

	Bharat Heavy Electricals Limited, Piping Centre, Chennai-17 Technical Delivery Conditions for Forgings, Forged Y-Piece, Forged-Tee, Rounds, Stubs, Nozzles, Matching piece- SA 105, SA 182.	TDG:104 : Rev 09 Date: 06.06.2015 Page 1 of 5
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1.0 GENERAL

Materials shall meet Indian Boiler Regulations, (IBR) in addition to the latest version of SA105, SA 182 & Code Case 2179 (for SA182 F92) as on date specified in the Purchase Order (PO).

2.0 RAW MATERIAL

- The raw material used shall meet the respective specification and the test certificate shall be furnished.
- Raw material Steel for IBR forging items to be inspected at Mill & test certificate countersigned by IBR approved Authority, if the mill is not approved under IBR as well known steel maker.
- 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. Indigenous vendors shall procure the raw material for other than SA182 F91 & F92 (code case 2179) from IBR approved sources.
- For SA 105 : Carbon : 0.25% max.
For SA182 F92 : Si: 0.10-0.50%; Ni: 0.30 max and Cu: 0.25 max.
- SS:All raw materials used in steel making including incoming scrap shall be checked by supplier to ensure freedom from radioactivity.

3.0 PROCESS

- Process of manufacture shall conform to applicable standards.
- Unless otherwise specified in the P.O, SA182 F11/12 items shall be supplied as per class 2 and SA182 F22 shall be of Class 3 only.
- Dimensions shall be as per drawings indicated in Purchase Order.
- For SA 182 F91 & F92 (Code Case 2179) : Steel for forging shall be check tested for product analysis at vendor's works and shall be witnessed by IBR / IBR authorised agency. The check test report along with Mill-TC shall be certified by IBR / IBR authorised agency.
- Forging:** to ensure uniformity of structure & strength with reduction ratio in area 4: 1 min from ingot to final forging, close to final size & shape. Flow lines to be parallel to axis of openings. Forged items order to this TDC shall be forged to the nearest shape before machining to final dimensions as per respective drawing.
- Blooms / Billets** used for forgings (Side Length, Dia $\geq$ 50mm) shall be UT tested & for acceptance norm refer sl.5(j). For finished bars this can be done at Final stage.

4.0 HEAT TREATMENT

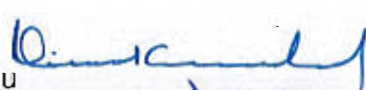
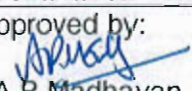
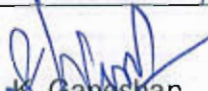
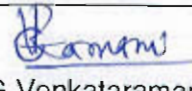
4.1 All items shall be heat treated as below:

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

4.2 SA182 F91 & F92 :-

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.

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**5.0 TESTING**

- (a) **Product analysis:-** Product analysis shall be carried out on One piece / Heat / HT lot / Size.
- (b) **Corrosion test:-** Corrosion test (IGC) shall be carried out on one piece / Heat / HT lot / Size for SS items.
- (c) **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.
- (d) **LPI (After Heat Treatment) :**100% for SS as per ASTM E165, No linear indications acceptable.
- (e) **SS:** Finished forgings shall be checked for radioactive contamination and reported. Survey meter shall be used to measure at 5cm near the surface. Acceptance limits: Shall be less than 0.1 milli Rontgen (MR) per hr or 1 micro Sievert per hr.
- (f) **Tension test:-**Tension test shall be carried out on one Test piece for each specification, heat, heat treatment lot and size.
- (g) **Bend test:-** (a) 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.
(b) Bend test for AS (SA182): One Sample of 25.4 mm width and thickness = t to be bent 180 deg around mandrel of radius = 1.5 t. Test on representative sample is also acceptable.
- (h) **Photomicrograph test for F91 & F92 :-** Photomicrograph test shall be carried from a specimen of forging in the as finished condition for each individual size (OD & 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.
- (i) **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.
- (j) **Ultrasonic Test:-** All items shall be ultrasonically tested as per SA388 and acceptance norms shall be as per ASME Sec VIII Div .2 Cl. 3.3.4.

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

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

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**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. Pickled & Passivated as per ASTM A380 for SS items. 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, PACKING & END PROTECTION

8.1 PAINTING: All items except SS to be applied with resin type rust preventive coating with visibility to punched and stenciled details on outside and either with rust preventive coating or rust inhibitor inside. SS items to be surface treated as per ASTM A380 both inside and outside.

8.2 COLOUR CODING: All items shall be colour coded circumferentially at ends as given below.

SA105	=	Blue
SA182 F11	=	Green & White
SA182 F12	=	Black & Red
SA182 F22	=	Blue & Red
SA182 F91	=	Brown & Red
SA182 F92	=	Brown & Blue
SA182 F316	=	Black & Blue
SA182 F316L	=	Blue, Brown & Yellow

8.3 MARKING (In English only) :-

8.3.1 The items 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 items 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.

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

9.0 INSPECTION & CERTIFICATION (In English only) :-

9.1 All items are to be Inspected at the manufacturer's works by the Inspection agencies / authorities as per IBR and as indicated in the P.O. Inspection certificate in IBR Form IIIC (Form IIIF for well known forger under IBR) shall be submitted along with the Work Test Certificate countersigned by any of the above authorities and shall include the following.

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1. Test Certificate Number & date.
2. BHEL P.O Number & Amendment Number(if any)
3. BHEL P.O. Serial Number
4. BHEL TDC Number
5. Size-wise Quantity
6. Specification, Grade & Year of code.
7. Heat/Melt Number
8. Steel making / forming process
9. Ladle and product Analysis of Raw Material.
10. IBR approved certificate for manufacturing creep resistance steel in case of indigenous steel makers.
- *11. Product analysis report.
- *12. Tensile Test report
- *13. Bend Test report.
- *14. Intergranular corrosion test report for SS
- *15. Measured radioactivity levels shall be reported in the Mill test certificate(Not to be recorded in IBR Form).
- *16. Repair details if any, Certified copy of TC for starting material.
- *17. Guarantee of HTP shall be given in the test certificate as follows if hydro test is not carried out :- "Forgings are capable of with standing without failure, breakage or impairment of their serviceability a hydrostatic test pressure equal to that prescribed for the specified matching pipe of equivalent material".

*Details furnished in the Test certificate in lieu of chart/report is acceptable.

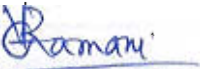
9.2 The following reports shall be **furnished separately** along with the Form III C & MTC indicated in para 9.1 above.

- i. NDE reports for VT, LPI, MPI, 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)

10.0 AUDIT CHECKS AT BHEL

BHEL reserves the right to carry out audit checks for chemistry, HT condition, mechanical test and NDT on representative test bars or job.

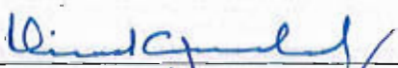
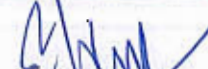
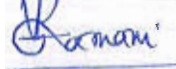
Supplies found defective during check or subsequent processing at BHEL are liable for rejection.

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11.0 Records of Revisions:-

- Revision 02 : Material specification SA 182 F316 added.
- Revision 03 : (i) Para 4.0, 6.0 included.
(ii) Para 5.0 (b),(c),(h),(j), 8.0 and 9.0 (17) are revised.
- Revision 04 : (i) New material specification SA 182 F92 added.
(ii) Para 1.0, 3.0, 4.2, 5 (f), (g) & 8.2 are revised.
(iii) Para 5 (a) to (h) are modified for better clarity.
- Revision 05 : (i) Para 10.0 added.
(ii) Para 2 (c), 3.0, 8.2, 8.3.2 & 9.0 are revised.
(iii) Para 5 (c), 5 (d) & 5 (i) are modified for better clarity.
- Revision 06 : (i) Para 2 (b), 3 (e),(g) & 9.0 are revised.
(ii) Para 4.1, 4.2, 5(h), 6.0, 8.1, 8.2, 8.3 & 8.4 are modified for better clarity.
- Revision 07 : (i) Para 3 (e) deleted-(Creep Test (Type Test) requirement), further clauses renumbered.
(ii) Para 9.0 revised.
- Revision 08 : (i) Para 2.0(b), 3.0(d) & 5.0(g) are revised.
(ii) Para 4.2 modified for better clarity.
- Revision 09 : (i) Items : Forged Y-Piece & Forged-Tee are added.
(ii) Para 2.0(b)(e), 5.0(e) & 9.2 are added.
(iii) Para 3.0(e) & 9.0 modified for better clarity.

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