1.0 GENERAL

Materials: SA106GrB, Gr C; SA 335 P11, P12, P22, P91 & P92 (Code case: 2179).
This Technical Delivery Condition specifies the requirements in addition to ASME SA 106, SA 335.

2.0 CHEMICAL COMPOSITION

For SA106 Gr B and Gr C: - Carbon content shall be limited to 0.25% max, for pipe thickness <= 20 mm; and 0.30% max,f or pipe thickness above 20 mm.
For SA335 P92: Si: 0.10-0.50%; Ni: 0.30max and Cu: 0.25max.

3.0 TOLERANCES

Unless otherwise specified in the PO, tolerances shall be as below:

3.1 OD specified pipes:-

SA335 P91& P92: the tolerance on OD shall be: ±1 % (Max: 4mm) of Nominal OD.
Other than SA335 P91& P92: the tolerance on OD shall be: ±1 % upto OD 660mm and for OD > 660mm tolerance shall be ±1 % (Max: 4mm) of Nominal OD.

3.2 ID specified pipes are specified by the maximum Internal Diameter and Minimum wall thickness. The tolerance if not specified in the PO shall be: ID: +0.0mm, -3.2mm & Thickness: +3.2mm, -0.0mm

4.0 STRAIGHTNESS

The Pipes shall not deviate from straightness by more than 1mm in any one meter and shall not be more than 6mm over the entire length. A sharp bend at the end or kink and twist are not acceptable. These limitations are applicable for any given plane.

5.0 HEAT TREATMENT & MECHANICAL TESTS

5.1 HEAT TREATMENT

CS: OD <= 76.1mm no heat treatment required. OD > 76.1mm shall be in Normalised conditioned.
AS: All sizes – SA335 P11, P12 & P22 – Either in Normalised and tempered or Isothermal Annealed condition.
AS: All sizes – SA335 P91 & P92:
Normalising Temp. : 1050°C - 1080°C (*for wall thickness larger than 75 mm, accelerated cooling may be done to obtain a fully martensitic structure).*
Tempering Temp. : 750°C - 780°C Soaking time: 2.5min/mm of thickness (1 hr min.), still air cooling.

5.2 MECHANICAL TESTS:

Number of Test (as per IBR): 2 numbers up to first 100 pipes and additional 1 number per 100 or part thereof for pipes over 100 numbers.
For P91 Pipes, Ys (0.2% offset) - 450 MPa Min ; Ts – Min 630 MPa, Max 850 MPa.
For P92 pipes Ts- Min 655 Mpa, Max 850 Mpa.
For other grades, Ys and Ts shall be as per specifications.

5.3 HARDNESS FOR SA 335 P91 & P92 PIPES Hardness test shall be carried out on each pipe. The hardness value for P91 shall be 191-250 BHN and that for P92 shall be 196-250 BHN. The hardness test values shall be indicated in the Test certificate

6.0 SUPPLEMENTARY TESTS

These are applicable to SA 106 Cr C, SA335 P11, P12, P22, P91 & P92. The supplementary test results shall be indicated in the Test Certificate along with the mandatory test results.

6.1. Product Analysis (S1):- Product Analysis shall be carried out on 5% of pipes per heat per heat treatment batch (minimum 2 Nos) for size NB 200 mm and above.

6.2. Transverse tension test (S2):- Transverse tension test shall be carried out (for size NB 200 mm and above) on one end of 5% of pipes per heat per heat treatment batch (minimum 1 No).

6.3. Photomicrograph test for P91 & P92 (S5):- Photomicrograph test shall be carried out from a specimen of pipe in the as finished condition for each individual size (OD and wall thickness) from each heat per heat treatment batch. Acceptance norms - The Material shall be free from any micro fissures. Microstructure shall show tempered martensite and also to be examined for any grain growth. Photomicrograph with 500x (Min) magnification along with Photomicrograph report to be provided. The actual magnification shall be indicated.

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7.0 NON DESTRUCTIVE TEST

Each pipe shall be ultrasonically tested as per ASTM E 213 in both clockwise & anticlockwise directions; calibration to be done on two axial notches of 50 mm length (inside & outside) and a depth of 5% of wall thickness (minimum 0.3 mm; maximum 1.5mm). The results shall be indicated in the Test Certificate.

8.0 REPAIR

Repair by welding is prohibited. The pipe shall meet the dimensional tolerance (clause 3.0 above) after any mechanical repair as permitted in the standard.

9.0 WORKMANSHIP

The Inside & outside surfaces of the pipes shall be free from any imperfections & defects like laps,seams,folds, cracks, pitting etc;. Localised imperfections, if any,may be removed by skin machining only to a surface finish of ≤ 6.3 microns ensuring the wall thickness, inside and outside diameter.Local depressions or ground spots are not acceptable. Loose scales shall be removed by blast cleaning in both inside and outside surface.

10.0 MARKING & COLOUR CODING

The following details are to be marked on the consignment for identification

1) PO Number 2) Supplier's emblem/code 3) Specification & grade 4) Heat number
5) Size 6) No. of pipes 7) Inspector's seal

OD up to 31.8 mm (excluding)	Details 1 to 7 shall be stamped on metal / plastic tag attached to bundle
OD 31.8 mm to OD 76.1mm (including)	Details 1 to 5 shall be paint stencilled on each pipe. Details1 to 7 to be stamped on Metal / Plastic tag attached to bundle.
OD above 76.1 mm	Details 2,3,4,5 & 7 shall be hard stamped with round edged stamp at 100mm from an end of each pipe. Details 1 to 5 shall be paint stencilled on each pipe.

Longitudinal colour bands shall be made throughout the length of the pipe. The colours shall be as per BHEL procedure SIP: PP: 21(Latest).

11.0 PRESERVATION

- Outside: - Resin type rust preventive coating with visibility to stencilled details. Thick Black coating which camouflages the Surface of the pipes is not permitted.
- Inside: - Rust inhibitor or resin type rust preventive coating.
- Ends of the pipes shall be secured with caps.

12.0 INSPECTION AND CERTIFICATION (In English Only)

12.1. Pipes shall be inspected at the manufacturer's works by the IBR / IBR approved Inspecting Authority. Inspection certificate in IBR Form IIID for Well-known pipe maker recognised in IBR and others in IBR Form III A, along with Mill Test certificate and NDT reports certified by IBR / IBR approved Inspecting Authority shall be submitted.

12.2. Test Certificate shall include PO no.(BHEL) ,TDC no., Pipe size and quantity- melt wise, specification and grade with year of code, Heat no., Steel &Pipe making process, chemistry including incidental elements on Ladle and Product analysis, Heat treatment details with actual temperature and soaking time, Mechanical results.

12.3. Detailed NDT reports with reference norms, acceptance standards and test results shall be furnished along with Test certificates.

12.4. For P91 & P92 pipes the Photomicrograph test report along with photomicrograph with 500x (min) magnification shall be furnished.

RECORDS OF REVISIONS

i) Rev 03 – Para 4.1, 4.2.b are included; Para 6.0, 13.0 are modified
ii) Rev 04 – Para 3.1, 3.2 modified
iii) Rev 05 – SA335 P92 included. Para 1.0, 2.0, 4.1, 4.2, 5.0, 6.0 are modified & Para 5.3, 13.4 included.
iv) Rev 06 – Para 4.0 added. Para 1.0, 3.1, 3.2, 4.1, 5.1, 5.2, 6.1, 6.2, 6.3, 9.0, 10.0, 11.0 & 12.1 revised and further clauses renumbered.

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1.0 GENERAL

Fabricated Tees and Y-piece shall meet Indian Boiler Regulations (IBR) and the following requirements in addition to the latest version of relevant material specifications namely

ASME SA 105, SA 106 , SA 182, SA 335.

2.0 FORGINGS.

2.1 Material : SA 105, SA 182 F11, F12, F22, F91 & F92 (Code Case 2179).

2.2 Raw forge vendor details shall be furnished in the technical part of the bid for BHEL's approval. Raw forge sources shall be approved by BHEL.

2.3 Carbon content of SA105 items shall be restricted to 0.25% maximum.

2.4 Unless otherwise specified in the P.O, items of SA182 F11/12 shall be supplied as per class 2 and SA182 F22 shall be supplied as per class 3 only.

2.4 **Heat Treatment:-**

2.4.1 All fittings shall be heat treated as below:

SA 105	- Normalised
SA 182 F11 / F12 / F22	- Normalised & Tempered

2.4.2 SA 182 F91 & F92 forgings shall be normalised at 1040 to1070 deg C (for wall thickness larger than 75 mm, accelerated cooling may be done to obtain a fully martensitic structure) and tempered at 760 $\pm$ 10 deg C. Soaking time 1 hour minimum, still air cooling.

2.5 **Product analysis** shall be carried out on One piece / Heat / HT lot / Size.

2.6 **Tension test** shall be carried out on one Test piece for each specification, heat, heat treatment lot and size.

2.7 **Bend test**:- (a) For CS (SA 105) : One sample of 19 mm thick and 25mm width to be bent 180 deg around mandrel of radius 6.35mm.
(b) For AS (SA182): One Sample of 25.4 mm width and thickness = t to be bent 180deg around mandrel of radius =1.5 t. Test on representative sample is also acceptable.

2.8 **Hardness test:-** (i) For SA 182 F91 :- 100% of items; Value: 191-250 BHN
(ii) For SA 182 F92 :- 100% of items; Value: 196-250 BHN
(iii) For other specn :- 10% of items; Value - As per specn.
The hardness test values shall be indicated in the Test certificate.

2.9 **MPI (After Heat Treatment) :**100%: As per ASTM E 709. Linear Indications like cracks, folds & other injurious defects are unacceptable.

Dry MPI : CS, AS (other than F91, F92) : all sizes.
Wet MPI : SA182 F91, F92 : all sizes.

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2.10 **Ultrasonic Test:-** Forgings of all thickness shall be ultrasonically tested as per SA 388 and acceptance norms shall be as per 3.3.4 of ASME Section VIII Division 2.

2.11 **Photomicrograph test for F91 & F92 :-** Photomicrograph test shall be carried out on one per heat, per size. Acceptance norms - The Material shall be free from any micro fissures. Microstructure shall show tempered martensite and also to be examined for any grain growth. Photomicrograph with 500x (Min) magnification along with Photomicrograph report to be provided. The actual magnification shall be indicated.

3.0 PIPES.

3.1 Material : SA 106 Gr.C, SA 335 P11, P12, P22 , P91 & P92 (Code case : 2179).

3.2 Pipe vendor details shall be furnished in the technical part of the bid for BHEL's approval. Pipe sources shall be approved by BHEL.

3.2 The pipes used shall meet the requirements indicated in Technical delivery condition ref. TDG: 101. The applicable / latest revision number of this document is indicated in the Tender / Purchase order.

4.0 FABRICATION OF Y Piece and Tees

4.1 Fit up, fabrication, dimension and tolerance shall be as per BHEL drawing.

4.2 Welding: WPS and PQR shall be approved by well known independent inspecting agencies like Lloyds, BV, SGS, ... Copy of approved WPS & PQR shall be furnished along with the Technical part of the bid for approval by BHEL.

4.2.1 Welding of F91 / P91 & F92 / P92 materials :

MATERIAL SPECIFICATION	ELECTRODES TO BE USED	
	GTAW PROCESS	SMAW PROCESS
SA F91 / P91	ER 90S – B9	E9015 – B9
SA F92 / P92	9Cr WV TIG	Thermanit MTS-616

GTAW rods and SMAW electrodes used shall be of following makes.

a) Bohler Schweisstechnik Austria, Austria
b) Bohler Thyssen Schweisstechnik, Germany
c) Kobe Steels Ltd., Japan
d) Oerlikon Welding Ltd, Switzerland
e) Metrode Products, U.K

The core wire chemistry shall be equivalent to F91/ P91 & F92 / P92. Synthetic electrodes are not permitted.

4.3 PWHT for F91 / P91 & F92 / P92 materials shall be 760 ± 10 deg C. Holding time shall be minimum 2 hours for thickness up to 50mm; minimum 4 hours for thickness 51 to 100 mm. PWHT for other material shall be as per ASME B31.1.

5.0 NON DESTRUCTIVE EXAMINATION

5.1 All NDE shall be done after PWHT only – and witnessed by Inspection authorities.

5.2 NDE procedures (MT-Wet, PT, RT, UT and Hardness) shall be approved by BHEL.

5.3 All welds shall be subjected to RT, Wet MT and PT as per ASME Sec V. Evaluation and acceptance norms shall be as per ASME B31.1 Clause 136.4.5 for RT, Clause 136.4.3 for MT, Clause 136.4.4 for PT. Hardness shall be as per SA 234.

5.4 All welds shall also be subjected to UT and its methodology and acceptance shall be as per AD 2000 Merkblatt HP 5/3-2002 Edition, with additional requirements as in 5.4.1 through 5.4.3 below.

5.4.1 The examination shall be conducted by Pulse Echo contact testing.
The following digital equipments or its equivalent models with A-scan presentation that generates and receives frequencies in the range of 1 MHz to 5 MHz. shall be used for examination: GE Inspection Technology (Krautkramer make), Olympus (EPOCH IV, XT), Sonatest (Master scan series-350M/380M) U.K.

The calibration blocks used shall be of same material specification, diameter & thickness.

The UT equipment shall be calibrated at the beginning of each period of extended use or every 3 months whichever is less.

5.4.2 All recordable indications will be stored in memory of either the digital flaw detector or a PC for review at a later period.

5.4.3 The equipment calibration data for specific weld as well as the hard copy of 'Static echo-trace pattern'– showing the flaw-echo amplitude with respect to DAC, flaw depth, projection surface distance (probe position) and beam-path shall be attached to UT test report. This hard-copy of echo-trace with equipment calibration data will form part of test documentation.

5.5 Qualified Level II personnel shall perform the examination as well as evaluation, and a test report shall be issued.

5.6 Hardness test shall be carried out and report to be furnished. The maximum hardness (HV 10) shall be 300 for F91 & F92 material; and 225 for F11, F12 & F22.

6.0 POSITIVE MATERIAL IDENTIFICATION (PMI) FOR ALLOY STEEL FITTINGS.

Each alloy steel fitting shall be checked for the correctness of the material during manufacturing and final inspection using X-ray fluorescence principle or spark emission spectrography.

7.0 WORKMANSHIP, FINISH AND REPAIR

All items shall have smooth, workman like finish, and to be free from scale & defects like laps, seams, folds, cracks, etc. Surface defects can be removed by mechanical means and defective areas smoothly dressed up with the adjacent surface. Minimum dimension after repair shall meet drawing / Specification. Repairs by fusion welding are prohibited.

8.0 PAINTING, COLOUR CODING, MARKING

8.1 **PAINTING:** All fittings shall be **painted** on the external surface as given below

a) Surface preparation: Blast cleaning
b) Primer coat: One coat of 60 microns of In-Organic Ethyl Zinc Silicate primer.
c) Finish coat : Two coats of 20 microns each of Heat Resistance Aluminium paint to IS13183 Gr-1.
d) Total DFT : 100 microns minimum.
d) Shade : Aluminium -- for all fittings.

The internal surface shall be protected with rust preventive coating or rust inhibitor.

8.2 **COLOUR CODING:** All fittings shall be colour coded circumferentially at ends as given below:-

SA 105 / SA 106 Gr.C	=	Blue
SA 182 F11 / SA 335 P11	=	Green & White
SA 182 F12 / SA 335 P12	=	Black & Red
SA 182 F22 / SA 335 P22	=	Blue & Red
SA 182 F91 / SA 335 P91	=	Brown & Red
SA 182 F92 / SA 335 P92	=	Brown & Blue

8.3 **MARKING** (In English only)**:-**

8.3.1 The fittings dispatched to **BHEL Stores** shall be hard punched / etched with Material code, Heat number, material specification, maker`s emblem, Inspectors seal and Statutory authorities seal (as applicable).
In addition, the above details along with size shall be paint stencilled on the fittings.

8.3.2 The fittings dispatched directly to project site as **DTS** shall be hard punched and paint Stencilled with DU code (14 digit work order du detail) as given by purchase in addition to marking done as per para 8.3.1.

9.0 PACKING AND END PROTECTION: Machined ends of the fittings shall be well protected using end caps and fittings shall be suitably packed in box / crate to avoid transit & other damages.

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10.0 MANUFACTURING QUALITY PLAN.

Vendor shall submit manufacturing Quality plan along with technical part of the bid for BHEL approval.

11.0 INSPECTION & CERTIFICATION (In English only)**:-**

11.1 All items are to be inspected at the manufacturer's works by the Inspection agencies / authorities as per IBR. Inspection certificate for finished product in IBR Form IIIC shall be submitted along with the Work Test Certificate (EN 10204 Type 3.2) countersigned by authorities as per IBR and shall include the following details. (Three ink signed originals required)

i. Test Certificate Number & date.
ii. BHEL P.O Number & Amendment Number(if any)
iii. BHEL P.O. Serial Number
iv. BHEL TDC Number, Drawing number
v. Size-wise Quantity
vi. Specification, Grade & Year of code.
vii. Heat / Melt Number
viii. Steel making process.
ix. Material details
x. Ladle and product Analysis of Raw Material.
xi. Tensile Test
xii. Bend Test
xiii. Guarantee of HTP shall be given in the test certificate as follows, if hydro test is not carried out: - "Fabricated Y piece / welded Tees are capable of withstanding without failure, breakage or impairment of their serviceability a hydrostatic test pressure equal to that prescribed for the specified matching pipe of equivalent material".
xiv. References to the NDT & other test reports covered in 11.2 below.

11.2 The following reports shall be **furnished separately** along with the Form III C & MTC indicated in para 11.1 above.

i. NDE reports for VT, MT, RT, UT (UT Reports in soft copy + hard copy).
ii. Positive Material identification (PMI) report for Alloy steel.
iii. Heat Treatment Chart.
iv. Hardness Test report.
v. Photomicrograph test report along with photomicrograph with minimum 500 x magnifications.
vi. Dimensional report (as built drawing with dimensions)

12.0 RECORDS OF REVISION.

Revision 01 : a) Para 3.0, 4.2.1 ,6.0 , 10.0 are included.
b) Para 1.0,4.2,4.3,8.2,11.0 are revised.

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Revision 02 : a) Para 2.10,4.2.1,8.1, 8.2, 9.0 are revised.

Revision 03 : a) Para 2.12, 8.0 and 11.0 (18) are revised.

Revision 04 : a) Para 8.1 modified as sea worthy painting.
b) Para 11 modified. Works TC 'EN 10204 Type 3.2' specified. Individual reports are required.

Revision 05 : a) Para 5.6 (Hardness test) included.
b) Para 8.1 modified indicating colour shades.
c) Para 11 modified for better clarity with respect to documentation.

Revision 06 : a) New material specn. SA 182 F92 & SA 335 P92 are included.
b) Para 2.1, 2.3, 2.4.1, 2.4.2, 2.8, 2.11, 3.1, 4.2.1, 4.3, 5.6, 8.2, 11.2(vi) are revised.
c) Para 2.5, 2.6, 2.7, 2.9 & 2.10 are modified for better clarity.

Revision 07 : a) Para 2.2 & 3.2 are added.
b) Para 2.9, 8.1 & 8.3.2 are revised.
c) Para 2.8 modified for better clarity.

** ** **

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1.0 GENERAL

Pipe with stubs, branches and attachments shall be manufactured as per BHEL drawing and shall meet Indian Boiler Regulations (IBR). The following requirements shall be taken care in addition to the latest version of relevant material specifications.

2.0 PIPES.

2.1 Material : SA 106, SA 335 P11, P12, P22, P91.

2.2 The pipes used shall meet the requirements indicated in Technical delivery condition ref. TDG : 101. The applicable / latest revision number of this document is indicated in the Tender / Purchase order. Test certificate in IBR Form IIIA format meeting IBR requirement shall be furnished. The Pipes used shall be of renowned make and the same shall be indicated in the Technical part of the bid. Vendors shall procure the pipes only from Pipe manufacturers approved by BHEL.

2.3 All pipes used shall be of single length without joints. In case of any joints to make up the required length, specific approval shall be taken from BHEL during Technical bid discussions.

3.0 FORGINGS.

3.1 Material: SA 105, SA 182 F11, F12, F22, F91.

3.2 Carbon content of SA105 items shall be restricted to 0.25% maximum.

3.3 SA 182 F91 forgings shall be normalised at 1040 to1070 deg C (for wall thickness larger than 75 mm, accelerated cooling may be done to obtain a fully martensitic structure) and tempered at 760 $\pm$ 10 deg C

3.4 Unless otherwise specified in the P.O, items of SA182 F11/12 shall be supplied as per class 2 and SA182 F22 shall be supplied as per class 3 only

3.5 Product analysis shall be carried out on One piece / Heat / HT lot / Size.

3.6 Tension test shall be carried out on one Test piece for each specification, heat, heat treatment lot and size.

3.7 Bend test for CS (SA 105) : One sample of 19 mm thick and 25mm width to be bent 180 deg around mandrel of radius 6.35mm.

3.8 Bend test for AS (SA182): One Sample of 25.4 mm width and thickness = t to be bent180deg around mandrel of radius =1.5 t. Test on representative sample is also acceptable.

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3.9 Hardness test shall be carried out on all items of F91, and minimum 10% for other material Grades; acceptance norm shall be as per relevant material specification (SA 105 / SA 182).

3.10 All forgings shall be tested by MT as per ASTM E-709 and acceptance norm shall be as per ASME B 31.1 Clause 136.4.3

3.11 Forgings of all thickness shall be ultrasonically tested as per SA 388 and acceptance norms shall be as per 3.3.4 of ASME Section VIII Division 2.

3.12 Metallography:- Metallography shall be carried out on one per heat, per size, per heat treatment lot of F91 forgings. Acceptance norms - The Material shall be free from any micro fissures. Microstructure shall show tempered martensite and also to be examined for any grain growth. Photomicrograph with 500x (Min) magnification along with Metallography report to be provided. The actual magnification shall be indicated.

3.13 Test certificate in IBR Form IIIC format meeting IBR requirement shall be furnished.

4.0 PLATES FOR BOTTOM SUPPORT AND STRUCTURAL ATTACHMENTS:

4.1 The Plates used for bottom support and structural attachments (non pressure retaining part) shall meet the respective material specification indicated in the drawing and necessary test certificate shall be furnished.

5.0 FABRICATION

5.1 Fit up, fabrication, dimension and tolerance shall be as per BHEL drawing

5.2 Welding : WPS and PQR shall be approved by well known independent inspecting agencies like Lloyds, BV, SGS, ... Copy of approved WPS & PQR shall be furnished along with the Technical part of the bid for approval by BHEL. The welders shall be qualified as per ASME Sec IX and IBR.

5.2.1 Welding of F91 / P91 material :
GTAW rods (ER 90S – B9) and SMAW electrodes (E9015 – B9) used shall be of following makes.

a) Bohler Schweisstechnik Austria, Austria
b) Bohler Thyssen Schweisstechnik, Germany
c) Kobe Steels Ltd., Japan
d) Oerlikon Welding Ltd, Switzerland
e) Metrode Products, U.K

The core wire chemistry shall be equivalent to F91/ P91 . Synthetic electrodes are not permitted.

5.2.2 For F91 / P91, PWHT shall be done immediately after welding.

5.3 PWHT shall be done in a calibrated furnace.

5.4 PWHT for F91 / P91 material shall be 760 ± 10 deg C. Holding time shall be minimum 2 hours for thickness up to 50mm; minimum 4 hours for thickness 51 to 100 mm.

5.5 PWHT for other material shall be as per ASME B31.1. However, the holding time shall be 30 minutes minimum for SA 105, SA 106; 60 minutes minimum for P11,P12 & P22 materials.

6.0 NON DESTRUCTIVE EXAMINATION

6.1 All NDE shall be done after PWHT only – and witnessed by Inspection authorities.

6.2 NDE procedures (PT, MT, UT, RT and Hardness)shall be approved by BHEL

6.3 **Pipe to Stub / Branch weld** - shall be subjected to UT, PT and MT as per ASME Section V - article 4, 6 and 7 respectively and acceptance as per ASME B31.1 Cl 136.4.6 , 136.4.4 and 136.4.3 respectively.

6.3.1 **Pipe to Stub / Branch Welds for SA335P91 materials** - shall be subjected to wet MT, PT & UT. The wet MT and PT shall be as per ASME Section V–article 7, 6 respectively and acceptance norms shall be as per ASME B31.1 Cl 136.4.3 , 136.4.4 respectively. The methodology and acceptance for UT shall be as per AD 2000 Merkblatt HP 5/3-2002 Edition, with additional requirements as in 6.6.1 through 6.6.3 below.

6.4 **Pipe to structural attachment (non pressure retaining part) weld** - shall be subjected to MT (for SA335P91 materials- wet MT) and PT as per ASME Sec V article 7, 6 respectively. The acceptance norms shall be as per ASME B 31.1 Cl 136.4.3 and 136.4.4 respectively.

6.5 **Butt welds** - shall be subjected to MT and RT as per ASME Sec V . Evaluation and acceptance norms shall be as per ASME B31.1 Clause 136.4.3 and 136.4.5 respectively.

6.6 **Butt welds for SA335P91** shall be subjected to wet MT, RT and UT.
The wet MT and RT shall be as per ASME Sec V. Evaluation and acceptance norms shall be as per ASME B31.1 Clause 136.4.3 and Clause 136.4.5 respectively. The methodology and acceptance for UT shall be as per AD 2000 Merkblatt HP 5/3-2002 Edition, with additional requirements as in 6.6.1 through 6.6.3 below.

6.6.1 The examination shall be conducted by Pulse Echo contact testing.
The following digital equipments or its equivalent models with A-scan presentation that generates and receives frequencies in the range of 1 MHz to 5 MHz. shall be used for examination:
GE Inspection Technology (Krautkramer make), Olympus (EPOCH IV, XT), Sonatest (Master scan series-350M/380M)U.K

The calibration blocks used shall be of same material specification, diameter & thickness.
The UT equipment shall be calibrated at the beginning of each period of extended use or every 3 months whichever is less.

6.6.2 All recordable indications will be stored in memory of either the digital flaw detector or a PC for review at a later period.

6.6.3 The equipment calibration data for specific weld as well as the hard copy of 'Static echo- trace pattern'– showing the flaw-echo amplitude with respect to DAC, flaw depth, projection surface distance (probe position) and beam-path shall be attached to UT test report. This hard-copy of echo-trace with equipment calibration data will form part of test documentation.

6.7 All pipe ends after edge-preparation as per BHEL drawing shall be subjected to PT as per ASME Sec V. The acceptance norms shall be as per ASME B 31.1 Cl 136.4.4.

6.8 Qualified Level II personnel (in accordance with SNT-TC-1A of ASNT) shall perform the examination as well as evaluation, and a test report shall be issued.

6.9 Hardness test shall be carried out and report to be furnished. The maximum hardness (HV10) for SA335P91 material shall be 300 and for others namely SA335P11,P12,P22 shall be 225.

7.0 POSITIVE MATERIAL IDENTIFICATION (PMI) FOR ALLOY STEEL MATERIAL

Each alloy steel component shall be checked for the correctness of the material during manufacturing and final inspection using X-ray fluorescence principle or spark emission spectrography.

8.0 WORK MAN SHIP, FINISH AND REPAIR

All items shall have smooth, workman like finish, and to be free from scale & defects like laps, seams, folds, cracks, etc. Surface defects can be removed by mechanical means and defective areas smoothly dressed up with the adjacent surface. Minimum dimension after repair shall meet drawing / Specification. Repair on parent material (Pipe, Forging, Plate) by fusion welding are prohibited.

9.0 PAINTING, COLOUR CODING, MARKING

9.1 **PAINTING:** All components shall be **painted** on the external surface as given below

a) Surface preparation : Blast cleaning
b) Painting : Seaworthy Epoxy painting of DFT – 100 microns with colour shades as given below.
c) Shade : (i) Smoke grey -- for all carbon steel components
(ii) Sea green -- for all Alloy steel components

The internal surface shall be protected with rust preventive coating or rust inhibitor. Stainless steel components need not be painted.

9.2 **COLOUR CODING:** All components shall be colour coded circumferentially at ends as given below

SA 105 / SA 106 Gr.C	=	Blue
SA 182 F11 / SA 335 P11	=	Green & White
SA 182 F12 / SA 335 P12	=	Black & Red
SA 182 F22 / SA 335 P22	=	Blue & Red
SA 182 F91 / SA 335 P91	=	Brown & Red

9.3 **MARKING:**

9.3.1 The Pipe with stubs dispatched to **BHEL Stores** shall be punched / etched with Material code, Heat number, material specification, maker's emblem, Inspectors seal and Statutory authorities seal (as applicable) .
In addition, the above details along with size shall be paint stencilled on the finished component.

9.3.2 The Pipe with stubs dispatched directly to project site as **DTS** shall be punched and paint stencilled with DU code (14 digit Work order DU detail) as given by Purchase in addition to marking done as per para 9.3.1.

10.0 PACKING AND END PROTECTION: Machined ends of the Pipe with stubs shall be well protected using end caps and the materials shall be suitably packed in box / crate to avoid transit & other damages.

11.0 MANUFACTURING QUALITY PLAN: Vendor shall submit manufacturing Quality Plan along with technical part of the bid for BHEL approval.

12.0 INSPECTION & CERTIFICATION

12.1 All items are to be inspected at the manufacturer's works by the Inspection agencies / authorities as per IBR. Inspection certificate for finished product in IBR Form IIIA shall be submitted along with the Work Test Certificate (EN 10204 Type 3.2) countersigned by authorities as per IBR and shall include the following details. (Three ink signed originals required)

i. Test Certificate Number & date.
ii. BHEL P.O Number & Amendment Number(if any)
iii. BHEL P.O. Serial Number
iv. BHEL TDC Number, Drawing number
v. Size-wise Quantity
vi. Specification, Grade & Year of code.
vii. Heat / Melt Number
viii. Steel making process.
ix. Material details

x. Ladle and product Analysis of Raw Material.
xi. Tensile Test
xii. Bend Test
xiii. Guarantee of HTP shall be given in the test certificate as follows, if hydro test is not carried out: - "Fabricated Pipe with stubs, branches and attachments are capable of withstanding without failure, breakage or impairment of their serviceability a hydrostatic test pressure equal to that prescribed for the specified matching pipe of equivalent material".
xiv. References to the NDT & other test reports covered in 12.2 below.

12.2 The following reports shall be furnished separately along with the Form III A & MTC indicated in para 12.1 above.

i. NDE reports for VT, PT, MT, RT, UT (UT Reports in soft copy + hard copy)
ii. Positive Material identification (PMI) report for Alloy steel.
iii. Heat Treatment Chart.
iv. Hardness Test report
v. Metallography Report along with photomicrograph with minimum 500x magnification.
vi. Dimensional report.

S. Jayakumar, Engg	Approved by K. Vedaprasad, QC
P. Elangovan, QA	K. Ganeshan, MPL