1.0 GENERAL:-

The fittings shall meet Indian Boiler Regulations (IBR), unless specified otherwise, and the following requirements in addition to the standards specified in the Purchase Order (PO).

2.0 RAW MATERIALS:-

a) All pipes used for fittings shall meet the respective specification. The test certificate shall be furnished. Raw-material used for manufacturing of seamless fittings shall be seamless pipes or forgings only

b) All mother pipes used for fittings shall be subjected to a hydraulic test as per SA 530 or UT as per ASTM E 213 at the mill.

c) SA 335 P91 pipes shall be procured from the Mills listed in document ref.QCP:19(latest revision). Indigenous raw material for Alloy Steel other than SA 335 P91 shall be procured from IBR approved "creep resistance steel makers".

d) All plates used for fittings shall be UT tested as per S1 of SA578 and acceptance norms shall be as per Level B of SA578

e) The raw material forging shall be ultrasonically tested as per SA 388 and the acceptance norm shall be as per 3.3.4 of ASME Sec VIII Div 2.

f) SA 182 F91 forgings shall be procured from the Mills listed in document ref.QCP:18(latest revision). Indigenous raw material for Alloy Steel other than SA 182 F91 shall be procured from IBR approved "creep resistance steel makers".

g) Carbon content of SA 234 WPB, WPC, SA 105 fittings shall be restricted to 0.25% max

3.0 PROCESS:-

a) **MANUFACTURING PROCESS :**

i. Elbows: Formed type for all thickness

ii. Tees & Reducers: Upto 80mm thickness: Formed Type only.
Above 80mm thickness: Formed / Forged type.

b) Process of manufacture shall conform to applicable standards.

c) All fittings shall be of seamless unless otherwise specified in the purchase order.

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

e) Dimensions shall be as per ASME B16.9 or B16.28, Butt Weld edges shall be as given in Purchase Order. The ends of reducers shall have a straight portion of Minimum 13mm.

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

4.0 HEAT TREATMENT:-

4.1 All fittings shall be heat treated as below.

SA 234 WP B	- As per specification
SA 105, SA234 WP C	- Normalised
SA234 WP11/ WP12/ WP22	- Normalised & Tempered
SA182 F11/ F12/ F22	- Normalised & Tempered

Stainless Steel:-

SA 182 F304/ 316/ 321/ 347	- Solution annealed
SA 403 WP304/ 316/ 321/ 347	- Solution annealed
SA 815 (Duplex Stainless Steel)	- Solution annealed

4.2 Fittings conforming to SA 234 WP91 shall be normalized at 1040 to1070deg C (for wall thickness larger than 75 mm, accelerated cooling may be done to obtain a fully martensitic structure) and tempered at 760 ± 10 deg C. Soaking time:1Hr. Minimum. Still air cooling.

5.0 TESTING: -

(a) MPI / LPI:- All ferrous fittings shall be tested by MPI as per ASTM E-709 and SS fittings shall be LPI tested as per ASTM E 165.

(b) Tensile Test:- One fitting of each specification, heat, heat treatment lot and size shall be subjected to Tension Test as per applicable standard.

(c) Ultrasonic Test :- All fittings of wall thickness above 6mm or NB 200mm and above shall be Ultrasonically Tested as per SA 388; acceptance norms shall be 3.3.4 of ASME section VIII Div.2. If made form Plate shall be as per A578 Level-B

(d) Hardness Test:-

(i) For SA234 WP91:-100% of items;Value:191-250 BHN max.
(ii) For SA 815 (Duplex SS):- 100% of items; Value: 290 BHN max.
(iii) For other specn :- 10% of items; Value - As per specn.

The hardness test values shall be indicated in the Test certificate.

(e) Radiography Test (for Welded fittings):- All the welds shall be 100% RT tested and acceptance norms shall be UW 51 of ASME Sec VIII DIV-1.

(f) The following **supplementary tests** shall be carried out for specifications namely SA 234 WPC / WP11 / WP12 / WP22 / WP91 (No supplementary test applicable for SA 234 WPB)

a) Product analysis – one / heat / size.
b) Tension test – one / heat / heat treatment lot / size.

(g) Photomicrograph test for WP91:- 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.

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.

7.0 WORKMANSHIP, FINISH & 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. Repair by welding is not permitted for seamless fittings.

A.P.Madhavan Kutty, Quality	Approved by	C.Karunakaran, Engg
K. Ganeshan, OPC & MPL		G.Venkataramani, Engg & Qlty

8.0 PAINTING, COLOUR CODING, MARKING, PACKING & END PROTECTION

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

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.
d) Shade : Aluminium -- for all fittings.

The internal surface shall be protected with rust preventive coating or rust inhibitor. Stainless steel and Galvanised fittings need not be painted.

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

SA 234	WPB	=	Red
	WPC	=	Blue
	WP11	=	Green & White
	WP12	=	Black & Red
	WP22	=	Blue & Red
	WP91	=	Brown & Red
	WP 304	=	Blue & Yellow
	304H	=	Black, Blue & Yellow
	316	=	Black & Green
	316L	=	Blue, Brown & Yellow
	321	=	Blue & Brown
	347	=	Yellow & Black
SA 815 (Duplex Stainless Steel)		=	Red, White & Green

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.
If the thickness of the fitting is less than 6 mm, punching is not permitted and the above details shall be paint stencilled only. Fittings of size up to 2" (50mm) shall be tied together and the above details shall be punched / etched in a separate tag and tied to it.

8.3.2 The fittings 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.

A.P.Madhavan Kutty, Quality	Approved by C.Karunakaran, Engg
K. Ganeshan, OPC & MPL	G.Venkataramani, Engg & Qlty

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 as per the Packaging procedure PC: PKG: 01 to avoid transit & other damages

9.0 INSPECTION & CERTIFICATION (In English only): -

9.1 All fittings 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 III C shall be submitted along with the Work Test Certificate countersigned by the above authorities and shall include the following (Three ink signed originals required)

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. Raw-material TC with traceability from mill and accountability
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.

9.2 The following reports shall be **furnished separately** along with the Form III C & MTC indicated in para 8.1 above.

i. NDE reports for VT, MT, RT, UT (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) Thickness Measurement Report for Elbows as per Doc No : TDG102:001 & for Tees as per Doc No : TDG102:002

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.

	Approved by	
A.P.Madhavan Kutty, Quality		C.Karunakaran, Engg
K. Ganeshan, OPC & MPL		G.Venkataramani, Engg & Qlty

THICKNESS MEASUREMENT REPORT FOR ELBOW

Doc No: TDG102:001 Rev.00

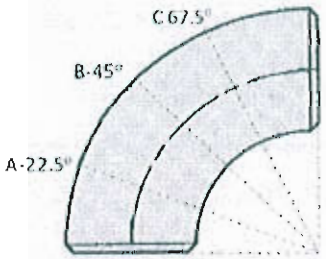
Date: 03.02.2014

PO Number:

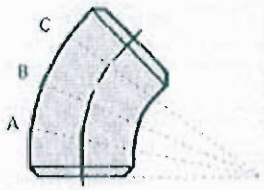
Work order/Du:

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.						

Approved by

A.P.Madhavan Kutty, Quality

C.Karunakaran, Engg

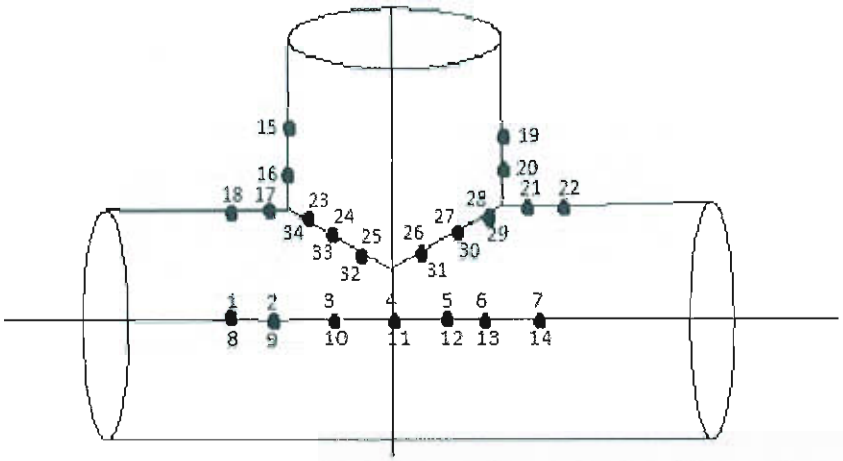
K. Ganeshan, OPC & MPL

G.Venkataramani, Engg & Qlty

THICKNESS MEASUREMENT REPORT FOR TEE's

Doc No: TDG102:002 Rev.00
Date: 24.06.2015

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			

A.P.Madhavan Kutty, Quality

Approved by

C.Karunakaran, Engg

K. Ganeshan, OPC & MPL

G.Venkataramani, Engg & Qlty

10.0 RECORDS OF REVISION:-

Rev 01 : **a)** Fully revised for better clarity.
b) Para 2.0 (e) added.

Rev 02 : **a)** Para 2.0 (c): UT acceptance norms revised from level A to B.

Rev 03 : **a)** Fully revised for better clarity.
b) Para 4.2, 6.0, 8.0 (11) added.
c) Para 2 (d), 4.1, 5 (d) are revised.

Rev 04 : **a)** Para 5.0 (g), 7.0 and 8.0 (17) are revised.

Rev 05 : **a)** New material specification SA 815 Duplex Stainless Steel included.
b) Para 4.1, 4.2, 5.0 (d), 7.1 & 7.2 are revised.
c) 5.0 (a), (b), (c), (e), (f), (g), 7.3.1 & 7.3.2 are modified for better clarity.

Rev 06 : **a)** Para 8.2 added.
b) Para 5.0(d), 5.0(g), 7.1, & 8.1 are revised.
c) Para 1.0 & 7.2 are modified.

Rev 07 : Para 8.2 - vii added.

Rev 08 : **a)** Title revised for better clarity
b) Para 1.0,2.0(a),5.0(c),8.4,9.1(8) & 9.2(vi) are revised.
c) From Para 3.0(f), 4.2,5.0(d),(f),(g),7.2 forging spec removed
d) Para 2.0(c),(f),3.0(a),7.0 &10.0 added
e) Para 3.0(e) deleted
f) Document no.TDG102:002 Rev.00 added.

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A.P.Madhavan Kutty, Quality	Approved by	C.Karunakaran, Engg
K. Ganeshan, OPC & MPL		G.Venkataramani, Engg & Qlty