

	BHEL – Tiruchirappalli - 620014, India. Quality Assurance Department TECHNICAL DELIVERY CONDITIONS	DOC No: TDC:0:404 Rev: 18 Effective Date: 21/02/2018 Page: 1 of 3
Product: Carbon, Alloy & Stainless Steel Forgings (Boilers And Valves)		

Revisions Record:

Rev 09: New materials F23, F91 & F92 requirements added in Cl.1.0, Cl.2.0, and Cl.4.0 to Cl.6.0. CE marking certification clarity included in Cl.10.

Rev 10: Cl 1:F6a Class 2 added, Code case corrected. Cl 2: Steel makers names removed and requirement for creep testing added as per IBR Reg 4, Cl 4: Tempering temperature and soaking time modified for SA 182 F91, F92 & F23. Cl 4 & 10: Photomicrograph requirement added for F91 & F92 forgings, Cl 2, 6 & 10: modified for SS, Cl 5: Bend test Clarified, Cl 6: Wet MPI added.

Rev 11: Cl 2 Pt 3, 4, 5 modified. Cl 6 – Wet MPI for CS, AS added, Cl 10.1 – IBR Forms indicated

Rev 12: Cl 1, 2, 4, 6 and 7 – requirements for grades SA 182 F1, SA 336 F1, F12, F22 Cl 3 and F91 added (for Neyveli Project). Creep test criteria in-line with BHEL R&D included. Cl 2 Pt 8 modified. Cl 6 Pt 1 – SA388 changed to ASTM A 388 based on ASME Sec II Ed 2013.

Rev 13: Dt: 17/11/2014: Cl 2 Cl 4 Cl 10 Cl 12 modified.

Rev 14: Dt: 06/10/2015: Cl.4.3, 5.2, 5.8, 10.1.b.9 added; Cl 1.0, 2.1, 2.2, 2.3, 4.1, 4.2, 5.3, 6.2, 9.0, 10 modified.

Rev 15: Dt: 23/12/2015: Cl 1, 2, 3, 5, 6, 7, 10, 11 & 12 modified.

Rev 16: Dt: 06/02/2017: Cl 1 changed to indicate the use of latest revisions of referred codes, standards, specifications, drawings, procedures, etc; Tempering temperature added for F12 material in Cl 4, Requirements of API 6D removed from Cl 1, 2, 4, 5, 10, 12 since the API 6D certificate license was not applied for; Definitions for relevant, linear and rounded indications provided in Cl 6; Type 3.2 certification changed as per BS EN 10204-2004 in Cl 10.2.

Rev 17: Dt: 27/11/2017: Cl 1, 4 modified to include SA 266 & SA 336 F92 materials; Cl 5 modified to include 100% hardness testing & Creep testing requirements; Cl 6 changed to include UT for forgings above 40 mm; Cl 10 modified suitably.

Rev: 18 Dt: 21/02/2018 – Material SA182 F51 added in Cl 1 based on Engineering/Valves input and minor corrections made in Cl 4 & 5.

1. MATERIAL SPECIFICATIONS:

All the codes, standards, specifications, drawings & procedures, etc., referred in this TDC shall be of latest revision as on the date of Enquiry/Purchase Order, whichever is earlier, unless specified otherwise.

Carbon Steel (CS)	:	SA 105, SA 266, SA 350 LF 2
Alloy Steel (AS)	:	SA 182 F12 Class 2, F22 Class 3, SA 182 F23 (Code case: 2199), SA 182 F91 & SA182 F92 (Code Case: 2179), SA 182 F1, SA 336 F1, SA 336 F12, SA 336 F22 Cl 3, SA 336 F91, SA 336 F92 (Code Case: 2179)
Stainless Steel (SS)	:	SA 182 F6a Class 2, F6a Class 3, SA 182 Gr. F 304, 304L, 316, 316L, 316H, 321, 321H, 347 & 347H; F51 AISI 410 for TOA Gland and bushings.
Additional Requirement	:	As listed below (Supplementary to above material specifications)
Size and Quantity	:	As per Purchase order & Drawing.

2. CHEMICAL COMPOSITION & PROCESS

- Melting: fully killed.
Product analysis per heat: CS: C ≤ 0.25% , AS: SA182 F23: Si: 0.25-0.50% & Cu: 0.25max
SA182 F92: Si: 0.10-0.50%, Ni: 0.30 max & Cu:0.25% max
- Raw material Steel for IBR forging items to be inspected at Mill & test certificate countersigned by IBR approved inspecting authority, if the mill is not approved under IBR as well known steel maker.
- Forging: Hot working 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 ordered 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 or Dia ≥ 50mm) shall be UT tested. For Acceptance criteria refer Cl.6.0. For finished bars, this can be done at final stage.
- SS: All raw materials used in steel making including incoming scrap shall be checked by supplier to ensure freedom from radioactivity.
- Tolerance for chemistry shall be as per the applicable material specifications/standards specified in Cl 1.

3. DIMENSIONS AND TOLERANCES

Dimensions & their tolerances shall be as per drawing. For untoleranced dimensions: CS & AS: as per SA 29;
SS: as per SA 484.

4. HEAT TREATMENT(HT)

- Heat treatment shall be as per applicable drawing. Unless otherwise specified, the following heat treatment shall be following:

CS: SA 105: Normalised; SA 266: As per material specification;

SA 350 LF 2: Normalised at 880-900°C & Tempered at 620-640°C.

AS: Normalised and Tempered. For F12: Tempering at 650°C (min).

For SA 182 F91, F92 & F23, SA336 F91, SA 336 F92: Normalising at 1050-1080°C & Tempering at 750-780°C.

SS: As per applicable material specification & grade.

AISI 410: Supply in Quenched & Tempered condition as below.

Quenching at 955-1010°C in air or water or oil or Polymer. Soaking 30 mts/inch maximum thk. Tempering at 663°C.min. Soaking :60 mts/inch maximum thickness and air cool.



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- 2) Photomicrograph test for F91 & F92 forgings - one per heat treatment lot per size and shall be reported in test certificate. Acceptance – The material shall be free from any micro fissures. Microstructure shall show lath tempered martensite and also to be examined for grain growth. Photomicrograph with 400x (Min) magnification along with Photomicrograph report to be provided. The actual magnification and result of actual microstructure shall be certified/indicated.

5. MECHANICAL TESTS

- 1) Extent of test: One Specimen for each size/heat/HT batch from sample product or identical test coupon.
2) **Tensile test:** The test specimens shall be removed from a test coupon (TC) after the final heat-treatment cycle. Perform tensile tests at room temperature in accordance with the procedures specified in ASTM A370. Perform a minimum of one tensile test. All yield strengths shall be determined using 0.2 % offset method of ASTM A370. The results of the tensile test(s) shall satisfy the applicable material specification requirements.

If the results of the tensile test(s) do not satisfy the applicable requirements, two additional tests on two additional test specimens (removed from the same TC with no additional heat treatment) may be performed in an effort to qualify the material. The results of each of these tests shall satisfy the applicable requirements.

- 3) **Additional requirements for SA182 F23, F91 & F92:**
F91: Yield: (0.2% offset): Min 450 MPa; Tensile: Min 630 MPa, Max 850 MPa; Hardness (HBW): Min 195, Max 248.
F92: Tensile: Min 630 MPa, Max 850 MPa; Hardness (HBW): Min 191, Max 269
F23: Tensile: Min 510 MPa, Max 730 MPa; Hardness (HBW): Min 150, Max 220
Hardness testing shall be 100% as per ASTM E10 or E18.
4) AISI 410: Hardness (100% testing shall be as per ASTM E10 or E18): 197-235 HBW. No other mechanical test required.

Additional requirements of tests: (Other than AISI 410 Only)

- 5) **Bend test: Acceptance as per IBR**
CS: Sample 19mm.Thick(t) x 25.4mm width to be bent 180 deg. around mandrel of radius 6.35 mm.
AS, SS: Sample 19mm.Thick(t) x 25.4mm width to be bent 180 deg. Around mandrel of radius = 1.5 x t.
6) **Impact test for QCNR Valves & CRHNR Valves:** CS, AS and SS: 1 / HT batch. As per ASTM A370, 2mm Charpy-U notch, at Room temperature. Acceptance: Avg of 3 specimens: 36 Joules, Min Single value: 24 Joules
7) **For PED 2014/68/EU (CE-marking) items:** Charpy- V impact test at 20°C as per ASTM A370, Acceptance: Avg of 3 specimens: 40 Joules, Min. single value: 27 Joules.
8) Creep testing & reporting shall be carried out as per SIP:RM:01 (latest revision) whenever indicated in the Enquiry/Purchase Order/Engineering Drawing.

6. NON DESTRUCTIVE TEST

- 1) Extent of test: for each product. Stage of test : After heat treatment.
2) **Volumetric NDE - UT:** As per ASTM A388. All finished forgings of dia/wall thickness > 40 mm; All Body & yoke of special class valves & all forgings of SA 182 F91, F92 & F23, SA 336 F91.
Acceptance: ASME Sec.VIII Div. 2 Cl.3.3.4.
3) **Surface NDT -**
a) **Relevant indication:** Surface-rupture NDE indication with major dimensions > 1.6 mm (1/16 in).
b) **Linear indication:** Surface NDE indication whose length is ≥ three times its width.
c) **Rounded indication:** Surface NDE indication whose length is < three times its width.
d) **MPI for CS & AS : 100% : As per ASTM A275.**
Dry MPI: CS, AS (other than SA 182 F91, F92, F23, SA 336 F91) : all sizes.
Wet MPI : SA 182 F91, F92, F23; SA 336 F91: all sizes.
Acceptance: ASME B16.34 Appendix II. Linear Indications like cracks, folds & other injurious defects are unacceptable.
e) **LPI for SS: 100%: ASTM E165. Acceptance:** No linear indications acceptable.
4) **SS:** Finished forgings shall be checked for radioactive contamination and reported. Survey meter shall be used to measure at 5 cm near the surface. Acceptance limits: Shall be less than 0.1 milli Rontgen (MR) per hr or 1 micro Sievert per hr.

7. WORKMANSHIP AND FINISH

Forged items to spec SA336 shall be machined in the inside surface as it is meant for steam application. Items to be proof machined as per drawing or shot blasted for CS/AS; Pickled & passivated as per ASTM A380 for SS, & be free from scales & defects like laps, seams, folds, cracks, etc. Machined items (except SS) to be coated with a layer of transparent rust preventive before despatch.

8. REPAIR

Repairs by fusion welding are prohibited. Surface defects can be removed by mechanical means and defective areas smoothly dressed up with the adjacent surface. Minimum thickness after repair to meet drawing / Specification.



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9. MARKING AND PACKING

Details of stamping on each item with low stress stamps: Heat/melt number; material specification, grade & class; Code case number (for Gr 92 & 23); Maker's emblem/code & Inspection Authority's seal. Forgings to be properly packed and dispatched to avoid damage during transit.

10. INSPECTION AND CERTIFICATION

10.1 For IBR Items:

- Products shall be inspected at supplier's works/mill and the applicable IBR Form must be countersigned by the Inspecting Authority as indicated below in case the supplier's works/mill is not recognised as a "Well known Forger/Steel maker" under IBR:
 - ☐ **Imported Items:** Inspecting Authority approved by IBR for the Country of origin.
 - ☐ **Indigenously Supplied items:** Director of Boilers/Chief Inspector of Boilers/Inspecting Authority approved by IBR, for the respective state in India.
- Certification in IBR Form III-G for IBR items from "IBR-Well Known Forger" or "Inspecting Authority", as applicable, to be submitted. IBR Form III-G and a separate **manufacturer** Test certificate in English language with following details, shall accompany the product (including proof machined):
 - Purchase Order No.(BHEL), TDC No & its revision no, Test certificate no & date.
 - Specification, Grade & Class with applicable year of code, Code case number (for Gr 92 & 23), Heat Number, Drawing No., Quantity & Size.
 - Supplier of the steel used in making the finished product (well known and others in IBR Form IV).
 - Melting & forging process, Chemistry with incidental elements-Heat wise, Product analysis, Carbon Equivalent (CE).
 - Heat treatment details of the material and test bars. For F91, F92 supplies – Photomicrograph at 400x resolution.
 - Mechanical test results- Tensile (UTS, YTS (0.2% offset), % elongation, % reduction in area), Bend, Impact, Hardness and NDE test results with reference & acceptance standards.
- Repair details if any, Certified copy of TC for starting material.
- For SS:** Measured Radioactivity levels shall be reported in the Mill Test Certificate (not to be recorded in IBR Form).
- Creep test report as per SIP:RM:01 (latest revision) whenever indicated in the Enquiry/Purchase Order/Engineering Drawing.

10.2 For PED 2014/68/EU (CE-marking) items, the test certificates with details specified in Cl 10 (b) shall be submitted as per BS EN 10204.

- For pressure parts**, test certificates of type 3.1 or 3.2 are acceptable.

Type 3.1 – Suppliers shall have ISO 9001-2008/2015 certification certified by Notified Body recognized by European Community and test certificate certified by supplier's authorized inspection representative.

Type 3.2 – Components inspected and test certificates certified by both the supplier's authorized inspection representative and Notified Body recognized by European Community.
- For non-pressure parts**, test certificates of type 2.2 are acceptable.

Type 2.2 – suppliers test certificates signed by suppliers authorized inspection representative with test results as required by this TDC.

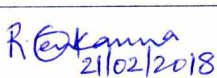
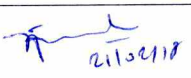
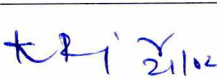
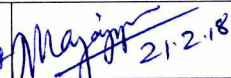
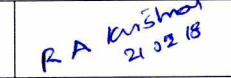
11. AUDIT CHECKS AT BHEL

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 will be rejected.

12. END USE

Valve bodies, bonnets, discs, socket ends, body guides, etc., Pressure part fittings in boilers & low, high temperature service like discs, socket weld tees, elbows, weld neck flanges & stubs (except drum nozzles) meeting IBR, ASME Section I, ASME B16.34 and PED 2014/68/EU.

Non pressure part items in boilers and valves: For these, requirements on starting material, bend test and inspection by IBR are not required.

 21/02/2018	 21/02/18	 21/02/18	 21.2.18	 21.02.18	 21/02/18
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