1.0 SCOPE: -

The fittings shall meet respective ASME standard requirements, unless otherwise specified, and the following requirements in addition to the standards specified in the Purchase Order (PO).

Applicability: *Other than Gr-91 & Gr-92 material grades.*

Grade, Size & Quantity: As per Purchase Order &/ Drawing.

2.0 RAW MATERIALS: -

a) All fittings shall be of seamless construction unless otherwise specified in the purchase order. Pipes used for manufacturing of seamless fittings shall be seamless pipes or forgings only.

b) All pipes used for fittings shall meet the respective specification. The test certificate shall be furnished with Traceability.

3.0 MANUFACTURING & TESTING REQUIREMENTS:

3.1 MANUFACTURING PROCESS:

(i) Seamless Fittings: -

A) Tees & Reducers: Upto 80mm thickness: Formed Type.
Above 80mm thickness Formed or Forged type.

B) Elbows: Formed type for all thickness

(ii) Welded Fittings: - Supplied only if indicated in P.O and shall be of **Two-Half construction.**

3.2 Machined Fittings (Max size permitted 4"- directly from bar) – Reducers, Couplings, Nozzles, Stubs & End Caps. Fittings machined from Castings are **prohibited.**

Starting material Rolled or Forged Bars (Killed Steel)	Heat treatment	CS – Normalised AS – Normalised & Tempered SS & Duplex SS (UNS32205) – Solution Annealed
	NDE – UT	To be done after Heat treatment. For size above 40mm – to be done as per ASTM A 388 Acceptance to - ASME Sec.VIII Div.2 Cl.3.3.4. Actual measured notch depth to be specified in Test Certificate.
Finished fitting (after machining)	Heat treatment	Not required
	NDE (for all sizes)	• MT (100%) - Procedure - As per ASTM E709. No linear indications are acceptable (Linear Indication : Length ≥ 3XWidth) • LPI – **SS & Duplex SS (UNS32205)**: Shall be done as per ASTM E165. No linear indications are acceptable.
	Hardness	Hardness for. WPB, WPC, WP11, WP12, WP22 – 197 HBW max. Duplex SS (UNS32205) – 300BHN max
	Dimension	ASME B16.9 or as per Engineering Drawing indicated in Purchase Order.
	Bend Test - **One sample of each specification, heat, heat treatment lot and size**	Specimen: 19mm. Thickness (t) x 25.4mm width - cold bent 180 deg. over thin section without fracture, mandrel radius: CS :<=6.35 mm. AS, SS : <=1.5 times specimen thick.

3.3 Seamless Formed Fittings – Ells, Tees, Reducers, Dished end (End cover / Cap)

<table>
<tr><td>Starting material:</td><td>Heat treatment shall be as per starting material specification</td><td>CS – Normalised
AS – Normalised & Tempered
SS & Duplex SS (UNS32205) – Solution Annealed</td></tr>
<tr><td>1)Tube & Pipe</td><td>NDE – UT</td><td>UT shall be done as per - ASTM E 213 with longitudinal notch of 5% wall thickness with max.1.5mm and min. 0.3mm. Actual measured notch depth to be specified in Test Certificate.</td></tr>
<tr><td>2) Forged blank (For End covers)</td><td>NDE – UT</td><td>For size above 40mm
UT shall be done as per - ASTM A 388
In acceptance to - ASME Sec.VIII Div.2 Cl.3.3.4. Actual measured notch depth to be specified in Test Certificate.</td></tr>
<tr><td>3) Plate</td><td>NDE – UT</td><td>For size above 10mm
SA 578, Acceptance Level – B. Actual measured notch depth to be specified in Test Certificate.</td></tr>
<tr><td rowspan="8">Finished fitting (cold/hot forming)</td><td>Heat treatment after forming</td><td>Shall be done as per SA234 and follow below table for heat treatment values.
<table>
<tr><th rowspan="2">Material</th><th colspan="2">Heat Treatment Temp,°C</th><th colspan="2">Soaking time, hr/in</th></tr>
<tr><th>Normalising</th><th>Tempering</th><th>Normalising</th><th>Tempering</th></tr>
<tr><td>CS- WPB & WPC</td><td>870-900</td><td>-</td><td>1/2</td><td>-</td></tr>
<tr><td>AS–WP11 & WP12</td><td>920-960</td><td>640-670</td><td>1/2</td><td>1</td></tr>
<tr><td>AS–WP22</td><td>920-960</td><td>680-710</td><td>1/2</td><td>1</td></tr>
</table>
Stainless Steel - All grades & Duplex SS (UNS32205): - Solution Annealed: 1050-1100 Deg C
Soaking time : ½ hr per inch with minimum 15 minutes
Note: Normalising shall be done for a minimum time of 30 min while tempering to be done for a minimum time of 60min for all materials except SS & Duplex SS (UNS32205).</td></tr>
<tr><td>NDE (for all sizes) – Except for Plate formed Dished end</td><td>• MT (100%) - Shall be as per - ASTM E709 No linear indications are acceptable.
• LPI – SS & Duplex SS (UNS32205): Shall be done as per ASTM E165. No linear indications are acceptable.</td></tr>
<tr><td>NDE–for Plate formed Dished end</td><td>For Plate Formed Dished end – 100% MT as per - ASTM E709 on both inner and outer surfaces of Knuckle radius and weld ends. No linear indications are acceptable.
UT shall be as per A578 Level-B. Actual measured notch depth to be specified in Test Certificate.</td></tr>
<tr><td rowspan="2">NDE – UT

For OD >/= 200mm
or

W.T >/= 6mm</td><td>If made from Pipe & Tube –
Shall be done as per - ASTM E 213 with longitudinal notch of 5% wall thickness with max.1.5mm and min. 0.3mm. Actual measured notch depth to be specified in Test Certificate.</td></tr>
<tr><td>If made from Forging - Shall be as per - ASTM A 388
In acceptance to - ASME Sec.VIII Div.2 Cl.3.3.4. Actual measured notch depth to be specified in Test Certificate.</td></tr>
<tr><td>Hardness</td><td>Base material Hardness for
WPB, WPC, WP11, WP12, WP22 – 197 HBW max.
Duplex SS (UNS32205) – 300HBW max</td></tr>
<tr><td>Dimension</td><td>ASME B16.9 or As per Engineering drawing indicated in Purchase Order. The ends of reducers shall have a straight portion of Minimum 13mm.</td></tr>
<tr><td>Bend Test (if starting material is forged blank) - One sample of each specification, heat, heat treatment lot and size</td><td>Specimen: 25.4 mm x 19 mm thick - cold bent 180 deg. over thin section without fracture, internal radius of bend: CS :<=6.35 mm.
AS, SS: <=1.5 times specimen thick.</td></tr>
</table>

3.3 Forged Fittings –Tees, Reducers, Couplings, Flanges, Nozzles, Stubs & Dished End (End cover/Cap)

Shall be forged to the shape with a minimum forge reduction ratio of 1:4. Fitting shall not be machined directly from bars.

<table>
<tr><td rowspan="8">Starting material:
Rolled or Forged Bars, Blooms, Billets (Killed steel)</td><td>Heat treatment shall be as per starting material specification</td><td>CS – Normalised
AS – Normalised & Tempered
SS & Duplex SS (UNS32205) – Solution Annealed</td></tr>
<tr><td>NDE – UT</td><td>To be done for diameter or thickness above 40mm
Procedure - As per ASTM A388
In acceptance to - ASME Sec.VIII Div.2 Cl.3.3.4. Actual measured notch depth to be specified in Test Certificate.</td></tr>
<tr><td rowspan="6">Finished fitting</td><td>Heat treatment
After forging (cold/hot forging)</td><td>Shall be done as per SA234 and follow below table for heat treatment values.
<table>
<tr><th rowspan="2">Material</th><th colspan="2">Heat Treatment Temp,◦C</th><th colspan="2">Soaking time, hr/in</th></tr>
<tr><th>Normalizing</th><th>Tempering</th><th>Normalizing</th><th>Tempering</th></tr>
<tr><td>CS- SA105</td><td>870-900</td><td>-</td><td>1/2</td><td>-</td></tr>
<tr><td>AS–SA182 F11 & F12</td><td>920-960</td><td>640-670</td><td>1/2</td><td>1</td></tr>
<tr><td>AS–SA182 F22</td><td>920-960</td><td>680-710</td><td>1/2</td><td>1</td></tr>
</table>
Stainless Steel (SA182) - All grades & Duplex SS (UNS32205-SA182): -
Solution Annealed: 1050-1100 Deg C
Soaking time : ½ hr per inch with minimum 15 minutes

Note: Normalising shall be done for a minimum time of 30 min while tempering to be done for a minimum time of 60min for all materials except SS & Duplex SS (UNS32205).</td></tr>
<tr><td>NDE – UT
For OD >/= 200mm or W.T >/= 6mm</td><td>UT shall be done as per - ASTM A388
In Acceptance to - ASME Sec.VIII Div.2 Cl.3.3.4. Actual measured notch depth to be specified in Test Certificate.</td></tr>
<tr><td>NDE (for all sizes)</td><td>MT- (100%) Shall be done as per ASTM E709.
No linear indications are acceptable.

LPI – SS & Duplex SS (UNS32205): Shall be done as per ASTM E165. No linear indications are acceptable.</td></tr>
<tr><td>Hardness</td><td>SA105 : 137-187HBW; SA182 F11, F12, F22 – 143-207HBW.

Duplex SS (UNS32205) – 300BHN max</td></tr>
<tr><td>Dimension</td><td>ASME B16.9 or ASME B16.5 or as per Engineering drawing indicated in Purchase order.</td></tr>
<tr><td>Bend Test - One sample of each specification, heat, heat treatment lot and size</td><td>Specimen: 19mm. Thickness (t) x 25.4mm width - cold bent 180 deg. over thin section without fracture, mandrel radius: CS :<=6.35 mm.
AS, SS : <=1.5 times specimen thick.</td></tr>
</table>

3.5 Welded Fittings– Ells, Tees, Reducers (Two-Half construction):

Pipe made from plate and long seam welded shall not be used as a starting material.

<table>
<tr><td>Starting material:
Plate</td><td>NDE – UT</td><td>For thickness above 10mm
SA 578, Acceptance Level – B.</td></tr>
<tr><td rowspan="6">Finished fitting</td><td>Heat Treatment

After forming</td><td>Shall be done as per SA234 and follow below table for heat treatment values.
<table>
<tr><td rowspan="2">Material</td><td colspan="2">Heat Treatment Temp,°C</td><td colspan="2">Soaking time, hr/in</td></tr>
<tr><td>Normalizing</td><td>Tempering</td><td>Normalizing</td><td>Tempering</td></tr>
<tr><td>CS- WPBW & WPCW</td><td>870-900</td><td>-</td><td>1/2</td><td>-</td></tr>
<tr><td>AS–WP11W & WP12W</td><td>920-960</td><td>640-670</td><td>1/2</td><td>1</td></tr>
<tr><td>AS–WP22W</td><td>920-960</td><td>680-710</td><td>1/2</td><td>1</td></tr>
</table>
Stainless Steel - All grades & Duplex SS (UNS32205): - Solution Annealed: 1050-1100 Deg C
Soaking time : ½ hr per inch with minimum 15 minutes</td></tr>
<tr><td>Post Weld Heat Treatment (PWHT)</td><td>PWHT shall be done as indicated below.
<table>
<tr><td>Material</td><td>Heat Treatment Temp,°C</td><td>Soaking time</td></tr>
<tr><td>CS- WPB-W & WPC-W
If weld thk>19mm</td><td>595-635</td><td rowspan="2">2.5min per mm of weld thk; Minimum 30minutes.</td></tr>
<tr><td>AS–WP11-W&WP12-W</td><td>650-680</td></tr>
<tr><td>AS–WP22-W</td><td>690-710</td><td>2.5min per mm of weld thk; Minimum 60minutes.</td></tr>
</table></td></tr>
<tr><td>NDE (for all sizes)</td><td>• MT (100%)- Procedure - As per ASTM E709.
No linear indications are acceptable

• LPI – SS & Duplex SS (UNS32205) : Shall be done as per ASTM E165.
No linear indications are acceptable.</td></tr>
<tr><td>NDE – for Weld</td><td>• RT (100%)- Acceptance norm shall be UW 51 of ASME Sec VIII DIV-1.</td></tr>
<tr><td>Hardness</td><td>Base material Hardness for
WPB, WPC, WP11, WP12, WP22 – 197 HBW max.

Duplex SS (UNS32205) – 300BHN max</td></tr>
<tr><td>Dimension</td><td>ASME B16.9 or as per Engineering drawing indicated in Purchase order.</td></tr>
<tr><td>Bend Test - One sample of each specification, heat, heat treatment lot and size</td><td>Specimen: 19mm. Thickness (t) x 25.4mm width - cold bent 180 deg. over thin section without fracture, mandrel radius: CS :<=6.35 mm.
AS, SS : <=1.5 times specimen thick.</td></tr>
</table>

4.0 GENERAL REQUIREMENTS:

a) Carbon < or = 0.25% for WPB (all thickness) and WPC (thickness < or = 20mm)
b) Carbon < or = 0.30% for WPC (thickness > 20mm)
c) **If UT not done on the starting material, the same shall be done by the fitting manufactures before forming / fabrication.**

d) **Mechanical Testing** –Test samples shall be tested in the Heat treatment of fitting delivered condition.
1. *Tensile Test*: - One sample of each specification, heat, heat treatment lot and size shall be subjected to Tension Test as per applicable standard.
2. The following ***supplementary tests*** shall be carried out for specifications namely SA 234 WPC / SA105/WP11/F11/WP12/F12/WP22/F22 (No supplementary test applicable for SA 234 WPB)
   i) Product analysis – one / heat / size.
   ii) Tension test – one / heat / heat treatment lot / size

e) In case of welded fittings, WPS, PQR & welder qualification shall be approved by BHEL, prior to start of welding.

f) Unless otherwise specified in the P.O SA 234 WP 11/12/22 fittings shall be supplied as per class1.

g) Unless otherwise specified in the P.O SA 182 F11/12 shall be supplied as class 2 & F22 fittings shall be supplied as per class 3.

h) **Stainless Steel (SS) & Duplex SS (UNS32205):** Finished fittings 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.

5.0 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.

6.0 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 & Duplex SS (UNS32205). 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.

Flatness on curved surfaces of fittings shall be limited to 6% of nominal OD.

Thickness: Outer Diameter & Transition: Variation shall be merged smooth to min 1:4 taper.

7.0 PAINTING, COLOUR CODING & MARKING

7.1 **PAINTING:** All fittings (except stainless steel and galvanized) shall be **painted** on the external surface as given below (unless otherwise specified): -

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

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

Stainless steel and Duplex SS (UNS32205) fittings need not be painted.

7.2 **COLOUR CODING:** All fittings shall be colour coded circumferentially at all ends as given below:

Material Specification		Colour Code
SA 234 / SA182	WPB	Red
	WPC & **SA105**	Blue
	WP11 / F11	Green & White
	WP12 / F12	Black & Red
	WP22 / F22	Blue & Red
SA 403	WP304	Blue & Yellow

	WP304H	Black, Blue & Yellow
	WP316	Black & Green
	WP316L	Blue, Brown & Yellow
	WP321	Blue & Brown
	WP347	Yellow & Black
SA182 & SA815 (Duplex Stainless Steel)		Red, White & Green

7.3 **MARKING** (In English only)**:**

7.3.1 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.

Special / Additional Marking : *Symbol "**-M**" to be hard punched / etched / 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.

7.3.2 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	:	
Qty.	:	
Serial No	:	(Example : 1,2,3,.....& 25)
Weight.	:	

8.0 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.

9.0 INSPECTION & CERTIFICATION (In English only)**: -**

9.1 Supplier shall have valid ISO:9001-2015 certificate for the duration of the contract. However, ISO:9001-2008 certification is acceptable till 14th September 2018.

9.2 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.9.3 to 9.4 below.

9.3 1. Test Certificate Number & date.
2. BHEL P.O Number & Amendment Number
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. Starting material details with traceability.
9. Steel making process
10. Ladle Analysis of Raw Material and product analysis of fitting.
*11. Supplementary Test (Product analysis, Tension test.) results.
12. Tensile Test Report
*13. Guarantee of HTP shall be given as follows: - "Fittings are capable of withstanding without failure, leakage 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 Tests certificate in lieu of chart/report is acceptable.

9.4 The following reports shall be **furnished separately** along with the **BS EN 10204 Type 3.2** & MTC indicated in para 9.3 above.

i. NDE reports for MT, RT, UT (UT Reports in soft copy + hard copy). Actual measured UT-notch depth to be specified in Test Certificate.
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 500x magnifications.
vi. Dimensional report (as built drawing with dimensions)
vii. Thickness Measurement Report for Elbows & Tees as per Doc No : TDG102:001 & TDG102:002 enclosed.
viii. Print of the Stamp of Inspection Authority, which is used in fitting hard punching.

10.0 AUDIT CHECKS AT BHEL

BHEL reserves the right to carry out audit checks for Chemistry, HT condition, Mechanical test and NDT on fittings.
Supplies found defective during check at BHEL are liable for rejection.

11.0 RECORDS OF REVISION: -

Rev 00 : Fresh Issue

*****

THICKNESS MEASUREMENT REPORT FOR ELBOW

Doc No: TDG102:001 Rev.00

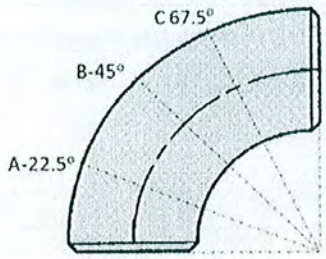
Date: 03.02.2014

PO Number:

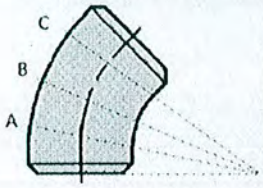
Work order/Du:

Heat no:

Size:



90° Elbow



Less than 90°

Measurement (Extrodus) points

Angle	A	B	C
90	22.50°	45.00°	67.50°
60	15.00°	30.00°	45.00°
45	11.25°	22.50°	33.75°
30	NA	15.00°	NA

Description of item :
Material Spec :
Material Code :

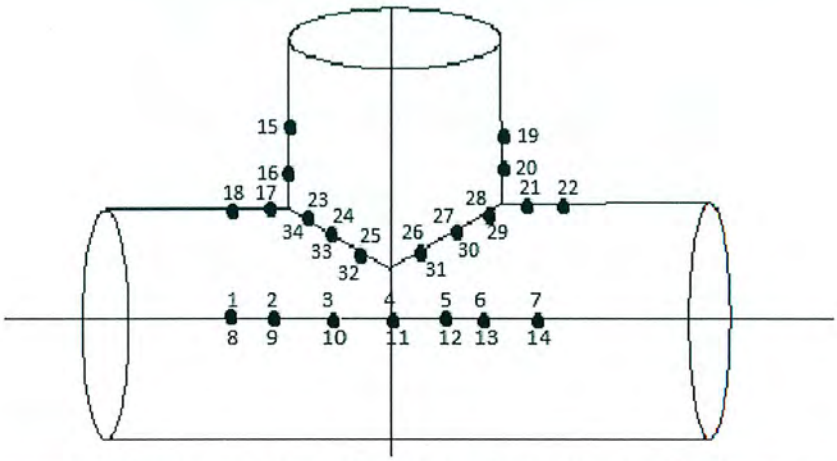
No	Wall thickness at ends		Wall Thickness at angle			Remarks
	End 1	End 2	A	B	C	
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						
11.						
12.						
13.						
14.						
15.						

Vivekananda Yellu/ QA	Rajitha K / MM	C. Karunakaran / Engg	P Ravi Shankar / Quality
Prepared by	Reviewed by		Approved by

THICKNESS MEASUREMENT REPORT FOR TEE's

Doc No: TDG102:002 Rev.00
Date: 20.06.2015

PO Number:
Description of Material:
Size:
Material Spec.
Work order/Du:



Location	Thickness (mm)	Location	Thickness (mm)	Location	Thickness (mm)
1		13		24	
2		14		25	
3		15		26	
4		16		27	
5		17		28	
6		18		29	
7		19		30	
8		20		31	
9		21		32	
10		22		33	
11		23		34	
12		24			

Vivekananda Yellu/ QA	Rajitha K / MM	C. Karunakaran / Engg	P Ravi Shankar / Quality
Prepared by	Reviewed by		Approved by