Supplier's Name , address , logo etc	SUGGESTIVE QUALITY ASSURANCE PLAN for REACTOR HEADER CARBON STEEL FORGINGS							1 of 7				
	ITEM: REACTOR HEADER-CARBON STEEL FORGING SA 350 GR-LF2							QP No: SQP-RH-01 Rev 01 Project : Reactor Header Fleet Order.				
	QAPNO :To be filled by Supplier							P.O No: To be filled by Supplier				
SR.No	COMPONENT /OPERATION	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY				REMARKS
									P	W	R	H	
1	2	3	4	5	6	7	8	9	10				11
MAIN JOB FORGING													
1	Review of ladle analysis certificate of ingot used as electrode	Heat analysis &Chemical Composition	CR	Checking of TC, Heat No, Grade, melting practice, etc.	100%	TDCAT:8	TDCAT:8	Raw material certificate report	3	---	2,1	---	-----
2	ESR product analysis	Chemical Composition	CR	Chemical Composition	100%	TDCAT:8	TDCAT:8	TC per Header	3	---	2,1	---	Top & Bottom of the billet shall be identified.
3	Mockup Forging i) Mockup forgings to be manufactured as per Clause 3.1 of TDCAT:08 ii) Forging ratio to be mentioned (Refer Clause no. 4.4 of TDCAT:08)	Profile & Dimensional check	MA	Profile, Dimensional check & NDE	100%	TDCAT:8 & Applicable drawing	TDCAT:8 & Applicable drawing	TC	3	---	---	2,1	----

13/01/2021

Supplier	LEGEND: - 1.NPCIL/TPI 2.BHEL 3. SUPPLIER H: HOLD POINT,"P"PERFORM,"W"WITNE SS AND "R"REVIEW, MA-MAJOR, CR-CRITICAL, MI-MINOR. TC-TEST CERTIFICATE.	BHEL	NPCIL
SEAL & SIGNATURE WITH DATE		SEAL & SIGNATURE WITH DATE	SEAL & SIGNATURE WITH DATE

Supplier's Name , address , logo etc	SUGGESTIVE QUALITY ASSURANCE PLAN for REACTOR HEADER CARBON STEEL FORGINGS							2 of 7				
	ITEM: REACTOR HEADER-CARBON STEEL FORGING SA 350 GR-LF2							QP No: SQP-RH-01 Rev 01 Project : Reactor Header Fleet Order.				
	QAPNO :To be filled by Supplier							P.O No: To be filled by Supplier				

SR.No	COMPONENT /OPERATION	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY				REMARKS
									P	W	R	H	
1	2	3	4	5	6	7	8	9	10				11
4	Forging	Forging process & dimensional check	MA	Profile, Dimensional check	100%	TDCAT:8 & Applicable drawing	TDCAT:8 & Applicable drawing	TC	3	2	1	---	Forging ratio to be mentioned
5	First rough machining	Machining & dimensional check	MA	Profile & Dimensional check	100%	TDCAT:8 & Applicable drawing	TDCAT:8 & Applicable drawing	Record	3	---	2,1	----	---
6	Heat Treatment	Monitoring of temperature and time	**CR**	Witness of Job loading and at the end of soaking time, review of HT chart,	100%	1) TDCAT:8 & 2)HT Plan Number: *(to be submitted by Supplier)*	1) TDCAT:8 & 2)HT Plan Number: *(to be submitted by Supplier)*	HT chart	3	---	---	1,2	HT chart shall be submitted along with TC
7	Straightness & stress relieving (If required)	Stress relieving	**MA**	Stress relieving	100%	1) TDCAT:8 & 2)HT Plan Number: *(to be submitted by Supplier)*	1) TDCAT:8 & 2)HT Plan Number: *(to be submitted by Supplier)*	Record	3	---	2,1	---	----

13/01/2021

Supplier	LEGEND: -	BHEL	NPCIL
	1.NPCIL/TPI 2.BHEL 3. SUPPLIER H: HOLD POINT,"P"PERFORM,"W"WITNE SS AND "R"REVIEW, MA-MAJOR, CR-CRITICAL, MI-MINOR. TC-TEST CERTIFICATE.		
SEAL & SIGNATURE WITH DATE		SEAL & SIGNATURE WITH DATE	SEAL & SIGNATURE WITH DATE

Supplier's Name , address , logo etc	SUGGESTIVE QUALITY ASSURANCE PLAN for REACTOR HEADER CARBON STEEL FORGINGS							3 of 7				
	ITEM: REACTOR HEADER-CARBON STEEL FORGING SA 350 GR-LF2							QP No: SQP-RH-01 Rev 01 Project : Reactor Header Fleet Order.				
	QAPNO :To be filled by Supplier							P.O No: To be filled by Supplier				

SR.No	COMPONENT /OPERATION	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY				REMARKS
									P	W	R	H	
1	2	3	4	5	6	7	8	9	10				11
8	Second Round machining	Machining& dimensional check	**MA**	Profile & Dimensional check	100%	TDCAT:8 & Applicable drawing	TDCAT:8 & Applicable drawing	Record	3	--	2,1	---	----
9	Ultrasonic Examination	UTE	MA	Surface & Volumetric Examination	100 %	TDCAT:8 & UTE Procedure No: *(to be submitted by Supplier)*	TDCAT:8 & UTE Procedure No: *(to be submitted*	UTE Report	3	--	---	2,1	---
10	Test Coupon identification and cutting for: i)**RTC:** as supplied condition (i.e. Normalized condition) ii)**STC:** Simulated HT condition	Identification & stamping	MA	Identification & stamping	100 %	TDCAT:8 & MSTP No: *(to be submitted by Supplier)*	TDCAT:8 & MSTP No: *(to be submitted by Supplier)*	TC	3	--	--	2,1	---
11	Simulated Heat Treatment on STC test coupons	Monitoring of temperature and time	CR	Witness of Job loading and at the end of soaking time, review of HT chart ,	100%	1) TDCAT:8 & 2)HT Plan Number: *(to be submitted by Supplier)*	1) TDCAT:8 & 2)HT Plan Number: *(to be submitted by Supplier)*	HT chart	3	--	--	2,1	HT chart shall be submitted along with TC

12/11/2021

Supplier	LEGEND: - 1.NPCIL/TPI 2.BHEL 3. SUPPLIER H: HOLD POINT,"P"PERFORM,"W"WITNE SS AND "R"REVIEW, MA-MAJOR, CR-CRITICAL, MI-MINOR. TC-TEST CERTIFICATE.	BHEL	NPCIL
SEAL & SIGNATURE WITH DATE		SEAL & SIGNATURE WITH DATE	SEAL & SIGNATURE WITH DATE

Supplier's Name , address , logo etc	SUGGESTIVE QUALITY ASSURANCE PLAN for REACTOR HEADER CARBON STEEL FORGINGS	4 of 7
	ITEM: REACTOR HEADER-CARBON STEEL FORGING SA 350 GR-LF2	QP No: SQP-RH-01 Rev 01 Project : Reactor Header Fleet Order.
	QAPNO :To be filled by Supplier	P.O No: To be filled by Supplier

SR.No	COMPONENT /OPERATION	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY				REMARKS
									P	W	R	H	
1	2	3	4	5	6	7	8	9	10				11
12	Cutting & Machining of test specimen and their identification. All Mechanical & chemical testing shall be done as per TDCAT:8 clause no. 7.0 and 8.0 in normalized & SHT condition	Testing & their identification	**MA**	Identification & testing witness	100%	1) TDCAT:8 & 2) MSTP Number: *(to be submitted by Supplier)*	TDCAT:8	TC	3	--	---	2,1	---
13	Third rough machining	Machining& dimensional check	**MA**	Profile & Dimensional check	100%	TDCAT:8 & Applicable drawing	TDCAT:8 & Applicable drawing	Record	3	--	2,1	--	---

13/01/2021

Supplier	LEGEND: -	BHEL	NPCIL
	1.NPCIL/TPI 2.BHEL 3. SUPPLIER H: HOLD POINT,"P"PERFORM,"W"WITNE SS AND "R"REVIEW, MA-MAJOR, CR-CRITICAL, MI-MINOR. TC-TEST CERTIFICATE.		
SEAL & SIGNATURE WITH DATE		SEAL & SIGNATURE WITH DATE	SEAL & SIGNATURE WITH DATE

Supplier's Name , address , logo etc	SUGGESTIVE QUALITY ASSURANCE PLAN for REACTOR HEADER CARBON STEEL FORGINGS							5 of 7				
	ITEM: REACTOR HEADER-CARBON STEEL FORGING SA 350 GR-LF2							QP No: SQP-RH-01 Rev 01 Project : Reactor Header Fleet Order.				
	QAPNO :To be filled by Supplier							P.O No: To be filled by Supplier				

SR.No	COMPONENT /OPERATION	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY				REMARKS
									P	W	R	H	
1	2	3	4	5	6	7	8	9	10				11
14	Ultrasonic Examination of al nozzles (Large & Small) in rough machining condition	UTE	**MA**	Surface & Volumetric Examination	100%	TDCAT:8 & UTE Procedure No: *(to be submitted by Supplier)*	TDCAT:8 & UTE Procedure No: *(to be submitted by Supplier)*	UTE Report	3	--	--	2,1	---
15	Residual Stress Measurement	Residual Stress Measurement	**MA**	Residual Stress Measurement	100%	TDCAT:8 & Procedure No: *(to be submitted by Supplier)*	TDCAT:8 & Procedure No: *(to be submitted by Supplier)*	TC	3	2	1	--	---
16	Stress Relieving (If performed)	Stress Relieving	**MA**	Stress Relieving	100%	1) TDCAT:8 & 2)HT Plan Number: *(to be submitted by Supplier)*	1) TDCAT:8 & 2)HT Plan Number: *(to be submitted by Supplier)*	HT Chart	3	1,2	---	---	HT chart shall be submitted along with TC
17	Final Machining	Machining & Dimensional Check	**MA**	Profile & Dimensional Check	100%	TDCAT:8 & Applicable drawing	TDCAT:8 & Applicable drawing	TC	3	---	2,1		----

13/5/2024

Supplier	LEGEND: -	BHEL	NPCIL
	1.NPCIL/TPI 2.BHEL 3. SUPPLIER H: HOLD POINT,"P"PERFORM,"W"WITNE SS AND "R"REVIEW, MA-MAJOR, CR-CRITICAL, MI-MINOR. TC-TEST CERTIFICATE.		
SEAL & SIGNATURE WITH DATE		SEAL & SIGNATURE WITH DATE	SEAL & SIGNATURE WITH DATE

Supplier's Name , address , logo etc	SUGGESTIVE QUALITY ASSURANCE PLAN for REACTOR HEADER CARBON STEEL FORGINGS							6 of 7				
	ITEM: REACTOR HEADER-CARBON STEEL FORGING SA 350 GR-LF2							QP No: SQP-RH-01 Rev 01 Project : Reactor Header Fleet Order.				
	QAPNO :To be filled by Supplier							P.O No: To be filled by Supplier				
SR.No	COMPONENT /OPERATION	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	R	H	
1	2	3	4	5	6	7	8	9	10				11
17a	Axes Marking	Axes Marking	**MA**	Visual , Dimensions	100%	TDCAT:8 & Applicable drawing	TDCAT:8 & Applicable drawing	TC	3	---	1	2	---
18	Dimensional and visual inspection including boroscopic inspection	Dimensional, Visual& UT thickness measurement	**MA**	Dimensional, Visual &UT thickness measurement	100%	TDCAT:8 & Applicable drawing	TDCAT:8 & Applicable drawing	TC	3	--	---	2,1	---
19	Magnetic Particle Inspection	**MPI**	**MA**	Surface & Subsurface Examination	100%	TDCAT:8, MPI Procedure No: *(to be submitted by Supplier)*	TDCAT:8, MPI Procedure No: *(to be submitted by Supplier)*	MPI Report	3	--	---	2,1	---
20	Dye Penetrant Examination on all edge preparation and radius portion of all nozzles	DPE	**MA**	Surface Examination	100%	TDCAT:8, DPE Procedure No: *(to be submitted by Supplier)*	TDCAT:8, DPE Procedure No: *(to be submitted by Supplier)*	DPE Report	3	--	---	2,1	---

13/01/2021

Supplier	LEGEND: -	BHEL	NPCIL
	1.NPCIL/TPI 2.BHEL 3. SUPPLIER H: HOLD POINT,"P"PERFORM,"W"WITNE SS AND "R"REVIEW, MA-MAJOR, CR-CRITICAL, MI-MINOR. TC-TEST CERTIFICATE.		
SEAL & SIGNATURE WITH DATE		**SEAL & SIGNATURE WITH DATE**	**SEAL & SIGNATURE WITH DATE**

Supplier's Name , address , logo etc	SUGGESTIVE QUALITY ASSURANCE PLAN for REACTOR HEADER CARBON STEEL FORGINGS								7 of 7				
	ITEM: REACTOR HEADER-CARBON STEEL FORGING SA 350 GR-LF2							QP No: SQP-RH-01 Rev 01 Project : Reactor Header Fleet Order.					
	QAPNO :To be filled by Supplier							P.O No: To be filled by Supplier					

SR.No	COMPONENT /OPERATION	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY				REMARKS
									P	W	R	H	
1	2	3	4	5	6	7	8	9	10				11
21	Low Stress Marking	Marking	**MA**	Verification	100%	TDCAT:8	TDCAT:8	TC	3	2	1	---	---
22	Final Documentation Review	Documentation	**MA**	Verification	100%	TDCAT:8	TDCAT:8	TC	3	---	---	2,1	---
23	Preservation and Packing	Surface Preservation & Packing Quality	**MA**	Verification	100%	TDCAT:8	TDCAT:8	TC	3	1,2	---	---	---
24	Shipping Release	Documentation	**MA**	Verification	100%	TDCAT:8	TDCAT:8	Shipping Release	3	---	---	1,2	---

Notes:

1) MPP (Manufacturing Process Plan) , HT(Heat Treatment Plan) , MSTP(Material Sampling and Testing Plan) , UTE procedure , MPE Procedure , DPE Procedure ,Format of Test Reports(including NDE reports) shall be submitted for approval (BHEL&NPCIL) by the successful bidder after PO Placement.
2) For Drop Weight Test, consumable used for Crack Starter bead shall be qualified as per ASTM E 208.
3) MSTP shall contain the details of Test coupons, sketches showing the location of Test coupons in the forging, Main Working Direction (MWD) , Size and Location of the Test coupons, Sketch of the specimens in the Test coupons, Size of the specimens (Tensile , Impact , Drop weight , etc). Applicable standards for tests. Separate MSTPs shall be made for separate type of Products.
4) Steel melting route shall be mentioned in MPP.

BHEL

-Prepared- -Reviewed & Approved-

13/01/2021

[NITHIN-O-R] [S. LAKSHMI/DGM/QA]

Supplier	LEGEND: - 1.NPCIL/TPI 2.BHEL 3. SUPPLIER H: HOLD POINT,"P"PERFORM,"W"WITNE SS AND "R"REVIEW, MA-MAJOR, CR-CRITICAL, MI-MINOR. TC-TEST CERTIFICATE.	BHEL	NPCIL
SEAL & SIGNATURE WITH DATE		SEAL & SIGNATURE WITH DATE	SEAL & SIGNATURE WITH DATE

Specification for Reactor Header Carbon Steel Forgings

(Fleet mode Order – CMM/FTP/00-33-1-1199/e-PO/43563)

Rev No	Date	Prepared	Reviewed			Approved
		QA	Engg	NDTL	MP	QA
00	24.12.2020	Nithin.O.R	Nithin.K. Krishnan	(Clause 9-NDE) Dilip Kumar Singh	Seikholien Haokip	S. Lakshmi
01	13.01.2021	Nithin.O.R	Nithin.K. Krishnan	(Clause 9-NDE) Dilip Kumar Singh	Seikholien Haokip	S. Lakshmi

Rev 00: First Issue
Rev 01: Clause 5.0 (Chromium Content) modified.

1.0 Scope

1.1 This specification establishes minimum requirements for Carbon steel forgings conforming to specification SA350 Grade LF2 Class-1 for Reactor Headers.

Reactor Header is designed, manufacture, tested & examined as a Class I Pressure Vessel in accordance with ASME B&PVC Code Section III Division-1 Sub-section NB. This component is to be manufactured, inspected, tested & delivered as per the requirements of this specification, applicable drawings, governing codes & standards. The position & location of nozzles are very critical and require strict control on the linear and angular dimensional tolerances during manufacturing. The header forging with integral nozzles shall be in single piece as shown in the relevant drawing.

2.0 Applicable Documents

In case of conflict between the codes/standards listed below and this specification, generally this specification will govern. The supplier must obtain necessary clarification from the purchaser in such a case.

2.1 ASME Sec IIA: Latest Edition.

2.2 ASME Sec III Division-1: Sub section NB- Class 1 Latest Edition.

2.3 ASME Sec V – Latest Edition.

2.4 ASME Sec IIA: SA20 & SA-370 – Latest Edition.

2.5 ASTM (Latest Edition): E208, E606, E10, E350, E112, E45, E381 & other relevant ASTM Standards.

2.6 Drawing Number (including size and Quantity): As per Enquiry/Purchase Order.

3.0 MATERIALS AND WORKMANSHIP

3.1 General

The Reactor Header forgings shall fully comply with the requirements of ASME Section III-NB for Class I Components as applicable to pressure vessels and also any additional requirements specified in this specification.

All materials, components, processes and workmanship required for fulfilment of this specification which are not specifically designated herein, shall be of high quality and shall comply with the best standards of manufacturing practice pertinent to pressure vessels I equipment for Nuclear Power Plants.

Seamless single piece header forgings, integral with all large nozzles (500 mm NB and 250 mm NB on outlet headers, 450 mm NB and 200 mm NB on inlet headers) & small nozzles (50 mm NB, 65 mm NB and 100 mm NB) and end caps shall be of SA 350 Grade LF 2 Class1 material. The material shall be fully killed, fine grained steel, produced by vacuum treatment followed by electro slag re-melting (ESR). The special requirements and final finished configurations for these headers and caps shall meet the requirements given in the applicable drawings also. The manufacturing process adopted shall ensure cleanliness of the highest order, isotropy of the mechanical, chemical and metallurgical properties, superior fracture toughness and weldability. Each Reactor Unit consists of 4 nos. Reactor Outlet Header (ROH) and 4 nos. Reactor Inlet Header (RIH).

Supply shall include (per reactor unit):-

i) 4 nos. Reactor Inlet Header forgings. Header forgings shall be in single piece, integral with all large (450 mm NB and 200 mm NB) and small (20 mm NB, 50 mm NB and 65 mm NB) nozzles.

ii) 4 nos. Reactor Outlet Header forgings. Header forgings shall be in single piece, integral with all large (500 mm NB and 250 mm NB) and small (20 mm NB and 100 mm NB) nozzles.

iii) 2:1 ellipsoidal end caps - 8 nos. for RIH and 8 nos. for ROH.

iv) Forged Pipe for Procedure Qualifications: 1 No. each (per Project of 2 Reactor Units) sample of RIH and ROH forgings of 795mm length with small size nozzles for welding procedure qualification etc. during further fabrication of Header assembly at BHEL.

v) Sample Forgings (Mock up piece of Header Forging): 2 Nos. each (per Project of 2 Reactor Units) sample of RIH and ROH forgings of 1200mm length with large size and small size nozzles for sectioning and verifying the nozzle profiles before start of actual production.

vi) Reference blocks for ultrasonic examination as per clause No:9

Before machining the nozzles on the actual job, suppler shall produce mock up piece of Header forging along with large size and small size nozzles to verify the nozzle profile and other details and to establish the feasibility of machining these nozzles as per the drawing requirements including ID side comer radius machining. These mock up pieces are to be sectioned at the nozzle center plane in both longitudinal & circumferential planes for inspection by "BHEL" & "NPCIL/TPI". The sectioned pieces and balance material are to be supplied with the main forgings.

All the test/mock up samples mentioned above shall be produced by the same material and process as that of the header forging & shall undergo same NDEs.

3.2 Header Forgings

Reactor Inlet Header forging shall be 457 mm outside diameter x 65 mm minimum wall thickness with all integral nozzles (large &small) and other integral projections.

Reactor Outlet Header forging shall be 508 mm outside diameter x 65 mm minimum wall thickness with all integral nozzles (large &small) and other integral projections.

Around the large integral nozzle openings, the wall thickness is further increased to meet the reinforcement requirements. These large nozzle opening reinforcement and transition shape details as given in the respective drawings are to be strictly adhered.

All header forging ends and nozzle ends shall be weld edge prepared as per applicable drawing. Weld edge preparation at terminal point shall be subject to approval by NPCIL.

3.3 Header End Caps

Forged header end caps shall be of size and dimensions matching with the header ends and the wall thickness at these butt weld ends shall also be not less than 65 mm. The

end caps shall be ellipsoidal (2:1) dished heads with 65 mm min. thickness and 84 mm min. skirt length. All header end caps shall be weld edge prepared as per applicable drawing.

4.0 PROCESS OF MANUFACTURE

4.1 Melting

The steel shall be produced in basic electric arc furnace; vacuum degassed to remove objectionable gases, fully killed and produced to fine grain practice. Vacuum system should be of sufficient capacity to effect a blank-off pressure which is adequately low for sufficiently long duration. The steel shall be subjected to secondary refining by Electro Slag Re-melting (ESR) process.

4.2 Discard

A sufficient discard shall be made to secure freedom from injurious defects and undue 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 all 3 directions. The micrographs for assessing the microstructure shall be made at a magnification allowing unambiguous assessment (as a rule: X 200).

4.4 Forging Process

Each header shall be supplied in a single piece forging with integral nozzles as shown in the applicable drawings. Headers are to be manufactured by hot forging process to work the metal throughout its section. The forging ratios shall not be less than 4. The initial forged piece of header shall be suitably configured to have sufficient material for integral nozzles and test coupons. Material flow shall be such as to favourably resist the stresses encountered in service (Main Working Direction).

4.5 Machining

The initial forged piece may have to undergo suitable stages of machining till the final shape & dimensions are achieved. The supplier shall submit the various stages of manufacture in detail for review & approval by BHEL & NPCIL. The sequence shall include initial forging shape, various machining stages, heat treatment stage, initial, intermediate and final NDE stages, test coupon location details & its removal stage etc.

4.5.1 Header Nozzles - General

The nozzles in the header shall be formed by machining the projected portion/thick wall of the forged shell. The end dimensions of thus formed nozzles shall match the dimensions of connecting pipes/nozzle extensions. The supplier shall qualify his manufacturing procedures to the satisfaction of the purchaser, by production of two samples of each small size nozzle and one sample of large size nozzle. These nozzles shall be made from the same materials and by the same techniques as for the production job. This qualification shall be done separately for RIH and ROH.

4.5.2 500 and 250 mm NB Nozzles in Outlet Header Forging

The 500 and 250 mm NB nozzles in outlet header forging shall be manufactured by machining the protrusion & thick wall of forged shell. At the neck of the nozzles, contour shall be provided as per relevant drawings. The nozzles shall meet the requirements of ASME Sec.III NB.

4.5.3 450 and 200 mm NB Nozzles in Inlet Header Shell

The 450 and 200 1ru11 NB nozzles in inlet header forging shall be manufactured by machining the protrusion & thick wall of forged shell. At the neck of the nozzles, contour shall be provided as per relevant drawings. The nozzles shall meet the requirements of ASME Sec.III NB.

4.5.4 Feeder Nozzles in Header Shell

The 100 mm NB, 65 mm NB and 50 mm NB feeder nozzles in header shell shall be manufactured by machining and boring the thicker wall of forged shell. The dimensions and other details shall be in accordance with the applicable drawings.

4.5.5 Instrumentation Nozzles in Header Shell

The 20 mm NB nozzles for instrumentation connection in the header shell shall be provided by machining the forged shell and by boring in accordance with the applicable drawings.

5.0 CHEMICAL COMPOSITION

In addition to meeting the requirements of SA-350 Gr. LF2 Class I, the material shall also meet supplementary requirements on Chemical composition which are as follows: -

Element	Weight Percentage	Element	Weight Percentage
C	0.30(max.)	Al	0.040(max.)
Mn	0.60-1.35	Sn	0.011 (max.)
Si	0.15-0.30	As	0.025(max.)
Mo	0.12(max.)	Sb	0.007(max.)
Ni	0.40(max.)	P	0.025(max.)
Cr	0.20-0.28	S	0.025(max.)
Cu	0.30(max.)	N	0.013(max.)
V	0.010(max.)	Nb	0.02(max.)
Co	0.020(max.)	---	---

6.0 HEAT TREATMENT

6.1 The forgings shall be supplied in normalized condition.

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

The supplier shall provide the heat treatment details such as stage at which the heat treatment is carried out, rate of heating & cooling, holding temperature & time and cooling scheme, heat treatment furnace details, temperature control during heating & cooling cycle etc. for approval by BHEL & NPCIL.

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. Coupons subjected to such heat treatment are called Simulated Heat Treated Coupons (STC). Test coupons identified as simulated heat treated coupons shall be heated to 610°C ± 10°C, held at that temperature for 5 hours and then cooled to room temperature. The rate of heating and cooling shall not exceed 30°C. However, if the supplier envisages any intermediate heat treatment for the purpose of straightening operation etc. such heat treatment shall also to be added to the SHT coupons.

7.0 MECHANICAL PROPERTIES

7.1 Tensile Test

The mechanical tests shall be conducted as per ASME Section II-A SA-20 and SA-370. Following minimum requirements shall be met in both Normalized and simulated heat treated condition.

Required mechanical properties at room temperature

	At Room Temperature
Tensile Strength (MPa)	485- 655
Yield Strength [0.2% offset] (MPa)	250 (Min.)
% Elongation	22 (Min.)
% Reduction in area	30 (Min.)

7.2 Notch Toughness

7.2.1 Fracture Toughness requirement

Fracture toughness of the header material shall be determined as per the requirements of Class I vessels in line with NB-2300 of ASME Section III NB.

The nil-ductility transition temperature (T_{NDT}) as determined by drop weight test in accordance with ASTM-E-208 shall not be higher than – 15 °C (Minus 15°C).

7.2.2 Reference Nil Ductility Transition Temperature (RT_{NDT})

Three ISO-V specimens shall be tested at T_{NDT} + 33°C for certification of RT_{NDT}. The minimum absorbed energy and lateral expansion shall not be less than 68 J and 0.89 mm respectively, for any of the specimens. The percent shear fracture shall be reported. The RT_{NDT} thus determined shall not be higher than -15°C (Minus 15°C).

7.2.3 ISO-V test specimens shall exhibit the following minimum values at -46°C.

i) Average of 3 Specimens: 20 J (Min.)
ii) Lowest single value: 16 J (permitted for one specimen only per a set of3)

7.2.4 Cv-Impact Curve

Charpy V-notch impact strength versus temperature curves shall be established. Tests shall be conducted at least at seven different temperatures including -46°C, -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 T_{NDT} + 33°C and -46°C shall meet the requirements of 7.2.2 and 7.2.3.

7.3 Fatigue Test

One set of Fatigue test in accordance with ASTM E606 is required to be performed per order for establishing a factor of safety of 2 on Sa (strain amplitude) and 20 on N (cycles) with respect to ASME design fatigue curve.

7.4 Hardness Test

Hardness of each forging shall be measured after normalizing heat treatment before any further processing, along the grid at 120° apart. A minimum of 3 readings are to be taken on the edges followed by at every 1000mm distance on the surface of the header forgings and dished ends to demonstrate uniformity. Tests shall be carried out as per ASTM-E-10 and shall meet the requirement of ASME Section II-A SA-350.

7.5 Bend Test

Bend test shall be performed as per ASME Section II-A SA-20. The specimen shall be cold bent through 180° on a mandrel of 25.4 mm diameter. There shall not be any crack on the outer fiber of the specimen after bending as above.

8.0 TESTS & EXAMINATIONS

8.1 Test Coupons

Raw material Test coupon (RTC) and Simulated Heat Treated Test Coupons (STC) shall be used for Carrying out various tests as per the specification requirements.

8.2 Test Coupon Location

It is essential to demonstrate the homogeneity of material properties across the entire forging in all the 3 directions. Sufficient numbers of test specimens are to be taken from each test location to carry out all the tests indicated in table shown in clause no:8.6. Each end of the Header forging represents either top or bottom end of the ingot. Sufficient material in the form of integrally forged prolongations shall be provided for the purpose of test coupons at each end. Apart from this, test coupons are to be taken from the middle of the forging. Additionally, specimens shall also to be taken from the core of the large and small nozzles and from the adjacent material. Similarly, test coupons shall also be taken from the dished end forgings.

Coupons shall be taken from the adjacent areas at suitable locations of the cross section in the following manner:

i) Test coupons shall be parted off from the forging prolongations after the final quality heat treatment (normalizing).

ii) Identification of the coupons shall be ensured by suitable methods prior to their separation from the forging and all through the various stages of testing. Sufficient numbers of coupons are to be taken from each end and at other locations as required to accommodate all the test specimens.

iii) 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 and surplus material shall be dispatched along with the header forgings.

Supplier shall provide the test ring/ coupon layout and test specimen layout in each test coupons that are to be tested in the supplier's works for the approval of BHEL & NPCIL.

8.3 Test Specimen Location

The test specimens shall be taken in such a way that the test specimens shall have their longitudinal axis at least 1/4 T from any surface and with the mid length of the specimens at least 1/2 T 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) Axial: Parallel to the main working direction
ii) Tangential: Transverse to the main working direction
iii) Radial: Parallel to the direction of thickness

8.5 Chemical Analysis

Chemical analysis shall be carried out in accordance with ASTM-E 350 or ASTM E415. 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 heat treated 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.

8.6 Mechanical Tests

Mechanical tests shall be conducted on normalized & simulated test coupons as per ASME Section II-A SA-20 and SA-370. The material properties are to be established in all the 3 directions as indicated in clause 8.4 above. Sufficient number of test specimens is to be taken from each test location to carry out all the tests indicated below. The supplier shall submit a detailed proposal of various test specimen layout in various test coupons locations to establish the homogeneity of the material properties across the entire forging for the review and acceptance of BHEL & NPCIL.

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

NDT temperature (T_{NDT}) shall be determined using STC Pellini (P2) specimens. The T_{NDT} temperature so determined shall also be confirmed by tests on two additional specimens taken from other locations.

Following tests shall be conducted.

Sl No	Name of Test
1	Product Analysis
2	Micro Structure Evaluation
3	Tensile Test
4	Hardness Test (≤ 197 HB)
5	Impact Test at -46° , +18°C
6	FATT(Fracture Appearance Test Temperature) at 7 different temperatures.
7	Determination of T_{NDT} by Drop Weight Test.
8	T_{NDT} verification on samples from other test locations : No break at -10°C (Minus 10°C).
9	Determination of T_{NDT} by ISO V notch impact test at T_{NDT}+33 °C
10	Fatigue Test
11	Bend Test
12	Grain Size(6 or finer)
13	Inclusion rating Evaluation

Inclusion rating shall be carried out as per ASTM E-45. Total inclusion rating (A+B+C+D) shall be ≤ 4. Thick series inclusions of stringer type are not acceptable.

8.7 Macro etch Test

Macro etch examination shall be carried out at each end of the forging covering 450 mm^2 area for full thickness at four locations 90° apart as per ASTM E-381. Macro etch photographs are to be included in the final documentation.

8.8 Micrographic Examination

Microstructure examination shall be carried out at each end & at the mid-section of each forging in longitudinal and transverse direction. The examination may be carried out on the broken impact test specimens of simulated heat treated test coupons. Test shall be carried out as per ASTM E-112. Photographs are to be included in the final documentation.

8.9 Inspection of Sample Nozzles

The following paragraph is applicable for RIH and ROD Separately:

Subsequent to the specified non-destructive examinations, out of 3 samples (1 sample for qualification purpose during fabrication at BHEL & 2 samples for mock-ups), nozzle sectioning shall be carried out in two samples which are identified for Mock-ups. Sectioning of large as well as small nozzles in two planes through the nozzle centre-line (through and at right angles to the header centre-line) shall be done to verify nozzle profile before start

of actual production. The sections shall conform to the requirements of applicable drawings. Supplier shall prepare the sectioning plan and submit for approval from BHEL& NPCIL. One sectioned surface from each quadrant shall be polished, etched and inspected. The material shall be free from cracks, tears, injurious inclusions, laminations and other defects. The third sample is allocated for preparation of the nozzle weld qualification etc. at BHEL. The sectioned nozzles and balance materials shall be supplied along with header forgings.

9.0 NON DESCTRUCTIVE EXAMINATION

Non-destructive examination shall be performed with a detailed written and qualified (for all essential variables of ASME Section-V & Section III NB) procedure, which shall, as a minimum contain the requirements of this specification & ASME Section-V, item specific scan plan/technique sheets/instruction sheets, demonstration & demonstration records (for all essential variables), reporting format, equipment calibration & calibration records, personnel qualification/certification details, consumable details & certificate, extent of coverage, drawing & dimensional records of the reference/calibration blocks/specimens/standards, retention & control of standard specimen/blocks.

The examination shall be carried out as per the approved documents as mentioned above. Supplier shall prepare the above component specific documents and obtain the purchaser's (BHEL & NPCIL) approval prior to the commencement of manufacturing. Procedure & scan plan/technique sheet/instruction sheets shall be demonstrated to the satisfaction of the Inspector (BHEL & NPCIL/TPI) as per T-150 Article-1 of the ASME Code Section V.

9.1 Ultrasonic Examination

The header forgings, ellipsoidal end caps and sample forgings shall undergo ultrasonic examination to cover 100% of the metal volume. Ultrasonic examination shall be performed in accordance with the requirements of NB-2500 of section III of ASME Code using procedures and standards such as to ensure consistent detection and discrimination of transverse and longitudinal defects. Since meaningful UT examination may not be possible after final machining due to the geometry of finished headers, this examination has to be carried out during intermediate stages to cover the entire metal volume. While examining at any of the intermediate stages the defect/calibration standards pertaining to final machined nominal wall thickness of the component section/location shall be followed. UT examinations at following stages are suggested:

I. After initial machining and heat treatment.
II. Suitable intermediate stage(s).
III. After machining of nozzles in cylindrical shape.

The above components are to be considered as pressure boundary components of a class-I pressure vessel. Accordingly, ultrasonic testing shall be carried out as per the requirements of ASME Section V Article 5 and NB-2500 of ASME Section III NB (Class -1 component). UT examination shall be carried out by both straight beam and angle beam methods to cover 100% of the metal volume. The angle beam examination shall be carried out in 2 mutually opposite circumferential & 2 mutually opposite axial directions. Straight beam examination of forgings must be performed from both thickness faces, end faces and from the cylindrical surface. The reference standards shall be made from material of same composition, diameter, thickness and surface condition and heat treatment conditions as of

the material which is to be examined. A detailed drawing shall be submitted for all applicable reference/calibration blocks/specimens/standards.

Examination shall be done with specific item wise scan plan in combination with the written procedure. Scan Plan/Technique Sheets/Instruction sheets is a documented examination strategy that provides a standardized and repeatable methodology for examinations. The scan plan shall display cross-sectional geometry of the component, component drawing &, dimension during scanning, thickness, surface condition, range of variables, extent of coverage, search unit size(s), type, make, model, angle, near field zone, focal depth (for dual element probe), crystal dimensions and frequency(ies), beam plots of all angles used, test metal distance/beam path, probe technical data sheet with distance amplitude curve), limiting angle for circumferential scan, search unit(s) position in relation to the well-defined reference line/point, schematic calibration positions on the blocks and reference reflectors, search unit mechanical fixturing device (if any), zonal/coverage overlap, acceptance, standard specimen/block details (drawing and dimensional report) etc. A tabulation of all the various stage dimensions (OD, ID, thickness, taper angle etc.) along with ultrasound beam path, calibration etc. shall be also annexed.

9.1.1 Search units (Probe):

on a curved component having a diameter less than 350 mm (at the examination surface location) scanning shall be performed using a contoured wedge, to ensure sufficient ultrasonic coupling is achieved and to limit any potential rocking of the search unit as it is moved along the circumference of the component.

(a) Search units shall be contoured as required by the following equation:

$$D \leq \left[\frac{(A \times A)}{(2.87\ \text{mm})} \right]$$

where A = length of search unit footprint during circumferential scanning or the width when scanning in the axial direction, in mm
D = the component diameter at inspection surface (O.D.), in mm

The footprint is defined as the physical dimension of the search unit in the curved direction of the component. The search unit contoured dimension shall be selected from the table-1, and shall be determined using the same component dimension from which the examination is being performed (O.D.):

Table- 1

Actual Component Outside Diameter, in. (mm)	Allowable Increase in Contour Diameter Over Component O.D., in. (mm)
<4.0 (<100)	<1 (<25)
≥4.0 to 10 (≥100 to 250)	<2 (<50)
>10 (>250)	<4 (<100)

Dual-element transducers shall be used to inspect those regions of a forging where the presence of a bore, taper or other feature prevents scanning the near field region, of the single element transducers used, from the opposite surface. Dual-element transducers shall

be used to inspect areas near the back-wall of forgings where indications caused by noise exceed the reporting requirements.

Over and above the approved documents, other frequencies, search units, method may be used if desirable for evaluating, pinpointing & concluding the doubtful indications (if any observed during inspection).

Complete proposed UT system (procedure, Method, Technique, Search units, Instrument, scan plan etc.) shall be capable of detecting and sizing the applicable reference reflectors & indication throughout the 100% volume of the final forging dimensions with the minimum SNR 3:1. When, at reference level amplification setting, the signal to noise ratio is lesser than 3:1 the forgings shall be examined with the suitable different search units and same shall be mentioned in the procedure/scan plan.

9.1.2 General & Equipment Calibration

Screen Height Linearity and Amplitude Control Linearity shall be met at intervals not to exceed one year, or prior to first use thereafter. The ultrasonic instrument screen high linearity shall be evaluated in accordance with Mandatory Appendix I of ASME BPVC sect. V Article. 4. The ultrasonic instrument amplitude control linearity shall be evaluated in accordance with Mandatory Appendix II of ASME BPVC sect. V Article. 4. Other calibration requirements are as per section V.

Calibrations shall include the complete ultrasonic system and shall be performed prior to use of the system in the thickness range under examination. Any control, which affects instrument linearity (e.g. filters, reject or clipping) shall be at the same position for calibration, calibration checks, instrument linearity checks, and examination. The temperature differential between the calibration block (when used) and examination surfaces shall be within 14 °C.

Calibrations shall be performed from the surface corresponding to the surface of the component from which the examination will be performed, the same couplant to be used during the examination shall be used for calibration. The couplant including additives, shall not be detrimental to the material being examined and shall meet the requirements of Clause 10.0 of this TDC.

The pulse repetition rate shall be small enough to assure that a signal from a reflector located at the maximum distance in the examination volume will arrive back at the search unit before the next pulse is placed on the transducer.

9.1.3 Reference level (Sensitivity Calibration) & calibration/reference block:

a) For straight beam, reference level shall be Ø2 mm FBH (flat bottom hole) for T ≤ 100 mm, Ø3 mm FBH (flat bottom hole) for 100mm≤T ≤ 200mm, Ø4 mm FBH (flat bottom hole) for T ≥200mm. However, for integral nozzles region or nozzles, reference level shall be Ø 0.5 mm CRR (circular reference reflector)/FBH. FBH location shall be at T/4, T/2 and 3T/4 (wherever is possible).
b) For angle beam scanning: Notch: 3 mm wide x 12 mm long x Depth 2 % of T or 1 mm, whichever is greater. Also, additional scanning in the circumferential directions (two mutually opposite) with 35^0 angle probes shall be carried out with 1.2 mm CRR and

notch (U-type notch) dimensions of 1.6 mm max. width and 2.5 mm depth, whichever is stringent (to be proven based on physical block).

c) In addition to the above mentioned (a, b) general requirements, the respective locations of the forgings where the integral nozzles/end caps/protrusion will be envisaged, the additional requirements of UT as mentioned in Table-1 shall be also met with.

d) For circumferential scanning, the standard defects/reflectors shall be axial notches on the outside and inside surfaces of the reference specimen/block. For axial scanning in accordance, a transverse (circumferential) notch shall be introduced on the inner and outer surfaces of the reference specimen/block. Dimensions of the transverse notch shall not exceed those of the longitudinal notch. Location of the reflector shall not be closer than T from block edge.

e) Where **"T"** is final machined nominal wall thickness of the component section/location. In case of multi thickness value, lower value will be considered for the selection of notch depth or FBH, otherwise multiple reference block/specimen shall be made to suite the specific location thickness range of the entire component.

f) The test surface finish on the calibration block shall be comparable but no better than the item to be examined. Item surface finish/condition shall be as per approved drawing.

Table-1 (Additional-Scan)

Locations on the component (as applicable as per the drawing)	**Nominal Thickness mm**	**Scanning probe angles**	**Scanning Directions**	**Calibration Standard - Reflectors**						
				Angle Beam						
				Axial & Circumferential SDH (essentially parallel to the examination surface).	**Axial ID & OD notch**			**Circumferential ID & OD notch**		
					Length #	**Width #**	**Depth #**	**Length #**	**Width #**	**Depth #**
Outlet/Inlet Header Dished end caps and end side of the header	65	45^0 & 60^0	Extent Possible 2 mutually opposite circumferential & 2 mutually opposite axial directions	Ø4.8mm Length 38 mm	12	3	1.3	12	3	1.3
500, 450, 250, 200 NB Integral Nozzles	-	45^0 & 60^0		-	Refer (b) of 9.1.1					
100NB Integral Nozzles	13.5	45^0 & 70^0		-	12	3	0.67	12	3	0.67
65NB Integral Nozzles	10	45^0 & 70^0		-	12	3	0.5	12	3	0.5
50NB Integral Nozzles	9	45^0 & 70^0		-	12	3	0.45	12	3	0.45
20NB Integral Nozzles	5	45^0 & 70^0		-	12	3	0.25	12	3	0.25

g) Tolerance and other general details for reference reflectors/block/specimen- shall be based on ASTM E428 & ASME Section V for FBH, and for SDHs ASME Section V & Notches - ASTM specification SE-213. Prior to fabrication, the block material shall be completely examined with a straight beam search unit. Areas that contain an indication exceeding the remaining back-wall reflection shall be excluded from the beam paths required to reach the various calibration reflectors. The same shall be recorded. The standard defects shall be machined by very precise machining process in such a way that the indications of each of them are separate and distinct without any mutual acoustic interface or amplification. The calibration block shall be long enough to simulate the handling of the product being examined through the examination equipment. All upset metal, burrs, etc., adjacent to the reference notches shall be removed. Calibration Standard/Block shall be able to produce minimum SNR value 3:1 in records for all the reflectors with the actual test speed condition. Also, signal from each reflectors have to be clearly distinguishable. Measurements may be made by optical, replicating, or CMM techniques. The all actual dimension of the calibration standard/Block including reflectors shape & size details shall be checked and shall be reported. These dimensions shall be also witnessed & certified (once) by the Inspector (BHEL/NPCIL).

h) No point on the DAC curve shall be less than 20% of full screen height (FSH). When any portion of the curve will fall below 20% FSH, a split curve shall be used. The first calibration reflector on the second curve shall start at 80% ± 5% FSH, when reflector signal-to-noise ratio precludes effective indication evaluation and characterization, a split DAC should not be used (Refer Article 4, No mandatory Appendix Q ASME Section V for example).

i) All physical reference/standard blocks used in UT examination shall be dispatched along with the component. Apart from above, additional sets as per the Enquiry/P.O shall also be despatched to BHEL (One Set consisting of 6 nos. reference block in each set as per attached drawing no.3_RH1A,1B, 2-5).

9.1.4 Scanning level

The scanning sensitivity level shall be set in a such a way that the detection and evaluation of all indications exceeding 20% of reference sensitivity calibration curve, the gain should be increased an additional amount so that no calibration reflector indication is less than 40% FSH. As an alternate, the scanning sensitivity level may be set at 14 dB higher than the reference level gain setting (This additional gain makes the reference sensitivity calibration curve a 20% sensitivity calibration curve so that indications exceeding 20% sensitivity calibration curve may be easily identified and evaluated). However, evaluation will be done as per required sensitivity level only.

9.1.5 Recording & Evaluation Level

Any indications exceeding 20 % of reference sensitivity level shall be recorded. All ultrasonic indications shall be investigated to determine the indications/defect characteristics such as size, shape, type/nature, location and orientation.

9.1.6 Calibration Confirmation & interim calibration

Calibration confirmation & interim calibration check shall be performed at start and end of 8 hours shift, and when examination personnel, variables are changed and shall meet the requirements of T-467 of ASME Section V.

9.1.7 Acceptance Criteria

a) Products shall not be accepted if indications of echoes are higher than (>) DAC (or reference sensitivity level) for UT examination in straight or angle beam.

b) A forging shall be unacceptable if the results of straight beam examinations show one or more reflectors which produce indications accompanied by a complete loss of back reflection not associated with or attributable to geometric configurations. Complete loss of back reflection is assumed when the back reflection falls below 5% of full calibration screen height.

c) A forging shall be unacceptable if the results of the straight beam radial examination show one or more reflectors producing a continuous complete loss of back reflection accompanied by continuous indications on the same plane that cannot be encompassed with a circle whose diameter is 3 in. (75 mm) or one-half of the wall thickness, whichever is greater.

d) In addition, two or more reflectors smaller than described in (c) above shall be unacceptable unless separated by a minimum distance equal to the greatest diameter of the larger reflector or unless they may be collectively encompassed by the circle described in (c) above.

9.1.8 Documentation & Reports

The results obtained during the ultrasonic examination carried out by supplier form the base line/ reference data for future in inspections to be conducted by the purchaser. Hence, characteristics of all recordable indications within acceptance limits as well as descriptions of ultrasonic procedure, scan plan and equipment etc. shall be documented in detail such that any of those recordable defect indications could be identified and reproduced at a later date and during service life of header assemblies, any changes in characteristics of these defect indications could be monitored and compared with respect to the base line/reference data. The documentation shall include sketches or maps showing the recordable indications sites with respect to well defined reference points on Header forgings/component. Retention & control of standard specimen/blocks shall be mentioned in the procedure.

All documents mentioned under 9.0 shall be properly indexed with proper identification and shall form part of history docket/final documentation also.

A detailed report of the examinations shall be made. The report shall include above records and records indicated in T-590 of Article 5 ASME Section V. A sample report format in line with the above requirement shall be attached with the procedure.

9.2 Magnetic Particle Examination

Each header 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. Residual magnetism shall be checked, measured and reported for all the examination. Magnetic testing materials used, shall comply with clause 10 of this TDC. Supplier shall submit detailed Magnetic Particle examination procedure and item wise technique/instruction sheets, for review & approval by BHEL & NPCIL.

At least two separate examinations shall be performed on each area, during the second examination, the lines of magnetic flux shall be approximately perpendicular to those used during the first examination. Magnetic particle examination technique shall ensure the detection sensitivity in the sub-surface zone of material which are not examined due to technical limitation in UT (if any).

A technique sketch shall be prepared for each different geometry examined, showing the part geometry, cable arrangement and connections, magnetizing current for each circuit, pole spacing, contact position/grid points, lighting requirement, consumable details and the areas of examination where adequate field strengths are obtained. Parts with repetitive geometries, but different dimensions, may be examined using a single sketch provided that the magnetic field strength is adequate when demonstrated in accordance with T-756.2 ASME Section V.

A detailed report of the examinations shall be made. The report shall include above records and records indicated in T-790 of Article 7 ASME Section V. The documentation shall include sketches or maps showing the recordable indications sites with respect to well

defined reference points on Header forgings/component. A sample report format in line with the above requirement shall be attached with the procedure.

9.2.1 Acceptance standards (Sec. III NB 2545.3)

An indication of a discontinuity may be larger than the discontinuity that causes it; however, the size of the indication and not the size of the discontinuity is the basis of acceptance or rejection.

Any indication in excess of the Acceptance standard below, which is believed to be non-relevant, shall be re-examined other non-destructive examination methods to verify whether or not actual defects are present.

Surface conditioning may precede the re-examination, non-relevant indications which would mask defects are unacceptable.

Only imperfections producing indications with major dimensions greater than 1,5 mm shall be considered relevant imperfections.
Imperfections producing the following relevant indications are unacceptable:

(a) any linear indications greater than 1,5 mm long for material less than 16 mm thick, greater than 3 mm long for material from 16 mm thick to under 50 mm thick, and 5 mm long for material 50 mm thick and greater;

(b) rounded indications with dimensions greater than 3 mm for thicknesses less than 16 mm and greater than 5 mm for thicknesses 16 mm and greater;

(c) four or more relevant rounded indications in a line separated by 1,5 mm or less edge to edge;

(d) ten or more indications in any 4000 mm2 of area whose the major dimension is no more than 150 mm with the dimensions taken in the most unfavourable location relative to the indications being evaluated.

9.3 Dye Penetrant Examination

Dye penetrant examination on all edge preparation and non-accessible (in MT) regions of small size nozzles in accordance with ASME Section III, Para NB-2546. Supplier shall submit detailed Dye Penetrant examination procedure for review & approval by BHEL & NPCIL. Whenever MT is possible, MT shall be preferred over dye penetrant examination, supplier shall indicate such area in the scan plan of MT wherever PT is applicable.

Penetrant testing materials used, shall comply with clause 10 of this TDC.

A detailed report of the examinations shall be made. The report shall include above records and records indicated in T-690 of Article 6 ASME Section V. The documentation shall include sketches or maps showing the recordable indications sites with respect to well defined reference points on Header forgings/component. A sample report format in line with the above requirement shall be attached with the procedure.

10.0 CLEANING

Cleaning and surface treatment procedure shall be submitted for approval from BHEL & NPCIL. All chemicals and fluids such as cleaning agents, penetrants, developers, water and paints used for marking shall be free of halogen & sulfur. However, in no case more than 25 ppm of halogen & sulfur shall be permitted. Examination materials, chemicals, fluids or any other materials used for examination, inspection and tests shall be removed from the product to achieve clean dry surface.

11.0 AXES MARKING ON HEADER FORGINGS: Axes on the header shall be marked as follows.

Axis Punch marking required on the following axis of the reactor header.

1. 0° Axis
2. 90° Axis
3. 180° Axis
4. 270° Axis
5. 135° Axis
6. 225° Axis

On each of the above axis,

- 2 punches (25mm apart) shall be marked at approximately 100mm from the free end of forging on either side.
- 2 punches (25mm apart) shall be marked at approximately 100mm from the centre reference line of the forging.

Axis marking on the Header Reference line (Centre rib)

1. 2 punches (100mm apart) shall be marked on the Reference line towards 270° axis and 90° axis on perpendicular plane.
2. Single punch mark shall be marked on the Reference line at 45°, 135°, 225°, 315° axis plane.

All the punches shall be identified by Circle or O-punch (low stress punching).

12.0 DIMENSIONAL CHECK

Each header 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.

13.0 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 BHEL & NPCIL. Repairs involving welding are prohibited.

All non-conformities shall be recorded and reported to BHEL & NPCIL to determine their disposal.

14.0 PROCEDURES, PLANS, REPORTS AND DOCUMENTATION

The manufacturer shall prepare and submit the following documents for approval from BHEL & NPCIL prior to the commencement of manufacture.

i) Manufacturing Drawings.
ii) Quality assurance plan (QAP).
iii) Manufacturing Process Plan (MPP).
iv) Material Sampling and Testing Plan (MSTP).
v) Heat Treatment Plan.
vi) Non Destructive Examination Procedures, report format and Technique sheets/Instruction Sheets/Scan plan etc. as mentioned in clause no. 9.0.
vii) Cleaning and surface treatment procedure.
viii) Preservation and Packing Plan.
ix) Report Formats.
x) Procedure for axes marking and Inspection.

The manufacturer shall be responsible for preparation and issue of all certificates, reports and documents which shall be certified by "BHEL" & "NPCIL/TPI". Such certified final documents shall form part of history dockets and shall be supplied in bound volumes (3 copies) with proper identification. Final documentation shall also be submitted in soft form (pdf format) with proper indexing.

15.0 QUALITY SURVEILLANCE

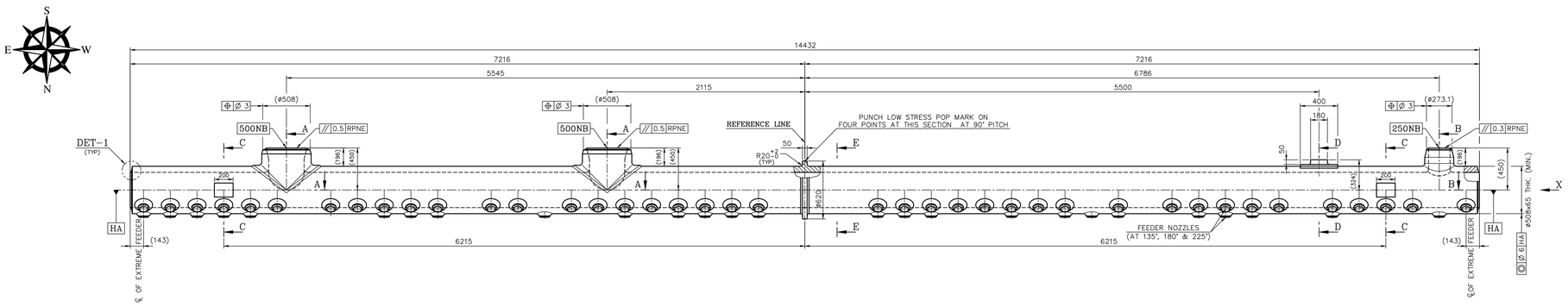
The header forgings shall be subjected to quality surveillance by "BHEL" & "NPCIL/TPI" during manufacture. The forgings shall not be shipped until the shipping release is given by BHEL & NPCIL.

16.0 MARKING, PACKING AND SHIPMEN

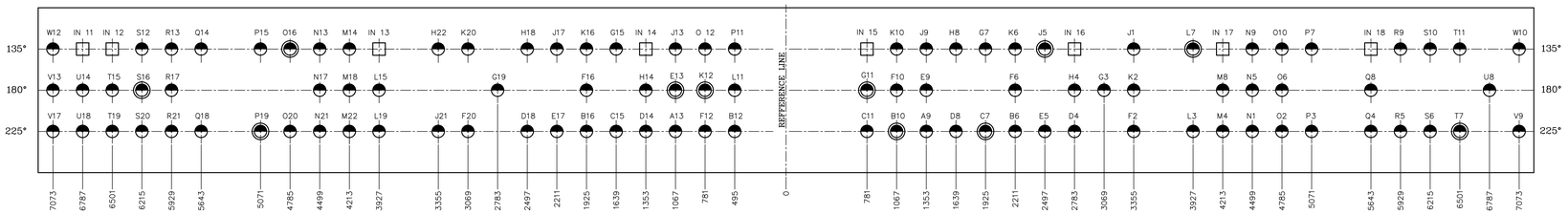
Each header forging shall be marked with Product Serial Number, Heat number, Material Specification and main working direction.

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 approval by BHEL & NPCIL. Before shipment, suitable rust preventive coating shall be applied on the forgings to ensure sea-worthiness and tropical storage at least for two years.

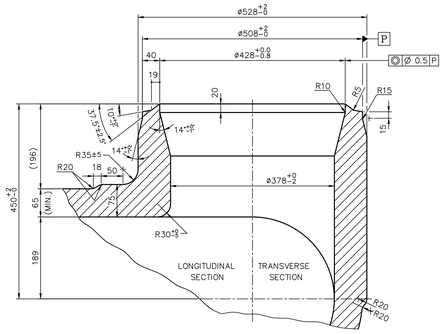
DRAWING NO: 0-93-422-05305



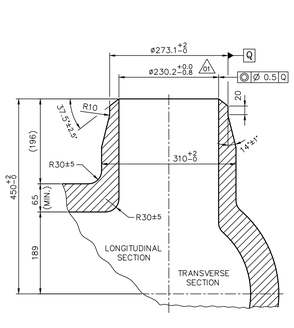
REACTOR OUTLET HEADER (ROH) – H1



FEEDER PIPE NOZZLE DEVELOPED PLAN FOR (ROH) – H1



SECTION–AA
(500 NB)
(1:5)



SECTION–BB
(250 NB)
(1:5)

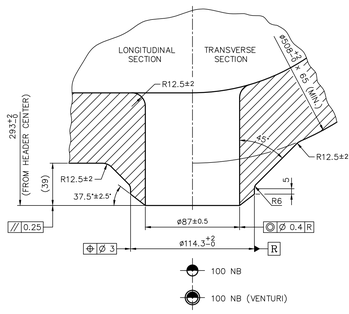
SECTION–CC
(VIEW WITHOUT LARGE SIZE NOZZLE DETAILS)
(1:10)

SECTION–DD
(VIEW WITHOUT LARGE SIZE NOZZLE DETAILS)
(1:10)

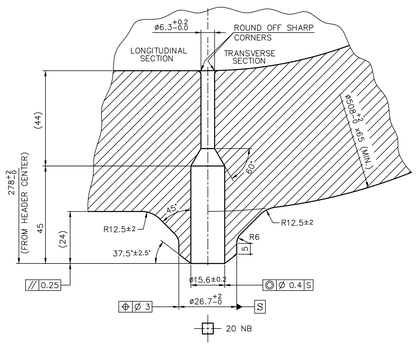
SECTION–EE
(VIEW WITHOUT NOZZLE AND FEEDERS DETAILS)
(1:10)

NOZZLE LEGEND & QUANTITY DETAILS

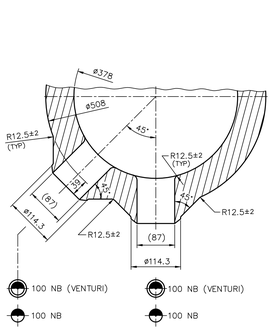
SYMBOL	NOZZLE DESCRIPTION	QUANTITY
	FEEDER PIPE NOZZLE 100NB	87
	FEEDER PIPE NOZZLE 100NB (VENTURI)	11
	INSTRUMENTATION NOZZLE 20NB	8
250 NB	SHUT DOWN COOLING INLET	1
500 NB	STEAM GENERATOR INLET	2



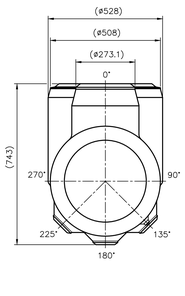
100 NB NOZZLE DETAILS
(1:2)



20 NB NOZZLE DETAILS
(1:1)



MERGING DETAILS
(MAJOR NOZZLES)
(1:5)



VIEW–X
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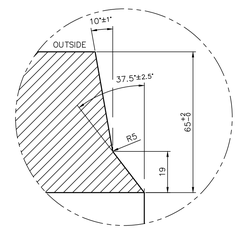


DETAIL–1
(1:1)

ALL DIMENSIONS ARE IN MILLIMETERS

NOTE

01. MATERIAL SPECIFICATION FOR THE HEADER FORGING IS SA350 GR. LF2 CLASS–1 WITH SUPPLEMENTARY REQUIREMENTS ON CHEMICAL COMPOSITION AS GIVEN IN THE APPROVED TDC
02. FORGED HEADER MATERIAL, MANUFACTURING, TESTING, EXAMINATIONS AND PACKING SHALL BE IN ACCORDANCE WITH ASME SEC.III NB CL.1 AND AS PER APPROVED TDC
03. THE HEADER WITH INTEGRAL NOZZLES SHOWN IN THE DRAWING SHALL BE MANUFACTURED BY FORGING AND MACHINING OR COMBINATION OF SIMILAR OPERATIONS
04. HEADER IS TO BE FORGED AS SINGLE PIECE AND IT SHALL BE SUPPLIED IN NORMALISED CONDITION, WELD JOINTS ARE NOT PERMITTED TO FORM THE HEADER
05. HEADERS H1 TO H8 SHALL BE IN FULL COMPLIANCE WITH TDC, WITH THE FOLLOWING EXCEPTIONS AND ADDITIONAL REQUIREMENTS
    5.1 FULLY KILLED, FINE GRAINED STEEL PRODUCED BY VACUUM TREATMENT AND REFINED BY ELECTRO SLAG RE–MELTING SHALL BE USED, ADDITIONAL IMPURITY ELEMENTS RESTRICTION AS MENTIONED IN TDC SHALL APPLY
    5.2 REPRESENTATIVE NOZZLES SHALL BE SECTIONED AS GIVEN IN TDC AND SHALL BE EXAMINED FOR METAL FLOW, SOUNDNESS, REQUIRED CONTOURS AND REINFORCEMENT BY SUPPLIER. SAMPLE NOZZLES AND HEADER PIPE TEST SECTIONS FROM SAME PRODUCTION HEAT FOR PURCHASER'S USE SHALL BE SUPPLIED
    5.3 TEST COUPONS TAKEN FROM EACH HEADER SHALL BE SUBJECTED TO SIMULATED POST WELD HEAT TREATMENT AS PER THE APPROVED TDC
    5.4 ADDITIONAL FRACTURE TOUGHNESS REQUIREMENT SHALL BE AS PER THE APPROVED TDC
    5.5 ALL SPECIFIED MECHANICAL, METALLOGRAPHIC AND CHEMICAL ANALYSIS: TEST SPECIMENS LOCATION, ORIENTATION AND ACCEPTANCE SHALL BE AS PER THE APPROVED TDC
    5.6 SURFACE FINISH SHALL BE $\overset{6.3}{\nabla}$ MICRONS ALL OVER
    5.7 WALL THICKNESS SPECIFIED ARE MINIMUM VALUES
06. WHEREVER NOT SPECIFIED, THE BEST TOLERANCE ACHIEVABLE ON THE VARIOUS DIMENSIONS SHALL BE CLEARLY INDICATED BY THE SUPPLIER
07. SPECIAL REQUIREMENTS WHEN NOZZLE PROTRUSIONS ARE OBTAINED BY MACHINING
    7.1 SPECIMEN SHALL BE TAKEN FROM THE CORE OF THE LARGE AND SMALL NOZZLE AND FROM THE ADJACENT MATERIAL AS PER APPLICABLE TDC
    7.2 DETAILS AND EXTENT OF THE MECHANICAL TEST AND NDE SHALL BE AS PER APPLICABLE TDC
08. DETAILED DRAWING INDICATING VARIOUS STAGES OF MANUFACTURING SHALL BE SUBMITTED FOR APPROVAL
09. WELD EDGES AND MACHINED SURFACES SHALL BE SUBJECTED TO MT / PT AS PER APPROVED TDC
10. ALL MACHINED SURFACES AND WELD EDGES SHALL BE SUITABLY PROTECTED DURING TRANSPORTATION
11. AXIS MARKING SHALL BE DONE ON HEADER FORGING AS PER TDC
12. HEADERS SHALL BE PROPERLY PACKED AND COVERED IN WOODEN BOX STRENGTHENED WITH SUITABLE STEEL STRUCTURE
13. HEADER FORGING SHALL BE SUPPLIED IN FINISH MACHINED CONDITION
14. DETAILED FORGING DRAWING SHALL BE SUBMITTED BY SHOWING LOCATIONS OF THE TEST COUPONS
15. REFERENCE PLANE OF NOZZLE END '(RPNE)' – THE PLANE PERPENDICULAR TO THE REFERENCE PLANE OF THE NOZZLE AXIS AND PARALLEL TO THE REFERENCE HEADER AXIS (HA) AT THE DISTANCE SHOWN IN THE DRAWING FROM REFERENCE HEADER AXIS '(HA)'
16. SUITABLE PERMANENT MARKS SHALL BE MARKED ON THE EXTERNAL SURFACE OF HEADER FOR DEFINING 'HA'
17. TOLERANCE ON LENGTH DIMENSIONS ARE ±3mm UNLESS OTHERWISE SPECIFIED
18. TOLERANCE IF NOT SPECIFIED SHALL BE AS GIVEN BELOW FOR MACHINING
    0 TO 50 ±0.2
    50 TO ABOVE ±0.3
19. "( )" – BRACKETED DIMENSIONS ARE ONLY FOR REFERENCE

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 :
01	13.01.21	SECTION–BB REVISED INLINE WITH NPCIL COMMENTS	

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: 700MWe REACTOR HEADER
W.O.No. D179–001–1–93–422–FLEET
(Customer DWG.No. 700FLEET/33117/2001, 2002 & 2005/DD)

BHEL CC–ECN–D

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

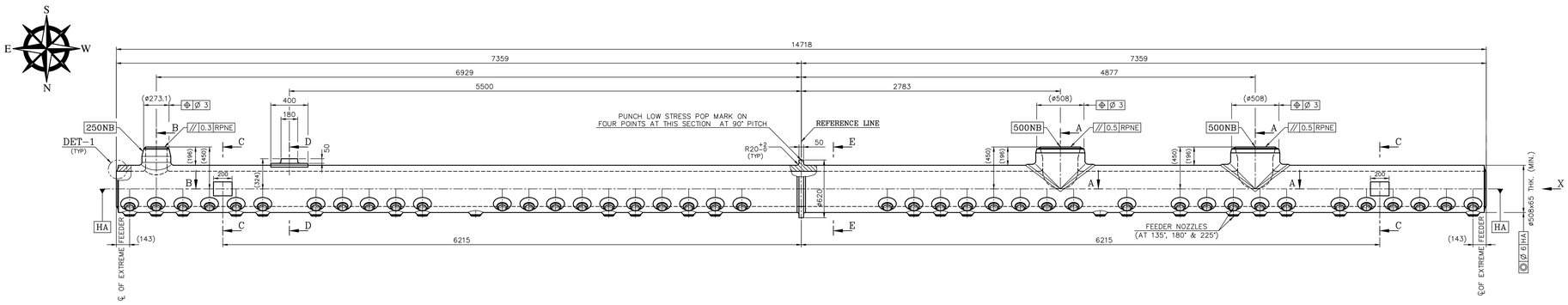
	NAME	SIGNATURE	DATE
DSN	RAMESH S		14.12.20
CHD	NKK		21.12.20
APPD	RA KRISHNAN		24.12.20

DEPT	GRADE OF CONTROL DTM	SCALE	WEIGHT (Kg)	REF TO ASSY / OLD DWG	ITEM NO	No. OF ITEMS
NC		1:20	10518			
CODE 150	C/M/P					

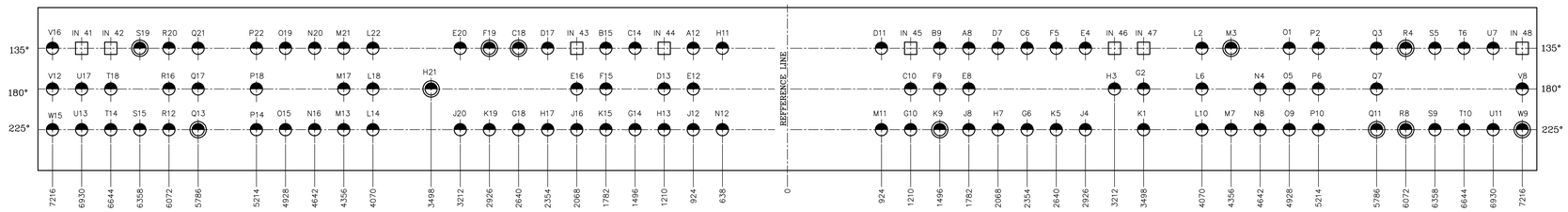
TITLE: REACTOR OUTLET HEADER–H1 (FORGING)
CARD CODE: U 01
DRAWING NO: 0–93–422–05305
REV: 01

Size A0

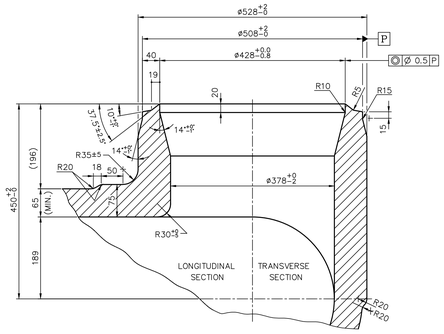
DRAWING NO: 0-93-422-05308



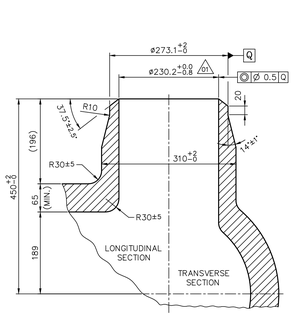
REACTOR OUTLET HEADER (ROH) – H4



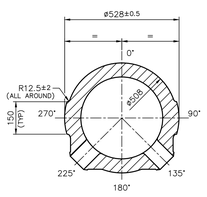
FEEDER PIPE NOZZLE DEVELOPED PLAN FOR (ROH) – H4



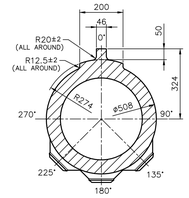
SECTION–AA
(500 NB)
(1:5)



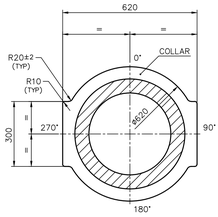
SECTION–BB
(250 NB)
(1:5)



SECTION–CC
(VIEW WITHOUT LARGE SIZE NOZZLE DETAILS)
(1:10)



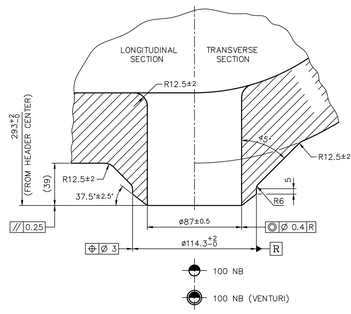
SECTION–DD
(VIEW WITHOUT LARGE SIZE NOZZLE DETAILS)
(1:10)



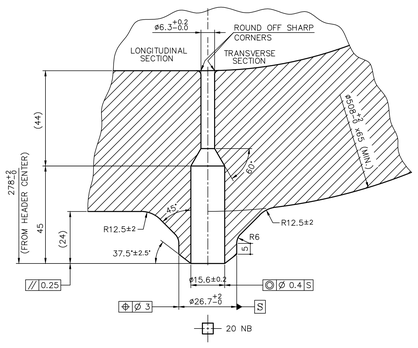
SECTION–EE
(VIEW WITHOUT NOZZLE AND FEEDERS DETAILS)
(1:10)

NOZZLE LEGEND & QUANTITY DETAILS

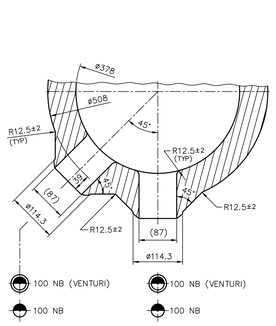
SYMBOL	NOZZLE DESCRIPTION	QUANTITY
	FEEDER PIPE NOZZLE 100NB	87
	FEEDER PIPE NOZZLE 100NB (VENTURI)	11
	INSTRUMENTATION NOZZLE 20NB	8
250 NB	SHUT DOWN COOLING INLET	1
500 NB	STEAM GENERATOR INLET	2



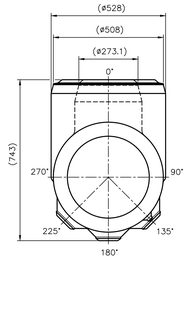
100 NB NOZZLE DETAILS
(1:2)



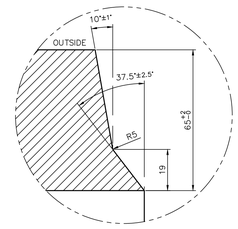
20 NB NOZZLE DETAILS
(1:1)



MERGING DETAILS
(MAJOR NOZZLES)
(1:5)



VIEW–X
(1:10)



DETAIL–1
(1:1)

ALL DIMENSIONS ARE IN MILLIMETERS

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    50 TO ABOVE ±0.3
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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 :
01	13.01.21	SECTION–BB REVISED INLINE WITH NPCIL COMMENTS	CHD&APPD :

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: 700MWe REACTOR HEADER
W.O.No. D179–001–1–93–422–FLEET
(Customer DWG.No. 700FLEET/33117/2001, 2002 & 2005/DD)

CO–GEN ☐

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

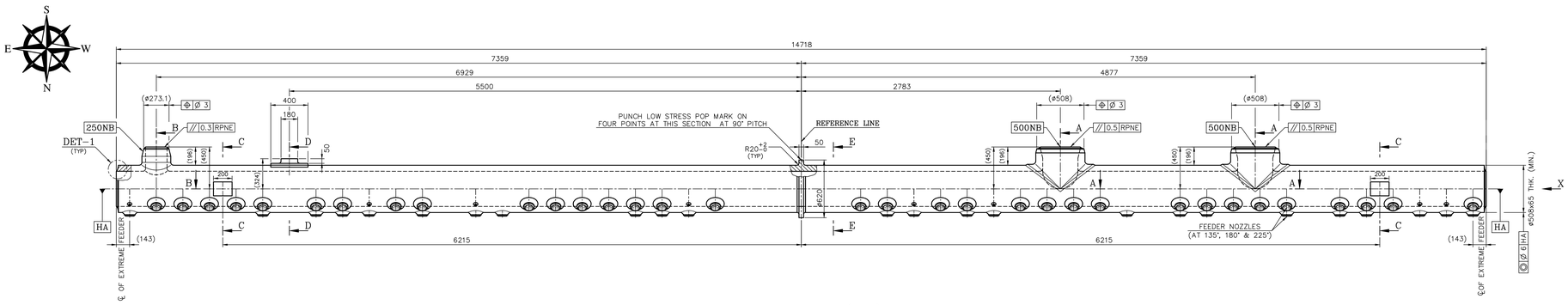
	NAME	SIGNATURE	DATE
DSN	RAMESH S		14.12.20
CHD	NKK		21.12.20
APPD	RA KRISHNAN		24.12.20

DEPT	GRADE OF UNTOL DIM	SCALE	WEIGHT (Kg)	REF TO ASSY / OLD DWG	ITEM NO	No. OF ITEMS
NC		1:20	10722			
CODE 150	C/M/P					

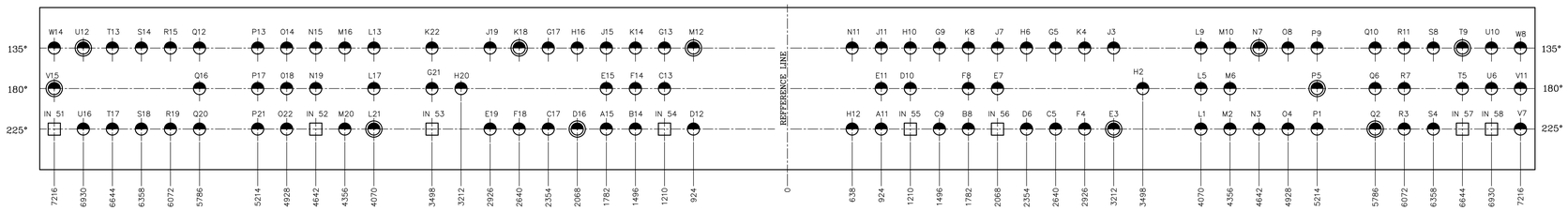
TITLE: REACTOR OUTLET HEADER–H4 (FORGING)
CARD CODE: U 01
DRAWING NO: 0–93–422–05308
REV: 01

Size A0

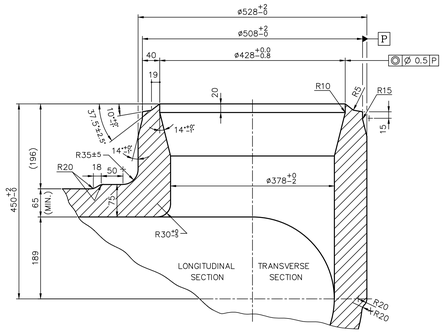
DRAWING NO: 0-93-422-05309



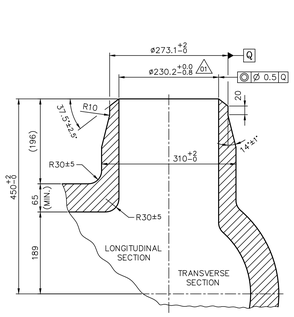
REACTOR OUTLET HEADER (ROH) – H5



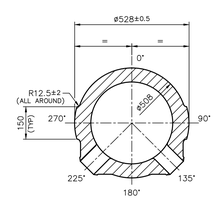
FEEDER PIPE NOZZLE DEVELOPED PLAN FOR (ROH) – H5



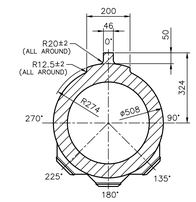
SECTION–AA
(500 NB)
(1:5)



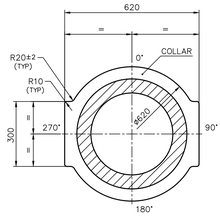
SECTION–BB
(250 NB)
(1:5)



SECTION–CC
(VIEW WITHOUT LARGE SIZE NOZZLE DETAILS)
(1:10)



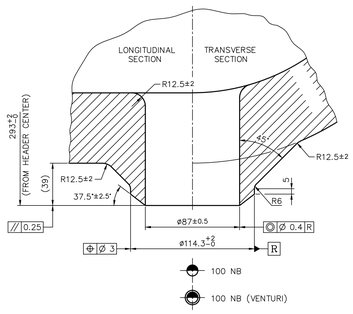
SECTION–DD
(VIEW WITHOUT LARGE SIZE NOZZLE DETAILS)
(1:10)



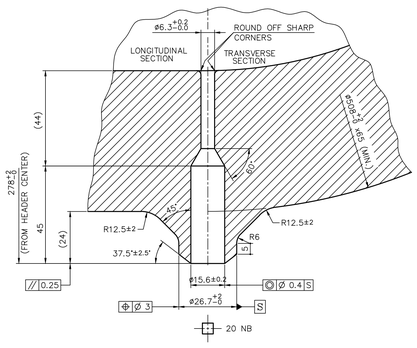
SECTION–EE
(VIEW WITHOUT NOZZLE AND FEEDERS DETAILS)
(1:10)

NOZZLE LEGEND & QUANTITY DETAILS

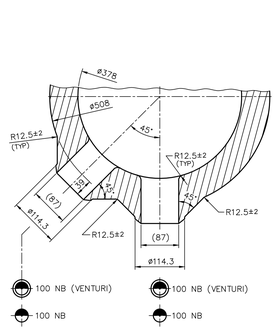
SYMBOL	NOZZLE DESCRIPTION	QUANTITY
	FEEDER PIPE NOZZLE 100NB	87
	FEEDER PIPE NOZZLE 100NB (VENTURI)	11
	INSTRUMENTATION NOZZLE 20NB	8
250 NB	SHUT DOWN COOLING INLET	1
500 NB	STEAM GENERATOR INLET	2



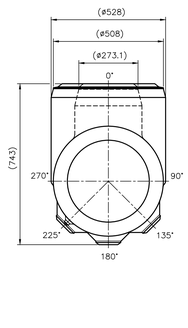
100 NB NOZZLE DETAILS
(1:2)



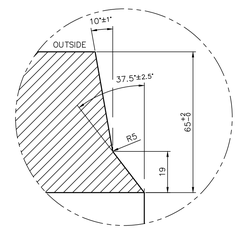
20 NB NOZZLE DETAILS
(1:1)



MERGING DETAILS
(MAJOR NOZZLES)
(1:5)



VIEW–X
(1:10)



DETAIL–1
(1:1)

ALL DIMENSIONS ARE IN MILLIMETERS

NOTE

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    5.4 ADDITIONAL FRACTURE TOUGHNESS REQUIREMENT SHALL BE AS PER THE APPROVED TDC
    5.5 ALL SPECIFIED MECHANICAL, METALLOGRAPHIC AND CHEMICAL ANALYSIS: TEST SPECIMENS LOCATION, ORIENTATION AND ACCEPTANCE SHALL BE AS PER THE APPROVED TDC
    5.6 SURFACE FINISH SHALL BE 6.3 MICRONS ALL OVER
    5.7 WALL THICKNESS SPECIFIED ARE MINIMUM VALUES
06. WHEREVER NOT SPECIFIED, THE BEST TOLERANCE ACHIEVABLE ON THE VARIOUS DIMENSIONS SHALL BE CLEARLY INDICATED BY THE SUPPLIER
07. SPECIAL REQUIREMENTS WHEN NOZZLE PROTRUSIONS ARE OBTAINED BY MACHINING
    7.1 SPECIMEN SHALL BE TAKEN FROM THE CORE OF THE LARGE AND SMALL NOZZLE AND FROM THE ADJACENT MATERIAL AS PER APPLICABLE TDC
    7.2 DETAILS AND EXTENT OF THE MECHANICAL TEST AND NDE SHALL BE AS PER APPLICABLE TDC
08. DETAILED DRAWING INDICATING VARIOUS STAGES OF MANUFACTURING SHALL BE SUBMITTED FOR APPROVAL
09. WELD EDGES AND MACHINED SURFACES SHALL BE SUBJECTED TO MT / PT AS PER APPROVED TDC
10. ALL MACHINED SURFACES AND WELD EDGES SHALL BE SUITABLY PROTECTED DURING TRANSPORTATION
11. AXIS MARKING SHALL BE DONE ON HEADER FORGING AS PER TDC
12. HEADERS SHALL BE PROPERLY PACKED AND COVERED IN WOODEN BOX STRENGTHENED WITH SUITABLE STEEL STRUCTURE
13. HEADER FORGING SHALL BE SUPPLIED IN FINISH MACHINED CONDITION
14. DETAILED FORGING DRAWING SHALL BE SUBMITTED BY SHOWING LOCATIONS OF THE TEST COUPONS
15. REFERENCE PLANE OF NOZZLE END '(RPNE)' – THE PLANE PERPENDICULAR TO THE REFERENCE PLANE OF THE NOZZLE AXIS AND PARALLEL TO THE REFERENCE HEADER AXIS (HA) AT THE DISTANCE SHOWN IN THE DRAWING FROM REFERENCE HEADER AXIS '(HA)'
16. SUITABLE PERMANENT MARKS SHALL BE MARKED ON THE EXTERNAL SURFACE OF HEADER FOR DEFINING 'HA'
17. TOLERANCE ON LENGTH DIMENSIONS ARE ±3mm UNLESS OTHERWISE SPECIFIED
18. TOLERANCE IF NOT SPECIFIED SHALL BE AS GIVEN BELOW FOR MACHINING
    0 TO 50 ±0.2
    50 TO ABOVE ±0.3
19. "( )" – BRACKETED DIMENSIONS ARE ONLY FOR REFERENCE

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 :
01	13.01.21	SECTION–BB REVISED INLINE WITH NPCIL COMMENTS	CHD&APPD :

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: 700MWe REACTOR HEADER
W.O.No. D179–001–1–93–422–FLEET
(Customer DWG.No. 700FLEET/33117/2001, 2002 & 2005/DD)

CO–GEN (I)

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

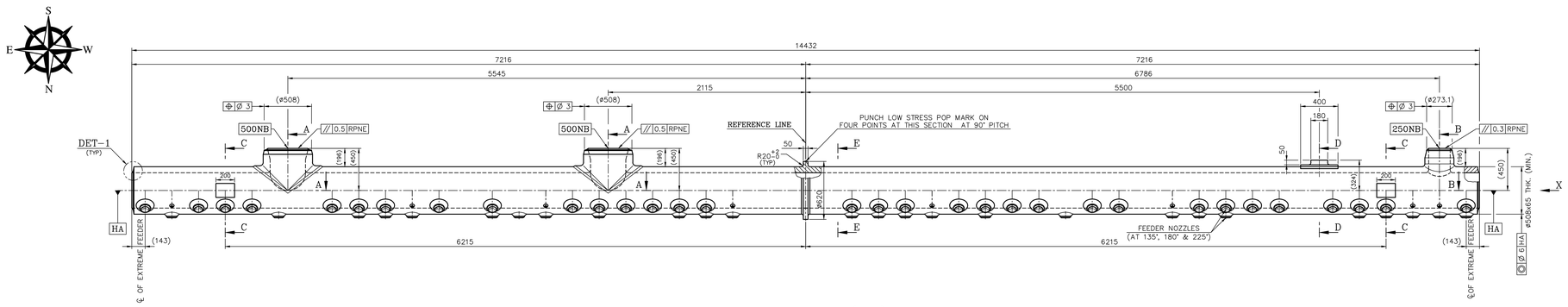
	NAME	SIGNATURE	DATE
DSN	RAMESH S		14.12.20
CHD	NKK		21.12.20
APPD	RA KRISHNAN		24.12.20

DEPT	GRADE OF CNTRL DTA	SCALE	WEIGHT (Kg)	REF TO ASSY / OLD DWG	ITEM NO	No. OF ITEMS
NC		1:20	10722			
CODE 150	C/M/P					

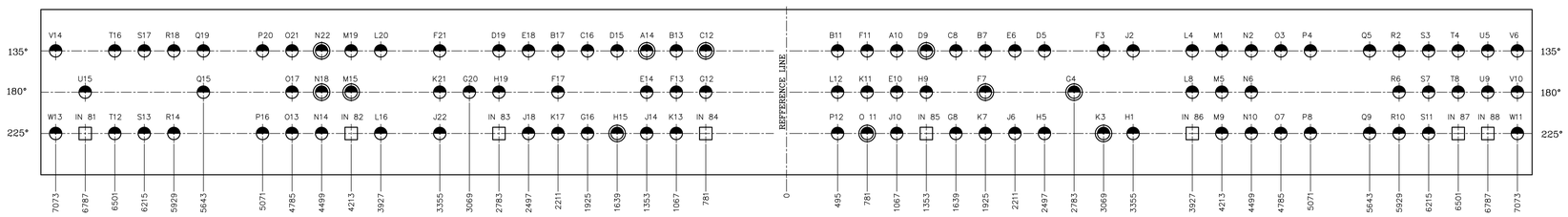
TITLE: REACTOR OUTLET HEADER–H5 (FORGING)
CARD CODE: U 01
DRAWING NO: 0–93–422–05309
REV: 01

Size A0

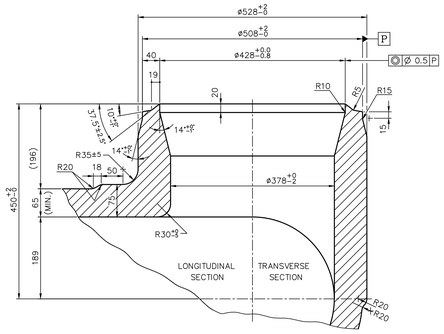
DRAWING NO: 0-93-422-05312



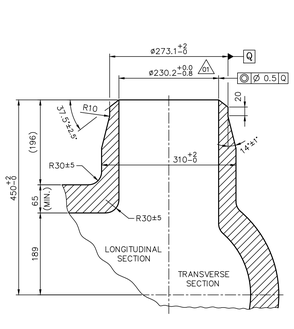
REACTOR OUTLET HEADER (ROH) – H8



FEEDER PIPE NOZZLE DEVELOPED PLAN FOR (ROH) – H8



SECTION–AA
(500 NB)
(1:5)



SECTION–BB
(250 NB)
(1:5)

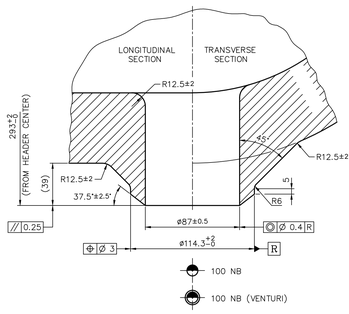
SECTION–CC
(VIEW WITHOUT LARGE SIZE NOZZLE DETAILS)
(1:10)

SECTION–DD
(VIEW WITHOUT LARGE SIZE NOZZLE DETAILS)
(1:10)

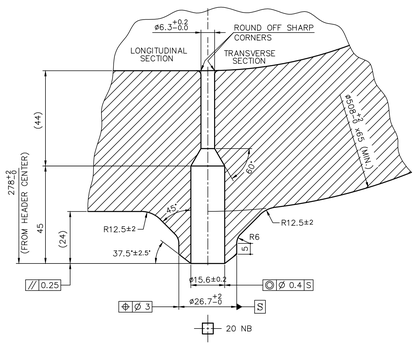
SECTION–EE
(VIEW WITHOUT NOZZLE AND FEEDERS DETAILS)
(1:10)

NOZZLE LEGEND & QUANTITY DETAILS

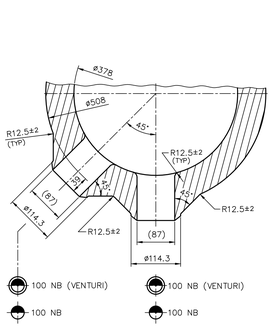
SYMBOL	NOZZLE DESCRIPTION	QUANTITY
	FEEDER PIPE NOZZLE 100NB	87
	FEEDER PIPE NOZZLE 100NB (VENTURI)	11
	INSTRUMENTATION NOZZLE 20NB	8
250 NB	SHUT DOWN COOLING INLET	1
500 NB	STEAM GENERATOR INLET	2



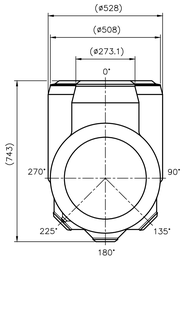
100 NB NOZZLE DETAILS
(1:2)



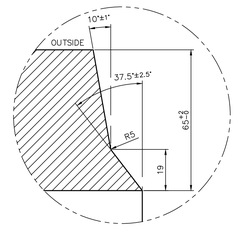
20 NB NOZZLE DETAILS
(1:1)



MERGING DETAILS
(MAJOR NOZZLES)
(1:5)



VIEW–X
(1:10)



DETAIL–1
(1:1)

ALL DIMENSIONS ARE IN MILLIMETERS

NOTE

01. MATERIAL SPECIFICATION FOR THE HEADER FORGING IS SA350 GR. LF2 CLASS–1 WITH SUPPLEMENTARY REQUIREMENTS ON CHEMICAL COMPOSITION AS GIVEN IN THE APPROVED TDC
02. FORGED HEADER MATERIAL, MANUFACTURING, TESTING, EXAMINATIONS AND PACKING SHALL BE IN ACCORDANCE WITH ASME SEC.III NB CL.1 AND AS PER APPROVED TDC
03. THE HEADER WITH INTEGRAL NOZZLES SHOWN IN THE DRAWING SHALL BE MANUFACTURED BY FORGING AND MACHINING OR COMBINATION OF SIMILAR OPERATIONS
04. HEADER IS TO BE FORGED AS SINGLE PIECE AND IT SHALL BE SUPPLIED IN NORMALISED CONDITION, WELD JOINTS ARE NOT PERMITTED TO FORM THE HEADER
05. HEADERS H1 TO H8 SHALL BE IN FULL COMPLIANCE WITH TDC, WITH THE FOLLOWING EXCEPTIONS AND ADDITIONAL REQUIREMENTS
    - 5.1 FULLY KILLED, FINE GRAINED STEEL PRODUCED BY VACUUM TREATMENT AND REFINED BY ELECTRO SLAG RE–MELTING SHALL BE USED, ADDITIONAL IMPURITY ELEMENTS RESTRICTION AS MENTIONED IN TDC SHALL APPLY
    - 5.2 REPRESENTATIVE NOZZLES SHALL BE SECTIONED AS GIVEN IN TDC AND SHALL BE EXAMINED FOR METAL FLOW, SOUNDNESS, REQUIRED CONTOURS AND REINFORCEMENT BY SUPPLIER. SAMPLE NOZZLES AND HEADER PIPE TEST SECTIONS FROM SAME PRODUCTION HEAT FOR PURCHASER'S USE SHALL BE SUPPLIED
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REV	DATE	ALTERED :	CHD&APPD :
01	13.01.21	SECTION–BB REVISED INLINE WITH NPCIL COMMENTS	CHD&APPD :

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: 700MWe REACTOR HEADER
W.O.No. D179–001–1–93–422–FLEET
(Customer DWG.No. 700FLEET/33117/2001, 2002 & 2005/DD)

BHEL CC–ISO–9001

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

	NAME	SIGNATURE	DATE
DSN	RAMESH S		14.12.20
CHD	NKK		21.12.20
APPD	RA KRISHNAN		24.12.20

DEPT	GRADE OF CONTROL DIM	SCALE	WEIGHT (Kg)	REF TO ASSY / OLD DWG	ITEM NO	No. OF ITEMS
NC		1:20	10518			
CODE 150	C/M/P					

TITLE: REACTOR OUTLET HEADER–H8 (FORGING)
CARD CODE: U 01
DRAWING NO: 0–93–422–05312
REV: 01

Size A0