICALS LIMITED**

MANAGER / PURCHASE
(FOSSIL BOILERS)
Yours faithfully,

NUCLEAR POWER CORPORATION OF INDIA LTD.
(A Govt. of India Enterprise)

Specification No. : PB-M-90 / Rev. 01

TECHNICAL SPECIFICATION

ON

LOW ALLOY STEEL FORGINGS

(USI No. 33111)

Revision No.	0	1		
Date of Issue Month/Year	February, 1988	October, 2006		
Total No. of Pages (Including cover sheet)	1 + 42 = 43	2 + 43 = 45		

ORIGINAL

PREPARED BY : V.K.SHARMA sd/- 04/02/1988

CHECKED BY : ---

REVIEWED BY : ---

APPROVED BY : CH. SURENDAR sd/- 04/02/1988

(Name & Designation) (Signature) (Date)

(For Revision See Revision Control Sheet)

REVISION CONTROL SHEET

DOCUMENT TYPE : TECHNICAL SPECIFICATION

NO. : PB-M-90 / Rev. No. 01

TITLE : Technical Specification for Low Alloy Steel Forgings

Rev. No. & Date	Description Of Revision	Revised by (Name & Signature)	Checked by (Name & Signature)	Reviewed by (Name & Signature)	Approved by (Name & Signature)
Rev. 01 06/10/2006	Fig. 2, 4 & 5 revised	(Ajit K. Shit) Exec.Engr.	(M.R.S.Saxena) ACE	(Bhaskar Pandit) ACE	(M.K.Sharma) ACE

SPECIFICATION

NO. PB-M-90

LOW ALLOY STEEL FORGINGS.

ISSUE

No.	DETAILS	INITIAL	No. OF PAGES	DATE
1	Original with		33	Feb. 1988
	Annexure 1		3	Feb.,88.
	Annexure 2		3	Feb.,88.
	Annexure 3		3	Feb.,88.
2.	Fig 2, 4 & 5 revised.	BLM	—	Oct 2006

COMPILED BY V.K. SHARMA V.K.Sharma REFERENCE FILE NO. 5NP/33111

APPROVED BY CH. SURENDAR 4/2/08

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QUENCHED AND TEMPERED LOW ALLOY STEEL FORGINGS

1.0 SCOPE

This Specification establishes minimum requirements for low alloy steel forgings used in the construction of Heat Exchangers and Pressure Vessels. The forgings are required to be made from fine grained, killed and vacuum degassed low alloy steel equivalent to DIN 20 Mn Mo Ni 55 grade with modified chemical composition. The manufacturing process adopted shall ensure cleanliness of the highest order, isotropy of the mechanical, chemical and metallurgical properties, superior fracture toughness and weldability.

2.0 APPLICABLE CODES AND STANDARDS

The following codes and standards of the issue in effect on the date of issuing the tender document shall form part of this specification. In case of conflict between the codes/ standards listed below and this specification, generally the specification will govern. The Supplier must obtain necessary clarification from the Purchaser in such a case.

i) ASME Section II - Part A - Ferrous Materials

ii) ASME Section III - Division 1 - Sub-Section NB

iii) ASME Section V - Non Destructive Examination

iv) ASTM - Relevant Standards

3.0 PROCESS OF MANUFACTURE

3.1 Melting

The steel shall be made by basic electric process and shall be vacuum degassed to remove objectionable gases particularly Hydrogen. Vacuum system should be of sufficient capacity to effect a blank-off pressure which is sufficiently low for sufficiently long duration.

3.2 Discard

Sufficient discard shall be made from each ingot to secure freedom from piping and excessive segregation.

3.3 Grain Size

Grain size shall be measured as per ASTM-E-112 and shall be 6 or finer. The grain size and microstructure shall be determined on a notched bar impact test specimen, obtained from Simulated Heat Treated Test Coupons. The examination

shall be on Longitudinal - Normal Section. In case of determination on an untested side (e.g. Tubesheet, Nozzles), these examinations shall be carried out on the forging directly. The micrographs for assessing the microstructure shall be made at a magnification allowing unambiguous assessment (as a rule: X 200).

3.4 Forging Process

The components shall be hot forged as close as practicable to their final finished shape and size by a press or hammer of sufficient capacity to work the metal throughout its section. The forging ratios shall not be less than 3. Tube sheet and primary head forgings, where overlay cladding is done, shall be processed in such a way that the minimum segregation portion shall be identified and kept for cladding zone.

Material flow shall be such as to favourably resist the stresses encountered in service (Main Working Direction).

3.5 Machining

Prior to the heat treatment, forgings shall be contour machined as close to the finish dimensions as possible.

4.0 CHEMICAL COMPOSITION

The chemical composition for both product and ladle analysis shall be as follows. The specimens for product analysis will be taken from simulated heat treated test coupons described elsewhere in this specification.

Element	Weight Percentage
C	0.17 - 0.23
Mn	1.20 - 1.50
Si	0.15 - 0.30
Mo	0.40 - 0.55 (1)
Ni	0.50 - 0.80
Cr	0.20 max.
Cu	0.12 max. (1)
V	0.02 max.
Co	0.03 max.

Element	Weight Percentage
Al (tot)	0.010 - 0.040
Sn	0.01 max.(1)
As	0.015 max.
Sb	0.007 max.
P	0.010 max.(1)
S	0.008 max.(1)
N (tot)	0.013(1)
H_2	1 ppm max.
O_2	20 ppm max.

The above chemical composition slightly differs from DIN 20 Mn Mo Ni 55 grade. Minor deviations may be permitted provided all other requirements of the specification are met. In the likelihood of the above limits being exceeded, the guaranteed maximum values shall be indicated in the bid itself.

Note (i) - If these figures are exceeded and check analysis levels of upto P $\leq$ 0.015%, S $\leq$ 0.015%, Mo $\leq$ 0.63%, Cu $\leq$ 0.18%, Sn $\leq$ 0.016% and N (tot) $\leq$ 0.015% are accepted, the inspection agency shall determine until further notice whether heat affected zone simulation tests and, where applicable, tangential section examinations are required. If intermediate annealing at 550 deg-C is planned in the course of further processing the permissibility of this annealing temperature shall be demonstrated in the course of the aforementioned tests/examinations. Extent and implementation of testing shall be agreed upon with the Inspection Agency.

5.0 HEAT TREATMENT

5.1 The forgings shall be supplied in quenched and tempered condition. The forgings, after contour machining near to finish dimensions, shall be heated to a temperature which produces an austenitic structure and then quenched in a suitable liquid medium ensuring uniform cooling. The tempering temperature shall be between 630 to 680°C. The measured highest temperature during stress relief heat treatment shall not be higher than the measured lowest temperature during tempering.

The uniformity of temperature during any of the heat treatment shall be proved by continuous temperature recording instruments with the help of thermocouples attached to the component.

5.2 Simulated Heat Treatment (SHT)

The simulated heat treatment (SHT) is intended to simulate the heating cycles which the actual component may experience during the course of fabrication. Such heat treatment is given to some of the test coupons called Simulated Heat Treated Test Coupons (STC). Heating and cooling rates shall be as indicated in figure below:

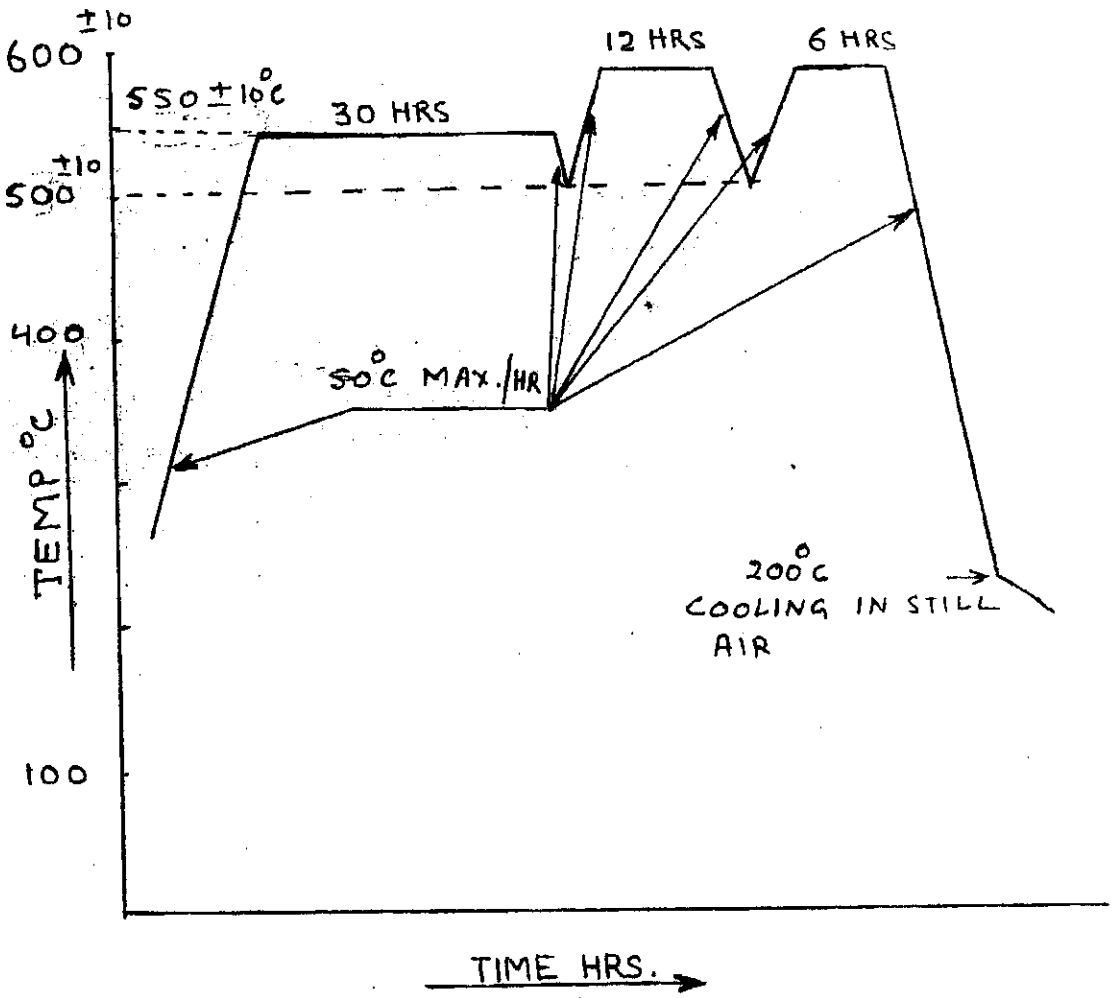


FIG.-1

6.0 MECHANICAL PROPERTIES

6.1 The mechanical tests shall be conducted as per ASTM A-20 and ASTM A-370 (DIN 50115, DIN 50125 and DIN 50145). Following minimum requirements shall be met with both in quenched and tempered and simulated heat treated condition.

Minima pertaining to mechanical properties at room temperature and 350 deg-C -

Product form	Test Temp.	Mechanical Properties		20 MnMoNi 55[1]	
Primary Head					
Spherical Ring	RT	Rm	l, tr, n	560-700	[N/mm^2]
Tube Sheet		$R_{p0.2}$	l, tr, n	390	[N/mm^2]
Shell		A_5	l, tr	19	[%]
Secondary Head		Z	l, tr	45 (EW)	[%]
Nozzles		Z	n	35 (EW)/ 45 (MW)	[%]
Primary Head	350°C	Rm	l, tr, n	505	[N/mm^2]
Spherical Ring		$R_{p0.2}$	l, tr, n	343[3]	[N/mm^2]
Shell		A_5	l, tr	16[2]	[%]
Secondary Head					
Nozzles					
Tube Sheet					

l = Longitudinal

tr = Transverse

n = Normal

EW = Smallest single value

MW = Average value of 3 specimens

A_5 = % Elongation on 5d (in 50 minimum gauge length)

Z = % Reduction in area

$R_{p0.2}$ = Yield Strength (0.2% Offset)

Rm = Tensile Strength

1) Sampling location T/4 x T/2 (resp. 80 x 80 mm for tube sheet).

2) 14% for Nozzles and Tube Sheet.

3) 314 N/mm^2 for Tube Sheet.

6.2 Notch Toughness

6.2.1 Nil Ductility Transition Temperature (T-NDT)

The nil-ductility transition temperature as determined by drop weight test in accordance with ASTM-E-208-84a shall not be higher than -15 deg-C.

In case T-NDT has already been established for this type of material, complete details of the test procedure and results will be reported which shall be subject to approval by the Purchaser.

6.2.2 Reference Nil-Ductility Transition Temperature (R-TNDT)

Three ISO-V transverse specimens will be tested at +18 deg-C for certification of RTNDT. The minimum absorbed energy and lateral expansion shall not be less than 68 J and 0.9 mm respectively, for any of the specimens. The percent shear fracture shall be reported.

6.2.3 Longitudinal and transverse ISO-V test specimens will exhibit the following minimum values at -15 deg-C.

i) Average of 3 specimens 41 J

ii) Lowest single value 34 J

6.2.4 Cv-Impact Curve

Charpy V-notch impact strength versus temperature curves shall be established. Tests shall be conducted at least at six different temperatures including -15 deg-C and +18 deg-C, to fully define upper and lower energy shelves. The upper energy shelf shall have 100% shear fracture and lower energy shelf a maximum of 10% shear fracture. The test reports shall include absorbed energy, percent shear fracture and lateral expansion, plotted against temperature. The upper

shelf energy shall be more than 100 J. The absorbed energy and lateral expansion values at +18 deg-C and -15 deg-C shall meet the requirements of 6.2.2 & 6.2.3.

6.3 Hardness Test

Hardness of each forging shall be measured after tempering, before any further processing, along the grid as defined in each product specification to demonstrate uniformity. The minimum and maximum hardness value of each forging shall be reported. The difference between the two values for a forging shall not exceed 20 BHN. Tests shall be carried out as per ASTM-E-10.

6.4 Inclusion Rating

Inclusion rating shall be determined as per ASTM-E 45 and shall be better than

A	B	C	D
2.0	2.0	1.0	1.5

7.0 TESTS & EXAMINATIONS

7.1 Categories of Test Coupons

Compliance of the material with the specification requirements is checked on various categories of test coupons described as under:

i) Raw Material Test Coupons (RTC)

Test coupons obtained from the quenched and tempered forgings or forging extensions.

ii) Simulated Heat Treated Test Coupons (STC)

Test coupons obtained from the quenched and tempered forgings and subjected to simulated heat treatment described in Section 5.2.

iii) Final Production Test Coupons (FTC)

These are in the same condition as RTC. RTC and STC shall be tested at the Supplier's works whereas FTC will be despatched with the ordered item for production tests at the Purchaser's works.

7.2 Test Coupon Location

Top and bottom of the forgings shall be same as respective ends of the ingot. Sufficient material in the form of integrally forged ring or disc prolongations shall be

provided for the purpose of testing. Cylindrical shells and nozzle forgings from which more than one nozzle is to be made, shall have prolongations at both ends. Dished ends, tubesheets and single nozzle forgings shall have prolongations on the bottom end. RTC samples shall be tested first.

STC, RTC & FTC shall be taken from the adjacent areas at any location of the cross section in the following manner:

i) Full circumferential test rings shall be parted off from the forging prolongations after the final heat treatment. Entire cross section shall be divided into three sectors (say A, B & C), equally spaced at 120 deg. apart.

ii) Each sector shall be suitably marked to accommodate STC, RTC & FTC, adjacent to each other. Identification of the coupons shall be ensured by suitable methods prior to their separation from the test ring and all through the various stages of testing.

iii) The location of test coupons in the top and bottom test rings shall be diametrically opposite to each other.

iv) Any balance material from the test rings, if in excess of the test requirement, shall be kept reserved for any contingency which may arise during the course of testing.

Refer Figures 7 to 17 for location of test coupons.

7.3 Test Specimen Location

The test coupons shall be taken in such a way that the test specimens shall have their longitudinal axis at least 1/4 t (80 mm for tube sheet) from any surface and with the mid length of the specimens at least 1/2 t (80 mm for tube sheet) from any second surface, where 't' is the maximum heat treated thickness of the forging.

7.4 Specimen Directions

The mechanical properties are to be established along the following three mutually perpendicular directions:

i) Longitudinal - Parallel to the main working direction.

ii) Transverse - Transverse to the main working direction.

iii) Normal - Parallel to the direction of thickness (applicable for thicknesses in excess of 70 mm).

7.5 Chemical Analysis

Chemical analysis shall be carried out in accordance with ASTM-E 30 & ASTM-E 350. If the ingot is made from one heat, only one ladle analysis is required. However, in case of an ingot made from more than one heat, weighted average shall be reported.

For product analysis, samples from each STC shall be analysed. Samples for chemical analysis shall be taken from a depth of 1/4 t from any tempered wall surface and at least at a distance of 1/2 t from the heat treated edge of the coupon. Broken mechanical test specimens may be used.

Apart from STC samples, the chemical composition shall also be determined as required by individual product specifications.

7.6 Mechanical Tests

The extent of tests required for each product has been included in tabular form under the product specifications.

For tension test, one specimen shall be tested from a sampling point at room temperature and at 350 deg-C. For impact test, one set of 3 Charpy-V notch specimens shall be tested at a given temperature.

NDT temperature shall be determined using STC Pellini specimens from one location. The NDT temperature so determined shall also be confirmed by tests on two transverse STC & RTC specimens from other locations.

7.7 Sulphur Prints (Baumann Prints)

Sulphur prints shall be prepared for each forging at the location and area specified in the relevant product specification.

8.0 NON DESTRUCTIVE EXAMINATION

8.1 Ultrasonic Examination

All forgings after the final heat treatment and machining shall be ultrasonically examined in accordance with SA-388, recommended practice for Ultrasonic Examination of Heavy Steel Forgings. Where ultrasonic examination is not feasible or only partially feasible due to the final component geometry after machining, examination shall be carried out for acceptance in the semi-machined condition. The forgings shall be examined for the total volume using both straight beam and angle beam search units, observing the scanning directions as indicated in figure 2, 3 and 4.

The reference level for the straight beam examination shall be 6 mm diameter flat bottomed hole for t > 100 mm and 3 mm for t ≤ 100 mm. For angle beam examination a 3 mm wide x 12 mm long x 0.03 t deep notch (3 mm maximum depth) where t is nominal thickness of the material.

All recordable indications (above 20 % of reference level), apparently within acceptable limits shall be investigated to confirm that they are parallel to the forging faces and not in the transverse direction i.e. not in the thickness direction. Defect indications exceeding 20 % of the reference level in thickness direction and exceeding the reference level parallel to the forging faces are not acceptable. In case of tube sheet with integral hub, the hub and the portion in the tubesheet underneath the hub for a depth of atleast one hub thickness, shall be free from defect indications equal to or above 3% hub thickness. Similarly, in case of forgings with integral protrusions, the protrusion for a depth equal to the thickness of the protrusion, shall be free from defect indication greater than or equal to the protrusion thickness.

When a cluster of small indications are obtained on the screen whose amplitudes cannot be resolved, then the gain shall be adjusted to give a back echo equal about 80% of full screen height on an adjacent defect free region. At this gain setting, the cluster of indications causing loss of back echo shall be a cause of rejection of the forging. Loss of back echo is assumed when the back reflection falls below 5% of full calibration screen height. Additionally, at such locations the sound attenuation shall be measured. The sound attenuation at 2 M Hz shall not be more than 4DB/ Meter of single sound path.

Examination of forged bars must be performed from both thickness faces and from the cylindrical surface with normal beam probes. Additional scanning in the circumferential direction with 35 deg. angle beam probes shall be carried out for bars larger than 120 mm in diameter. The acceptance standard shall be as follows:

D < 60 mm	C.R.R. - 2 mm
D > 60 mm	C.R.R - 3 mm
D > 120 mm	C.R.R. - 4 mm

(C.R.R. - Circular Reference Reflector)

8.2 Magnetic Particle Examination

Each forging after final machining, shall be examined by magnetic particle method (MT) in accordance with ASME

Section III, para NB - 2545. The acceptance standards shall be as per para NB - 2545.3. The extent of examination shall be 100%. Demagnetisation after the test is required.

8.3 Dimensional Check

Each forging shall be checked for dimensional compliance with the approved drawings. The actual dimensions shall be recorded in a sketch/drawing and submitted for final acceptance.

9.0 REPAIRS

Repair is generally not permitted. Slight surface defects may be smoothly ground and blended without impairing the minimum wall thickness. No other repair shall be carried out without prior approval of the Purchaser or his authorised inspection agency. Plans for all repairs requiring heat treatment shall be submitted to the Purchaser or his authorised inspection agency for review and approval, prior to taking up the job. Repairs involving welding are prohibited.

All non-conformities shall be recorded and reported to the Purchaser to determine their disposal.

10. PROCEDURES, PLANS, REPORTS AND DOCUMENTATION

The manufacturer shall prepare manufacturing, testing, examination procedures and obtain Purchaser's approval prior to the commencement of manufacture. The manufacturer shall be responsible for preparation and issue of all certificates, reports and documents which shall be certified

by the Purchaser or his authorised agency. Such certified final documents shall be supplied in bound volumes with proper identification.

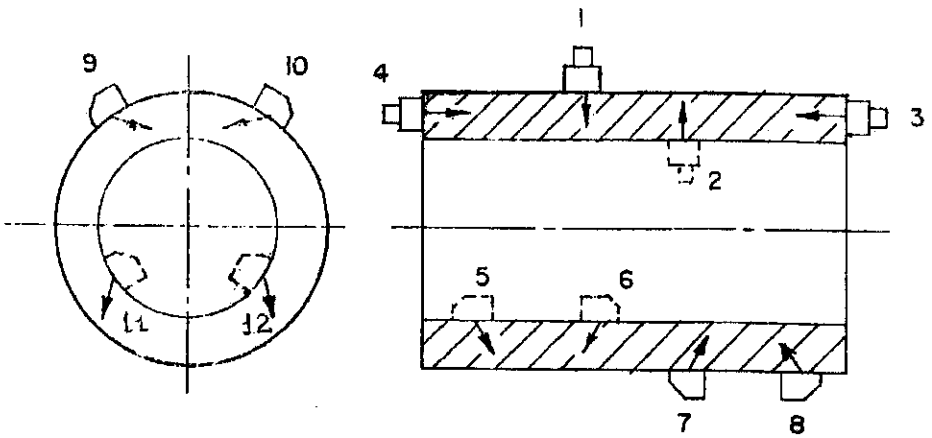
11. QUALITY SURVEILLANCE

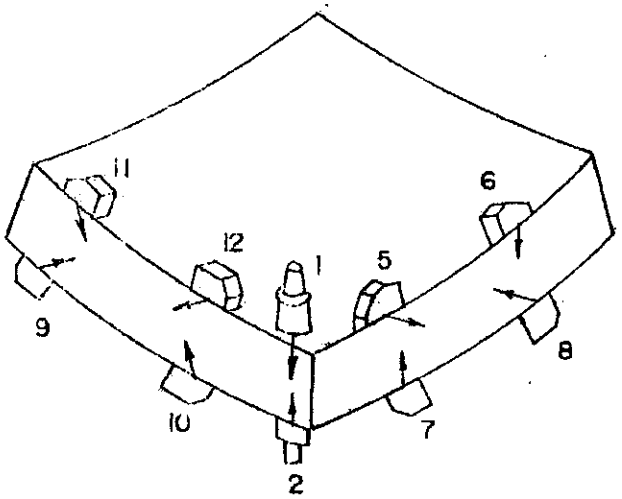
The forgings shall be subjected to quality surveillance by the Purchaser or his authorised agency during manufacture. The forgings shall not be shipped until the shipping release is given by the Purchaser/his authorised agency.

12. MARKING, PACKING AND SHIPMENT

Each forging shall be marked with Product Serial Number, Heat and Material Specification. In case of forgings accompanied with forged test plates, corresponding test plate identification shall also be marked on the main forging indicating correspondence with top/bottom of original ingot.

The forgings shall be protected against corrosion and damage in transit and shall be properly preserved and packed for sea-worthiness. The Supplier shall submit the preservation and packing plan for Purchaser's approval. Before shipment, suitable rust preventive coating shall be applied on the forgings to ensure sea-worthiness and tropical storage for two years.



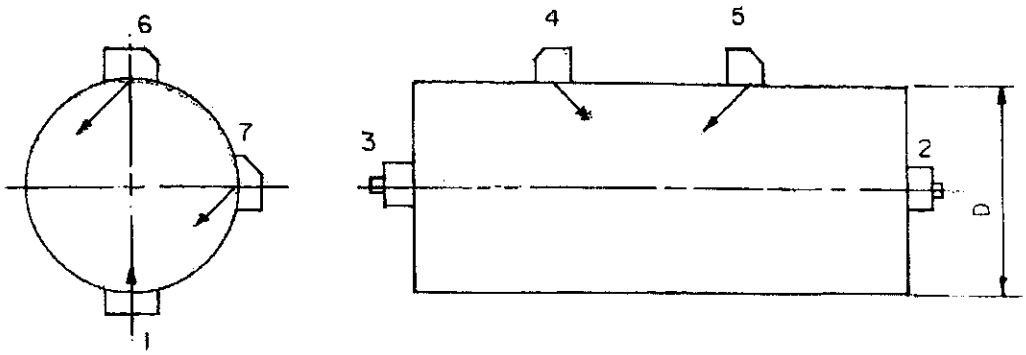


NOTES-

1. 1 TO 4 - NORMAL BEAM SCANNING
   5 TO 12 - ANGLE BEAM SCANNING
2. SCAN FROM INSIDE ONLY NECESSARY IF FURTHER INVESTIGATION OF INDICATION OBTAINED BY O.D. SCAN IS REQUIRED

SHELLS, TUBULAR FORGINGS, DISHED ENDS & PETALS

FIG. - 2



NOTES:-

1 1-3 NORMAL BEAM SCAN

2 4-7 ANGLE BEAM SCAN

3 SCANNING-

3.1 ① FOR ALL BARS.

ADDITIONAL

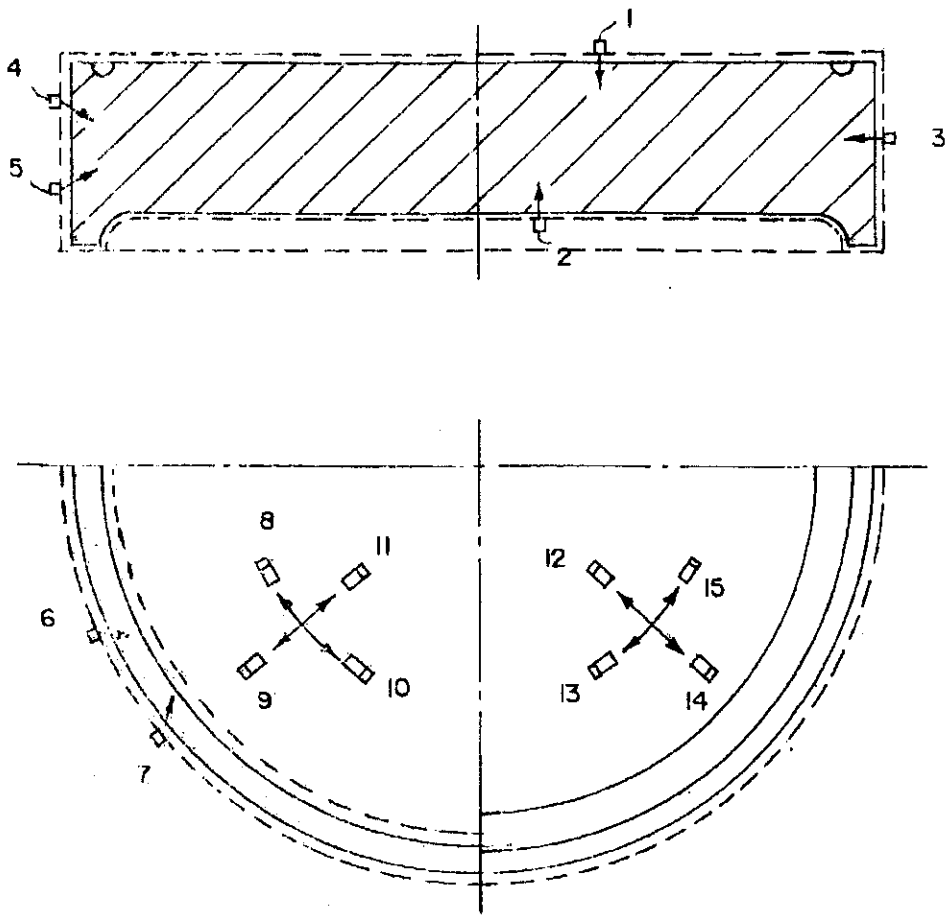
3.2 ② & ③ FOR D> 60 mm .

IF EVALUATION NOT POSSIBLE ④ + ⑤ WITH 45°

3.3 ⑥ & ⑦ FOR D>120 mm WITH 35° PROBE.

FORGED BARS

FIG.- 3



NOTES -

1 TO 3 - NORMAL BEAM SCAN

4 TO 7 - ANGLE BEAM SCAN

8 TO 15 - OPTIONAL ANGLE BEAM SCAN
(PRICES TO BE QUETED
SEPERATELY)

FIG. - 4

TABLE - 1

EXTENT OF TESTS - TUBE SHEET

N - Normal
T - Transverse
L - Longitudinal

Sr. No.	Description	Direction	STC A	STC B	STC C	RTC D	Remarks
1.	Tensile (RT)	N	1*	-	-	-	*If testing of first test specimen yields Z <45% two more specimens shall be tested from the same location.
		T	1	1	1	1	
		L	1	-	-	-	
2.	Tensile (350°C)	N	1	-	-	-	
		T	1	1	1	1	
		L	1	-	-	-	
3.	Impact at -15°C	N	3	-	-	-	
		T	3	3	3	3	
		L	3	-	-	-	
4.	Impact at +18°C	N	-	-	-	-	
		T	3	3	3	3	
		L	-	-	-	-	
5.	Impact Curve (-15°C, 18°C and 4 other temperatures	N	-	-	-	-	
		T	12	-	-	-	
		L	-	-	-	-	
6.	Drop weight test	T	8	-	-	2	Specimen P-2.
7.	Grain Size and Microstructure		1	1	1	-	Also required at 3 other locations as per Fig. 9.
8.	Product Analysis		1	1	1	-	Also required at 2 other locations. Refer Fig. 9.
9.	Hardness and Sulphur Print Test						Refer Fig. 9.
10.	U.T. & M.P.I.						100%; Refer Para 8.1 & 8.2.

TABLE - 2

EXTENT OF TESTS - SHELL & RING FORGINGS

N - Normal
T - Transverse
L - Longitudina

Sr. No.	Description	Direction	STC Bottom of Ingot A	B	C	RTC	STC Top of Ingot D	E	F	Remarks
1	Tensile at RT	N	1	-	-	-	1	-	-	See Note-1.
		T	1	1	1	1	1	1	1	
		L	1	-	-	-	-	-	-	
2	Tensile at 350°C	N	1	-	-	-	-	-	-	
		T	1	1	1	1	1	1	1	
		L	1	-	-	-	-	-	-	
3	Impact at -15°C	N	3	-	-	-	-	-	-	
		T	3	3	3	3	3	3	3	
		L	3	-	-	-	-	-	-	
4	Impact at +18°C	T	3	3	3	3	-	-	-	
5	Impact curve (-15°C, 18°C & 4 other temps.)	T	12	-	-	-	-	-	-	
6	Drop Weight Test	T	8	-	-	2	-	-	-	Specimen P-2
7	Grain Size & Microstructure		1	1	1	-	1	1	1	Examination on notched bar specimen in long.-normal section.
8	Product Analysis		1	1	1	-	1	1	1	See Note-2.
9	Hardness & Sulphur Print									See Note-3.
10	U.T. & M.P.I.									100%. Refer Para 8.1 & 8.2

Notes:

1. If testing of the first specimen at RT yields $Z < 45\%$, then two more test specimens from the same sampling location shall be tested.
2. Chemical composition shall be determined from one sampling location each from top and bottom. At other location C, Mn, P & S shall be verified.
3. Hardness along a maximum square grid of 1000 x 1000 mm on the cylindrical outside surface and end faces. Sulphur print on top and bottom faces at 120° apart and 200 mm long.

TABLE - 3

EXTENT OF TESTS - PRIMARY HEAD & DISHED END FORGINGS

N - Normal
T - Transverse
L - Longitudinal

Sr. No.	Description	Direction	STC A	STC B	STC C	RTC	Remarks
1	Tensile at RT	N	1[1)]	-	-	-	See Note-1.
		T	1	1	1	1	
		L	1	-	-	-	
2	Tensile at 350°C	N	1	-	-	-	
		T	1	1	1	1	
		L	1	-	-	-	
3	Impact at -15°C	N	3	-	-	-	
		T	3	3	3	3	
		L	3	-	-	-	
4	Impact at +18°C	T	3	3	3	3	
5	Impact Curve (-15°C, 18°C & 4 other temperatures)	T	12	-	-	-	
6	Drop Weight Test		8	-	-	2	Specimen P-2
7	Grain Size & Microstructure[3)]		1	1	1	-	See Note-3.
8	Product Analysis		1	1	1	-	
9	Hardness & Sulphur Print[2)]						See Note-2.
10	U.T. & M.P.I.						100%; Refer para 8.1 & 8.2.

Notes:

1) If testing of the first specimen at RT yields Z < 45% then two more specimens from the same location shall be tested.

2) Hardness values along a square grid of maximum 1000 x 1000 mm on inside and outside. Sulphur print on the face at 120° apart and 120 mm long.

3) Examination on notched bar specimen in Longitudinal - Normal Direction and in the centre (insitu).

TABLE - 4

EXTENT OF TESTS - NOZZLES OF I.D. UPTO 250 MM.

N - Normal
T - Transverse
L - Longitudinal

Sr. No.	Description	Direction	Bottom of Ingot STC-A	RTC	Top of[1] Ingot STC-B	Remarks
1	Tensile at RT	T	1	1	1	See Note-2.
2	Tensile at 350°C	T	1	1	1	See Note-2.
3	Impact -15°C	T	3	3	3	
4	Impact +18°C	T	3	3	3	
5	Drop Weight Test	T	2	-	-	Pellini - P-2 Specimen
6	Grain Size & Microstructure		1	-	1	Examination on notched bar specimen in Longitudinal - Normal Direction. Also see Note-3.
7	Product Analysis		1	-	1	
8	Hardness					Fig. 17
9	U.T. & M.P.I.					100%; Refer para 8.1 & 8.2

Notes:

1) If only one nozzle is made from a forging then test coupons shall be taken only from top of forging. For more than one nozzle from a forging, additional test coupon shall be taken from the top end.

2) Specimens for nozzles upto ID 160 mm need be taken only in longitudinal direction.

3) In case only one nozzle is made from a forging, the grain size and microstructure shall be examined at one location on the main product opposite to the sample location.

TABLE - 5

EXTENT OF TESTS - NOZZLES OF I.D. OVER 250 MM.

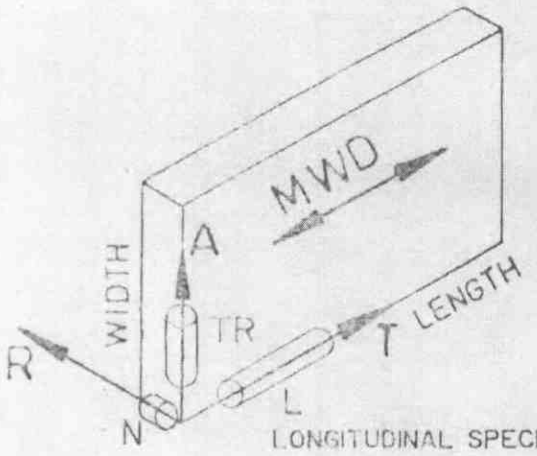
N - Normal
T - Transverse
L - Longitudinal

Sr.	Description	Direction	Bottom of Ingot STC A	STC B	RTC	Top of Ingot STC C	STC D	Remarks
1.	Tensile at RT	N	1 [1]	-	-	1 [1]	-	See. Note-1
		T	1	1	1	1	1	
		L	1	-	-	-	-	
2.	Tensile at 350°C	N	1	-	-	-	-	
		T	1	1	1	1	1	
		L	1	-	-	-	-	
		N	3	-	-	-	-	
3.	Impact-15°C	T	3	3	3	3	3	
		L	3	-	-	-	-	
4.	Impact at +18°C	T	3	3	3	-	-	
5.	Impact Curve -15°C, T 18°C & 4 other Temps		12	-	-	-	-	
6.	Drop Weight Test	T	2	-	-	-	-	Pellini P-2 Specimen
7.	Grain Size & Microstructure		1	1	-	1	1	See. Note-2
8.	Product Analysis		1	1	-	1	-	
9.	Hardness							Fig.17
10.	U.T. & M.P.I.							100% refer para 8. & 8.2

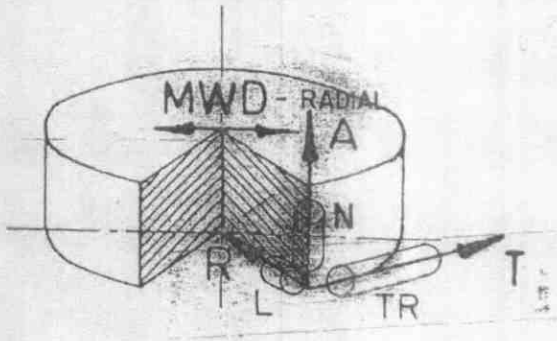
Notes:

1) If testing of first specimen at RT yields $\mathfrak{E} < 45\%$ then two more specimens from the same location shall be tested.

2) Examination on notched bar specimen in Longitudinal - normal direction.

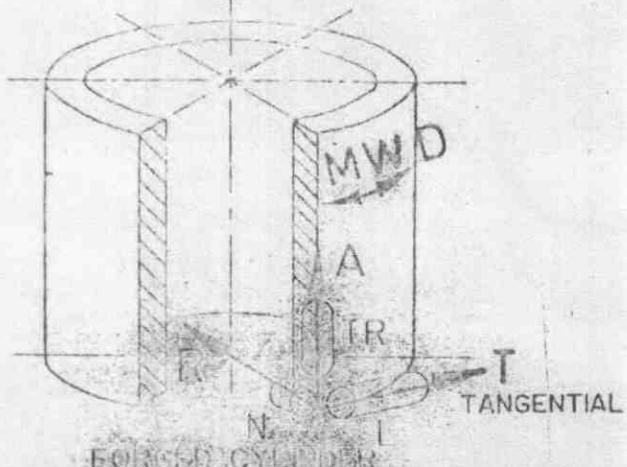


LONGITUDINAL SPECIMEN

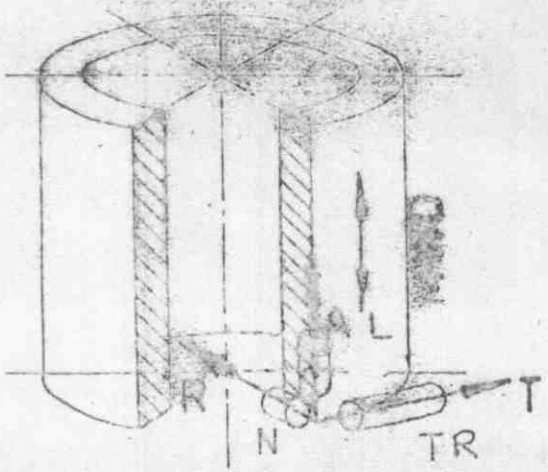


DISC FORGINGS
(TUBE SHEET)

PLATE

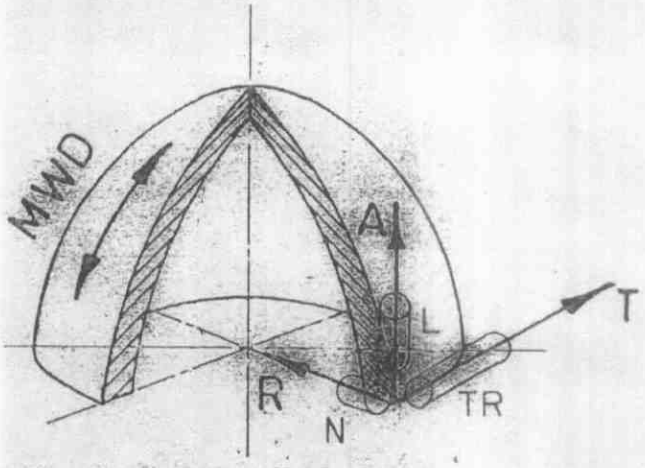


FORGED CYLINDER



FORGED CYLINDER

METAL WORKING DIRECTION AXIAL (NOZZLES)



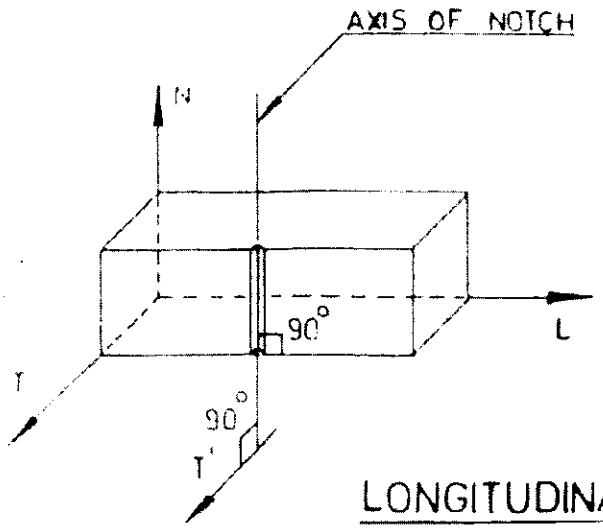
FORGED DISHED ENDS

T = TANGENTIAL	L= LONGITUDINAL
A = AXIAL	Tr= TRANSVERSE
R = RADIAL	N= NORMAL

MWD = MAIN WORKING DIRECTION
(TO BE INDICATED BY THE SUPPLIER FOR HIS PRODUCTS)

TEST SPECIMEN ORIENTATION

FIG- 5



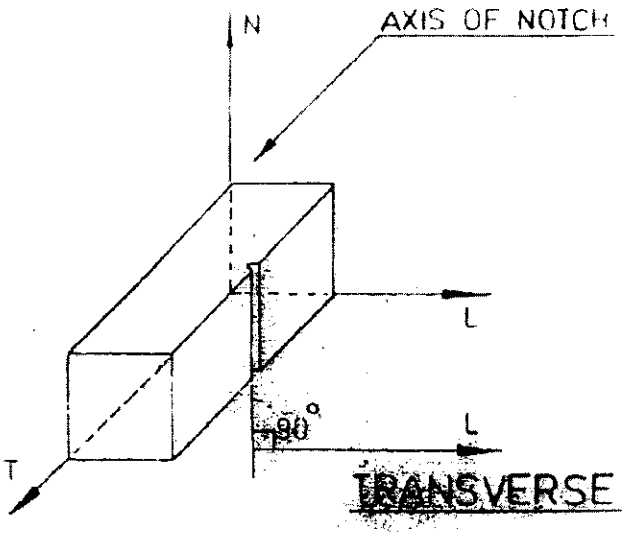
SPECIMEN ORIENTED ALONG

LONGITUDINAL AXIS

AXIS OF NOTCH PERPENDICULAR TO

LONGITUDINAL & TRANSVERSE DIRECTION.

LONGITUDINAL IMPACT TEST SPECIMEN

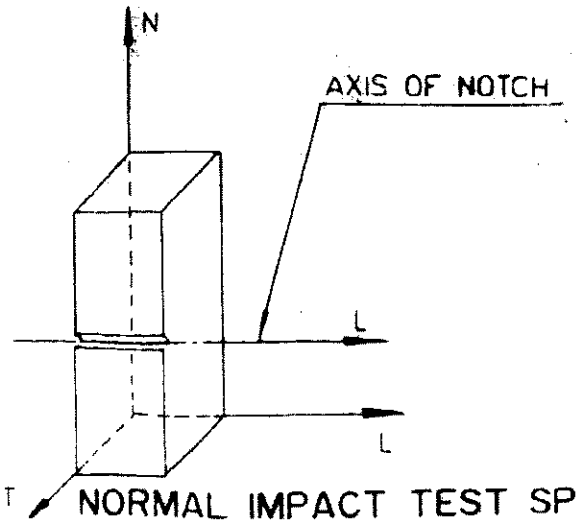


TEST SPECIMEN ALONG TRANSVERSE DIRECTION.

AXIS OF NOTCH PERPENDICULAR TO

LONGITUDINAL & TRANSVERSE DIRECTION.

TRANSVERSE IMPACT TEST SPECIMEN



TEST SPECIMEN ALONG NORMAL DIRECTION.

AXIS OF NOTCH PARALLEL TO

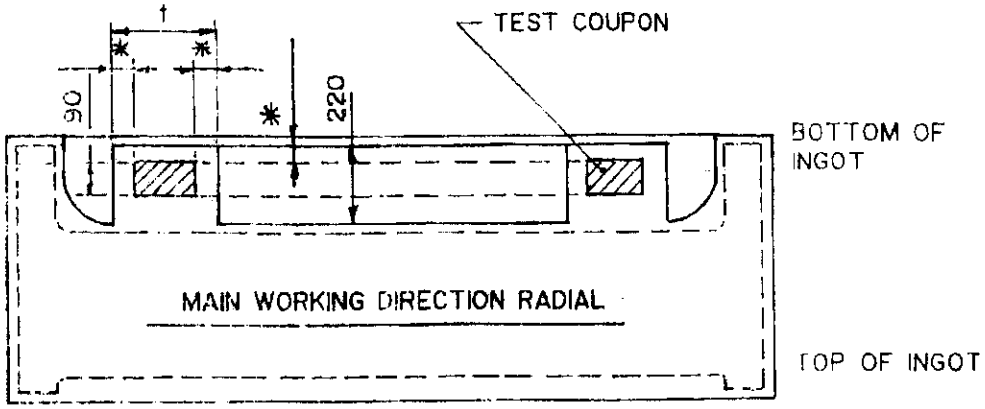
LONGITUDINAL DIRECTION.

NOTCH NEARER TO H.T. SURFACE

NORMAL IMPACT TEST SPECIMEN

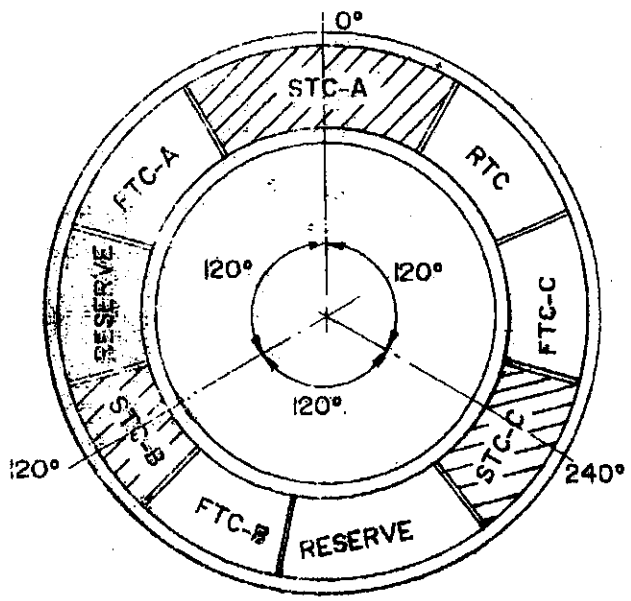
TEST SPECIMEN FOR IMPACT TESTS

FIG- 6



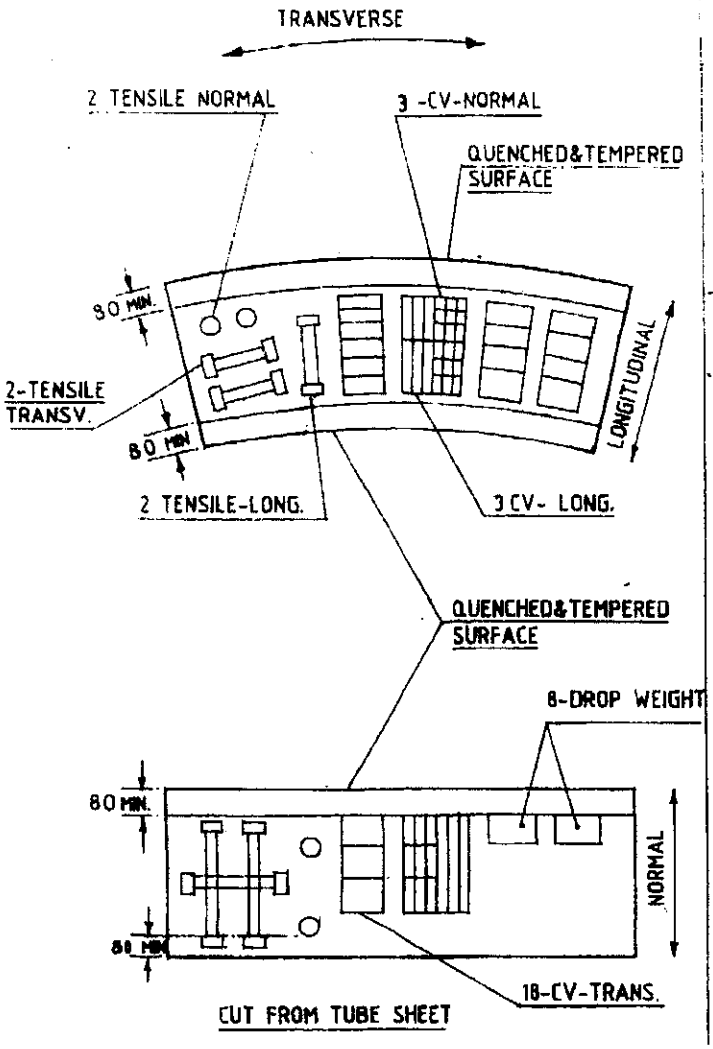
* ≥ 80 mm.

DIMENSION 't' MAY BE SUITABLY SELECTED BY THE SUPPLIER.

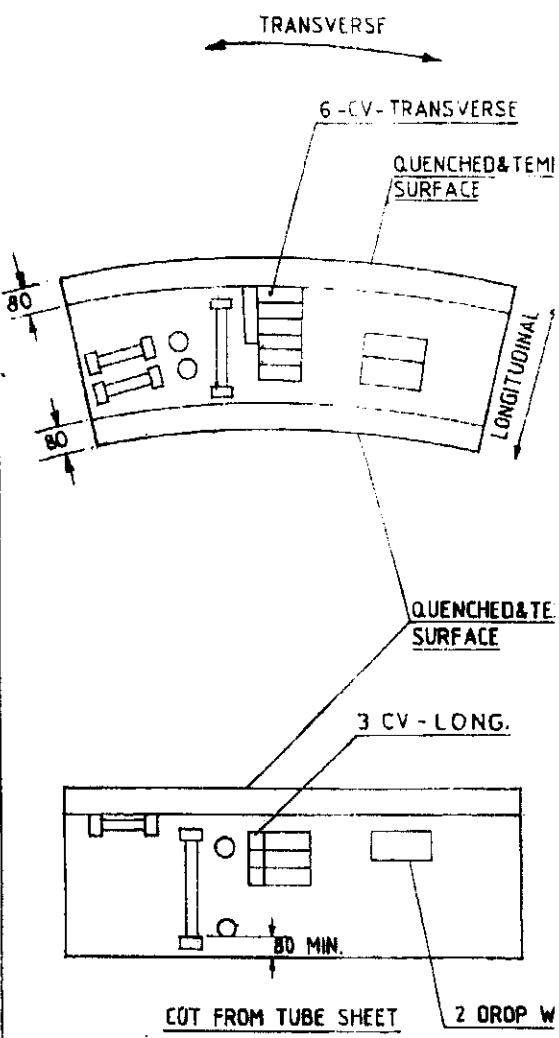


TEST COUPONS LOCATION - TUBE SHEET

FIG- 7



MATERIAL SAMPLING AND TESTING PLAN FOR STC - A



MATERIAL SAMPLING AND TESTIN PLAN FOR STC-B, STC-C & RTC-I

Sl. No.	TEST COUPONS TYPE OF TEST	STC -A N	L	T	FOR EACH STC-B,STC-C & RTC-D LOCATIONS N	L	T
1	TENSILE R.T.	1	1	1	-	-	1
2	TENSILE 350°C	1	1	1	-	-	1
3	IMPACT	3	3	18	3	3	6
4	DROP WEIGHT	-	-	8	-	-	2*

* REQD. FOR RTC

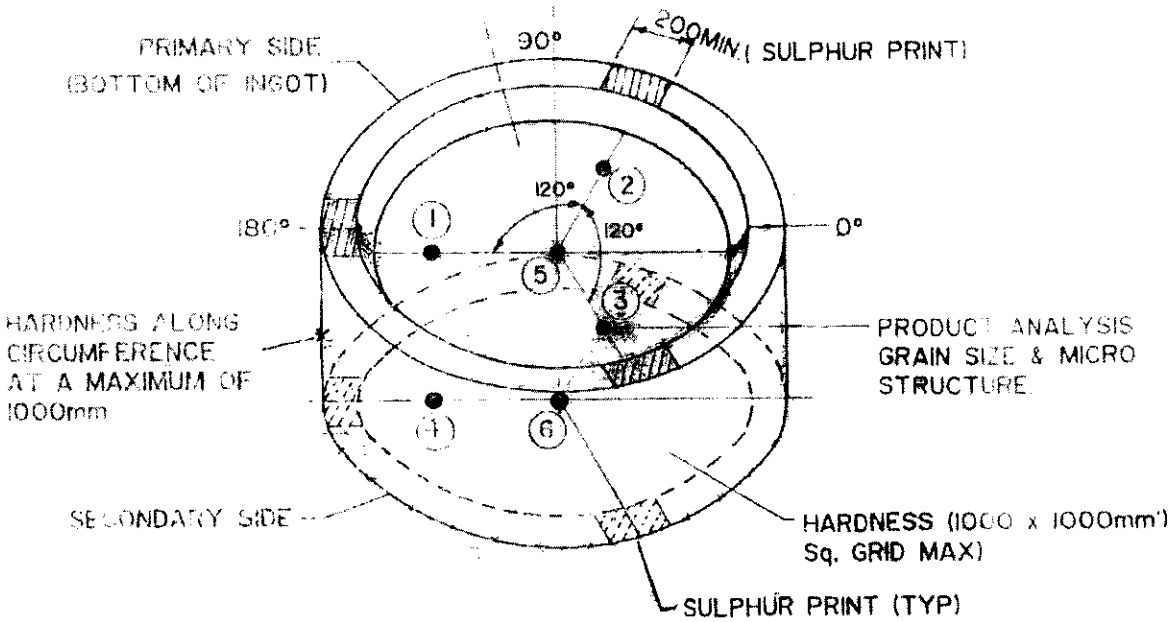
EXTENT OF TESTS- TUBE SHEET

LEGEND:-

N-NORMAL
L-LONGITUDINAL
T-TRANSVERSE

MATERIAL SAMPLING & TESTING PLAN - TUBE SHEET

– HARDNESS (MAXIMUM 1000mm x 1000mm Sq. GRID)



HARDNESS CHECK – a) ON BOTH END FACES ON A GRID PATTERN OF MAXIMUM 1000 x 1000mm.
[AFTER REMOVAL OF TEST COUPONS]
b) ALONG CIRCUMFERENCE AT MAX. OF 1000mm APART.

SULPHUR PRINT TEST – AFTER FINAL MACHINING.

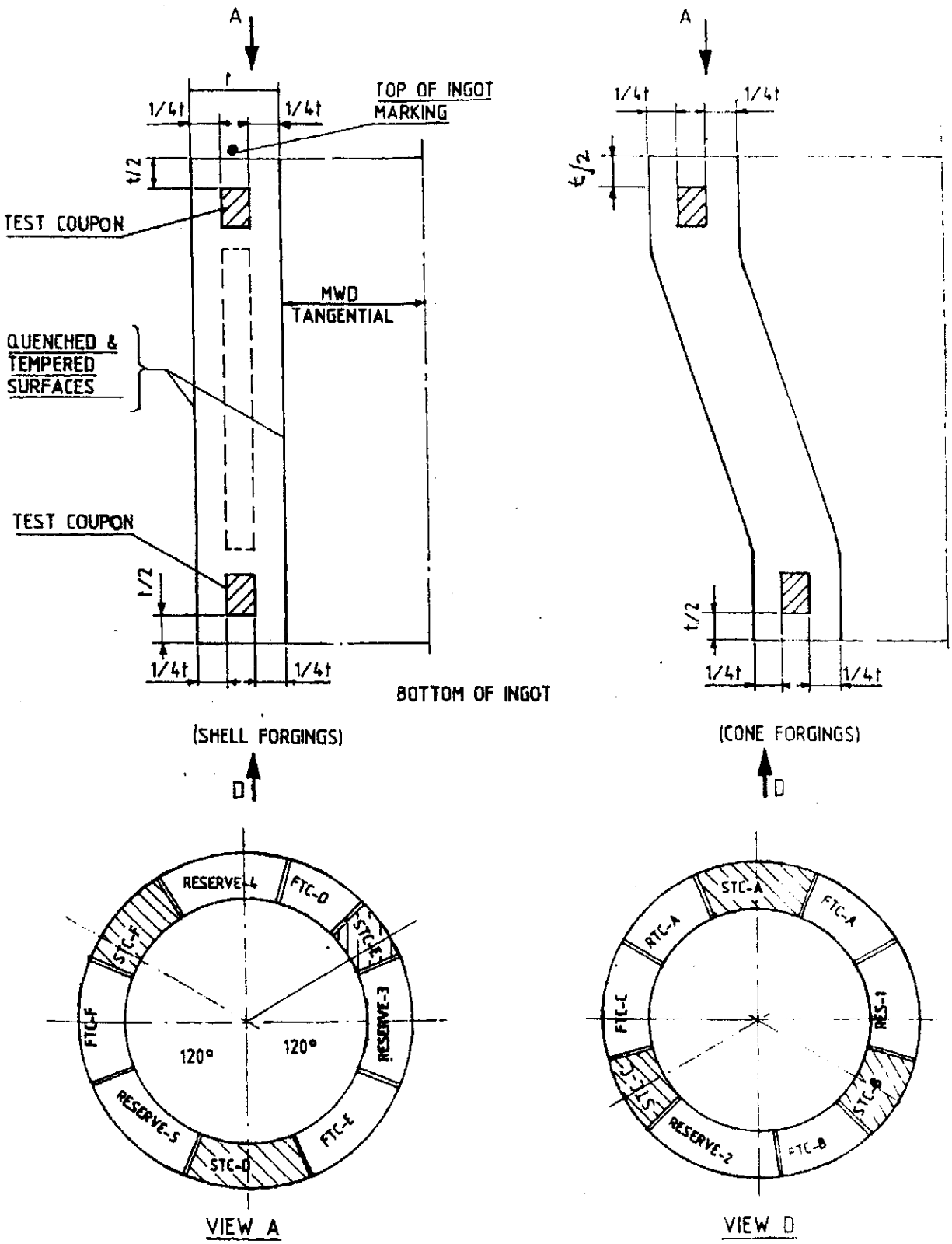
PRODUCT ANALYSIS – (1),(2),(3)– ACCEPTANCE TEST COUPONS FROM TEST RING
– (4),(5),(6) ADDITIONAL SAMPLES.

GRAIN SIZE & MICROSTRUCTURE – a) ON ONE NOTCHED BAR TEST SPECIMEN FROM EACH SAMPLING LOCATION (STC-A, STC-B, STC-C)

b) IN THE CENTRE OF THE PRIMARY & SECONDARY SIDE THE MICROSTRUCTURE AND SEGREGATION SHALL BE EXAMINED

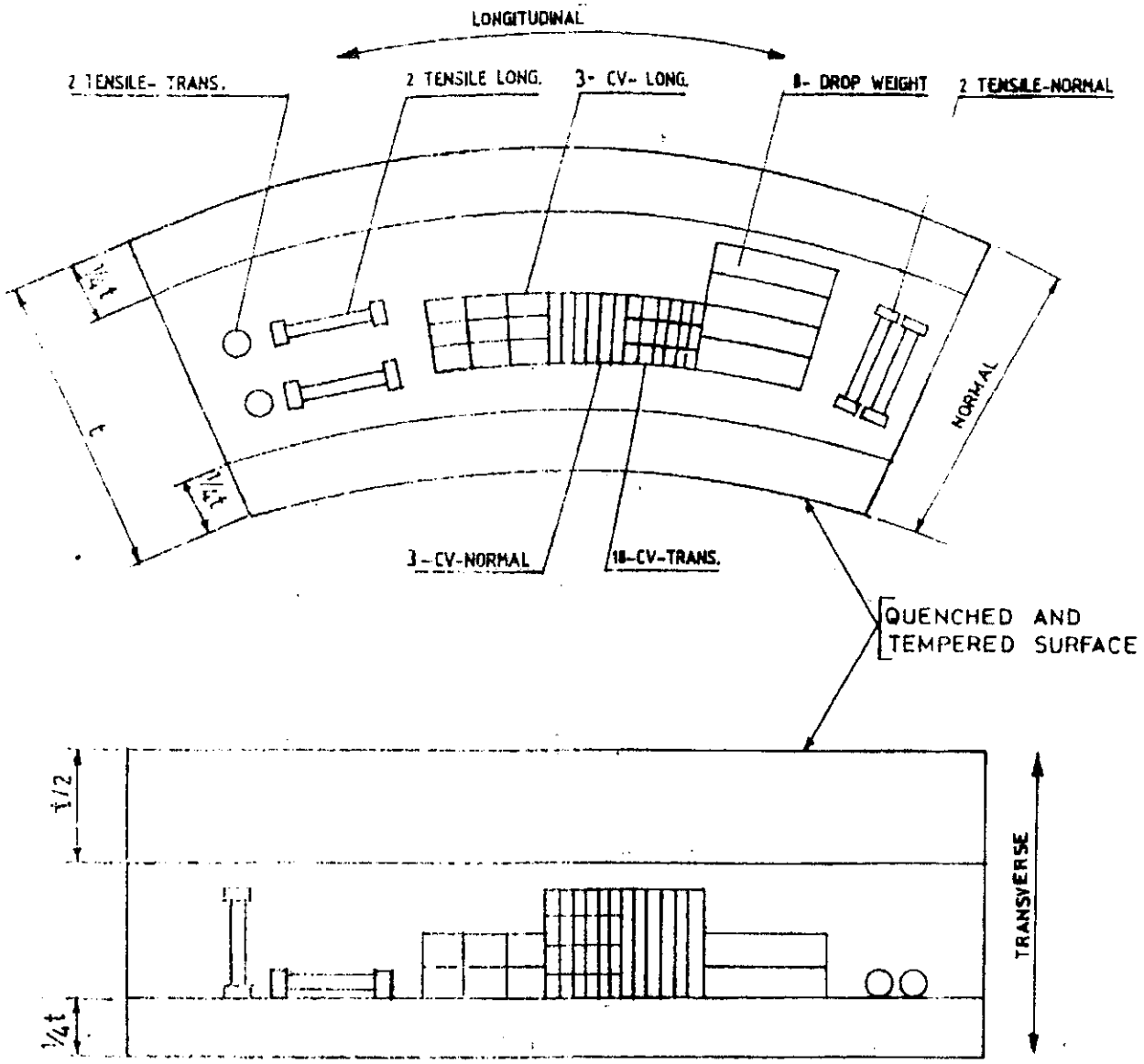
PRODUCT ANALYSIS & METALLURGICAL EXAMINATION (TUBE SHEET)

FIG- 9



TEST COUPONS LOCATION- RING FORGINGS

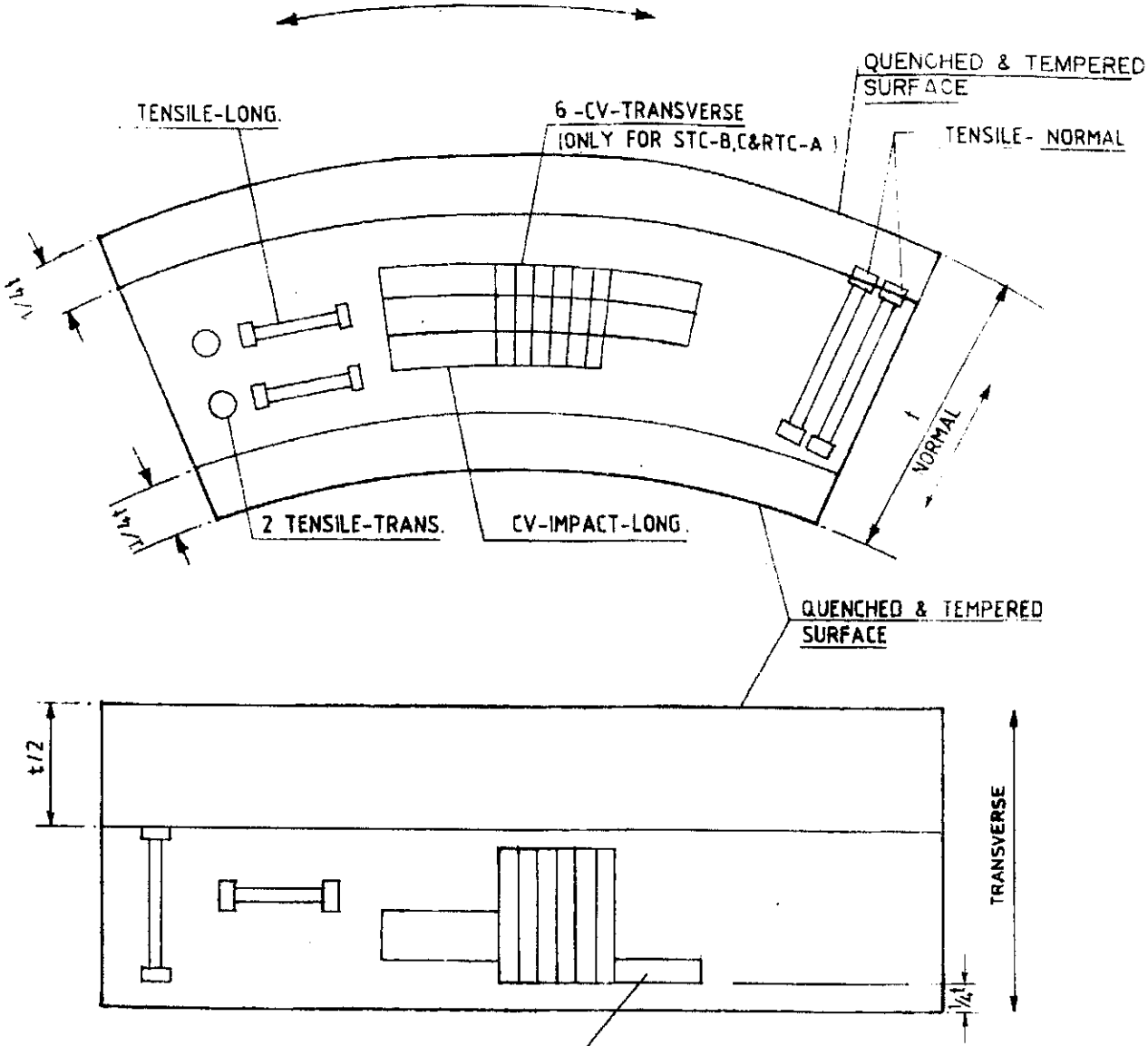
FIG-10



S. NO.	TYPE OF TEST	NO. OF TEST SPECIMEN		
		L	N	T
1	TENSILE AT RT	1	1	1
2	TENSILE AT 350°C	1	1	1
3	IMPACT TEST	3	3	18
4	DROP WEIGHT TEST	–	–	8

MATERIAL SAMPLING & TESTING PLAN FOR STC-A RING FORGINGS

FIG - 11



2- PELLINI-DROP Wt(RTC-A)
- LONGITUDINAL

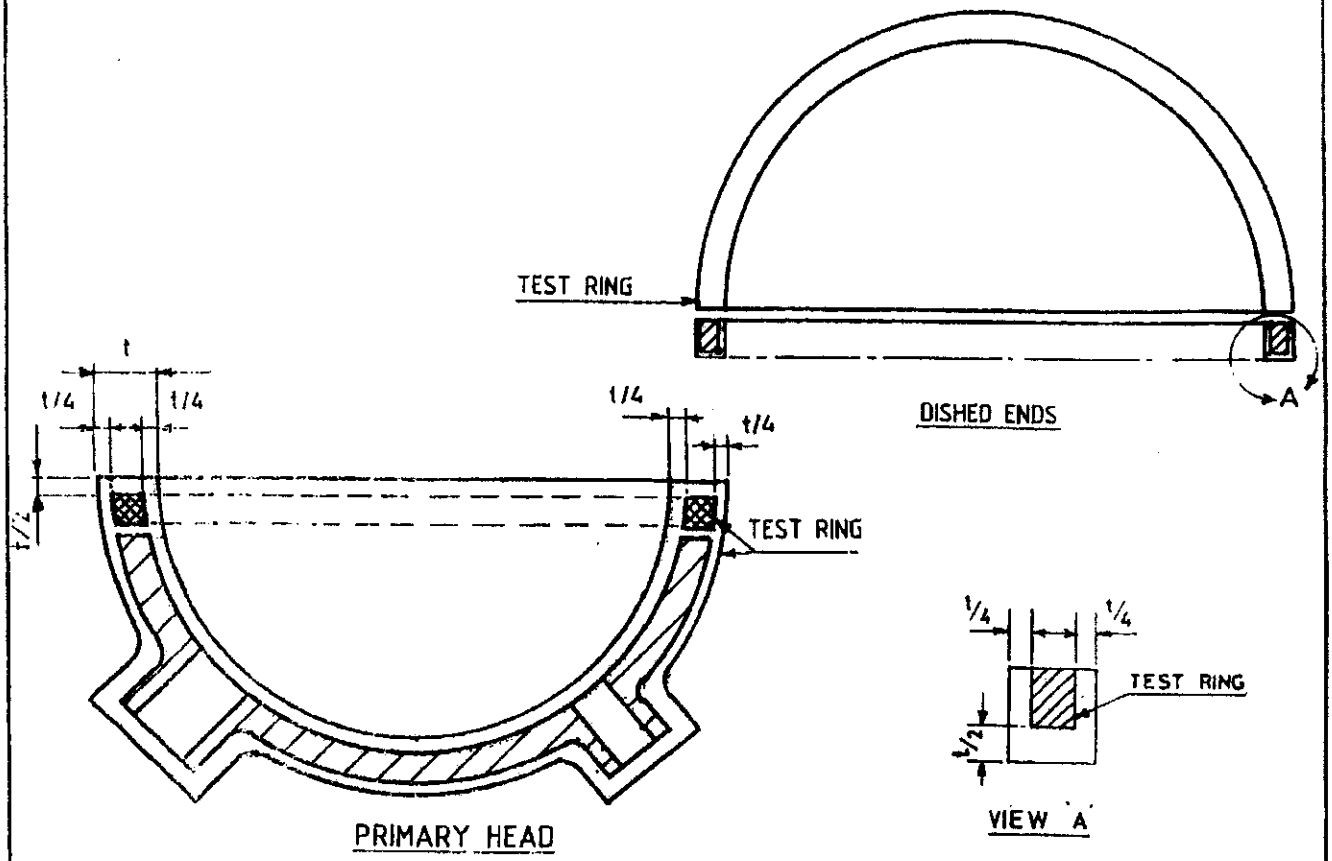
SL. No	TYPE OF TEST	NO. OF SPEC. FOR EACH OF STC-B & C			No. OF SPEC. FOR EACH OF STC-D,E&F			RTC-A No. OF SPEC		
		L	N	T	L	N	T	L	N	T
1	TENSILE AT RT	–	-	1	–	1*	1	–	–	1
2	TENSILE AT 350°C	–	-	1	–	-	1	-	–	1
3	IMPACT TEST	–	-	6	–	-	3	–	-	6
4	DROP WEIGHT TEST	–	-	-	–	-	-	–	-	2

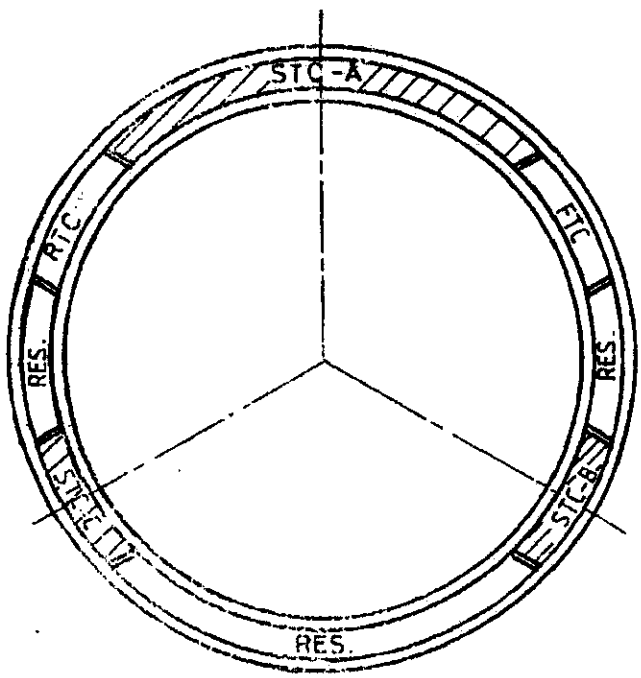
* ONLY FOR STC - D

NOTE- ALSO SEE TABLE-2 FOR EXTENT OF TESTS

MATERIAL SAMPLING TESTING PLAN- STC-B,C,D,E&F AND RTC-A - RING FORGINGS

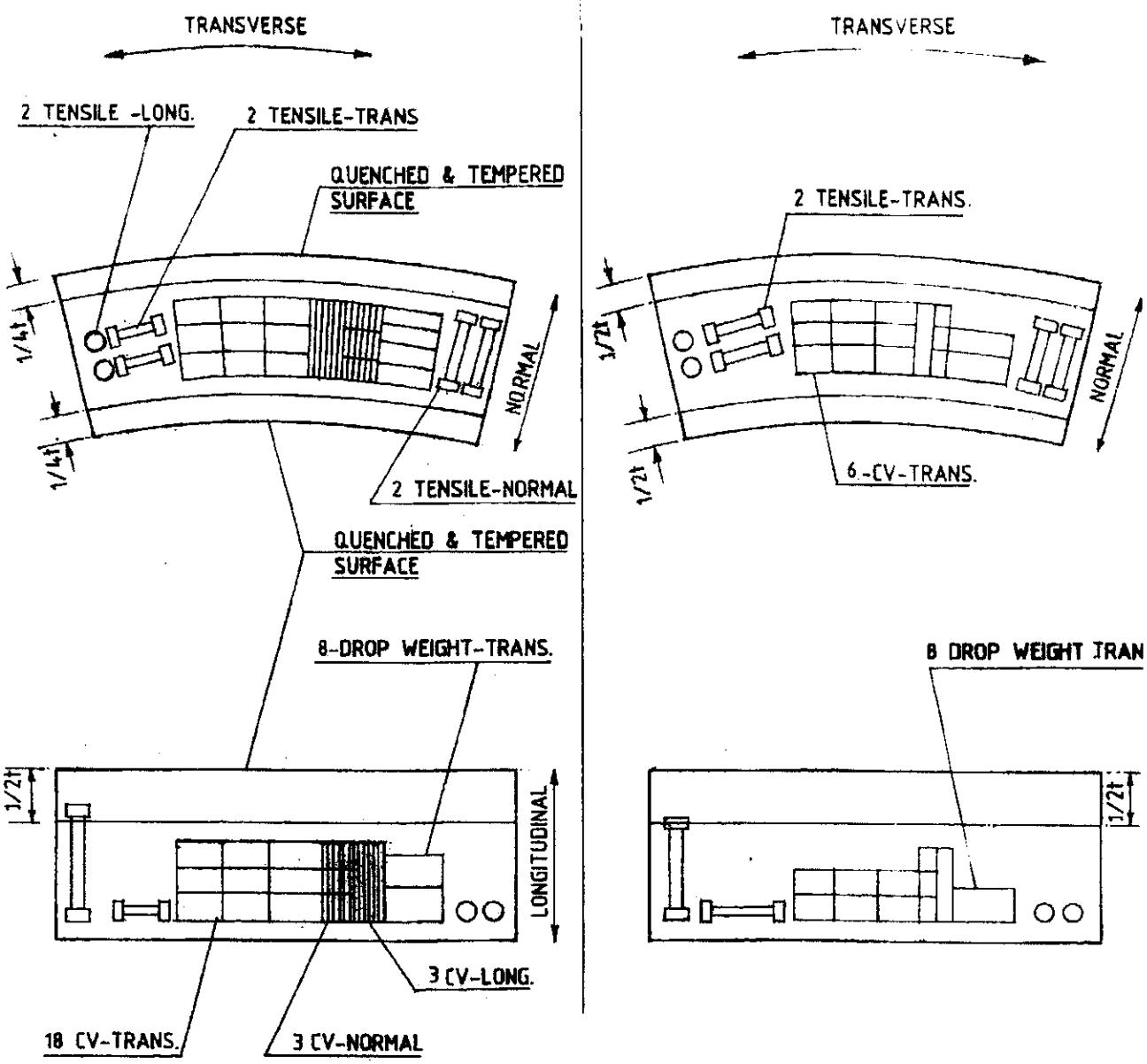
FIG - 12





TEST COUPONS-LOCATION- DISHED END FORGINGS

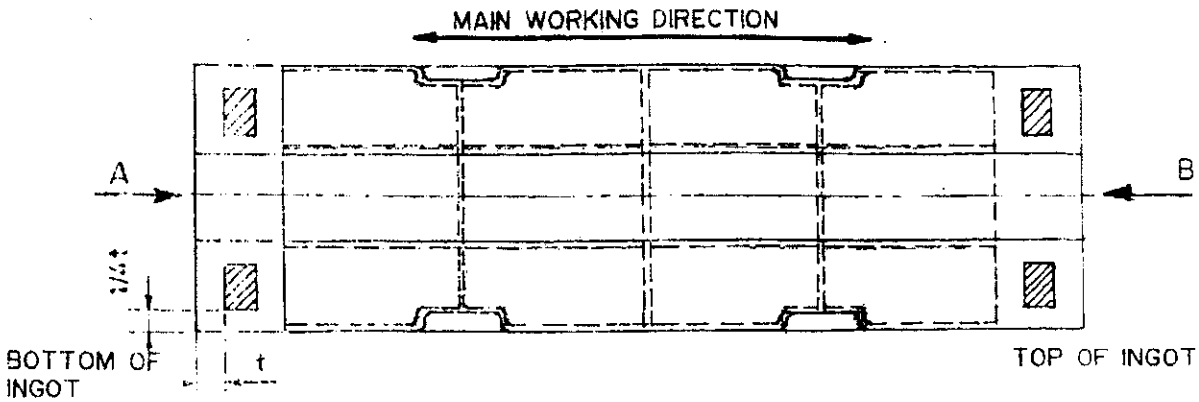
FIG- 13

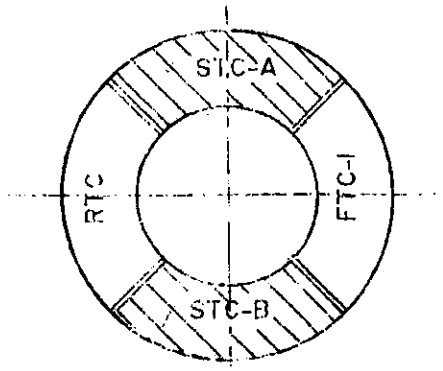


SL. No.	TYPE OF TEST	NO. OF TEST SPECIMEN					
		STC- A			FOR EACH OF STC-B, STC-C &RTC		
		L	N	T	L	N	T
1	TENSILE RT	1	1	1	–	–	1
2	TENSILE 350°C	1	1	1	–	–	1
3	IMPACT	3	3	18	–	–	6
4	DROP WEIGHT	-	-	8	-	-	2

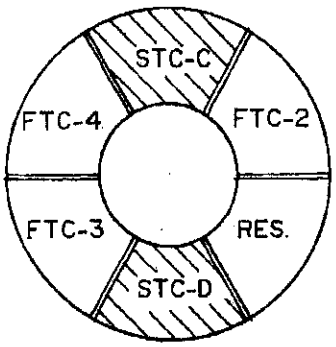
MATERIAL SAMPLING & TEST PLAN - DISHED END FORGINGS

FIG- 14





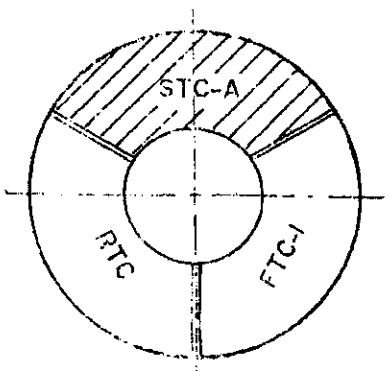
VIEW - A



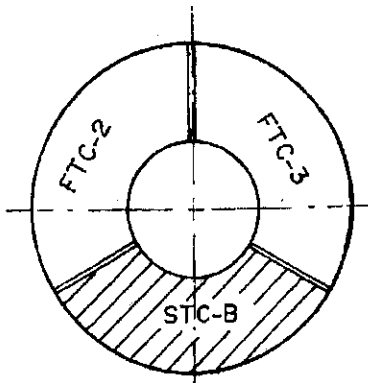
VIEW -B

(No. OF F.T.C.'S WILL BE EQUAL TO THE No. OF NOZZLES & OF SIZE EQUAL TO ATLEAST THAT OF S.T.C.-B)

SAMPLING PLAN FOR NOZZLES I.D. ABOVE 250



VIEW - A



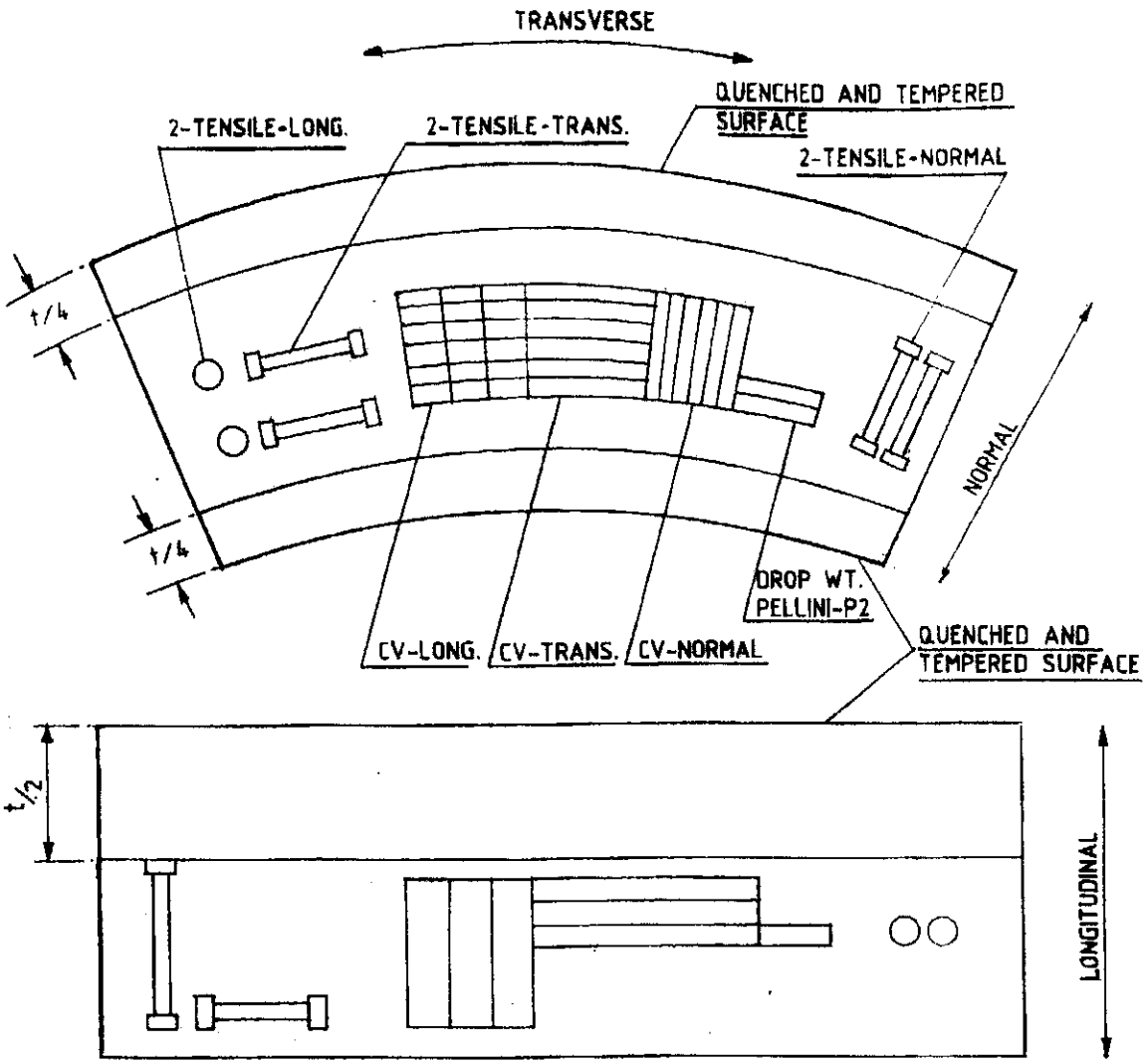
VIEW - B

NOTE:-
IF ONLY ONE NOZZLE IS MADE FROM A FORGING TEST COUPONS SHALL BE DRAWN ONLY FROM THE BOTTOM.

SAMPLING PLAN FOR NOZZLES I.D. UPTO 250

TEST COUPONS-LOCATION - NOZZLE FORGINGS

FIG- 15

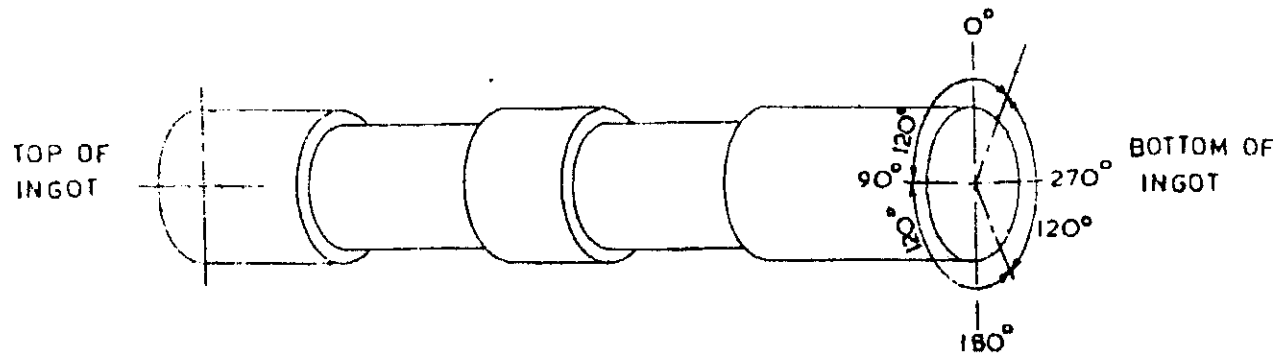


SL. No.	TYPE OF TEST	NO. OF TEST SPECIMEN															
		NOZZLE ID > 250									ID UPTO 160 mm				160 < ID < 250		
		STC-A			STC-B&D (EACH)			RTC			STC-A & B & RTC (EACH)				STC-A & B & RTC (EACH)		
		L	N	T	L	N	T	L	N	T	L	N	T		L	N	T
1	TENSILE RT	1	1	1	-	-	1	-	-	1	1	-	-		-	-	1
2	TENSILE 350°C	1	1	1	-	-	1	-	-	1	1	-	-		-	-	1
3	IMPACT -15°C	3	3	3	3	3	3	-	-	3	3	-	-		-	-	3
4	IMPACT +18°C	-	-	3	-	-	3●	-	-	3	3	-	-		-	-	3
5	ADDITIONAL FOR IMPACT CURVE	-	-	12	-	-	-	-	-	-	-	-	-		-	-	-
6	DROP WEIGHT *	-	-	2	-	-	-	-	-	-	-	-	2		-	-	2

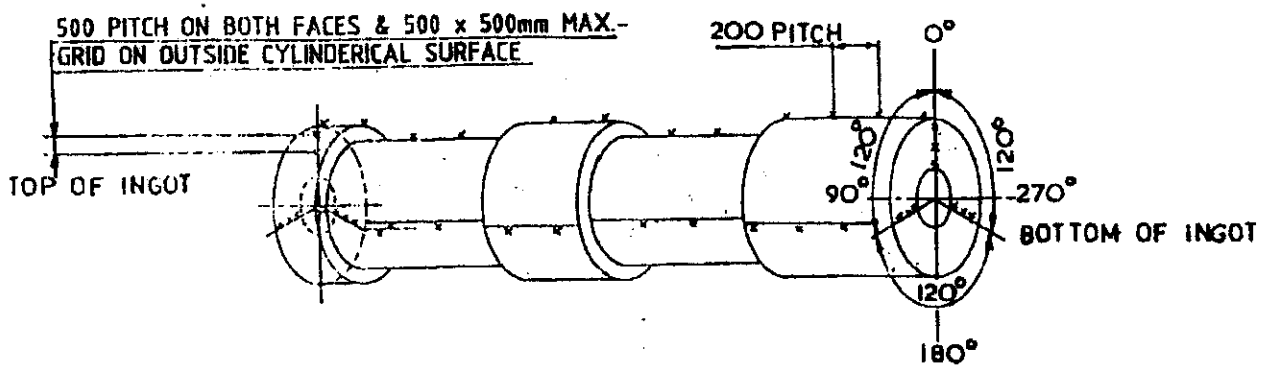
NOTE :-
1. * ONLY ON STC-A
2. ● ONLY FOR STC-B
3. ALSO REFER TABLE-5

MATERIAL SAMPLING & TEST PLAN- NOZZLES.

FIG- 16



SULPHUR PRINT AFTER Q&T



HARDNESS TEST AFTER REMOVAL OF TEST COUPONS

NOTE:

- — — HARDNESS TEST

METALLURGICAL TEST PLAN-NOZZLES

FIG-17

ANNEXURE-1

LOW ALLOY STEEL FORGINGS - 15 Mo 3

1.0 SCOPE

This Annexure covers the technical requirements for the supply of low alloy steel forgings conforming to DIN material number 1.5415.

2.0 PROCESS OF MANUFACTURE

2.1 Steel Melting

The steel shall be melted in an open hearth/electric furnace. The steel shall be fully killed and preferably vacuum degassed.

2.2 Discard

Sufficient discard shall be made from the ingot to secure freedom from piping and segregation.

2.3 Forging Process

The components shall be hot forged as close as practicable to their final shape by a press or hammer of sufficient capacity to work the metal throughout its section.

2.4 Repairs

Refer para 9.0 of PB-M-90.

3.0 CHEMICAL COMPOSITION

Both ladle and product analysis shall meet the following requirements:

Element	Weight Percentage
C	0.12 - 0.20
Si	0.15 - 0.35
Mn	0.50 - 0.70
P max	0.035
S max	0.035
Cr max	0.30
Mo	0.25 - 0.35
Cu max	0.30
N2 max	0.009

4.0 Heat Treatment

The forgings shall be supplied in the normalised condition.

5.0 MECHANICAL PROPERTIES

5.1 Mechanical tests shall be conducted in accordance with ASTM A-370 and ASTM E-21. Following minimum requirements shall be met with in final normalised condition. Wherever possible transverse specimen will be used failing which longitudinal specimens can be used for tests.

	RT	350 deg-C
Tensile Strength (N/sq mm)	440 - 580	To be reported
Yield Strength (N/sq mm)	270	190
% Elongation on 5d (in 50 mm gauge length)	21	To be reported
Reduction in area	35	-

5.2 Notch Toughness

Three ISO-V test specimens will be tested at 20 deg-C. The longitudinal and transverse specimen will exhibit the following minimum values.

i) Average of three specimens 55 J

ii) Lowest single value 39 J

5.3 Hardness Test

Hardness shall be measured on each forging after final heat treatment along the length as well as over the thickness of the forging at sufficient number of points to demonstrate uniformity.

6.0 TEST COUPONS AND SPECIMEN LOCATION

Two separate test coupons (RTC & FTC) shall be identified and taken out from the forged bars. RTC (Raw Material Test Coupons) shall be used for preliminary tests before taking up final forging. RTC (Final Test Coupon) shall undergo same amount of working and heat treatment as the final forging.

The specimens for testing shall be atleast 1/4 't' from a heat treated surface and 1/2 't' from the end where 't' is the heat treated thickness.

6.1 Tensile Test Specimen

Two tensile test specimens shall be taken from each coupon (RTC - 2 Nos. & FTC - 2 Nos.) for tests at room temperature and at 350 deg-C.

6.2 Impact Test Specimen

One set of Cv impact test specimen shall be taken from each (RTC & FTC) for tests at 20 deg-C. Lateral expansion and percent shear fracture shall be reported.

7.0 Non Destructive Examination

The dimensional checks, ultrasonic examination and magnetic particle tests shall be carried out on each forging as per para 8.1, 8.2 & 8.3 of PB-M-90.

8.0 QUALITY SURVEILLANCE, DOCUMENTATION, MARKING, PACKING AND SHIPMENT

Refer para 10, 11 & 12 of PB-M-90.

ANNEXURE-2

LOW ALLOY STEEL FORGINGS - ASTM-A-350 LF2

1.0 SCOPE

This Annexure covers the technical requirements for supply of low alloy steel forgings conforming to ASTM-A-350 Grade LF2.

2.0 MANUFACTURE

2.1 The steel shall be clean, homogeneous, intrisically tough produced by any recognised fine grain practice and shall be fully killed. The steel shall be produced by vacuum treatment. Details of the vacuum treatment and secondary metallurgical processes used shall be indicated in the bid.

2.2 The forgings shall be supplied in accordance with SA-350 grade LF2 with following additional requirements.

2.2.1 Chemical Composition

Sulphur, Phosphorus and other impurity elements shall be restricted as given below:

S	-	0.025% max.
P	-	0.025% max.
Al	-	0.04%
V	-	0.01%
Cr	-	0.25%
Cu	-	0.30%
Ni	-	0.40%
Sn	-	0.011%
As	-	0.025%
Sb	-	0.007%
N2	-	0.013%

2.2.2 Heat Treatment

The forgings shall be supplied in normalised condition.

2.2.3 Grain Size & Microstructure

The grain size and microstructure shall be determined on Longitudinal-Normal section of the forging. The micrographs for determining the microstructure shall be made with a minimum magnification of 200 X. The grain size shall be measured as per ASTM-E-112 and shall be 6 or finer.

3.0 MECHANICAL PROPERTIES

3.1 Mechanical tests shall be conducted in accordance with ASTM-A-370 and ASTM-E-21. Following minimum requirements shall be met with in final normalised condition and are applicable to all test specimen orientation viz. Longitudinal, Transverse and Normal.

	RT	350 deg-C
Tensile Strength (N/sq mm)	483-655	To be reported
Yield Strength (N/sq mm) (0.2% offset)	250	190
% Elongation in 50 mm	22	To be reported
Reduction in area	30	To be reported

3.2 Notch Toughness

In addition to the impact properties specified at -45.6 deg-C as called for in SA-350 LF2, ISO-V impact transverse test specimens will be tested at +18 deg-C for certification of RTNDT. The absorbed energy and lateral expansion shall not be less than 69 J and 0.9 mm respectively for any of the specimens. The percent shear fracture shall be reported. Two drop weight tests carried out at - 15 deg-C shall not indicate any break.

3.3 Hardness Test

Hardness of each forging shall be measured after the heat treatment before any further processing along the grid as defined in product specifications to demonstrate uniformity. Tests shall be carried out as per ASTM-E-10. The difference between the maximum and minimum hardness values shall not exceed 20 BHN.

3.4 Inclusion Rating

Refer para 6.4 of PB-M-90.

4.0 TESTS & EXAMINATION

For test coupon location and extent of tests refer para 7.2, 7.3, 7.4, 7.5, 7.6, 7.7 and product specification tables of PB-M-90.

5.0 NON DESTRUCTIVE EXAMINATION

Refer para 8.1, 8.2 & 8.3 of PB-M-90.

6.0 QUALITY SURVEILLANCE, DOCUMENTATION, MARKING, PACKING AND SHIPMENT

Refer para 10, 11 and 12 of PB-M-90.

ANNEXURE-3

BLEED CONDENSER FORGINGS

N-Normal
T-Transverse
L-Longitudinal

1. **EXTENT OF TESTS FOR:**

a) Primary Head with Integral Nozzles (5NP-I-1&2/33324/2501/TD)
b) Tube Sheet (5NP-I-1&2/33324/2506/TD)
c) Shell Flange (5NP-I-1&2/33324/2502/TD)
d) Hemispherical Head (5NP-I-1&2/33324/2503/TD)
e) Ellipsoidal Head (5NP-I-1&2/33324/2508/TD)

1.1 No. of Test Coupons - 2 (STC-A & STC-B)

1.2 Location of Test Coupons - Diametrically opposite to each other.

1.4 Condition of Test Coupons - Simulated Heat Treated

1.5 Extent of Tests

Description	Direction	STC-A	STC-B
Tensil (RT)	N	1	-
	T	1	1
	L	1	-
Tensile (350°C)	T	1	1
Impact -15°C	T	3	3
Impact +18°C	T	3	3
Drop Weight Test	T	2	-
Grain Size & * Microstructure	-	1	1
Product Analysis	-	1	
Hardness	At 500 x 500 mm grid		
UT & MPI	100% Refer 8.1 & 8.2 of PB-M-90.		

* Examination on notched bar specimen in Longitudinal - Normal Direction.

ANNEXURE-3

BLEED CONDENSER FORGINGS

N - Normal
T - Transverse
L - Longitudinal

2. EXTENT OF TESTS FOR:

a) Integral Forging of Cone & Shell (5NP-I-1&2/33324/2504/TD)

b) Shell Forging (5NP-I-1&2/33324/2505/TD)

2.1 No. of Test Coupons - 4 (STC-A & STC-B - Bottom of Ingot
STC-C & STC-D - Top of Ingot)

2.2 Location of Test Coupons - Diametrically opposite to each other on one face and displaced by 90° to the opposite face.

2.3 Condition of Test Coupons - Simulated Heat Treated

2.4 Extent of Tests

Description	Direction	Bottom of Ingot STC-A	Bottom of Ingot STC-B	Top of Ingot STC-C	Top of Ingot STC-D
Tensile (RT)	N	1	-	1	-
	T	1	1	1	1
	L	1	-	-	-
Tensile (350°C)	T	1	1	1	1
Impact -15°C	T	3	3	3	3
Impact +18°C	T	3	3	3	3
Drop Weight	T	2	-	-	-
Grain Size & Microstructure*		1	1	1	1
Product Analysis		1	1	1	-
Hardness		Along 500 x 500 mm grid			
UT & MPI		100% as per para 8.1 & 8.2 of PB-M-90			

* Examination on notched bar specimen in Longitudinal - Normal Direction.

ANNEXURE-3

BLEED CONDENSER FORGINGS

3. EXTENT OF TESTS FOR:

a) Nozzle Forgings 5 NP-I-1&2/33324/2509/TD

b) Heater Nozzle 5 NP-I-1&2/33324/2510/TD

3.1 No. of Test Coupons - 2 per forged bar (STC-A & STC-B) (Refer Fig. 15 of PB-M-90)

3.2 Location of Test Coupons - On opposite faces - diametrically opposite

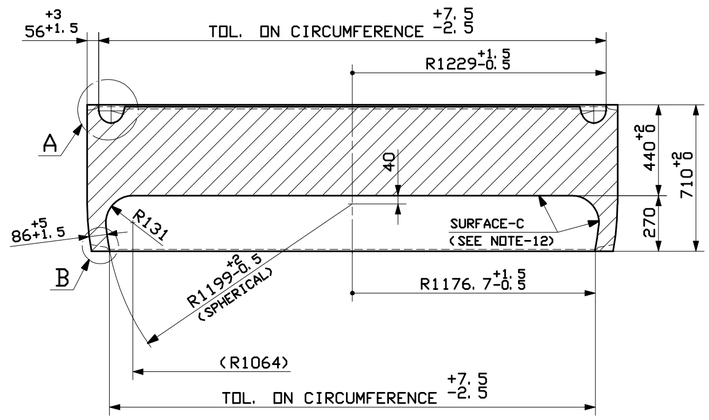
3.3 Condition of Test Coupons - Simulated Heat Treated

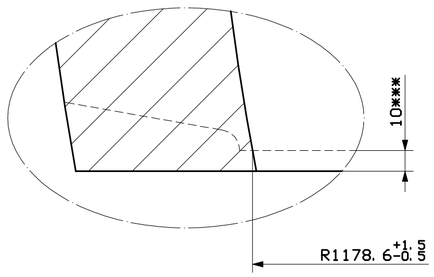
3.4 Extent of Tests

Description	Direction	STC-A	STC-B
Tensile (RT)	T	1	1
Tensile (350°C)	T	1	1
Impact -15°C	T	3	3
Impact +18°C	T	3	3
Drop Weight Test	T	2	-
Grain Size & Microstructure*		1	1
Product Analysis		1	1
Hardness	Along 200 x 200 mm grid		
UT & MPI	100% as per para 8.1 & 8.2 of PB-M-90.		

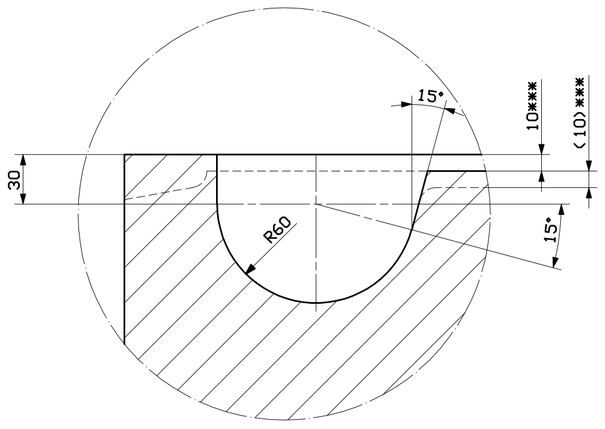
* Examination on notched bar specimen in Longitudinal - Normal Direction.

DRAWING NO: 2-93-170-05110





DETAIL-B
(1:2)



DETAIL-A
(1:2.5)

*** - MACHINING ALLOWANCE
(DOTTED LINES INDICATED FOR FINAL MACHINING ARE ONLY FOR INFORMATION)

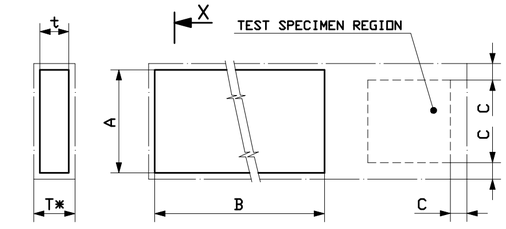
NOTES:-

ALL DIMENSIONS ARE IN MILLIMETERS

1. APPLICABLE SPECIFICATIONS :
   i) PB-M-90
2. MATERIAL SPECIFICATION : 20MnMoNi55.
3. SURFACE FINISH : 3.2 ON SURFACE 'C' & RING GROOVE, 6.3 OR FINER ON ALL OTHER SURFACES.
4. THE FORGING SHALL BE SUPPLIED IN FINISH MACHINED CONDITION AS SHOWN.
5. FINISHED FORGING SHALL BE SUBJECTED TO 100% M.T AS PER PB-M-90
6. THE FORGING SHALL ALSO BE CHECKED BY 100% U.T AS PER PB-M-90
7. SUITABLE RUST PREVENTIVE COATING WHICH IS EASILY REMOVABLE SHALL BE APPLIED ON ALL OTHER MACHINED SURFACES.
8. THE COMPONENT SHALL BE FORGED AS CLOSE TO THE FINISHED SHAPE AS POSSIBLE.
9. DETAILED DRAWINGS INDICATING THE VARIOUS STAGES OF MANUFACTURE SHALL BE SUPPLIED TO THE PURCHASER FOR HIS APPROVAL PRIOR TO TAKING UP THE MANUFACTURE OF THE JOB.
10. WALL THICKNESS INDICATED ARE MINIMUM VALUES.
11. F.T.C AS PER SPECIFICATION PB-M-90 SHALL BE SUPPLIED ALONG WITH THE FINISHED TUBESHEET FORGING.
12. SURFACE-'C' SHALL BE PROTECTED IMMEDIATELY AFTER MACHINING AND CARRYING OUT NDE BY BRIGHT COLOURED PEELABLE PLASTIC COAT IN ORDER TO PRESERVE THIS MACHINED SURFACE.
13. IN ADDITION TO THE MONITORING TEST COUPONS REQUIRED UNDER THE SPECIFICATION, PRODUCTION WELD TEST PLATES OF SIZE AND QUANTITY AS GIVEN BELOW, BELONGING TO THE SAME MELT NUMBER AND SIMILARLY HEAT TREATED AS THE COMPONENT, SHALL ALSO BE SUPPLIED.

S.NO.	t	A	B	C	QUANTITY
1	86	250	2500	T	1 NO. EACH WITH EVERY TUBESHEET FORGING
2	56	250	2500	T	
3	130	700	3000	1/2 T	
4	430	700	700	1/2 T	**

** THIS PLATE IS FOR DRILLING QUALIFICATION AND SHALL BE SUPPLIED IN QUANTITY ONE PER 4 TUBESHEET FORGINGS FROM ANY ONE OF THE MELT OF THESE 4 Nos. OF TUBESHEET FORGINGS.



SECTION-XX
(NTS)

* - Q&T THICKNESS

14. FOR 86mm THICK PLATE, IN ADDITION TO THE TESTS PERFORMED AT 1/4 T DEPTH, TESTS SHALL ALSO BE CONDUCTED WITH SPECIMENS TAKEN AT NEAR SURFACE AND MID THICKNESS.
15. APPROXIMATE WEIGHT : 18757 kg

TOLERANCE IF NOT SPECIFIED SHALL BE AS BELOW (REFER IS 2102-m)

LINEAR				ANGULAR	
0.5 TO 3	±0.1	400 TO 1000	±0.8	0 TO 10	± 1°
3 TO 6	±0.1	1000 TO 2000	±1.2	10 TO 50	±30′
6 TO 30	±0.2	2000 TO 4000	±2.0	50 TO 120	±20′
30 TO 120	±0.3	—	-	120 TO 400	± 10′
120 TO 400	±0.5	—	-	OVER 400	± 5′

REV	DATE	ALTERED :	CHD&APPD :
02	171209		

PROJECT NAME ADDED IN TITLE BLOCK

REV	DATE	ALTERED :	CHD&APPD :
01	150409		

'KAPP-3' ADDED IN TITLE BLOCK

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: 700MWe/KAPP-3/RAPP-7

Bharat Heavy Electricals Ltd
UNIT: HIGH PRESSURE BOILER PLANT
TIRUCHIRAPALLI - 620014
05-228/D

	NAME	SIGNATURE	DATE	NO. OF VAR
DRN	N.K.		200706	
CHD	SOUGAT		120608	
APPD	V.R		140608	

DEPT	GRADE OF UNTOL. DIM	SCALE	WEIGHT (Kg)	REF TO ASSY / OLD DWG	ITEM NO	No OF ITEMS
NC	C/M/F	1:20 ; 1:5 1:2 ; NTS		TAPP-3&4/33111/5003/DD REV-1		
CODE 150						

TITLE: TUBESHEET (FORGING)

CARD CODE: U 01

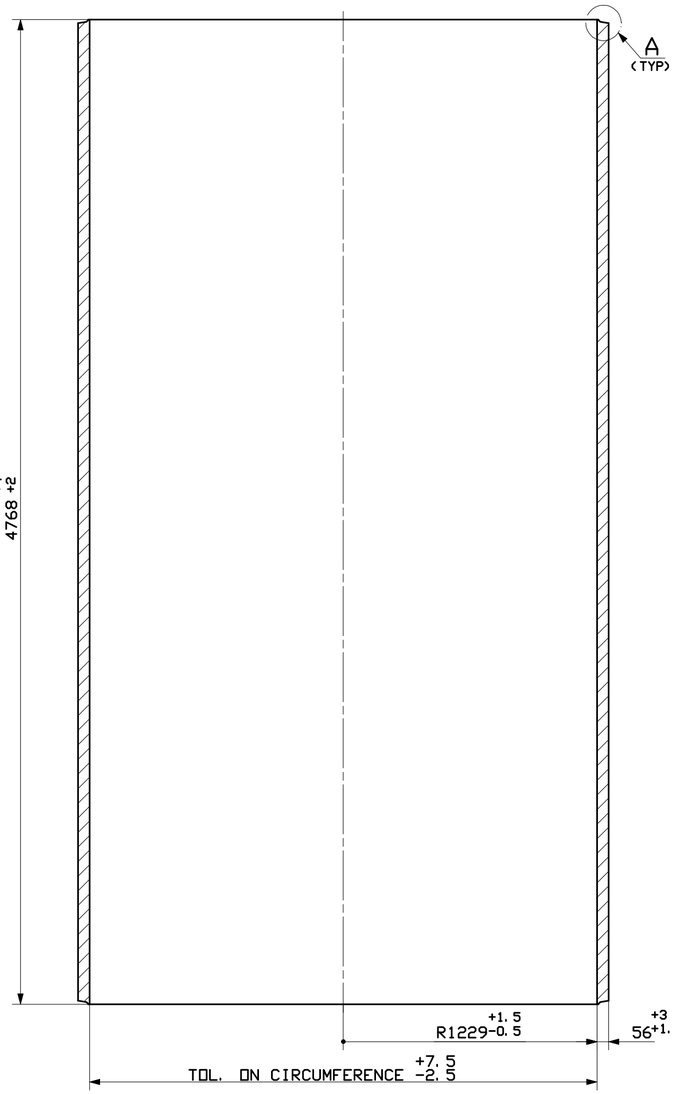
DRAWING NO : 2-93-170-05110

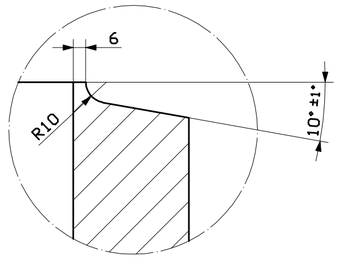
REV: 02

Size A2

DRAWING NO: 2-93-170-05111

ALL DIMENSIONS ARE IN MILLIMETERS

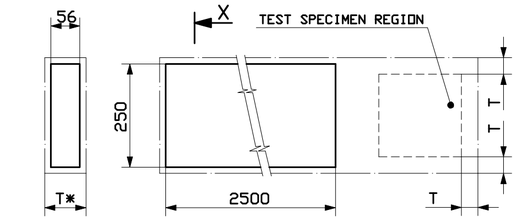




DETAIL-A
(1:2)

NOTES:-

1. APPLICABLE SPECIFICATIONS :
   i) PB-M-90
2. MATERIAL SPECIFICATION : 20MnMoNi55.
3. SURFACE FINISH : 3.2 ON INNER SURFACES, & 6.3 OR FINER ON ALL OTHER SURFACES.
4. THE SHELL SHALL BE SUPPLIED IN FINISH MACHINED CONDITION AS SHOWN.
5. FINISHED SHELL SHALL BE SUBJECTED TO 100% M.T AS PER PB-M-90
6. THE SHELL SHALL ALSO BE CHECKED BY 100% U.T AS PER PB-M-90
7. SUITABLE RUST PREVENTIVE COATING WHICH IS EASILY REMOVABLE SHALL BE APPLIED ON ALL OTHER MACHINED SURFACES.
8. THE COMPONENT SHALL BE FORGED AS CLOSE TO THE FINISHED SHAPE AS POSSIBLE.
9. DETAILED DRAWINGS INDICATING THE VARIOUS STAGES OF MANUFACTURE SHALL BE SUPPLIED TO THE PURCHASER FOR HIS APPROVAL PRIOR TO TAKING UP THE MANUFACTURE OF THE JOB.
10. WALL THICKNESS INDICATED ARE MINIMUM VALUES.
11. F.T.C AS PER SPECIFICATION PB-M-90 SHALL BE SUPPLIED ALONG WITH THE FINISHED SHELL.
12. IN ADDITION TO THE MONITORING TEST COUPONS UNDER THE SPECIFICATION, PRODUCTION WELD TEST PLATES OF SIZE AND QUANTITY AS GIVEN BELOW, BELONGING TO THE SAME MELT NUMBER AND SIMILARLY HEAT TREATED AS THE COMPONENT, SHALL ALSO BE SUPPLIED.
    i) PL. 56x250x2500 - 1 NO. EACH WITH EVERY SHELL-I FORGING ONLY.



SECTION-XX
(NTS)

X

* - Q&T THICKNESS

13. APPROXIMATE WEIGHT : 16497 kg

TOLERANCE IF NOT SPECIFIED SHALL BE AS BELOW (REFER IS 2102-n)

LINEAR				ANGULAR	
0.5 TO 3	±0.1	400 TO 1000	±0.8	0 TO 10	± 1°
3 TO 6	±0.1	1000 TO 2000	±1.2	10 TO 50	±30′
6 TO 30	±0.2	2000 TO 4000	±2.0	50 TO 120	±20′
30 TO 120	±0.3	—	-	120 TO 400	± 10′
120 TO 400	±0.5	—	-	OVER 400	± 5′

REV	DATE	ALTERED :	REV	DATE	ALTERED :
02	171209	CHD&APPD :	01	160409	CHD&APPD :
PROJECT NAME ADDED IN TITLE BLOCK			`KAPP-3' ADDED IN TITLE BLOCK		

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: 700MWe/KAPP-3/RAPP-7

Bharat Heavy Electricals Ltd
UNIT: HIGH PRESSURE BOILER PLANT
TIRUCHIRAPALLI - 620014

	NAME	SIGNATURE	DATE	NO. OF VAR
DRN	N.K.		220706	
CHD	SOUGAT		120608	
APPD	V.R		140608	

06-228/D

DEPT	GRADE OF UNTOL. DIM	SCALE	WEIGHT (Kg)	REF TO ASSY / OLD DWG	ITEM NO	NO OF ITEMS
NC	C/M/F	1:20 ; 1:2		TAPP-3&4/33111/5004/DD REV-1		
CODE 150						

TITLE: SHELL-I & II (FORGING)

CARD CODE: U 01

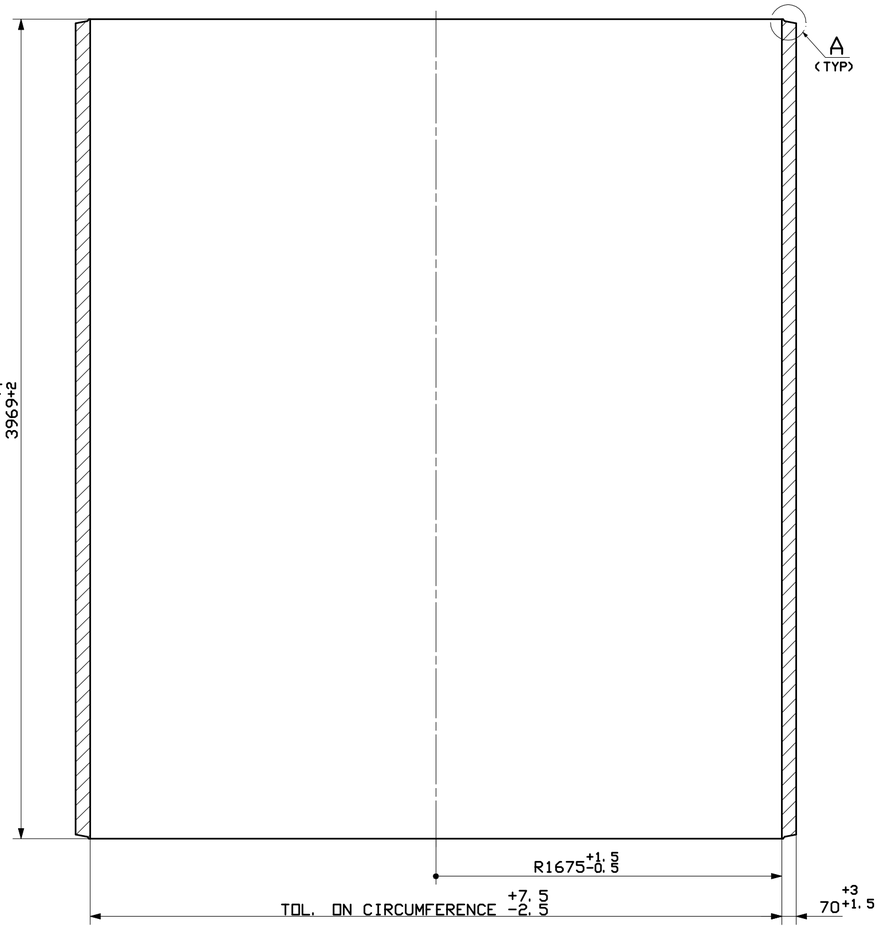
DRAWING NO : 2-93-170-05111

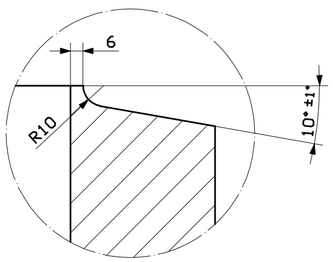
REV: 02

Size A2

DRAWING NO: 2-93-170-05113

ALL DIMENSIONS ARE IN MILLIMETERS

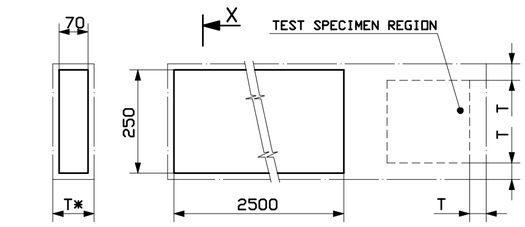




DETAIL-A
(1:2)

NOTES:-

1. APPLICABLE SPECIFICATIONS :
   i) PB-M-90
2. MATERIAL SPECIFICATION : 20MnMoNi55.
3. SURFACE FINISH : 3.2 ON INNER SURFACES, & 6.3 ON ALL OTHER SURFACES.
4. THE SHELL SHALL BE SUPPLIED IN FINISH MACHINED CONDITION AS SHOWN.
5. FINISHED SHELL SHALL BE SUBJECTED TO 100% M.T AS PER PB-M-90.
6. THE SHELL SHALL ALSO BE CHECKED BY 100% U.T AS PER PB-M-90.
7. SUITABLE RUST PREVENTIVE COATING WHICH IS EASILY REMOVABLE SHALL BE APPLIED ON ALL MACHINED SURFACES.
8. THE COMPONENT SHALL BE FORGED AS CLOSE TO THE FINISHED SHAPE AS POSSIBLE.
9. DETAILED DRAWINGS INDICATING THE VARIOUS STAGES OF MANUFACTURE SHALL BE SUPPLIED TO THE PURCHASER FOR HIS APPROVAL PRIOR TO TAKING UP THE MANUFACTURE OF THE JOB.
10. WALL THICKNESS INDICATED ARE MINIMUM VALUES.
11. F.T.C AS PER SPECIFICATION PB-M-90 SHALL BE SUPPLIED ALONG WITH THE FINISHED SHELL.
12. IN ADDITION TO THE MONITORING TEST COUPONS UNDER THE SPECIFICATION, PRODUCTION WELD TEST PLATES OF SIZE AND QUANTITY AS GIVEN BELOW, BELONGING TO THE SAME MELT NUMBER AND SIMILARLY HEAT TREATED AS THE COMPONENET, SHALL ALSO BE SUPPLIED.
    i) PL. 70x250x2500 - 1 NO. EACH WITH EVERY SHELL FORGING.



SECTION-XX
(NTS)

* - Q&T THICKNESS

13. APPROXIMATE WEIGHT : 23313 kg

TOLERANCE IF NOT SPECIFIED SHALL BE AS BELOW (REFER IS 2102-m)

LINEAR				ANGULAR	
0.5 TO 3	±0.1	400 TO 1000	±0.8	0 TO 10	± 1°
3 TO 6	±0.1	1000 TO 2000	±1.2	10 TO 50	±30′
6 TO 30	±0.2	2000 TO 4000	±2.0	50 TO 120	±20′
30 TO 120	±0.3	—	-	120 TO 400	± 10′
120 TO 400	±0.5	—	-	OVER 400	± 5′

REV	DATE	ALTERED :	REV	DATE	ALTERED :
02	171209	CHD&APPD :	01	160409	CHD&APPD :
PROJECT NAME ADDED IN TITLE BLOCK			'KAPP-3' ADDED IN TITLE BLOCK		

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: 700MWe/KAPP-3/RAPP-7

Bharat Heavy Electricals Ltd
UNIT: HIGH PRESSURE BOILER PLANT
TIRUCHIRAPALLI - 620014
05-228/D

	NAME	SIGNATURE	DATE	NO. OF VAR
DRN	N.K.		270706	
CHD	SOUGAT		120608	
APPD	V.R		130608	

DEPT	GRADE OF UNTOL. DIM	SCALE	WEIGHT (Kg)	REF TO ASSY / OLD DWG	ITEM NO	No OF ITEMS
NC	C/M/F	1:20 ; 1:2 NTS		TAPP-3&4/33111/5006/DD REV-1		
CODE 150						

TITLE: SHELL-IV (FORGING)

CARD CODE: U 01

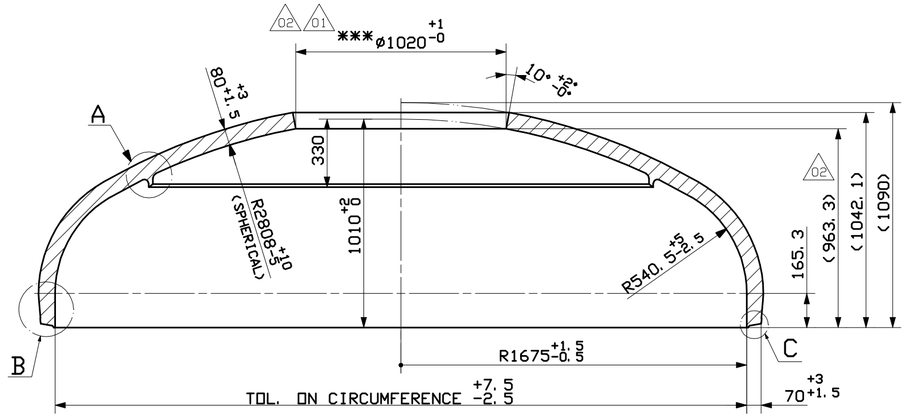
DRAWING NO : 2-93-170-05113

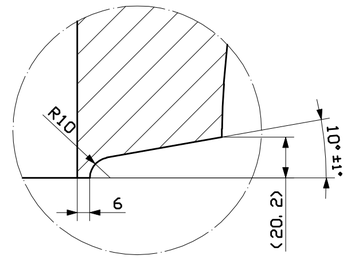
REV: 02

Size A2

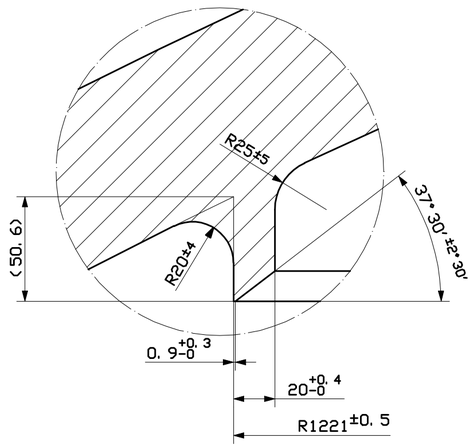
DRAWING NO: 2-93-170-05114

ALL DIMENSIONS ARE IN MILLIMETERS

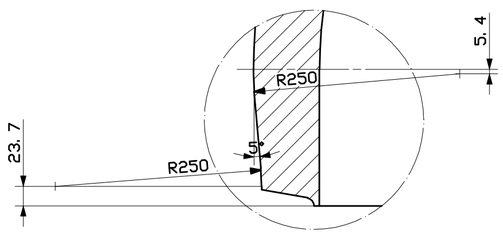




DETAIL-C
(1:2)



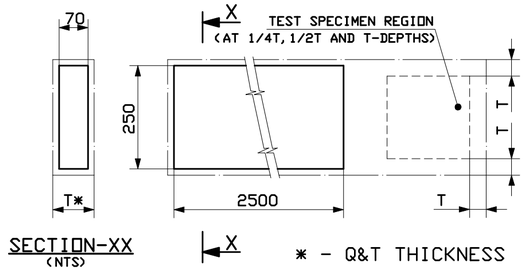
DETAIL-A
(1:2)



DETAIL-B
(1:5)

NOTES:-

1. APPLICABLE SPECIFICATIONS :
   i) PB-M-90
2. MATERIAL SPECIFICATION : 20MnMoNi55.
3. SURFACE FINISH : 3.2 ON INNER SURFACES, & 6.3 ON ALL OTHER SURFACES.
4. THE COMPONENT SHALL BE SUPPLIED IN FINISH MACHINED CONDITION AS SHOWN.
5. FINISHED COMPONENT SHALL BE SUBJECTED TO 100% M.T AS PER PB-M-90.
6. THE COMPONENT SHALL ALSO BE CHECKED BY 100% U.T AS PER PB-M-90.
7. SUITABLE RUST PREVENTIVE COATING WHICH IS EASILY REMOVABLE SHALL BE APPLIED ON ALL MACHINED SURFACES.
8. THE COMPONENT SHALL BE FORGED AS CLOSE TO THE FINISHED SHAPE AS POSSIBLE.
9. DETAILED DRAWINGS INDICATING THE VARIOUS STAGES OF MANUFACTURE SHALL BE SUPPLIED TO THE PURCHASER FOR HIS APPROVAL PRIOR TO TAKING UP THE MANUFACTURE OF THE JOB.
10. WALL THICKNESS INDICATED ARE MINIMUM VALUES.
11. F.T.C AS PER SPECIFICATION PB-M-90 SHALL BE SUPPLIED ALONG WITH THE FINISHED COMPONENT.
12. HANDLING LUGS MAY BE WELDED ON THIS FORGING, IF REQUIRED BY THE MANUFACTURER, ON SUITABLE BUTTERINGS.
13. IN ADDITION TO THE MONITORING TEST COUPONS UNDER THE SPECIFICATION, PRODUCTION WELD TEST PLATES OF SIZE AND QUANTITY AS GIVEN BELOW, BELONGING TO THE SAME MELT NUMBER AND SIMILARLY HEAT TREATED AS THE COMPONENET, SHALL ALSO BE SUPPLIED.
    i) PL. 70x250x2500 - 1 NO. EACH WITH EVERY TORISPHERICAL HEAD FORGING.



SECTION-XX
(NTS)

X

* - Q&T THICKNESS

14. APPROXIMATE WEIGHT : 8686 kg

02 01 ***-ID ø1020 +1 -0 SHALL BE MACHINED TO ID ø1313.3 +1 -0 AT BHEL.

TOLERANCE IF NOT SPECIFIED SHALL BE AS BELOW (REFER IS 2102-m)

LINEAR				ANGULAR	
0.5 TO 3	±0.1	400 TO 1000	±0.8	0 TO 10	± 1°
3 TO 6	±0.1	1000 TO 2000	±1.2	10 TO 50	±30′
6 TO 30	±0.2	2000 TO 4000	±2.0	50 TO 120	±20′
30 TO 120	±0.3	—	-	120 TO 400	± 10′
120 TO 400	±0.5	—	-	OVER 400	± 5′

REV	DATE	ALTERED :	REV	DATE	ALTERED :	REV	DATE	ALTERED :
03	171209	CHD&APPD :	02	010709	CHD&APPD :	01	160409	CHD&APPD :
PROJECT NAME ADDED IN TITLE BLOCK			DIMN. ø1020 +1 -0, 963.3 & 1042.1 WAS ø1047.9 +1 -0, 960.7 & 1039.5. CORRESPONDING NOTE CORRECTED.			`KAPP-3' ADDED IN TITLE BLOCK `HOLD' LIFTED & NOTE ADDED.		

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: 700MWe/KAPP-3/RAPP-7

Bharat Heavy Electricals Ltd
UNIT: HIGH PRESSURE BOILER PLANT
TIRUCHIRAPALLI - 620014
05-228/D

	NAME	SIGNATURE	DATE	NO. OF VAR
DRN	N.K.		290706	
CHD	SOUGAT		120608	
APPD	V.R		140608	

DEPT	GRADE OF UNTOL. DIM	SCALE	WEIGHT (Kg)	REF TO ASSY / OLD DWG	ITEM NO	NO OF ITEMS
NC	C/M/F	1:20 ; 1:5 1:2 ; NTS		TAPP-3&4/33111/5007/DD REV-1		
CODE 150						

TITLE: TORISPHERICAL HEAD (SHELL-V) (FORGING)

CARD CODE: U 01

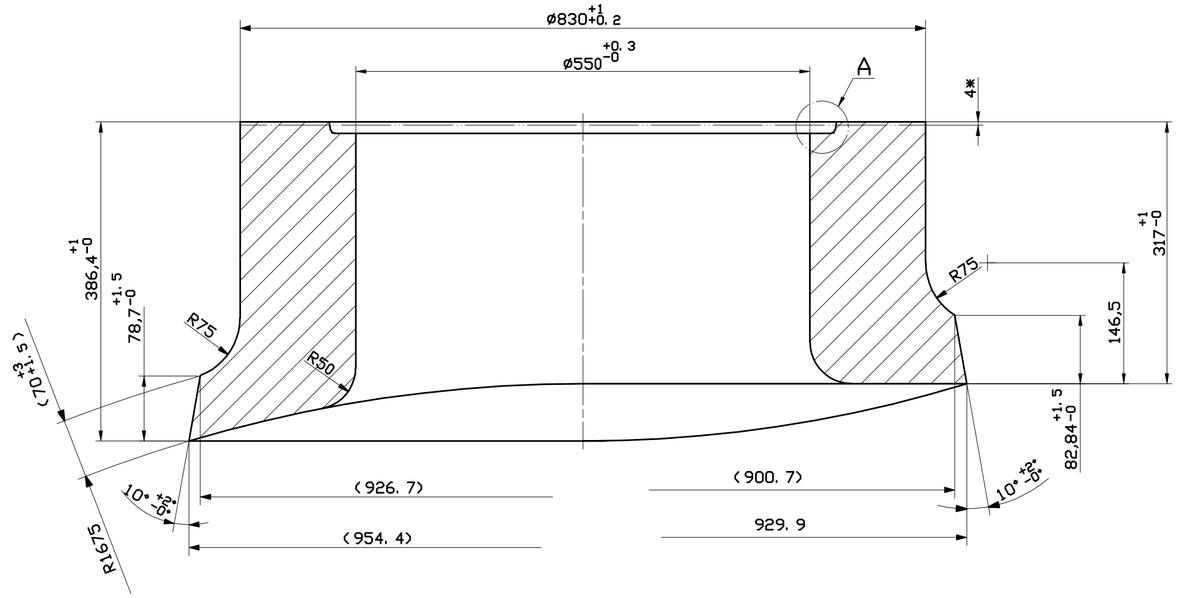
DRAWING NO : 2-93-170-05114

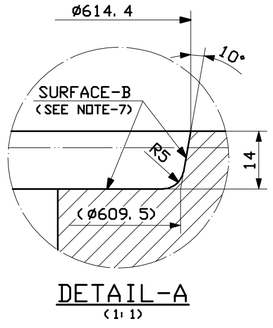
REV: 03

Size A2

DRAWING NO: 2-93-170-05123

ALL DIMENSIONS ARE IN MILLIMETERS





DETAIL-A
(1:1)

* - MACHINING ALLOWANCE.
(DOTTED LINE INDICATED FOR FINAL MACHINING IS ONLY FOR INFORMATION)

NOTES:-

1. APPLICABLE SPECIFICATIONS :
   i) PB-M-90
2. MATERIAL SPECIFICATION : 20MnMoNi55.
3. SURFACE FINISH : 3.2 OR FINER ALL OVER.
4. THE NOZZLE SHALL BE SUPPLIED IN FINISH MACHINED CONDITION AS SHOWN.
5. FINISHED NOZZLE SHALL BE SUBJECTED TO 100% M.T AS PER PB-M-90.
6. THE NOZZLE SHALL ALSO BE CHECKED BY 100% U.T AS PER PB-M-90.
7. SURFACE 'B' SHALL BE PROTECTED IMMEDIATELY AFTER MACHINING AND CARRYING OUT NDE BY BRIGHT COLOURED PEELABLE PLASTIC COAT IN ORDER TO PRESERVE THIS MACHINED SURFACE.
8. SUITABLE RUST PREVENTIVE COATING WHICH IS EASILY REMOVABLE SHALL BE APPLIED ON ALL MACHINED SURFACES.
9. THE COMPONENT SHALL BE FORGED AS CLOSE TO THE FINISHED SHAPE AS POSSIBLE.
10. DETAILED DRAWINGS INDICATING THE VARIOUS STAGES OF MANUFACTURE SHALL BE SUPPLIED TO THE PURCHASER FOR HIS APPROVAL PRIOR TO TAKING UP THE MANUFACTURE OF THE JOB.
11. WALL THICKNESS INDICATED ARE MINIMUM VALUES.
12. F.T.C AS PER SPECIFICATION PB-M-90 SHALL BE SUPPLIED ALONG WITH THE FINISHED NOZZLE.
13. APPROXIMATE WEIGHT : 880 kg

TOLERANCE IF NOT SPECIFIED SHALL BE AS BELOW (REFER IS 2102-m)

LINEAR				ANGULAR	
0.5 TO 3	±0.1	400 TO 1000	±0.8	0 TO 10	± 1°
3 TO 6	±0.1	1000 TO 2000	±1.2	10 TO 50	±30′
6 TO 30	±0.2	2000 TO 4000	±2.0	50 TO 120	±20′
30 TO 120	±0.3	—	-	120 TO 400	± 10′
120 TO 400	±0.5	—	-	OVER 400	± 5′

REV	DATE	ALTERED :	REV	DATE	ALTERED :
02	171209	CHD&APPD :	01	160409	CHD&APPD :
PROJECT NAME ADDED IN TITLE BLOCK			'KAPP-3' ADDED IN TITLE BLOCK		

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: 700MWe/KAPP-3/RAPP-7

Bharat Heavy Electricals Ltd
UNIT: HIGH PRESSURE BOILER PLANT
TIRUCHIRAPALLI - 620014

	NAME	SIGNATURE	DATE	NO. OF VAR
DRN	N.K.		160806	
CHD	SOUGAT		130608	
APPD	V.R		140608	

05-228/D

DEPT	GRADE OF UNTOL. DIM		SCALE	WEIGHT (Kg)	REF TO ASSY / OLD DWG	ITEM NO	No OF ITEMS
NC	C/M/F		1:5 ; 1:1		TAPP-3&4/33111/5016/DD REV-1		
CODE 150							

TITLE: SECONDARY MANHOLE NOZZLE (FORGING)

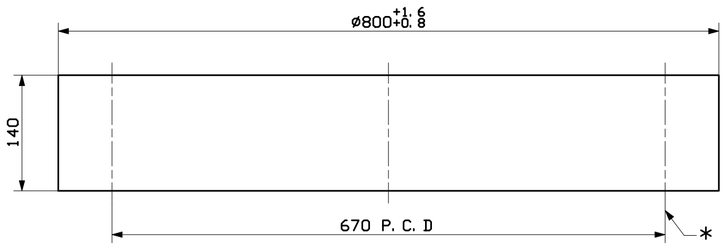
CARD CODE: U 01

DRAWING NO : 2-93-170-05123 REV 02

Size A2

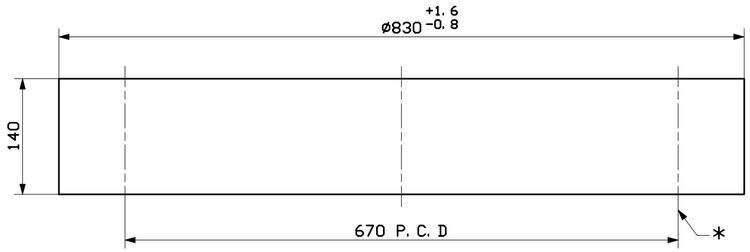
DRAWING NO: 2-93-170-05175

ALL DIMENSIONS ARE IN MILLIMETERS



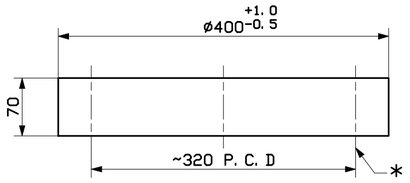
(a) PRIMARY MANHOLE COVER

APPROXIMATE WEIGHT : 553 kg



(b) SECONDARY MANHOLE COVER

APPROXIMATE WEIGHT : 595 kg



(c) HANDHOLE COVER

APPROXIMATE WEIGHT : 69 kg

NOTES: –

1. MATERIAL : 20MnMoNi55 AS PER PB–M–90
2. GENERAL TOLERANCES TO IS 2102–m
3. SURFACE FINISH : 3.2
4. FINISHED FORGING SHALL BE EXAMINED FOR 100%U.T. & 100%M.T. IN ACCORDANCE WITH PB–M–90
5. SUITABLE RUST PREVENTIVE COATING WHICH IS EASILY REMOVABLE SHALL BE APPLIED ON ALL MACHINED SURFACE.
6. THE COMPONENT SHALL BE FORGED AS CLOSE TO THE FINISHED SHAPE AS POSSIBLE.

*–DIAMETERS OF HOLE AND NUMBER OF HOLES WILL BE SPECIFIED BEFORE PLACEMENT OF ORDER.

TOLERANCE IF NOT SPECIFIED SHALL BE AS BELOW (REFER IS 2102–m)

LINEAR				ANGULAR	
0.5 TO 3	±0.1	400 TO 1000	±0.8	0 TO 10	± 1°
3 TO 6	±0.1	1000 TO 2000	±1.2	10 TO 50	±30′
6 TO 30	±0.2	2000 TO 4000	±2.0	50 TO 120	±20′
30 TO 120	±0.3	–	–	120 TO 400	±10′
120 TO 400	±0.5	–	–	OVER 400	± 5′

REV	DATE	ALTERED :	REV	DATE	ALTERED :
02	171209	CHD&APPD :	01	160409	CHD&APPD :
PROJECT NAME ADDED IN TITLE BLOCK			'KAPP–3' ADDED IN TITLE BLOCK		

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: 700MWe/KAPP–3/RAPP–7

Bharat Heavy Electricals Ltd
UNIT: HIGH PRESSURE BOILER PLANT
TIRUCHIRAPALLI – 620014
05–228/D

	NAME	SIGNATURE	DATE	NO. OF VAR
DRN	N.K.		220806	
CHD	SOUGAT		130608	
APPD	V.R		140608	

DEPT	GRADE OF UNTOL DIM	SCALE	WEIGHT (Kg)	REF TO ASSY / OLD DWG	ITEM NO	NO OF ITEMS
NC	C/M/F	1:5		TAPP–3&4/33111/2004/DD		
CODE 150						

TITLE: MANHOLE & HANDHOLE COVERS

CARD CODE: U 01

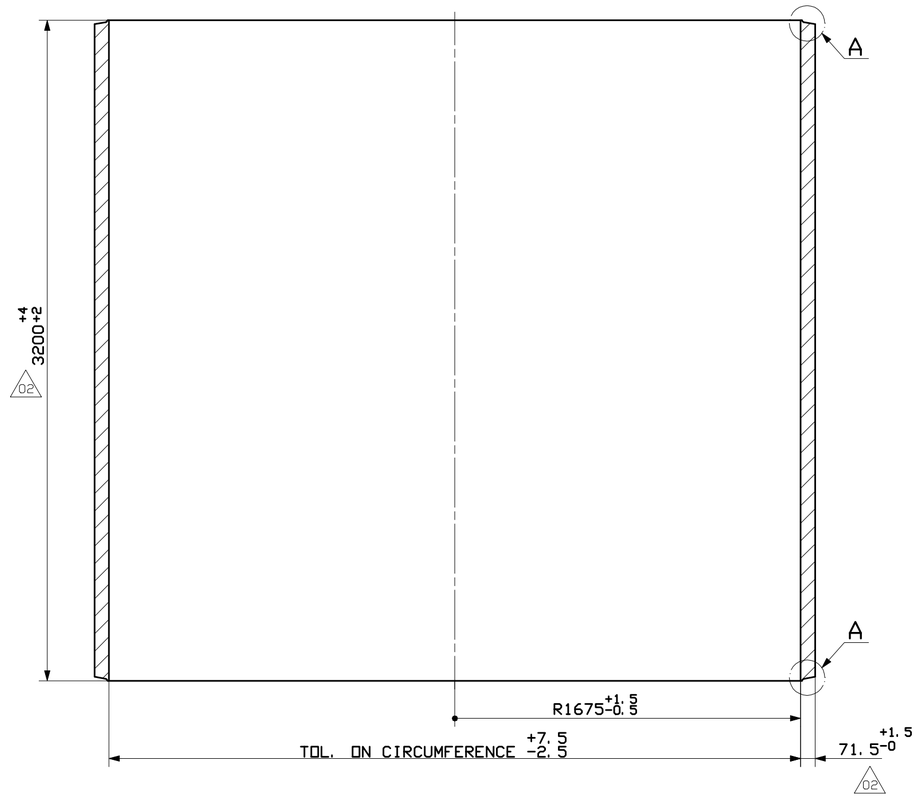
DRAWING NO : 2–93–170–05175

REV: 02

Size A2

DRAWING NO: 2-93-170-05196

ALL DIMENSIONS ARE IN MILLIMETERS

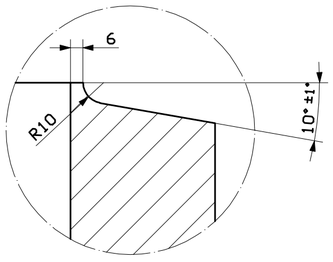


NOTES:-

1. APPLICABLE SPECIFICATIONS :
   I) PB-M-90
2. MATERIAL SPECIFICATION : 20MnMoNi55.
3. SURFACE FINISH : 3.2 ON INNER SURFACES, & 6.3 ON ALL OTHER SURFACES.
4. THE SHELL SHALL BE SUPPLIED IN FINISH MACHINED CONDITION AS SHOWN.
5. FINISHED SHELL SHALL BE SUBJECTED TO 100% M.T AS PER PB-M-90.
6. THE SHELL SHALL ALSO BE CHECKED BY 100% U.T AS PER PB-M-90.
7. SUITABLE RUST PREVENTIVE COATING WHICH IS EASILY REMOVABLE SHALL BE APPLIED ON ALL MACHINED SURFACES.
8. THE COMPONENT SHALL BE FORGED AS CLOSE TO THE FINISHED SHAPE AS POSSIBLE.
9. DETAILED DRAWINGS INDICATING THE VARIOUS STAGES OF MANUFACTURE SHALL BE SUPPLIED TO THE PURCHASER FOR HIS APPROVAL PRIOR TO TAKING UP THE MANUFACTURE OF THE JOB.
10. WALL THICKNESS INDICATED ARE MINIMUM VALUES.
11. F.T.C AS PER SPECIFICATION PB-M-90 SHALL BE SUPPLIED ALONG WITH THE FINISHED SHELL.

01

02 13. APPROXIMATE WEIGHT : 19331 kg



DETAIL-A
(1:2)

TOLERANCE IF NOT SPECIFIED SHALL BE AS BELOW (REFER IS 2102-m)

LINEAR				ANGULAR	
0.5 TO 3	±0.1	400 TO 1000	±0.8	0 TO 10	± 1°
3 TO 6	±0.1	1000 TO 2000	±1.2	10 TO 50	±30′
6 TO 30	±0.2	2000 TO 4000	±2.0	50 TO 120	±20′
30 TO 120	±0.3	—	-	120 TO 400	± 10′
120 TO 400	±0.5	—	-	OVER 400	± 5′

REV	DATE	ALTERED :	REV	DATE	ALTERED :
02	101109	CHD&APPD : first	01	160409	CHD&APPD : first
IN TITLE BLOCK SHELL-V CHANGED TO SHELL-VI AND KAPP-3 CHANGED TO RAPP-7, SHELL LENGTH 3000 CHANGED TO 3200 & THICKNESS ALSO CHANGED. SHELL WEIGHT CORRECTED.			`KAPP-3' ADDED IN TITLE BLOCK NOTE-12 REMOVED.		

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: 700MWe/RAPP-7

Bharat Heavy Electricals Ltd
UNIT: HIGH PRESSURE BOILER PLANT
TIRUCHIRAPALLI - 620014
05-228/D

	NAME	SIGNATURE	DATE	NO. OF VAR
DRN	N.K.		300806	
CHD	SOUGAT	first	170608	
APPD	V.R	first	180608	

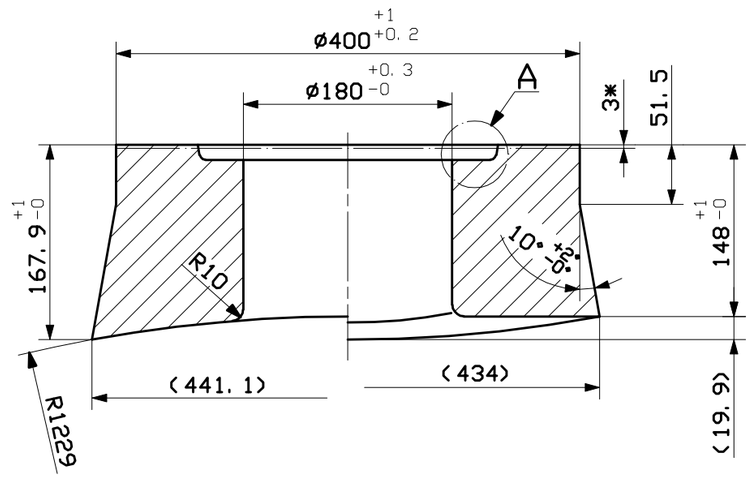
DEPT	GRADE OF UNTOL. DIM		SCALE	WEIGHT (Kg)	REF TO ASSY / OLD DWG	ITEM NO	No OF ITEMS
NC	C/M/F		1:20 ; 1:2				
CODE 150							

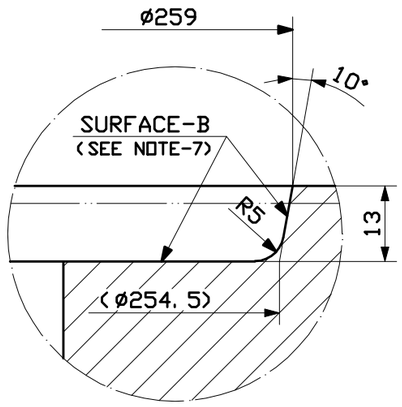
TITLE	CARD CODE	DRAWING NO :	REV
SHELL-VI (FORGING)	U 01	2-93-170-05196	02

Size A2

DRAWING NO: 3-93-170-05165

ALL DIMENSIONS ARE IN MILLIMETERS





DETAIL-A
(1:1)

* - MACHINING ALLOWANCE.

NOTES:-

1. APPLICABLE SPECIFICATIONS : PB-M-90
2. MATERIAL SPECIFICATION : 20MnMoNi55.
3. SURFACE FINISH : 3.2 OR FINER ALL OVER.
4. THE NOZZLE SHALL BE SUPPLIED IN FINISH MACHINED CONDITION AS SHOWN.
5. FINISHED NOZZLE SHALL BE SUBJECTED TO 100% M.T AS PER PB-M-90.
6. THE NOZZLE SHALL ALSO BE CHECKED BY 100% U.T AS PER PB-M-90.
7. SURFACE 'B' SHALL BE PROTECTED IMMEDIATELY AFTER MACHINING AND CARRYING OUT NDE BY BRIGHT COLOURED PEELABLE PLASTIC COAT IN ORDER TO PRESERVE THIS MACHINED SURFACE.
8. SUITABLE RUST PREVENTIVE COATING WHICH IS EASILY REMOVABLE SHALL BE APPLIED ON ALL MACHINED SURFACES.
9. THE COMPONENT SHALL BE FORGED AS CLOSE TO THE FINISHED SHAPE AS POSSIBLE.
10. DETAILED DRAWINGS INDICATING THE VARIOUS STAGES OF MANUFACTURE SHALL BE SUPPLIED TO THE PURCHASER FOR HIS APPROVAL PRIOR TO TAKING UP THE MANUFACTURE OF THE JOB.
11. F.T.C AS PER SPECIFICATION PB-M-90 SHALL BE SUPPLIED ALONG WITH THE FINISHED NOZZLE.
12. APPROXIMATE WEIGHT : 128 kg

TOLERANCE IF NOT SPECIFIED SHALL BE AS BELOW (REFER IS 2102-m)

LINEAR				ANGULAR	
0.5 TO 3	±0.1	400 TO 1000	±0.8	0 TO 10	± 1°
3 TO 6	±0.1	1000 TO 2000	±1.2	10 TO 50	±30′
6 TO 30	±0.2	2000 TO 4000	±2.0	50 TO 120	±20′
30 TO 120	±0.3	—	-	120 TO 400	± 10′
120 TO 400	±0.5	—	-	OVER 400	± 5′

REV	DATE	ALTERED : CHD&APPD :	REV	DATE	ALTERED : CHD&APPD :
02	171209		01	170409	
PROJECT NAME ADDED IN TITLE BLOCK			'KAPP-3' ADDED IN TITLE BLOCK		

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: 700MWe/KAPP-3/RAPP-7

Bharat Heavy Electricals Ltd
UNIT: HIGH PRESSURE BOILER PLANT
TIRUCHIRAPALLI - 620014
05-229/D

	NAME	SIGNATURE	DATE	NO. OF VAR
DRN	N.K.		050906	
CHD	SOUGAT		130608	
APPD	V.R		140608	

DEPT	GRADE OF UNTOL DIM		SCALE	WEIGHT (Kg)	REF TO ASSY / OLD DWG	ITEM NO	No OF ITEMS
NC	C/M/F		1:5 ; 1:1		TAPP-3&4/33111/5020/DD REV-1		
CODE 150							

TITLE: HAND HOLE NOZZLE (FORGING)

CARD CODE: U 01

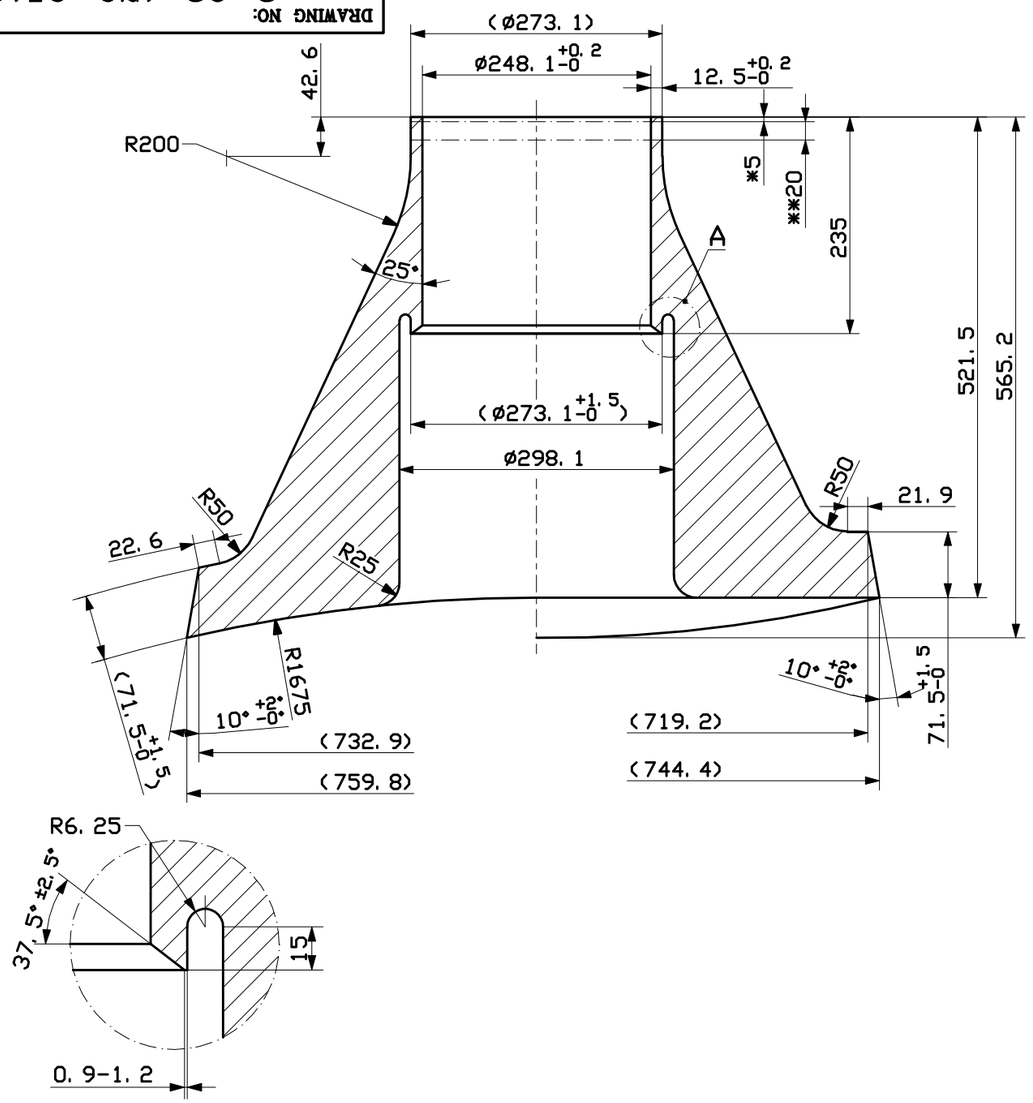
DRAWING NO : 3-93-170-05165

REV: 02

Size A3

DRAWING NO: 3-93-170-05166

ALL DIMENSIONS ARE IN MILLIMETERS



DETAIL-A

NOTES:-

1. APPLICABLE SPECIFICATIONS :
   I) PB-M-90
2. MATERIAL SPECIFICATION : 20MnMoNi55.
3. SURFACE FINISH : 3.2 OR FINER ALL OVER.
4. THE NOZZLE SHALL BE SUPPLIED IN FINISH MACHINED CONDITION AS SHOWN.
5. FINISHED NOZZLE SHALL BE SUBJECTED TO 100% M.T AS PER PB-M-90.
6. THE NOZZLE SHALL ALSO BE CHECKED BY 100% U.T AS PER PB-M-90.
7. SUITABLE RUST PREVENTIVE COATING WHICH IS EASILY REMOVABLE SHALL BE APPLIED ON ALL MACHINED SURFACES.
8. THE COMPONENT SHALL BE FORGED AS CLOSE TO THE FINISHED SHAPE AS POSSIBLE.
9. DETAILED DRAWINGS INDICATING THE VARIOUS STAGES OF MANUFACTURE SHALL BE SUPPLIED TO THE PURCHASER FOR HIS APPROVAL PRIOR TO TAKING UP THE MANUFACTURE OF THE JOB.
10. WALL THICKNESS INDICATED ARE MINIMUM VALUES.
11. F.T.C AS PER SPECIFICATION PB-M-90 SHALL BE SUPPLIED ALONG WITH THE FINISHED NOZZLE.

* - MACHINING ALLOWANCE.

** - OVER LENGTH FOR PRESSURE TEST.

TOLERANCE IF NOT SPECIFIED SHALL BE AS BELOW (REFER IS 2102-m)

LINEAR				ANGULAR	
0.5 TO 3	±0.1	400 TO 1000	±0.8	0 TO 10	± 1°
3 TO 6	±0.1	1000 TO 2000	±1.2	10 TO 50	±30′
6 TO 30	±0.2	2000 TO 4000	±2.0	50 TO 120	±20′
30 TO 120	±0.3	—	-	120 TO 400	± 10′
120 TO 400	±0.5	—	-	OVER 400	± 5′

REV	DATE	ALTERED :	REV	DATE	ALTERED :
02	171209	CHD&APPD :	01	170409	CHD&APPD :
PROJECT NAME ADDED IN TITLE BLOCK			'KAPP-3' ADDED IN TITLE BLOCK		

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: 700MWe/KAPP-3/RAPP-7

Bharat Heavy Electricals Ltd
UNIT: HIGH PRESSURE BOILER PLANT
TIRUCHIRAPALLI - 620014
06-229/D

	NAME	SIGNATURE	DATE	NO. OF VAR
DRN	N.K		080208	
CHD	MANDAL		170608	
APPD	V.R		180608	

DEPT	GRADE OF UNTOL. DIM	SCALE	WEIGHT (Kg)	REF TO ASSY / OLD DWG	ITEM NO	No OF ITEMS
NC	C/M/F	1:5 ; 1:2	514.6			
CODE 150						

TITLE: FEED WATER NOZZLE (FORGING)

CARD CODE: U 01

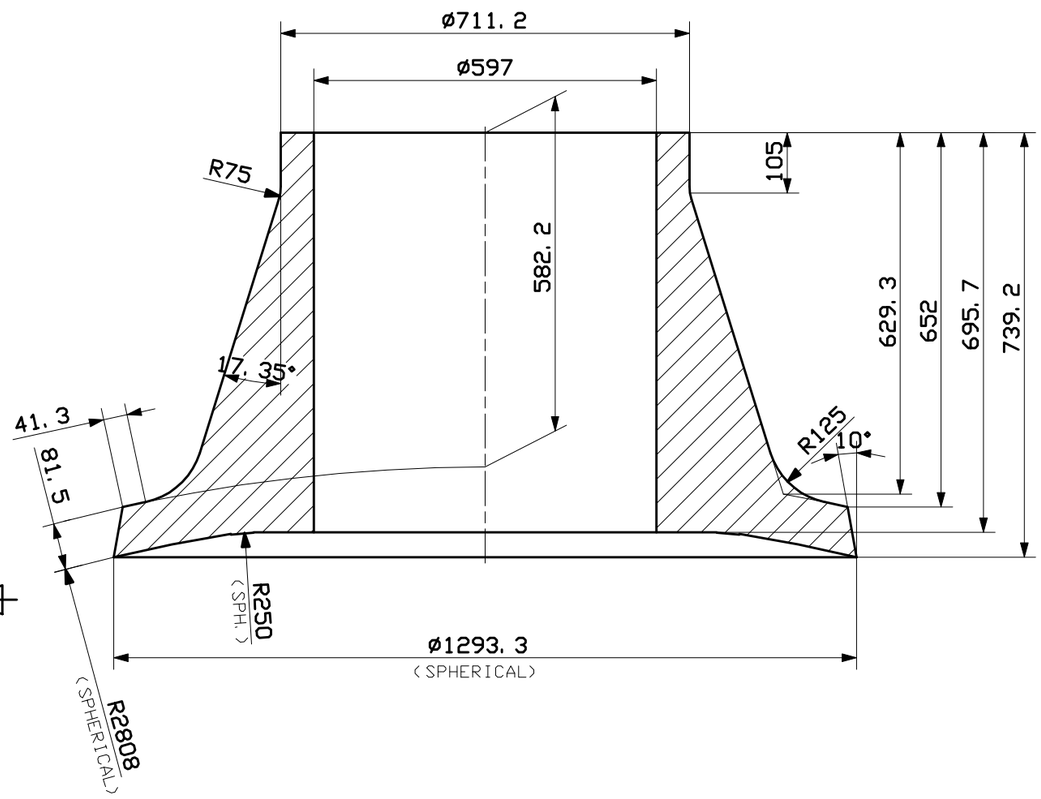
DRAWING NO : 3-93-170-05166

REV: 02

Size A3

DRAWING NO: 3-93-170-05167

ALL DIMENSIONS ARE IN MILLIMETERS



NOTES:-

1. APPLICABLE SPECIFICATIONS :
   i) PB-M-90
2. MATERIAL SPECIFICATION : 20MnMoNi55.
3. SURFACE FINISH : 3.2 OR FINER ALL OVER.
4. THE NOZZLE SHALL BE SUPPLIED IN FINISH MACHINED CONDITION AS SHOWN.
5. FINISHED NOZZLE SHALL BE SUBJECTED TO 100% M.T AS PER PB-M-90.
6. THE NOZZLE SHALL ALSO BE CHECKED BY 100% U.T AS PER PB-M-90.
7. SUITABLE RUST PREVENTIVE COATING WHICH IS EASILY REMOVABLE SHALL BE APPLIED ON ALL MACHINED SURFACES.
8. THE COMPONENT SHALL BE FORGED AS CLOSE TO THE FINISHED SHAPE AS POSSIBLE.
9. DETAILED DRAWINGS INDICATING THE VARIOUS STAGES OF MANUFACTURE SHALL BE SUPPLIED TO THE PURCHASER FOR HIS APPROVAL PRIOR TO TAKING UP THE MANUFACTURE OF THE JOB.
10. WALL THICKNESS INDICATED ARE MINIMUM VALUES.
11. F.T.C AS PER SPECIFICATION PB-M-90 SHALL BE SUPPLIED ALONG WITH THE FINISHED NOZZLE.
12. APPROXIMATE WEIGHT : 2074 kg

TOLERANCE IF NOT SPECIFIED SHALL BE AS BELOW (REFER IS 2102-m)

LINEAR				ANGULAR	
0.5 TO 3	±0.1	400 TO 1000	±0.8	0 TO 10	± 1°
3 TO 6	±0.1	1000 TO 2000	±1.2	10 TO 50	±30′
6 TO 30	±0.2	2000 TO 4000	±2.0	50 TO 120	±20′
30 TO 120	±0.3	—	-	120 TO 400	± 10′
120 TO 400	±0.5	—	-	OVER 400	± 5′

REV	DATE	ALTERED : / CHD&APPD :	REV	DATE	ALTERED : / CHD&APPD :
02	171209		01	030409	
PROJECT NAME ADDED IN TITLE BLOCK			NOZZLE DESIGN MODIFIED &'KAPP-3' ADDED IN TITLE BLOCK.		

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: 700MWe/KAPP-3/RAPP-7

Bharat Heavy Electricals Ltd
UNIT: HIGH PRESSURE BOILER PLANT
TIRUCHIRAPALLI - 620014
05-229/D

	NAME	SIGNATURE	DATE
DRN	N.K.		090906
CHD	SOUGAT		170608
APPD	V.R		180608

NO. OF VAR:

DEPT	GRADE OF UNTOL DIM	SCALE	WEIGHT (Kg)	REF TO ASSY / OLD DWG	ITEM NO	No OF ITEMS
NC	C/M/F	1:10				
CODE 150						

TITLE: STEAM OUTLET NOZZLE (FORGING)

CARD CODE: U 01

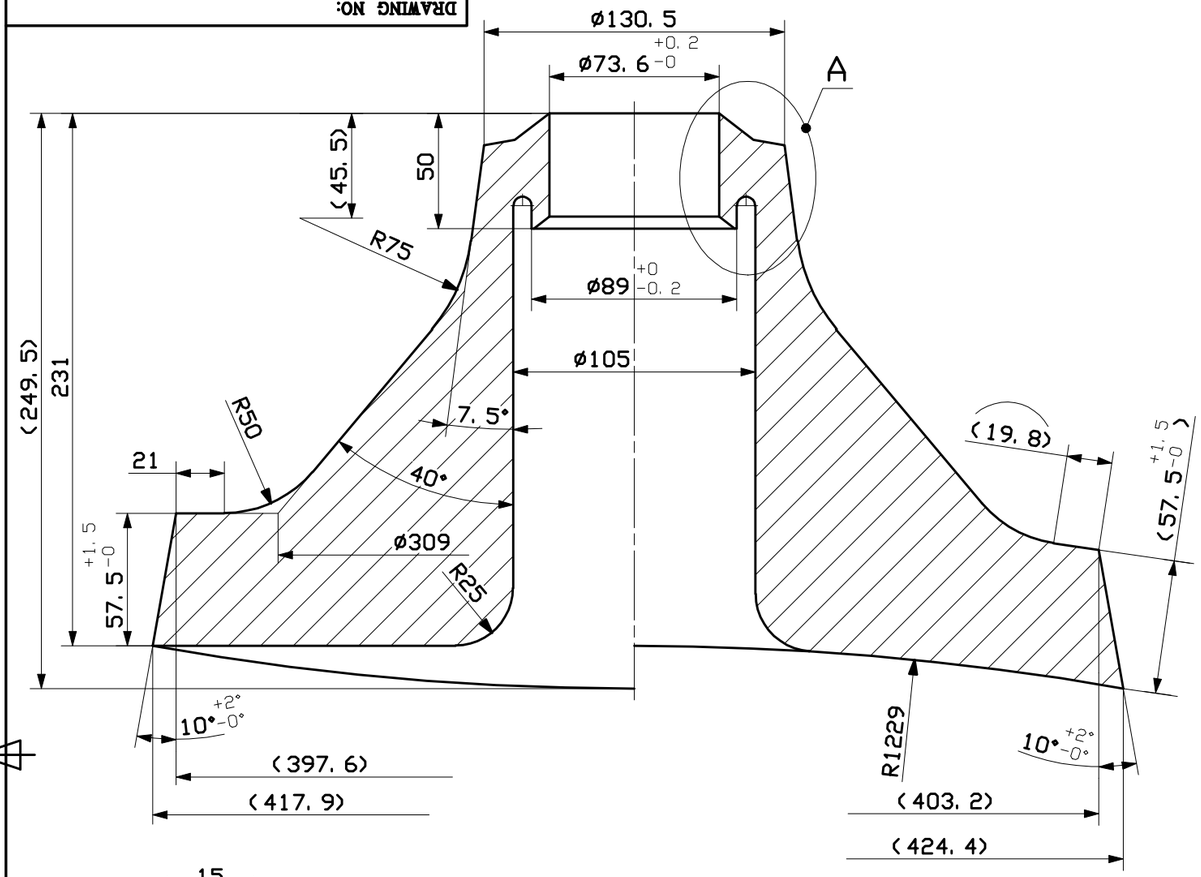
DRAWING NO : 3-93-170-05167

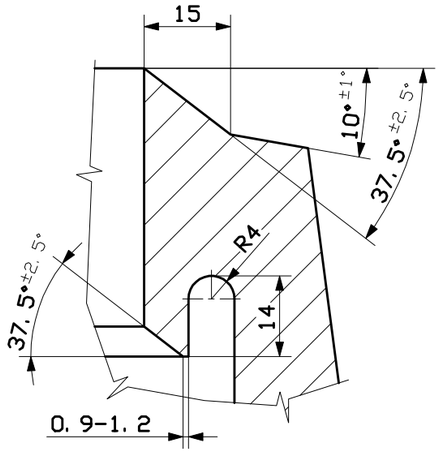
REV: 02

Size A3

DRAWING NO: 3-93-170-05231

ALL DIMENSIONS ARE IN MILLIMETERS





DETAIL-A
(1:1)

NOTES:-

1. APPLICABLE SPECIFICATIONS :
   i) PB-M-90
2. MATERIAL SPECIFICATION : 20MnMoNi55.
3. SURFACE FINISH : 3.2 OR FINER ALL OVER.
4. THE NOZZLE SHALL BE SUPPLIED IN FINISH MACHINED CONDITION AS SHOWN.
5. FINISHED NOZZLE SHALL BE SUBJECTED TO 100% M.T AS PER PB-M-90.
6. THE NOZZLE SHALL ALSO BE CHECKED BY 100% U.T AS PER PB-M-90.
7. SUITABLE RUST PREVENTIVE COATING WHICH IS EASILY REMOVABLE SHALL BE APPLIED ON ALL MACHINED SURFACES.
8. THE COMPONENT SHALL BE FORGED AS CLOSE TO THE FINISHED SHAPE AS POSSIBLE.
9. DETAILED DRAWINGS INDICATING THE VARIOUS STAGES OF MANUFACTURE SHALL BE SUPPLIED TO THE PURCHASER FOR HIS APPROVAL PRIOR TO TAKING UP THE MANUFACTURE OF THE JOB.
10. WALL THICKNESS INDICATED ARE MINIMUM VALUES.
11. F.T.C AS PER SPECIFICATION PB-M-90 SHALL BE SUPPLIED ALONG WITH THE FINISHED NOZZLE.
12. APPROXIMATE WEIGHT. : 90.736 Kg

TOLERANCE IF NOT SPECIFIED SHALL BE AS BELOW (REFER IS 2102-m)

LINEAR				ANGULAR	
0.5 TO 3	±0.1	400 TO 1000	±0.8	0 TO 10	± 1°
3 TO 6	±0.1	1000 TO 2000	±1.2	10 TO 50	±30′
6 TO 30	±0.2	2000 TO 4000	±2.0	50 TO 120	±20′
30 TO 120	±0.3	—	-	120 TO 400	± 10′
120 TO 400	±0.5	—	-	OVER 400	± 5′

REV	DATE	ALTERED :	REV	DATE	ALTERED :
02	171209	CHD&APPD : fnsl.	01	130409	CHD&APPD : fnsl.
PROJECT NAME ADDED IN TITLE BLOCK			NOZZLE DESIGN MODIFIED & WT. ALTD. 'KAPP-3' ADDED IN TITLE BLOCK.		

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: 700MWe/KAPP-3/RAPP-7

Bharat Heavy Electricals Ltd
UNIT: HIGH PRESSURE BOILER PLANT
TIRUCHIRAPALLI - 620014
05-229/D

	NAME	SIGNATURE	DATE	NO. OF VAR
DRN	N.K		080208	
CHD	MANDAL	fnsl.	170608	
APPD	V.R		180608	

DEPT	GRADE OF UNTOL. DIM		SCALE	WEIGHT (Kg)	REF TO ASSY / OLD DWG	ITEM NO	No OF ITEMS
NC	C/M/F		1:2.5 ; 1:1				
CODE 150							

TITLE: PDHRS NOZZLE (FORGING)

CARD CODE: U 01

DRAWING NO : 3-93-170-05231

REV: 02

Size A3