

SPECIAL CONDITION ANNEXURE - 1

PR No. 117687986 Dated 11.11.2017

1. Two-part bid. Open tender to be floated.
2. Supply of forgings as per DIN 20MnMoNi55 and NPCIL technical specification PC-M-960 Rev.01
3. These intended Forgings are required for GHAVP 1 & 2 (700MWe SG) project site. **End Use and End User Certificates will not be provided by BHEL.**
4. Supplier to give clause by clause confirmation for all clauses mentioned in NPCIL technical specification PC-M-960 Rev.01
5. Component forgings to be supplied as per the procurement drawing referred against the PR items. Refer Table 01. Supplier to read the notes given in the drawings. Deviations (if any) shall be mentioned in their offers.
6. Component forgings, corresponding test coupons and test plates shall be from same melt number. Refer Table .01
7. Wherever FTC requirement is mentioned in the component drawing, FTC material (from same melt as of forged component) shall also be supplied along with the components.
8. Weld Test Plates mentioned in the drawings are covered as separate items. However, the respective test plate shall be made from same melt of the corresponding forging.
9. Extent of tests for forged plates and test coupons shall be same as that of STC-A of tubesheet for bottom of the ingot and that of STC-B of tubesheet for top of the ingot and that of RTC-D of tubesheet for bottom of the ingot. STC-A and STC-B are for STC coupons of the plate and RTC-D is for RTC coupons of the plate.
10. Quantity given in the indent may increase or decrease, depends on the requirements of customer. Quantity being procured will be finalized before price bid opening.
11. For offer acceptance, previous experience is preferred. Supplier should have experience in supplying heavy forgings as per DIN 20MnMoNi55 or its equivalent (like SA508Gr3CL2). Supplier should have supplied the heavy forgings as listed in PR for similar applications (i.e. SGs of Nuclear Power Plants) as per requirement of ASME Section-III NB and meeting the NPCIL specification PC-M-960 Rev.01. This is to be established by documentary proof say **Test Certificates**. Test certificates shall be submitted for similar major components as given in indent along with quotation.

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12. New vendors (without previous experience) need to be pre-qualified by producing proto type forgings similar to the actual product form. These prototype forgings are to be produced at the same facility where the production forgings are to be produced by adopting the same manufacturing process and methods. These prototype forgings shall undergo adequate number of tests to the satisfaction of purchaser (BHEL) and NPCIL to establish the uniformity of properties in the entire metal volume in all the three perpendicular direction. The required volumetric examination shall also be carried out on these forgings to establish the soundness of the metal volume as per the PC-M-960 specification. For the qualification of Heavy Forgings to be procured from new vendor /manufacturer, the following additional tests in addition to the tests and requirements mentioned in the NPCIL Specification PC-M-960 are to be carried out:

- a) **For Shells:** STC-A, STC-B, STC and RTC coupons shall be taken from the ring cut out from the centre of the length of the shell and extent of testing shall be same as that for the coupons taken from the bottom of the ingot of Shell Forgings as mentioned in the tender specification no. PC-M-960
- b) **For Primary Head (Spherical Segment):** STC-A, STC-B, STC and RTC coupons shall be taken from the centre of the head and extent of testing shall be same as that for the coupons taken from the Primary Head Forging as mentioned in the tender specification no. PC-M-960
- c) **For Secondary Head (Torispherical Head):** STC-A, STC-B, STC and RTC coupons shall be taken from the centre of the head and extent of testing shall be same as that for the coupons taken from the Secondary Head (Dished End) Forging as mentioned in the tender specification no. PC-M-960
- d) **For Tubesheet:** STC-A, STC-B, STC and RTC coupons shall be taken from the centre of the tubesheet and extent of testing shall be same as that for the coupons taken from the Tubesheet Forging as mentioned in the tender specification no. PC-M-960

13. Offers received will be evaluated by BHEL and NPCIL. Final acceptance of the offers will be based on NPCIL recommendation.

14. Inspection agency for imports are BHEL & NPCIL or third party inspection (TPI) agency approved by NPCIL. Inspection charges arising out of third party inspection to be quoted separately.

15. Inspection agency for indigenous supply are BHEL and NPCIL.

16. For indigenous supply, chemical composition and mechanical tests to be carried out in NABL accredited laboratory only.

17. All the items given in PR to be procured on package basis from single source.

18. Supplier has to submit Quality documents and related test procedures for approval.

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19. The actual production of material is permitted only after approval of Quality Assurance Plan (QAP), Manufacturing Process Plan (MPP), and test procedures by BHEL and NPCIL
20. Dispatch clearance for material shall be given after acceptance of Test Certificates by BHEL & NPCIL
21. Three sets of documents containing (i.) Test Certificates, (ii.) copies of the approved quality documents and test procedure, (iii.) DCR and (iv.) Drawing etc. to be provided along with the supply of raw material.
22. Supplier shall submit quotation confirming to the above applicable points as given in this annexure.

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TECHNICAL SPECIFICATION

FOR

**QUENCHED & TEMPERED LOW ALLOY AND OTHER CARBON STEEL
FORGINGS FOR 700 MWe PROJECTS**

REF. USI NO. : 33111

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1.0 SCOPE

This specification establishes minimum requirements for low alloy steel forgings (Pressure boundary Shells, Tube Sheet, Integral Cone & Shell Dished Ends, Nozzles, Plates etc.) 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 20MnMoNi55 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. This specification is appended with following Annexures.

Annexure 1: Low Alloy Steel Forgings -16 Mo3

Annexure 2: Steel Forgings –ASME SA 350 LF2

Annexure 3: 20 Mn Mo Ni 55 Forgings for Bleed Condenser.

This specification is applicable for 700MWe projects beyond RAPP 7&8.

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3.0 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

4.0 PROCESS OF MANUFACTURE

4.1 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.

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4.2 **Discard**

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

4.3 **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 the 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).

4.4 **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 favorably resist the stresses encountered in service (Main Working Direction).

4.5 **Machining**

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

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5.0 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.

<u>Element</u>	<u>Weight percentage</u>
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.
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.

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The above chemical composition slightly differs from DIN 20 Mn.Mo Ni 55 grade. Subject to the approval by the purchaser, 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 (1) – 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 examination are required. If intermediate annealing at $550^{\circ}C$ 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.

6.0 HEAT TREATMENT

- 6.1 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 650 to $680^{\circ}C$. 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.

6.2 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 Coupons (STC). Heating and cooling rates shall be as indicated in the figure below:

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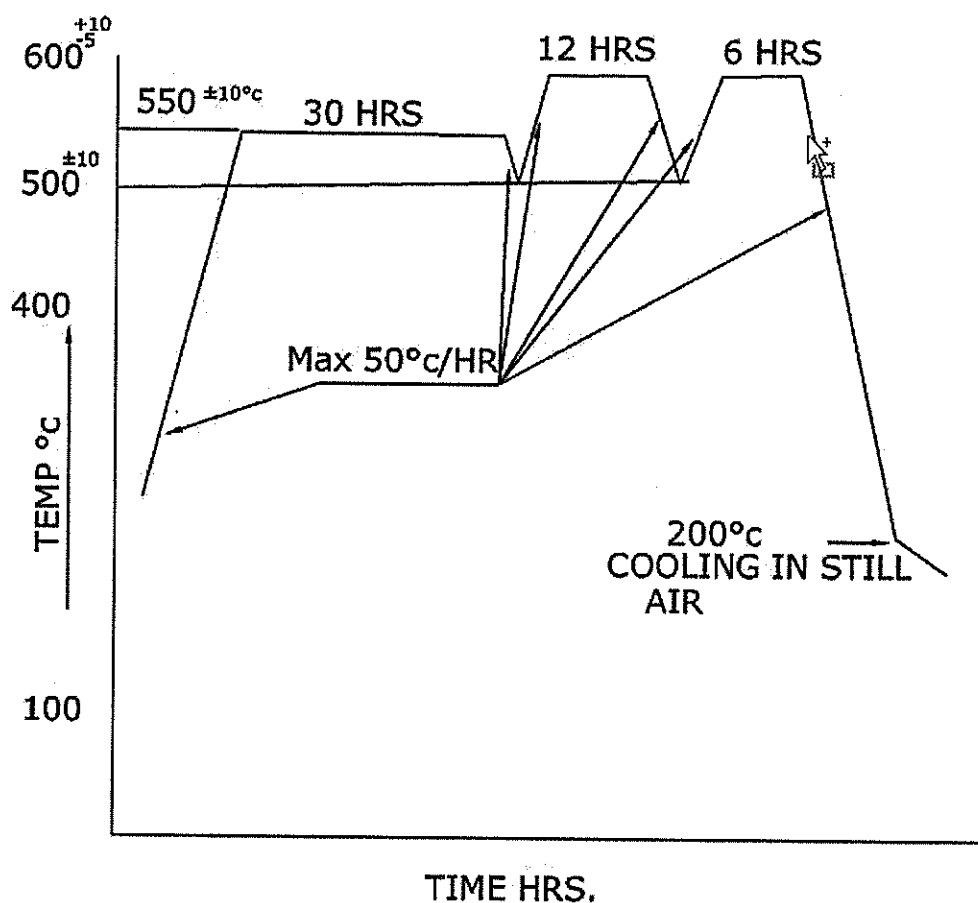


FIG.-1

7.0 MECHANICAL PROPERTIES

- 7.1 The mechanical tests shall be conducted as per ASTM A-20 and ASTM A-370 (DIN 50115, DIN 50125 and DIN EN 10002-1). Following minimum requirements shall be met with both in Quenched and Tempered and simulated heat treated condition for all products except manhole cover / handhole cover wherein minimum requirement shall be met in Quenched & Tempered condition.

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Minima pertaining to mechanical properties at room temperature and 350°C

Product form	Test Temp.	Mechanical Properties		20 MnMoNi 55 ¹⁾	Unit
Primary head Spherical Ring Tube sheet Shell Secondary Head Nozzles	RT	Rm	l, tr, n	560-700	[N/mm ²]
		R _{p0.2}	l, tr, n	390	[N/mm ²]
		A ₅	l, tr	19	[%]
		Z	l, tr	45 (EW)	[%]
		Z	n	35 (EW) / 45 (MW)	[%]
Primary head Spherical Ring Shell Secondary Head Nozzles Tube sheet	350°C	Rm	l, tr, n	505	[N/mm ²]
		R _{p0.2}	l, tr, n	343 ³⁾	[N/mm ²]
		A ₅	l, tr	16 ²⁾	[%]

l = Longitudinal
tr = Transverse
n = Normal

EW = Smallest single value
MW = Average value of 3 specimens

A₅ = % Elongation on 5d (in 50 mm 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/mm² for Tube Sheet

7.1.1 Testing scope of Manhole and Handhole covers in quenched & tempered condition shall be same as that of 'STC-B' of Shell forgings (Table – 2). Testing scope of Production Weld test Coupon (PWTC) in both quenched & tempered and simulated heat treated condition shall be same as that of STC-B of Shell forgings (Table – 2).

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7.2 Notch Toughness

7.2.1 Nil Ductility Transition Temperature (T-NDT)

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

7.2.2 Reference Nil Ductility Transition Temperature (R-TNDT)

Three ISO-V transverse specimens will be tested at +18°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.

7.2.3 Longitudinal, transverse and normal ISO-V test specimens will exhibit the following minimum values at -15°C.

- i) Average of 3 specimens 41 J
- ii) Lowest single value 34 J

7.2.3 **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°C and +18°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°C and - 15°C shall meet the requirements of 7.2.2 and 7.2.3.

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7.3 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 these two values for a forging shall not exceed 40 BHN. Tests shall be carried out as per ASTM-E-10.

7.4 Inclusion Rating

Inclusion rating (Heavy and Thin Series) shall be determined as per ASTM-E 45 (Method A or D) and shall be better than –

A	B	C	D
2.0	2.0	1.0	1.5

8.0 TESTS & EXAMINATIONS

8.1 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 6.2.

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 dispatched with the ordered item for production tests at the Purchaser's works.

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iv) Production Weld Test Coupon (PWTC)

PWTC wherever required shall be from the same heat. The PWTC shall undergo same amount of deformation and shall be supplied in same heat treatment condition (Q&T) as that of respective forgings.

8.2 **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, tube sheets and single nozzle forgings shall have prolongations on the bottom end. RTC samples shall be tested first.

STC, RTC and 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° apart.
- ii) Each sector shall be suitably marked to accommodate STC, RTC and 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.

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- v) Test coupon for forged plate for Manhole \ Handhole covers and PWTC shall be taken from one end of the forged plate.

8.3 Test Specimen Location

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

8.4 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 thickness in excess of 70 mm)

8.5 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 analyzed. Samples for chemical analysis shall be taken from a depth of $\frac{1}{4}t$ from any tempered wall surface and at least at a distance of $\frac{1}{2}t$ 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.

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8.6 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°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 specimens taken from STC & RTC coupons from other locations (See Tables 1, 2 & 3). However, in case of Nozzle forgings (Table 4 & 5) NDT temperature shall be confirmed by testing two transverse Pellini specimens from STC coupons as shown therein.

8.7 Sulfur Prints (Baumann Prints)

Sulfur prints shall be prepared for Tube sheet & Primary Head forgings at the location and area specified in Fig. 9 and Table -3 respectively. For other forgings Sulfur print is not required to be taken provided the bulk sulfur content as revealed by chemical analysis is less than or equal to 0.008% both in Ladle and Product analysis.

9.0 NON DESCTRUCTIVE EXAMINATION

9.1 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, 4 and 4A.

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The reference level for the straight beam examination shall be 6 mm diameter flat bottom hole for $t > 100$ mm and 3 mm for $t \leq 100$ mm. For angle beam examination a 3 mm wide x 12mm long x 0.03 t deep notch (3mm 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 under following conditions are not acceptable.

- Indications exceeding 20% of the reference level in thickness direction.
- Indications exceeding the reference level parallel to the forging faces.

In case of the tube sheet with integral hub, the hub and the portion in the tube sheet underneath the hub for a depth of at least 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 2MHz 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° 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)

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9.2 **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%. Demagnetization is required after test.

9.3 **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.

10.0 **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 authorized inspection agency. Plans for all repairs requiring heat treatment shall be submitted to the purchaser or his authorized 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.

11.0 **PROCEDURES, PLANS, REPORTS AND DOCUMENTATION**

The manufacturer shall prepare Quality assurance plan (QAP), manufacturing, testing, examination procedures, Fabrication drawings etc. 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 authorized agency. Such certified final documents shall be supplied in bound volumes with proper identification. Final documentation containing all the above shall also be submitted in soft form (pdf format) with proper indexing.

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12.0 QUALITY SURVEILLANCE

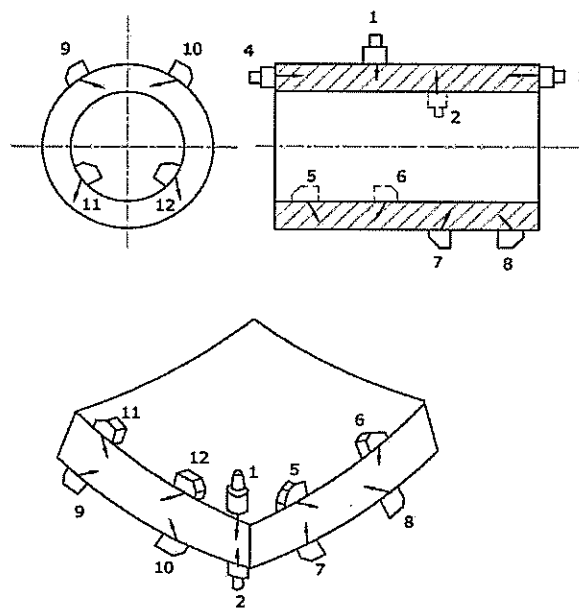
The forgings shall be subjected to quality surveillance by the Purchaser or his authorized agency during manufacture. The forgings shall not be shipped until the shipping release is given by the Purchaser/his authorized agency.

13.0 MARKING, PACKING AND SHIPMENT

Each forging shall be marked with Product Serial Number, Heat number, Material Specification and main working direction. 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.

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NOTES -

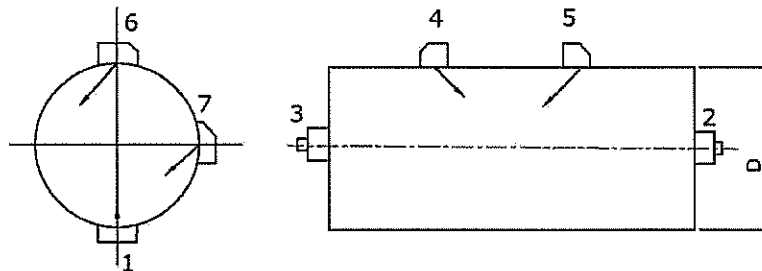
1. 1 TO 4 - NORMAL BEAM SCANNING
5 TO 12 - ANGLE BEAM SCANNING
2. SCAN FROM INSIDE ONLY NECESSARY
IF FURTHER INVESTIGATION OF INDICATION
OBTAINED BY O.C. SCAN IS REQUIRED.

SHELLS, TUBULAR FORGINGS, DISHED ENDS & PETALS

FIG. -2

Fig. -2 UT Scanning direction for Shells, Tubular Forgings, Dished Ends & Petals

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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 $D > 60^\circ$ mm.

IF EVALUATION NOT POSSIBLE ④ & ⑤ WITH 45°

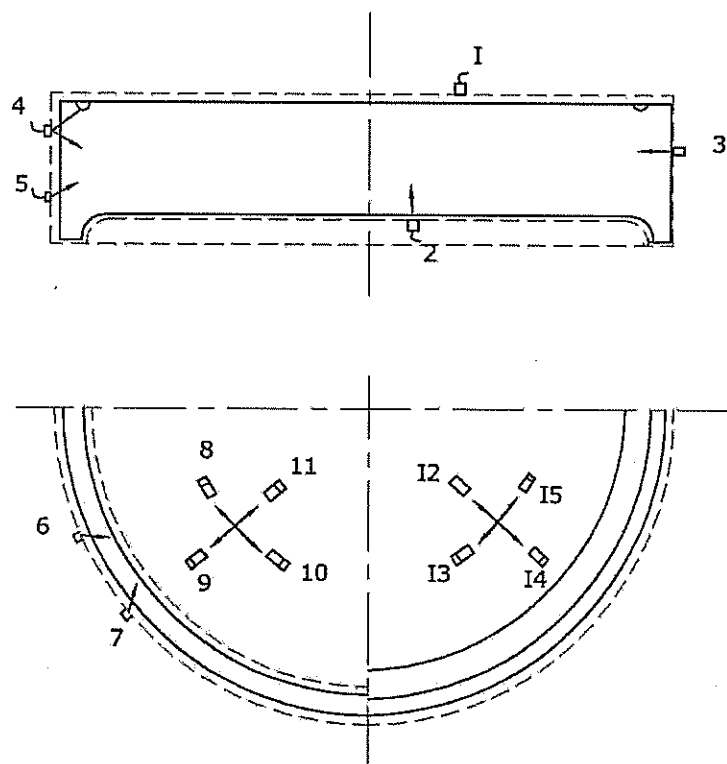
3.3 ⑥ & ⑦ FOR $D > 120$ mm. WITH 35° PROBE.

FORGED BARS

FIG.-3

Fig -3 UT Scanning Direction for Forged Bars

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NOTES:-

1 TO 3 - NORMAL BEAM SCAN

4 TO 15 - ANGLE BEAM SCAN

FIG. -4

UT Scanning Direction for Tube Sheet and Dished Ends



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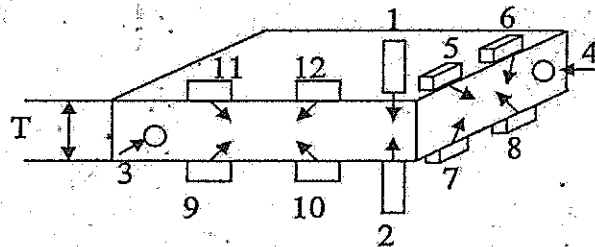
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Scanning direction for Ultrasonic Test



Specimen direction: 1 to 4 NORMAL BEAM SCAN
5 to 12 ANGLE BEAM SCAN (45°)

Forged plate for Manhole \ Handhole covers and PWTC

Fig 4A

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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 T L	1* 1 1	- 1 -	- 1 -	- 1 -	*If testing of first test specimen yields Z <45% two more specimen shall be tested from the same location.
2	Tensile (350°C)	N T L	1 1 1	- 1 -	- 1 -	- 1 -	
3	Impact at - 15°C	N T L	3 3 3	- 3 -	- 3 -	- 3 -	
4	Impact at +18°C	N T L	- 3 -	- 3 -	- 3 -	- 3 -	
5	Impact curve (- 15°C, 18°C and 4 other temperatures)	N T L	- 12 -	- - -	- - -	- - -	
6	Drop weight test	T	8	2	2	2	Specimen P-2
7	Grain size and microstructure		1	1	1	-	Also required at 2 other locations as per Fig.9
8	Product analysis		1	1	1	-	Also required at 3 other locations as per Fig.9
9	Hardness and Sulphur Print test						Refer Fig.9
10	U.T. & M.P.I						100%; Refer Para 9.1 & 9.2

Note : For the locations & extent of Sulfur Print test Refer Fig. 9.

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TABLE – 2
EXTENT OF TESTS – SHELL & RING FORGINGS

N – Normal, T – Transverse, L – Longitudinal

Sr. No	Description	Direction	Bottom of Ingot				STC			Remarks
			STC			R T C	Top of Ingot			
			A	B	C		D	E	F	
1	Tensile at RT	N	1	-	-	-	1	-	-	See Note-1
		T	1	1	1	1	1	1		
		L	1	-	-	-	-	-		
2	Tensile at 350°C	N	1	-	-	-	-	-	-	
		T	1	1	1	1	1	1		
		L	1	-	-	-	-	-		
3	Impact at - 15°C	N	3	-	-	-	-	-	-	
		T	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 and 4 other temperatures)	T	12	-	-	-	-	-	-	
6	Drop weight test	T	8	2	2	2	-	-	-	Specimen P-2
7	Grain size and 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 and Sulphur Print									See note-3.
10	U.T. & M.P.I									100%; Refer Para 9.1 & 9.2

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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 mm x 1000 mm on the cylindrical outside surface and end faces. In case Sulfur print is required to be carried out as specified in clause 8.7 of this Specification, than it shall be carried out on top and bottom faces at 120° apart and 200 mm long.

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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 T L	1 ^D 1 1	- 1 -	- 1 -	- 1 -	See Note-1
2	Tensile at 350°C	N T L	1 1 1	- 1 -	- 1 -	- 1 -	
3	Impact at - 15°C	N T L	3 3 3	- 3 -	- 3 -	- 3 -	
4	Impact at +18°C	T	3	3	3	3	
5	Impact curve (- 15°C, 18°C and 4 other temperatures)	T	12	-	-	-	
6	Drop weight test	T	8	2	2	2	Specimen P-2
7	Grain size and microstructure		1	1	1	-	See Note-3
8	Product analysis		1	1	1	-	
9	Hardness and Sulphur Print						See Note-2
10	U.T. & M.P.I						100%; Refer Para 9.1 & 9.2

Notes:

1. If testing of the first specimen at RT yields Z <45%, then two more test specimens from the same location shall be tested.
2. Hardness values along a square grid of maximum 1000 mm x 1000 mm on the inside and outside. Sulfur print on the face at 120° apart and 120 mm long (only for Primary Head See Clause 8.7).
3. Examination on notched bar specimen in Longitudinal – Normal direction and in the centre (insitu).

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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		Top of Ingot STC-B	Remarks
			STC-A	RTC		
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 at +18°C	T	3	3	3	
5	Drop weight test	T	2	-	-	Pellini - P-2 Specimen
7	Grain size and 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 9.1 & 9.2

Notes:

1. If only one nozzle is made from a forging then test coupon shall be taken only from bottom 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 to 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.

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TABLE – 5
EXTENT OF TESTS – NOZZLES OD I.D. OVER 250 MM

N – Normal
T – Transverse
L – Longitudinal

Sr. No	Description	Direction	Bottom of Ingot			Top of Ingot		Remarks
			STC-A	STC-B	RTC	STC-C	STC-D	
1	Tensile at RT	N T L	1 1 1	- 1 -	- 1 -	- 1 -	- 1 -	See Note-1
2	Tensile at 350°C	N T L	1 1 1	- 1 -	- 1 -	- 1 -	- 1 -	
3	Impact - 15°C	N T L	3 3 3	- 3 -	- 3 -	- 3 -	- 3 -	
4	Impact at +18°C	T	3	3	3	-	-	
5	Impact curve -15°C, 18°C and 4 other temperatures	T	12	-	-	-	-	
6	Drop weight test	T	2	-	-	-	-	Pellini - P-2 Specimen
7	Grain size and microstructure		1	1	-	1	1	See Note-2
8	Product analysis		1	1	-	1		See Note-2
9	Hardness							Fig.17
910	U.T. & M.P.I							100%; Refer Para 9.1 & 9.2

Notes:

1. If testing of first specimen at RT yields Z <45%, then two more test specimens from the same location shall be tested.
2. Examination on notched bar specimen in Longitudinal – Normal direction.



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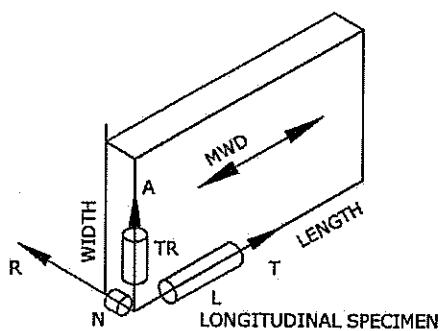
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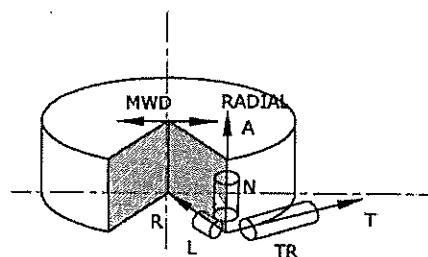
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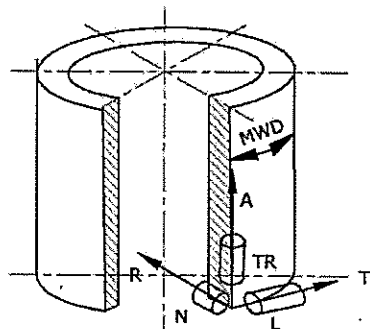
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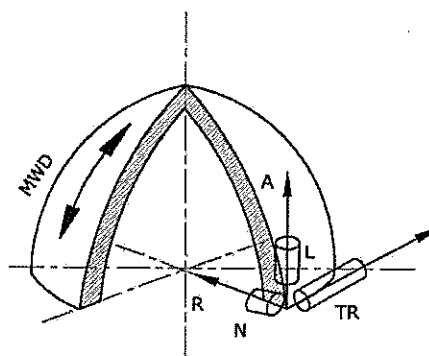
PLATE



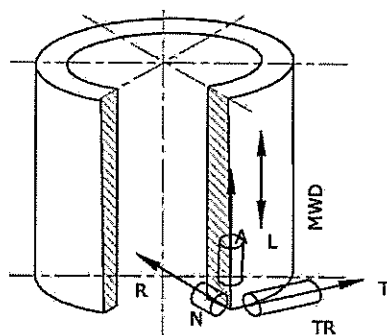
DISC FORGINGS
(TUBE SHEET)



FORGED CYLINDER



FORGED DISHED ENDS



FORGED CYLINDER

METAL WORKING DIRECTION AXIAL (NOZZLES)

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

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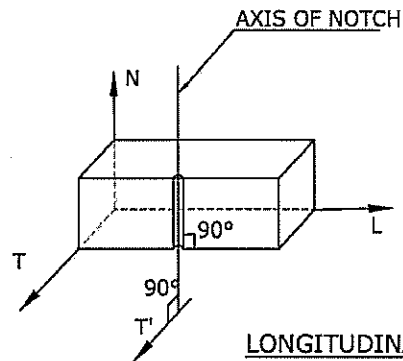
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TECHNICAL SPECIFICATION FOR

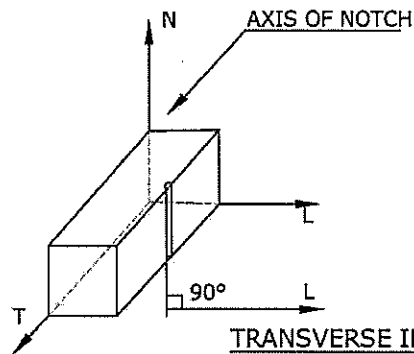
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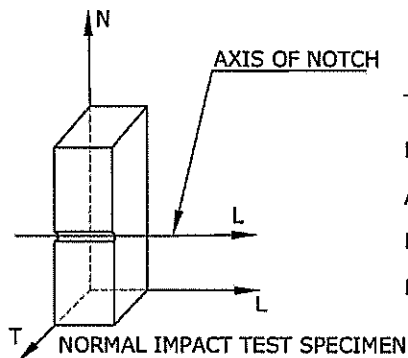
SPECIMEN ORIENTED ALONG
LONGITUDINAL AXIS
AXIS OF NOTCH PERPENDICULAR TO
LONGITUDINAL & TRANSVERSE DIRECTIC

LONGITUDINAL IMPACT TEST SPECIMEN



TEST SPECIMEN ALONG TRANSVERSE
DIRECTION.
AXIS OF NOTCH PERPENDICULAR TO
LONGITUDINAL & TRANSVERSE DIRECTIC

TRANSVERSE IMPACT TEST SPECIMEN

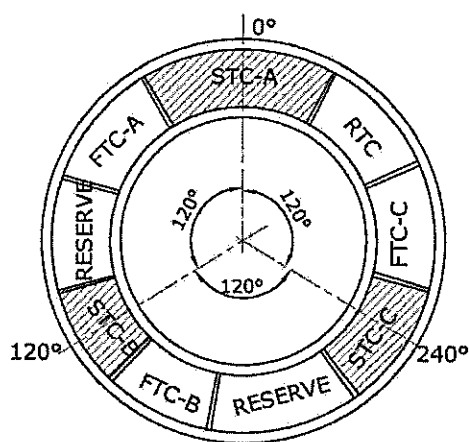
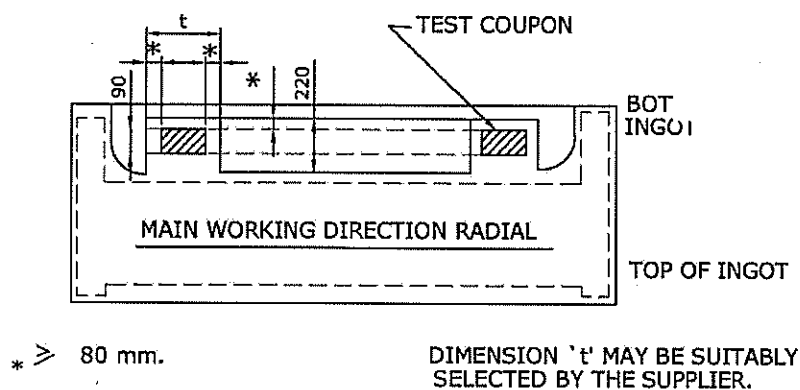


TEST SPECIMEN ALONG NORMAL
DIRECTION.
AXIS OF NOTCH PARALLEL TO
LONGITUDINAL DIRECTION.
NOTCH NEARER TO H.T. SURFACE

NORMAL IMPACT TEST SPECIMEN

TEST SPECIMEN FOR
Impact Tests
Fig.-6

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TEST COUPONS LOCATION - TUBE SHEET

FIG-7



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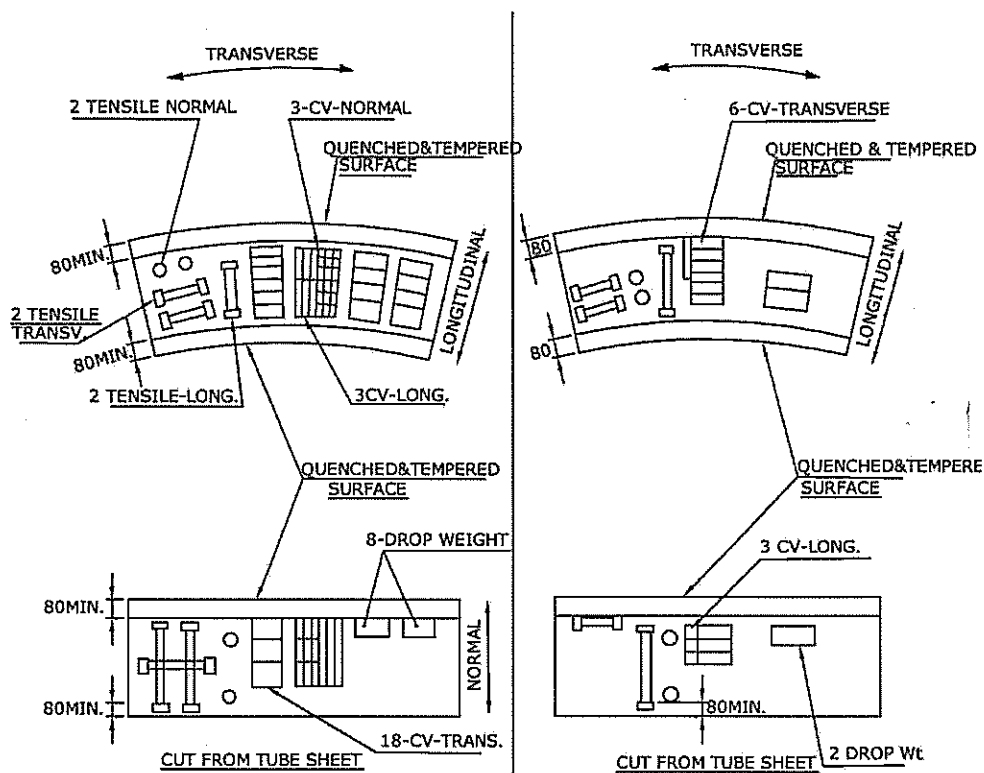
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**MATERIAL SAMPLING AND TESTING
PLAN FOR STC-A**

**MATERIAL SAMPLING AND TESTING
PLAN FOR STC-B, STC-C & RTC-1**

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

EXTENT OF TESTS- TUBE SHEET

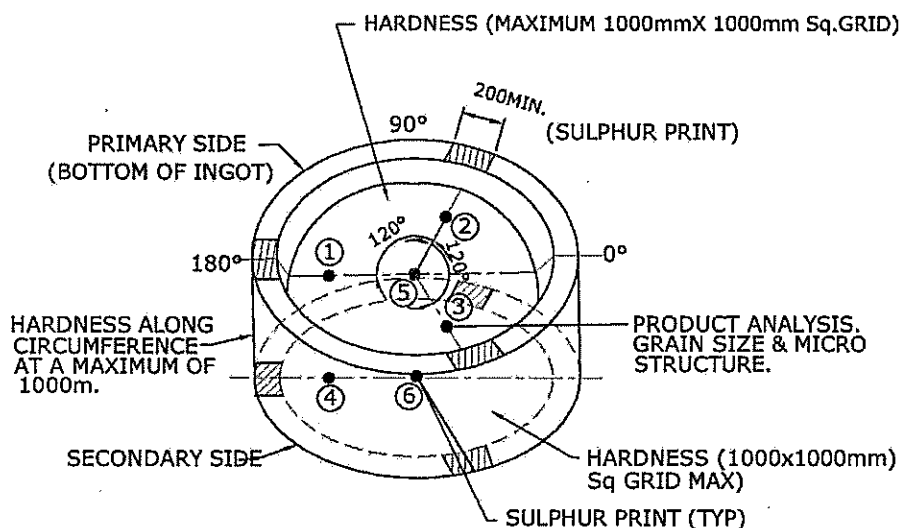
LEGEND:-

N - NORMAL
L - LONGITUDINAL
T - TRANSVERSE

MATERIAL SAMPLING & TESTING PLAN-TUBE SHEET

Fig.- 8

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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 CENTER OF THE PRIMARY & SECONDARY SIDE THE MICROSTRUCTURE AND SEGREGATION SHALL BE EXAMINED.

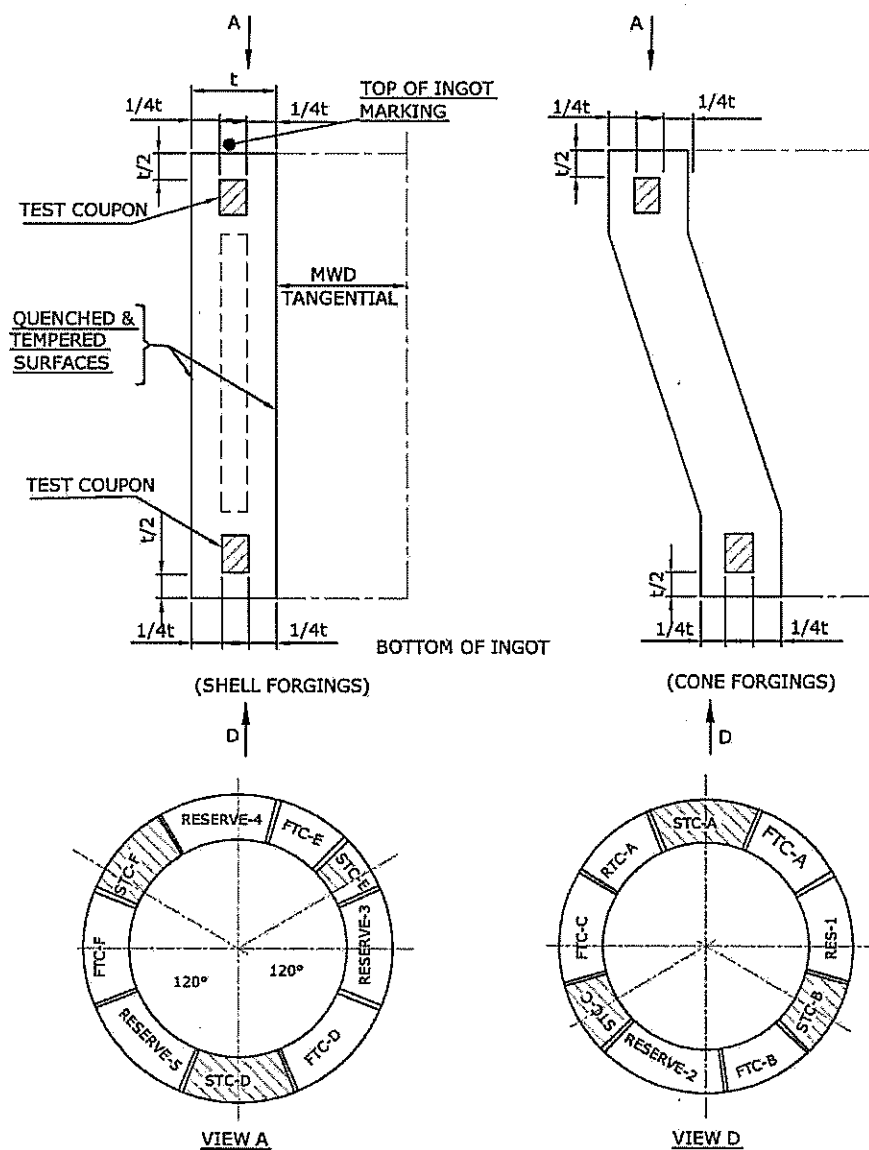
PRODUCT ANALYSIS & METALLURGICAL EXAMINATION (TUBE SHEET)

FIG-9

TECHNICAL SPECIFICATION FOR

QUENCHED & TEMPERED LOW ALLOY AND OTHER CARBON STEEL FORGINGS FOR 700 MWE PROJECTS

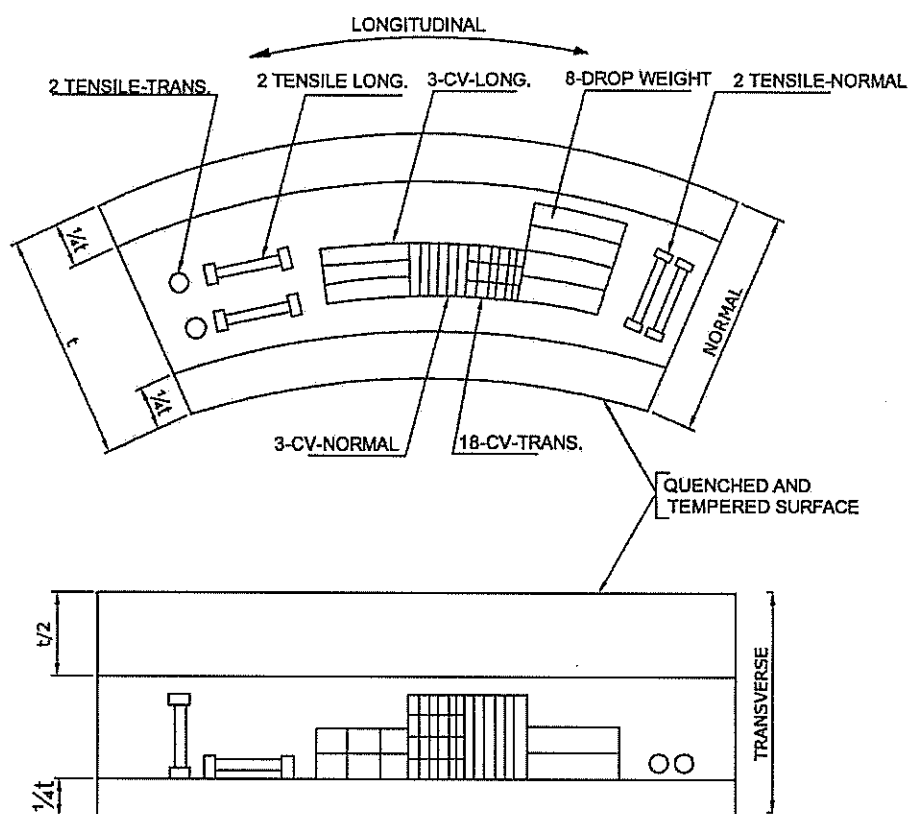
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TEST COUPONS LOCATON-RING FORGINGS

FIG-10

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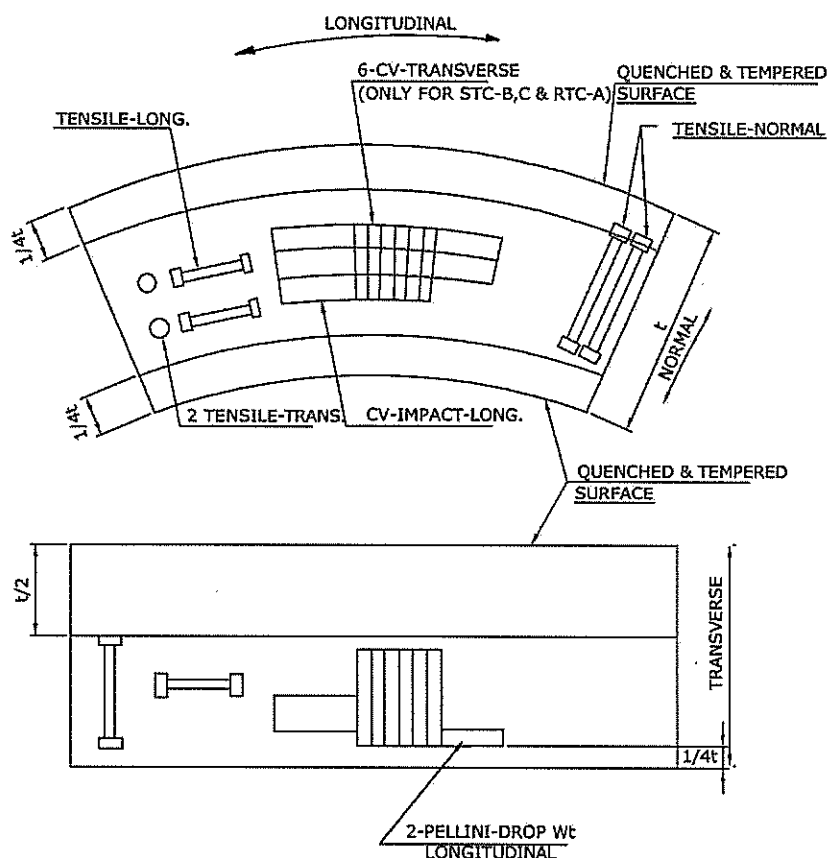


S. NO.	TYPE OF TEST	NO.OF TEST SPECIMEN		
		L	N	T
1	TENSILE AT RT	1	1	1
2	TENSILE AT 350°C	1	1	1
3	IMPACT TEST	3	3	18
4	DROP WEIGHT TEST	-	-	8

MATERIAL SAMPLING & TESTING
PLAN FOR STC-A RING FORGINGS

FIG-11

 एनपीसीआईएल NPCIL	NUCLEAR POWER CORPORATION OF INDIA LTD	
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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		
		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	-	-	-	-	-	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



NUCLEAR POWER CORPORATION OF INDIA LTD

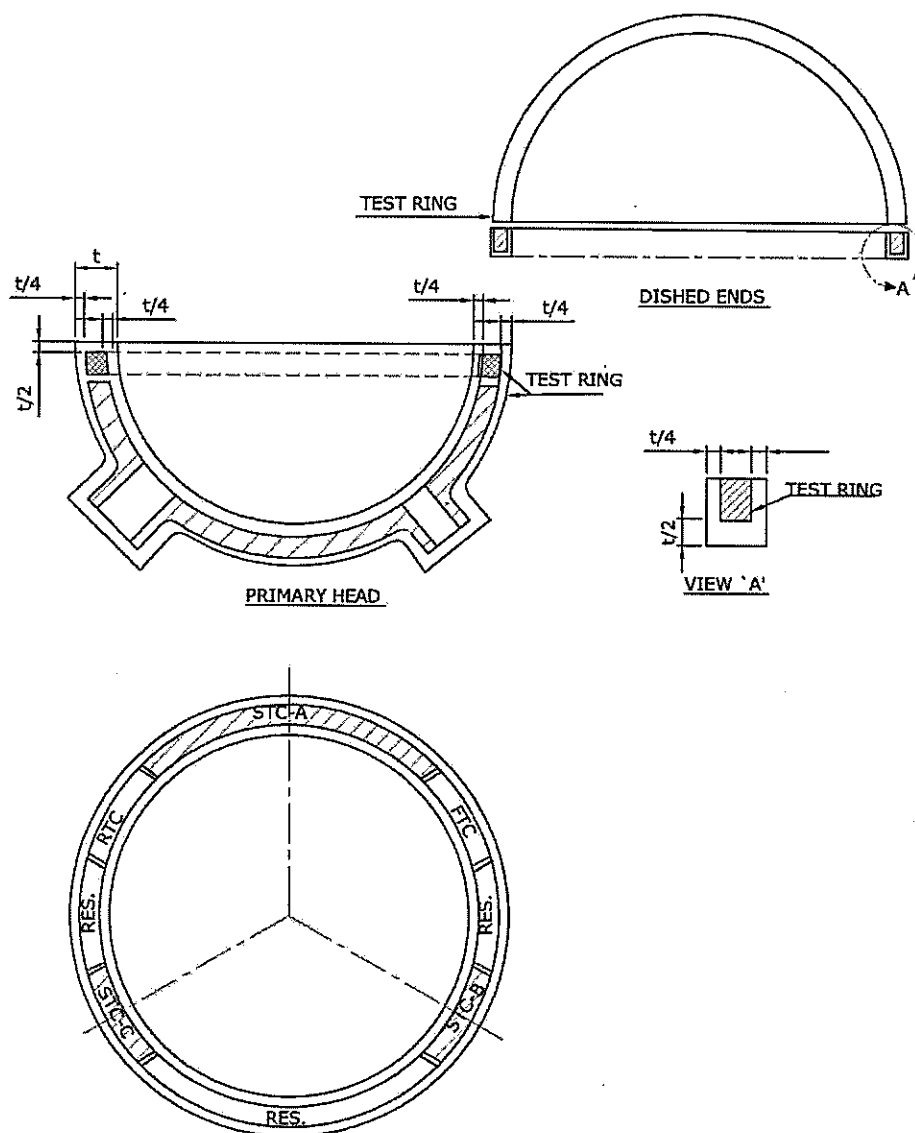
ATOMIC POWER PROJECT

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TECHNICAL SPECIFICATION FOR

QUENCHED & TEMPERED LOW ALLOY AND OTHER CARBON STEEL FORGINGS FOR 700 MWE PROJECTS

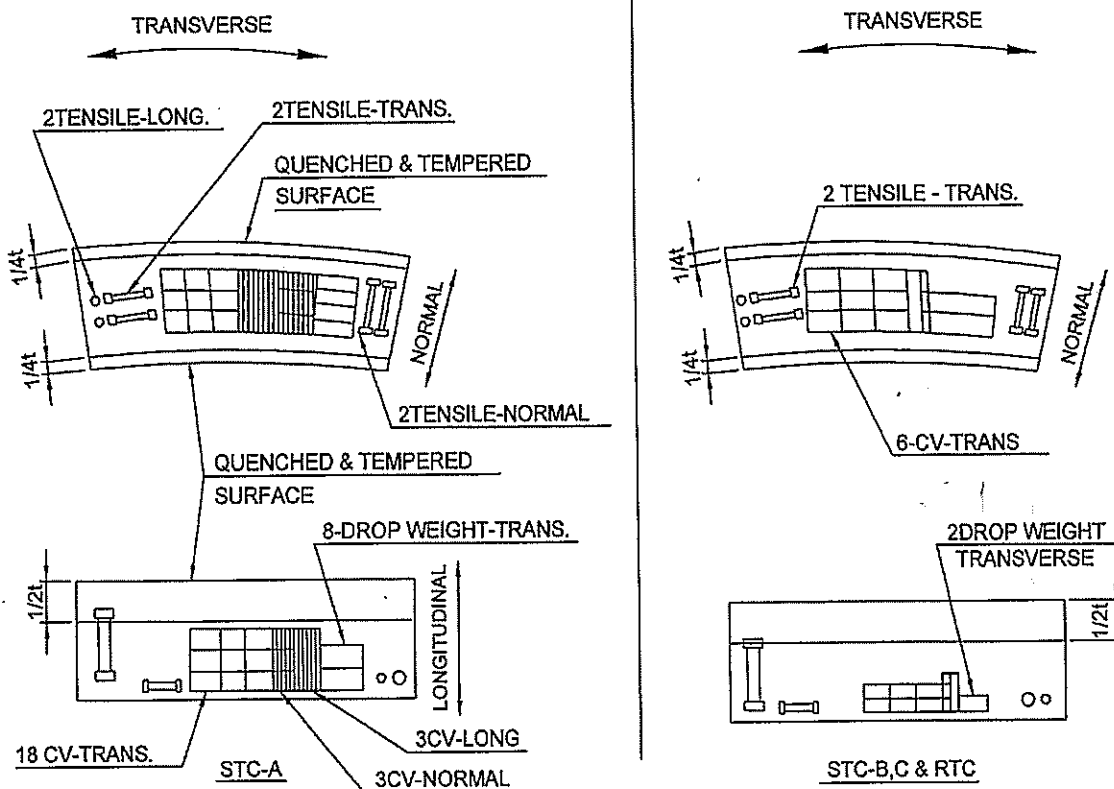
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TEST COUPONS-LOCATION-DISHED END FORGINGS

FIG-13

 एनपीसीआईएल NPCIL	NUCLEAR POWER CORPORATION OF INDIA LTD	
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FORGINGS FOR 700 MWE PROJECTS		



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	2	2

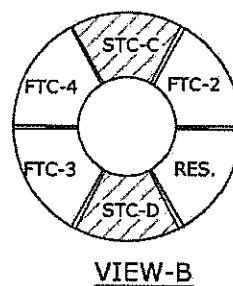
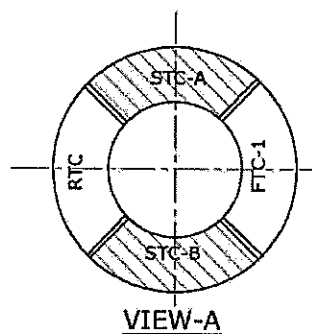
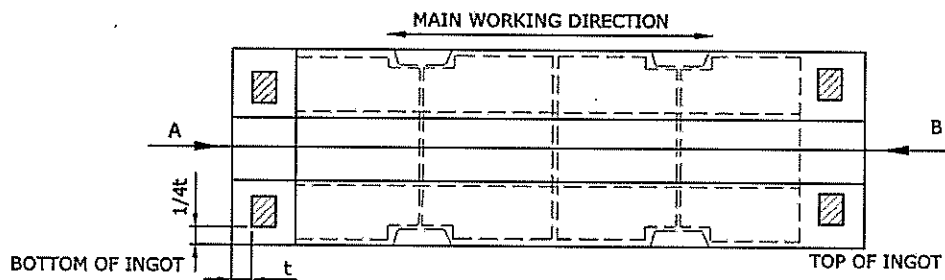
MATERIAL SAMPLING & TEST PLAN - DISHED END FORGINGS

FIG - 14

TECHNICAL SPECIFICATION FOR

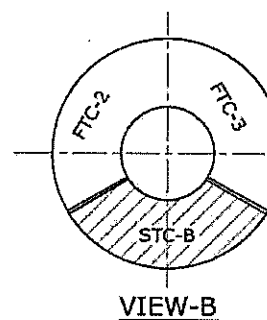
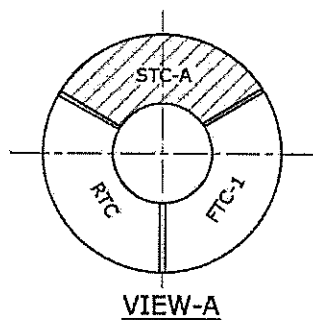
QUENCHED & TEMPERED LOW ALLOY AND OTHER CARBON STEEL FORGINGS FOR 700 MWE PROJECTS

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(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



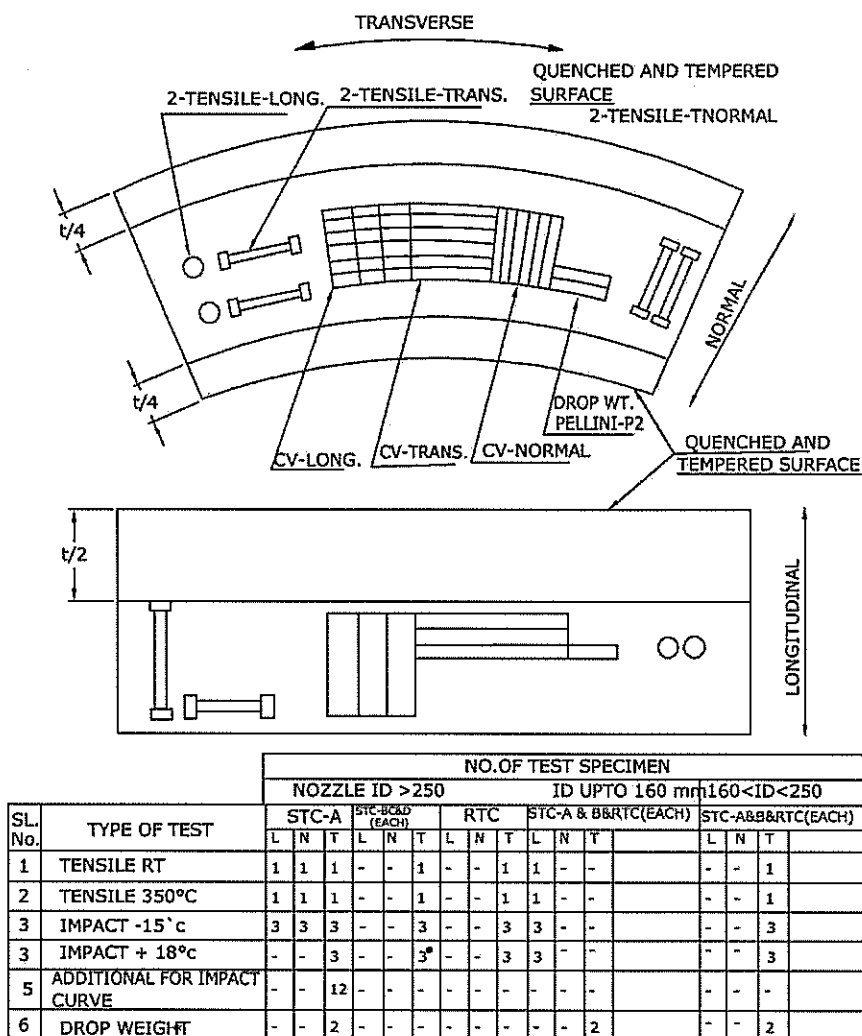
NOTE:-
IF ONLY ONE NOZZLE IS
MADE FROM A FORGING
TEST COUPONS SHALL BE
DRAWN ONLY FROM THE
BOTTOM.

SAMPLING PLAN FOR NOZZLES I.D. UPTO 250

TEST COUPONS-LOCATION-NOZZLE FORGINGS

FIG-15

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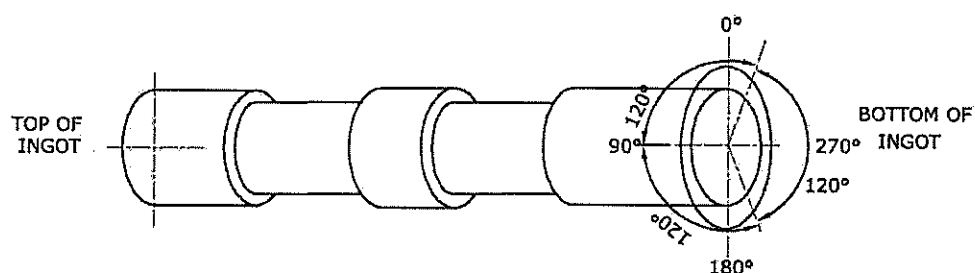


NOTE : 1.* ONLY ON STC-A
2.● ONLY FOR STC-B
3. ALSO REFER TABLE-5

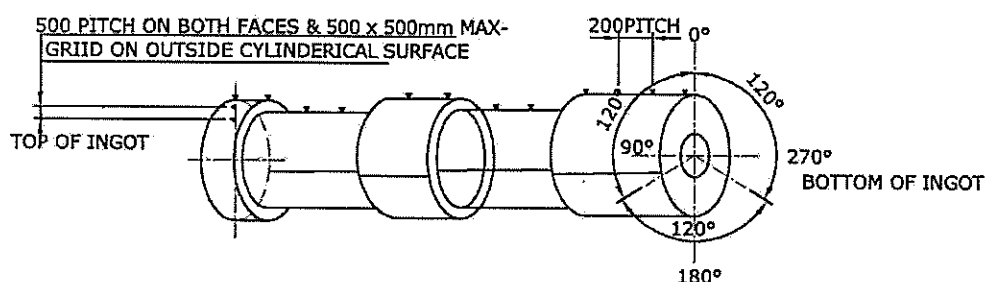
MATERIAL SAMPLING & TEST PLAN- NOZZLES.

FIG-16

 एनपीसीएल NPCIL	NUCLEAR POWER CORPORATION OF INDIA LTD	
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SULPHUR PRINT AFTER Q&T



HARDNESS TEST AFTER REMOVAL OF TEST COUPONS

NOTE:

▼ — HARDNESS TEST

METALLURGICAL TEST PLAN-NOZZLES

FIG-17

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ANNEXURE-1

LOW ALLOY STEEL FORGINGS – 16 Mo 3

1.0 SCOPE

This annexure covers the technical requirements for the supply of low alloy steel forgings conforming to DIN EN 10222-2 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 10.0 of PC-M-960.

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

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P max	0.035
S max	0.035
Cr	0.30 max
Mo	0.25 - 0.35
Cu max	0.30
N2 max	0.009

4.0 HEAT TREATMENT

The forgings shall be supplied in the normalized condition.

5.0 MECHANICAL PROPERTIES

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

	RT	350°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°C. The longitudinal and transverse specimen shall exhibit the following minimum values.

- | | |
|-------------------------------|------|
| i) Average of three specimens | 55 J |
| ii) Lowest single value | 39 J |

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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. FTC (Final Test Coupon) shall undergo same amount of working heat treatment as the final forging.

The specimens for testing shall be at least $1/4't$ 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°C.

6.2 Impact Test Specimen

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

7.0 NON-DESTRUCTIVE EXAMINATION

The ultrasonic examination, magnetic particle tests and dimensional checks shall be carried out on each forging as per para 9.1, 9.2 and 9.3 of PC-M-960.

8.0 QUALITY SURVEILLANCE, DOCUMENTATION, MARKING, PRACKING AND SHIPMENT

Refer para 11, 12 and 13 of PC-M-960.

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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 ASME-SA-350Grade LF2.

2.0 MANUFACTURE.

2.1 The steel shall be clean, homogeneous, intrinsically tough produced by any recognized fine grain melting 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

Sulfur, 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%

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2.2.2 Heat Treatment

The forgings shall be supplied in normalized 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 200X. 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 ASME-SA-370 and ASTM-E-21. Following minimum requirements shall be met within final normalized condition and are applicable to all test specimen orientation viz. Longitudinal, Transverse and Normal.

	RT	350°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°C as called for in SA-350 LF2, ISO-V impact transverse test specimens will be tested at + 18°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°C shall not indicate any break.

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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 7.4 of PC-M-960.

4.0 TESTS & EXAMINATION

For test coupon location and extent of tests refer para 8.2, 8.3, 8.4, 8.5, 8.6, 8.7 and product specification tables of PC-M-960.

5.0 NON-DESTRUCTIVE EXAMINATION

Refer para 9.1, 9.2 and 9.3 of PC-M-960.

6.0 QUALITY SURVEILLANCE, DOCUMENTATION, MARKING, PRACKING AND SHIPMENT

Refer para 11, 12 and 13 of PC-M-960.

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ANNEXURE-3
BLEED CONDENSER FORGING

N – Normal, T – Transverse, L - Longitudinal

1. EXTENT OF TESTS FOR

- a) Primary Head with Integral Nozzles
- b) Tube Sheet
- c) Shell Flange
- d) Hemispherical Head
- e) Ellipsoidal Head

- 1.1 No. of Test Coupons : 3 Nos. (STC-A, STC-B & RTC)
- 1.2 Location of Test Coupons : STC A&B Diametrically opposite to each other.
- 1.3 Condition of Test Coupons : Simulated Heat Treatment for STC (See Clause 6.2 of PC-M-960)
- 1.4 Extent of Tests

Description	Direction	STC -A	STC -B	RTC
Tensile (RT)	N	1	--	--
	T	1	1	1
	L	1	--	--
Tensile (350°C)	T	1	1	1
Impact at - 15°C	T	3	3	3
Impact at +18°C	T	3	3	3
Drop weight test	T	2	--	2
Grain size and * microstructure		1	1	--
Product analysis		1	--	--
Hardness		At 500 x 500 mm grid		
U.T. & M.P.I		100% Refer 9.1 & 9.2 of PC-M-960		

* Examination on notched bar specimen in Longitudinal – Normal direction.

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BLEED CONDENSER FORGINGS

N – Normal, T – Transverse, L - Longitudinal

2. EXTENT OF TESTS FOR

- Integral Forging of Cone & Shell
- Shell Forging

- 2.1 No. of Test Coupons 5 Nos.(STC-A, STC-B & RTC - 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. RTC at 90° to STC
- 2.3 Condition of Test Coupons: Simulated Heat Treatment for STC (See Clause 6.2 of PC-M-960)
Q&T for RTC

2.3 Extent of Tests

Description	Direction	Bottom of Ingot			Top of Ingot	
		STC -A	STC -B	RTC	STC -C	STC -D
Tensile (RT)	N	1	--	--	1	--
	T	1	1	1	1	1
	L	1	--	--	--	--
Tensile (350°C)	T	1	1	1	1	1
Impact at - 15°C	T	3	3	3	3	3
Impact at +18°C	T	3	3	3	3	3
Impact curve (- 15°C, 18°C and 4 other temperatures)	T	12	--	--	--	--
Drop weight test	T	2	-	-	-	2
Grain size and * microstructure		1	1	--	1	1
Product analysis		1	1		1	
Hardness	At 500 x 500 mm grid					
U.T. & M.P.I	100% as per para 9.1 & 9.2 of PC-M-960					

* Examination on notched bar specimen in Longitudinal – Normal direction.

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BLEED CONDENSER FORGINGS

3. EXTENT OF TESTS FOR

- a) Nozzle Forgings
- b) Heater Nozzle

3.1	No. of Test Coupons	3 per forged bar (STC-A,STC-B & RTC) (Refer Fig. 15 of PC-M-960)
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 1)	Bottom of Ingot		Top of Ingot
		STC -A	RTC	STC -B
Tensile (RT)	T	1	1	1
Tensile (350°C)	T	1	1	1
Impact at - 15°C	T	3	3	3
Impact at +18°C	T	3	3	3
Drop weight test	T	2	--	--
Grain size and microstructure 2)		1		1
Product analysis		1		1
Hardness	At 200 x 200 mm grid			
U.T. & M.P.I	100% Refer 9.1 & 9.2 of PC-M-960			

Notes :

- 1) For nozzles of size 160 NB and less, the specimens are to be taken from longitudinal direction.
- 2) Examination on notched bar specimen in Longitudinal – Normal direction.
Production weld test coupons (PWTC) wherever required shall be supplied as per clause no. 8.1 (iv) of PC-M-960.

Table 01 : Raw Material Quantity to be Procured for GHAVP-1&2 (700MW)

Sl.No.	Material Code	Component description	Drawing Reference	Size requirement with allowance (mm)	Special requirement (Same Melt No. requirement)	Indent Quantity.	
						Qty. (No.)	Weight (Kg).
1	D15730201001	Tube sheet (Forging)+FTC	2-93-170-05230 Rev. 00	as per drg.	Same Melt No. requirement for 1 set of forgings , FTC and test plates.	4	78368
2	D15730701001	Tube sheet test coupons	2-93-170-05230 Rev. 00	FPI. 87.5x250x2500		4	1719
3	D15730701002	Tube sheet test coupons	2-93-170-05230 Rev. 00	FPI. 57.5x250x2500		4	1130
4	D15730701004	Tube sheet test coupons	2-93-170-05230 Rev. 00	FPI. 130x700x3000		4	8583
5	D15730701005	Tube sheet test coupons	2-93-170-05230 Rev. 00	FPI. 450x700x700	From one of the Melt No. of the Tubesheet Forgings being supplied.	3	5199
6	D15730201002	Shell-I (Forging)+FTC	2-93-170-05231 Rev. 01	as per drg.	Same Melt No. requirement for 1 set of forging , FTC and test plates.	4	67816
7	D15730701006	Shell-I test plate	2-93-170-05231 Rev. 01	FPI. 57.5x250x2500		4	1130
8	D15730201003	Hand Hole Nozzle (Forging)+FTC	3-93-170-05293 Rev. 01	as per drg.	same Melt No. requirement for forging and FTC	18	2628
9	D15730201004	PDHRS Nozzle (Forging)+FTC	3-93-170-05295 Rev. 01	as per drg.	same Melt No. requirement for forging and FTC	5	470
10	D15730201005	Plate for support	-----	FPI. 160 x 700 x 750	-	8	5282
11	D15730201006	Rib for support-1 & 2	-----	FPI. 100 x 310 x 625	-	16	2437
12	D15730201007	Plate for support	-----	FPI. 160 x 850 x 1200	-	8	10262
13	D15730201008	Spherical Segment (Forging)+FTC	1-93-170-05155 Rev. 01	as per drg.	Same Melt No. requirement for 1 set of forgings, FTC and test plates.	4	22924
14	D15730701007	Spherical Segment test plate 1	1-93-170-05155 Rev. 01	FPI.87.5x250x2500		4	1719

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no. 012

Table 01 : Raw Material Quantity to be Procured for GHAVP-1&2 (700MW)

Sl.No.	Material Code	Component description	Drawing Reference	Size requirement with allowance (mm)	Special requirement (Same Melt No. requirement)	Indent Quantity.	
						Qty. (No.)	Weight (Kg).
15	D15730201009	Shell-II (Forging)+FTC	2-93-170-05313 Rev. 00	as per drg.	same Melt No. requirement for 1 set of forging and FTC	4	67124
16	D15730201010	Cone Shell-II+FTC	2-93-170-05236 Rev.02	as per drg.	same Melt No. requirement for 1 set of forging and FTC	4	71872
17	D15730201011	Top Lug-1	-----	FPI.100 x 450 x 470	-	16	2660
18	D15730201012	Top Lug-2	-----	FPI.110 x 270 x 470	-	32	3511
19	D15730201013	Shell-IV+FTC	2-93-170-05237 Rev. 01	as per drg.	same Melt No. requirement for 1 set of forging and FTC	4	76724
20	D15730201014	Feed Water Nozzle+FTC	3-93-170-05297 Rev. 01	as per drg.	same Melt No. requirement for forging and FTC	10	5410
21	D15730201015	Lifting Sup. Gusset	-----	FPI.45 x 200 x 210	-	36	535
22	D15730201016	Lifting Sup. Pl	-----	FPI.75 x 210 x 315	-	18	702
23	D15730201017	Guide Plate	-----	FPI.70 x 75 x 130	-	36	193
24	D15730201018	Shell-V+FTC	2-93-170-05314 Rev.00	as per drg.	Same Melt No. requirement for 1 set of forgings, FTC and test plates.	4	95308
25	D15730701008	Shell-V test plate	2-93-170-05314 Rev.00	FPI.71.5x250x2500		4	1405
26	D15730201019	Torispheical Head+FTC	2-93-170-05238 Rev.01	as per drg.	Same Melt No. requirement for 1 set of forgings, FTC and test plates.	4	35444
27	D15730701009	Torispheical Head test plate	2-93-170-05238 Rev.01	FPI.71.5x250x2500		4	1405
28	D15730201020	Steam Outlet Nozzle Forg.+FTC	3-93-170-05298 Rev. 01	as per drg.	same Melt No. requirement for forging and FTC	4	8324
29	D15730201021	Secondary Manhole Nozzle+FTC	3-93-170-05240 Rev. 01	as per drg.	same Melt No. requirement for forging and FTC	4	3804

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CHANDRA PRAKASH JOSHI
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Table 01 : Raw Material Quantity to be Procured for GHAVP-1&2 (700MW)

Sl.No.	Material Code	Component description	Drawing Reference	Size requirement with allowance (mm)	Special requirement (Same Melt No. requirement)	Indent Quantity.	
						Qty. (No.)	Weight (Kg).
30	D15730201022	Supp For Swinging Mech.	-----	FPL100x160x240	-	10	302
31	D15730201023	Pri Manhole Cover	2-93-170-05245 Rev. 01	as per drg.	-	8	4528
32	D15730201024	Sec Manhole Cover	2-93-170-05245 Rev. 01	as per drg.	-	4	2436
33	D15730201025	Hand Hole Cover	2-93-170-05245 Rev. 01	as per drg.	-	16	1168
34	D15730701010	Qc Blocks	-----	FPL100x500x500	-	30	5895
35	D15730701011	Plate for qualification-1	-----	FPL50x300x600	-	22	1556
36	D15730701012	Plate for qualification-2	-----	FPL50x300x400	-	80	3773
37	D15730701013	Plate for qualification-3	-----	FPL75x700x2000	-	15	12380
Total Quantity.						459	616126

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