**Revisions Record:**

**Rev: 01**: Source of supply for AS included.

**Rev: 02**: Text re-written, Class Nos introduced for Alloy steel. High temperature test removed. TDC: 03: 306/00 merged into this.

**Rev: 03**: Cl. 4, 6, 9 modified.

**Rev: 04**: Cl 5 revised to include Impact test for bars used for valves purchase orders, clarity brought in Cl 4.

**Rev: 05**: Heading modified. Cl 1 size restriction for CS and AS SA182 rolled bars added as per ASME. SA182 Gr 91&Gr 92 added and subsequent clauses modified for chemistry, Heat treatment, mechanical properties, photomicrograph and NDE. Cl 2 – Steel makers names removed and requirement for creep testing added as per IBR Reg 4. Cl 2, 6 &10 modified for SS. Cl 4 – SA 182 F91, F92 & F23 Tempering temperature and soaking time modified. Cl 5 – Bend test Clarified, Cl 6 – MPI added. Cl 11 added. Cl 10 – IBR Forms indicated. CS: SA675 Gr 70 added and its requirements added in Cl 1, 2, 4 in line with collaborator practise.

**Rev 06**: Dt: 25/11/2014 Cl 2, 4, 5, 6, 10 modified

**Rev 07**: Dt: 06/10/2015: Cl 2.5, 4.3, 5.6, 10.9 added; Cl 1.0, Cl.2.3, 4.2, 5.2, 6.1, 9.0, 10, 12.0 modified.

**Rev 08**: Dt: 24/12/2015: Cl 1, 2, 3, 5, 6, 7, 10, 11 & 12 modified.

**Rev: 09** Dt: 25/07/2016 – Cl 1 modified to add SA 182 F304L, Cl 5 modified to add impact requirement for SA 479 TP 410 Condition 2

**Rev 10**: 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 updated as per BS EN 10204-2004 in Cl 10 (b).

***Rev 11: Dt: 27/11/2017: Cl 2 modified; Cl 5 modified to include 100% hardness testing and Creep testing requirements; Cl 6 changed to inlcude UT for forgings above 40 mm; Cl 10 modified suitably.***

## 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 Steels (CS) | : | SA 105, SA 675 Gr 70 |
| Low Alloy Steels (AS) | : | SA 182 F11 Class 2, F12 Class 2 & F22 Class 3, SA182 F91 & SA182 F92 (Code case 2179); SA 193 B7 & B16 |
| Stainless Steels (SS) | : | Austenitic: SA 182 F304, F304L, F316, SA 479 TP 304;<br>Martensitic: SA 479 TP 410 Condition 2 |
| Additional Requirements | : | As listed below (Supplementary to above material specifications) |
| Size and Quantity | : | As per Purchase Order & Drawing. |

**SA 105 and SA 182 rolled bars shall be restricted to dia ≤ 114.3mm.**

## 2. CHEMICAL COMPOSITION & PROCESS

1) **Melting**: CS & AS: Fully killed. CS : SA 675 – Silicon and Aluminium killed. Product analysis per heat: CS: C≤ 0.25%. SA182 F92: Si: 0.10-0.50%, Ni: 0.30 max & Cu:0.25% max.
2) **CS, AS**: Rolled bars shall be processed by hot forging/rolling and subsequently finished by cold rolling (if required) to final size. **SS**: hot finished.
3) Raw material Steel to be inspected at Mill ***& IBR form IV shall be submitted.***
4) **SS**: All raw materials used in steel making including incoming scrap shall be checked by supplier to ensure freedom from radioactivity.
5) 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)

1) CS: SA 105 Normalised at 880-920$^0$C, SA 675 Normalised at 880-920$^0$C and Tempered at 600-650$^0$C
   AS (SA 182): Normalised and tempered. For F12:Tempering at 650$^0$C (min).
   For SA 182 F91, F92 Normalising at 1040-1080$^0$C & Tempering at 750-780$^0$C.
   SA 193: Quenched and tempered as per material specification & grades.
   SS: As per material specification & grade.

2) Photomicrograph test for F91 & F92 bars - one per heat treatment lot per size and reported in test certificate.
**Acceptance** – The material shall be free from any micro fissures. Microstructure shall show lathe 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.
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 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.
   Hardness testing shall be ***100%*** as per ASTM E10 or E18.
4) Additional tests: **Bend test**:
   **CS**: 1 Sample 19mm thick(t)x25.4mm width to be bent 180 deg around mandrel of radius 6.35mm.
   **AS (SA 182 only), SS**: 1 Sample 19mm thick(t) x 25.4mm width to be bent 180 deg around mandrel of radius 1.5 x t.
5) Bars meant for Valves purchase orders of SA105 and SA182 F22 Cl3 materials shall be impact tested.
   1/HT batch: ASTM A370, 2mm. Charpy-U Notch at room temperature.
   **Acceptance**: Avg of 3 specimens: 36 Joules, Min. single value: 24 Joules.
6) For PED 2014/68/EU (CE-marking) items: Charpy- V impact test at $20^0$C as per ASTM A 370.
   **Acceptance**: Avg of 3 specimens : 40 Joules, Min. single value: 27 Joules.
7) ***Creep testing 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.
   a) **Volumetric NDT - UT**: 100% for dia/***thickness*** > ***40mm*** and for all bars of SA 182 F91& F92 as per ASTM A388. **Acceptance**: ASME Sec.VIII Div. 2 Cl.3.3.4.
   b) **Surface NDT** –
      i. **Relevant indication**: Surface-rupture NDE indication with major dimensions > 1.6 mm (1/16 in).
      ii. **Linear indication**: Surface NDE indication whose length is ≥ three times its width.
      iii. **Rounded indication**: Surface NDE indication whose length is < three times its width.
      iv. **MPI for CS & AS (other than SA182 F91, F92)**: As per ASTM A275. Dry MPI:100%;
      **For SA182 F91, F92**: 100% Wet MPI.
      **Acceptance**: ASME B16.34 Mandatory Appendix II. Linear indications (like cracks, laps, folds & other injurious defects) are unacceptable.
      v. **LPI for SS**: 100%: ASTM E165. **Acceptance**: No linear indications acceptable.

2) **SS**: Finished bars 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.

## 7. WORKMANSHIP AND FINISH

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.

## 9. MARKING AND PACKING

1) Details of stamping on each item with dia ≥ 25 mm: with low stress stamps and bordered by paint: Heat/melt number; material specification, grade & class; Size; Code case number (for Gr 92); Maker's emblem/code & Inspection Authority's seal.
2) For items with dia < 25 mm: All above details to be painted.
3) Bars to be supplied in bundles < 1 ton, secured suitably for rough handling. Metal tags with details of specification, melt number and maker's emblem to be secured to the bundles.

## 10. INSPECTION AND CERTIFICATION

a) **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 IV for IBR items from "IBR-Well Known Forger/Steel Maker" or "Inspecting Authority", as applicable, to be submitted. IBR Form IV & a separate ***manufacturer*** test certificate in English language with following details, shall accompany the product (including proof machined):

1. Purchase Order No.(BHEL), TDC No & its revision no, Test certificate no & date.
2. Specification, Grade & class with applicable year of code, Code case number (for Gr 92), Heat Number, Drawing No, Quantity & Size.
3. Supplier of the steel used in making the finished product (well known and others in IBR Form IV).
4. Melting & rolling process, Chemistry including incidental elements - Heat wise, Product analysis, Carbon Equivalent (CE).
5. Heat treatment details of the material and test bars. For F91, F92 supplies – Photomicrograph at 400x resolution.
6. Mechanical test results- Tensile (UTS, YTS (0.2 offset), % elongation, % reduction in area), Bend, Impact, Hardness and NDE test results with reference & acceptance standards.
7. Repair details if any, Certified copy of TC for starting material.
8. **For SS**: Measured Radioactivity levels shall be reported in the Mill Test Certificate (not to be recorded in IBR Form).
9. ***Creep test report as per SIP:RM:01 (latest revision) whenever indicated in the Enquiry/Purchase Order/Engineering Drawing.***

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

1. **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.
2. **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

SA 105, SA 182 & SA 479 are for Pressure part components in Boilers & Valves of high temperature service meeting IBR, ASME Section I and PED 2014/68/EU. SA 193 is for high temperature bolting and for drive shafts.

| R. Venkanna 27/11/2017 | 27/11/17 | 27.11.17 | 27/11/17 | 27/11/17 | R A Krishnan 27/11/17 | 27/11/17 |
|---|---|---|---|---|---|---|
| Venkanna Rupani | G. Panneer Selvam | N. Kirubakaran | K. Rajasekaran | R. Rajappan | R. Ananthakrishnan | Amit Roy |
| Sr.Engineer/ QA | DGM/QA | SDGM/PE/ FB | SM/Valves/ Engg | SDGM/MM | AGM/Valves/ Purchase | AGM/QA& BE |
| **Prepared By** | **Reviewed By** | | | | | **Approved By** |