

	Bharat Heavy Electricals Limited, Piping Centre, Chennai Technical Delivery Conditions for Fabricated TEEs and Y- pieces Project : BIFPCL MAITREE STPP - 2X660 MW	Doc: TDG : 7328:009 Rev : 00 Dt : 03-12-2018 Page 1 of 7
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RECORDS OF REVISIONS : Rev 00 – Fresh Issue

1.0 GENERAL

Materials: ASME/ASTM SA105/A105; SA106/A106; SA335/A335 & SA182/A182.

This Technical Delivery Condition specifies the requirements in addition to respective ASME / ASTM specification requirements.

2.0 FORGINGS.

- 2.1 Material : SA 105, SA 182 F11, F12, F22, F91 & F92 (Code Case 2179).
- 2.2 For SA 182 F91& F92 (Code Case 2179): The raw material shall be procured from the Mills listed in document ref.QCP:18(latest revision). For raw material sources not listed in QCP:18, credentials shall be submitted by the vendor along with offer for BHEL review and approval.
Forgings shall be inspected at supplier's works and certified as per **BS EN 10204 Type 3.2 by any ASME Authorised Inspection Agency or their subsidiaries**. The test certificate shall be furnished with Traceability.
- 2.3 For SA 105: Carbon: 0.25% max.
For SA182 F92: Si: 0.10-0.50%; Ni: 0.30 max and Cu: 0.25 max.
- 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.
- 2.5 **CREEP TEST : Shall be done as per ASTM E139 (latest) or BS EN ISO 204 (latest).**
Creep testing is required for all high chrome castings and forgings as detailed out below for Grades 91 and 92.

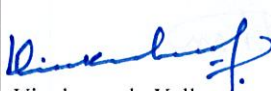
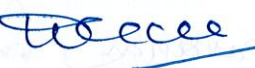
If the starting material is sourced from any mill which has not established creep properties, then creep testing shall be done on the product and shall be reported as per Table 1 & 2. If the Test results are meeting the requirements, then it can be treated as an approval of the creep values for the Mill which has supplied the starting material if the report is vouched by the mill.

Creep testing shall be done in line with the following:

Supplier shall produce the creep (stress rupture) test report for each material grade being supplied by them as per the Table 1 given below:

Table-1. Creep Testing Requirements

Alloy Steel Grade	Testing Hours	Testing Temperature (°C)	Stress Value (Mpa)	No. of tests & Specimen size
F91	1000	625	120	2 no.of tests with preferably M10 round sample.
F92	1000	625	140	

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- (i) Creep testing shall be done by the Mills at their own lab or at National Metallurgical Laboratory, Jamshedpur or Corporate Research & Development Laboratory of Bharat Heavy Electricals Limited, Hyderabad or any other established laboratory.
- (ii) In case the fitting supplier sources the steels from more than one source, the creep tests shall be done for all the sources from whom they would source the steels for BHEL supply.
- (iii) Acceptance Criteria: The samples tested shall not rupture and shall meet the requirement of 1,000 hours of creep testing at indicated temperatures & stress values as per Table 1.
- (iv) Reporting : As per Table-2

Table-2 : Suggested/Recommended Format for Reporting the Creep Testing Data:

Sl.No	Description	Details
01	Name and Address of the Product Manufacturer	
02	Name and Address of the Steel Maker/Raw Material Supplier	
03	Product Form	
04	Material Specification & Grade (Code Case, if applicable)	
05	Heat/Melt No, SI No (if applicable)	
06	Heat treatment details (Type & Temperature)	
07	Name and Address of Testing Laboratory	
08	Testing method/ Standard (ASTM E139 or BS EN ISO 204)	
09	Test Sample Size	
10	No. of test samples	
11	Temperature at which test is conducted (°C)	
12	Stress value observed (MPa)	
13	Test Start Date & Time	
14	Test End/Reporting Date & Time	
15	Test duration (hours of creep testing)	
16	% Elongation at the reporting/completion of test	
17	Test witnessed by (Name of Inspector & Agency)	
18	Test Result (Accepted/Not Accepted)	

2.6 Heat Treatment:-

2.6.1 All fittings shall be heat treated as below:

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

2.6.2 SA 182 F91 & F92 forgings shall be normalised at 1040 to 1070 deg C (for wall thickness larger than 75 mm, accelerated cooling may be done to obtain a fully martensitic structure) and tempered at 760 ± 10 deg C. Soaking time 1 hour minimum, still air cooling.

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

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- 2.8 **Tension test** shall be carried out on one Test piece for each specification, heat, heat treatment lot and size.
- 2.9 **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.
- 2.10 **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.
- 2.11 **MPI (After Heat Treatment) :100%:** As per ASTM E 709. Linear Indications like cracks, folds & other injurious defects are unacceptable.

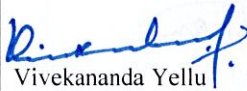
Dry MPI : CS, AS (other than F91, F92) : all sizes.
Wet MPI : SA182 F91, F92 : all sizes.
- 2.12 **Ultrasonic Test:-** Forgings of all thickness shall be ultrasonically tested as per SA 388 and acceptance norms shall be as per 3.3.4 of ASME Section VIII Division 2.
- 2.13 **Photomicrograph test for F91 & 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:7328:001**. 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.

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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.

- Bohler Schweisstechnik Austria, Austria
- Bohler Thyssen Schweisstechnik, Germany
- Kobe Steels Ltd., Japan
- Oerlikon Welding Ltd, Switzerland
- 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.

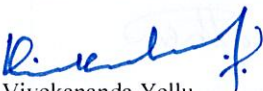
5.0 NON DESTRUCTIVE EXAMINATION

- 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.
- 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,

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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 on weld shall be carried out and report to be furnished. The maximum hardness (HV 10) shall be 300 for Gr91 & Gr92 material; and 225 for Gr11, Gr12 & Gr22.

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

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

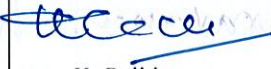
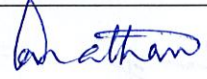
The internal surface shall be protected with rust preventive coating or rust inhibitor.

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, Running Serial number for the P.O. quantity and Statutory authorities seal as applicable.

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Special / Additional Marking : Symbol “-M” to be hard punched / etched and stencilled after the material code.

In addition, the above details along with size shall be paint stencilled on the fittings. If the thickness of the fitting is less than 6 mm, punching is not permitted and the above details shall be paint stencilled. Fittings of size up to 2” (50mm) shall be tied together and the above details shall be punched / engraved in a separate tag and tied to it.

8.3.2 In case of fittings dispatched directly to project site as **DTS**, material code shall be replaced with DU code (14-digit work order du detail) as given by purchase during DTS advice. All other details shall be hard punched & stencilled as indicated in Para 7.3.1.

Sample format for Punching & Stencilling is given below.

Vendor code & Name	:	Makers Emblem Insp. Authority Stamp
Material code / DU details	:	
Melt No.	:	
Material Specification (ASME code case)	:	
Qty.	:	
Weight.	:	

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 as per the Packaging procedure PC: PKG: 01 to avoid transit & other damages. End caps shall not be tack welded with fitting.

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 *Supplier shall have valid ISO:9001-2015 certificate for the duration of the contract.*

11.2 *Finished fittings/items shall be inspected at suppliers works and certified as per BS EN 10204 Type 3.2 by any ASME Authorised Inspection Agency or their subsidiaries covering all details listed in Cl.11.3 to 11.4 below.*

11.3

- 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

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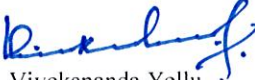
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- x. Ladle and product Analysis of Raw Material.
- xi. Tensile Test
- xii. Bend Test
- xiii. Guarantee of HTP shall be given in the test certificate as follows, if hydro test is not carried out: - "Fabricated Y piece / welded Tees are capable of withstanding 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 11.4 below.

11.4 The following reports shall be **furnished separately** along with the **BS EN 10204 Type 3.2 & MTC** indicated in para 11.3 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)
- vii. Creep test report as per cl.2.5**
- viii. *Print of the Stamp of Inspection Authority, which is used in fitting hard punching.*

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