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

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

2.9 **MPI:-** All fittings 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

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.

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3.0 PIPES.

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

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 $\pm$ 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.

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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) Painting: Seaworthy Epoxy painting of DFT – 100 microns with colour shades as given below.

c) Shade: (i) Smoke grey -- for all carbon steel fittings.
(ii) Sea green -- for all Alloy steel 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.

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

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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.
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.

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