



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

- (a) The raw material used shall meet the respective specification and the test certificate shall be furnished.
- (b) Steel for SA 182 F11, F12 & F22 if indigenously procured, to be procured from following manufacturers i) Alloy Steel Plant , Durgapur, ii) Tata Iron & Steel company, Jamshedpur & iii) Mahindra UGINE Steel Company , Mumbai, who are approved by IBR for creep resistant steels.
- (c) For SA 105 : Carbon : 0.25% max.
For SA182 F92 : Si: 0.10-0.50%; Ni: 0.30 max and Cu: 0.25 max.

3.0 PROCESS

- (a) Process of manufacture shall conform to applicable standards.
- (b) Unless otherwise specified in the P.O, SA182 F11/12 fittings shall be supplied as per class 2 and SA182 F22 shall be of Class 3 only.
- (c) Dimensions shall be as per Purchase Order.
- (d) Steel for forging for IBR items to be inspected at Mill & test certificate countersigned by IBR / IBR approved authority, if the mill is not approved under IBR as well known steel make.
- (e) **Creep testing (type test) for IBR items of SA 182 F91 & F92 :-** (i) The Steel maker shall have done Min 10000 hr creep test. The Forge shop shall have done min 1000 hr creep test.
(ii) **Import and indigenous suppliers** shall have creep test report (type test) for raw material steel and for forge shop separately, which shall be signed by concerned lab personnel.
(iii) Creep test for indigenous steel makers and forgers shall only be done at the following labs :- **NML Jamshedpur or BHEL R&D Hyderabad.**
- (f) **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.
- (g) **Blooms / Billets** used for forgings (Side Length, Dia \geq 50mm) shall be UT tested & for acceptance norm refer sl.5(h). For finished bars this can be done at Final stage.

4.0 HEAT TREATMENT

4.1 All fittings shall be heat treated as below:

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

4.2 Fittings conforming to SA182 F91 & F92 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 \pm 10 deg C. Soaking time: 1Hr. minimum. 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 fittings.
- (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) **Tension test:-**Tension test shall be carried out on one Test piece for each specification, heat, heat treatment lot and size.
- (f) **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.
- (g) **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.
- (h) **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.
- (i) **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 fitting 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. 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 fittings 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 fittings to be surface treated as per ASTM A380 both inside and outside.

8.2 COLOUR CODING: All fittings 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 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 (16 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 fittings shall be well protected using end caps and fittings shall be suitably packed in box / crate to avoid transit & other damages.

9.0 INSPECTION & CERTIFICATION (In English only) :-

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 (for items under IBR purview) 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. Product analysis report.
- *11. Creep reports from steel maker and forge shop shall be submitted as detailed in SI 3.
- *12. Heat Treatment Chart.
- *13. NDE report. (VISUAL.MPI, LPI, UT)
- *14. Tensile Test report
- *15. Bend Test report.
- *16. Hardness Test report
- *17. Intergranular corrosion test report for SS
- *18. Photomicrograph test report along with photomicrograph with 500x (min) magnification.
- *19. Dimensional conformance.
- *20. Repair details if any, Certified copy of TC for starting material.
- *21. 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.

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.

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.

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