



BHARAT HEAVY ELECTRICALS LTD
PIPING CENTRE, CHENNAI - 17
 QUALITY ASSURANCE & CONTROL DEPT.

STANDARD QUALITY PLAN FOR PIPE BENDS / PIPES WITH STUBS & ATTACHMENTS (MATERIAL ISSUED BY BHEL)

(Specification: SA106 GrB/GrC, SA335 P22, P91)

QP NO : QPG 73
 REV.NO : 03
 DATE : 12.05.2011

Sl.No	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORDS	AGENCY		REMARKS
									M	B	
1	2	3	4	5	6	7	8	9	D*	10	11
1.0	Material										
1.1	Seamless steel pipes SA106 GrB / GrC, SA335 P22, P91	Correctness of material : Chemical, Mech. Properties & Soundness	Major	Verification	100%	Correlation with TC and Stamping on the material, BHEL Drawing		TC	✓	P	V
1.2	Stubs / Branches (Pressure Parts) Material as per drg.	Correctness of the components as per drg.	Major	Verification	100%	Correlation with TC and Stamping on the material, BHEL Drawing		TC	✓	P	V
1.3	Attachments (non-Pressure Parts) Material as per drg.	Correctness of the components as per drg.	Major	Verification	100%	Material issue doc. by BHEL, Drawing		\$\$	✓	P	V
											\$\$ -Material issue doc. by BHEL
2.0	INPROCESS CONTROL										
2.1	Bending (Incremental, Induction)	Bending procedure shall be submitted by Vendor for BHEL approval and bending shall be carried out as per approved procedure. Making of two bends in each specn. and attachment welding (or as per P.O.) shall be witnessed by BHEL as first off trail.						Bending M/C Temp. Chart	✓	P	W*/V
2.1.1	Heat Treatment	Time / Temp control	Major	Review of HT Chart / Log	100%	Note 2		HT chart	✓	P	W*/R W*: Witness for FOT
2.1.2	Dimensions	Bend angle ,radius, Arm length, Ovality, Thinning \$ Wrinkles	Major	Measurement & Visual	100%	Drawing and Note 1 & 4		Report	✓	P	W*/V \$: Check thickness on tension side & at Ends.
2.1.3	Bend area	a) Surface quality b) Soundness	Major	MPI @ UT	100%	ASME Sec V / ASME B31.1 cl.136.4.3 Also refer Note 6 for P91 Refer Note 15		Report	✓	P	W @: For P91 before HT dry MPI, after HT Wet MPI.
2.1.4	Hardness	Hardness	Major	Measurement	100%	190-250 BHN for P91; 197 BHN max. for others. Variation within a bend 50 BHN max.		Report	✓	P	W #: : 3 replicas in one bend per HT batch.
2.1.5	P91 Bends	Micro Structure	Minor	Insitu Micro	#	No micro fissures, Tempered Martensite structure		Report@@	✓	P	V @@: With photo micro-graphs 500X min.

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PREPARED BY
 G. PANNEER SELVAM DGM/QA
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LEGEND:
 D*: RECORDS, INDENTIFIED WITH "TICK" (✓) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION.
 ** M: MANUFACTURER ; B: BHEL / BHEL AUTHORISED INSPECTION AGENCY
 P: PERFORM W: WITNESS AND V: VERIFICATION R: REVIEW RW: RANDOM WITNESS (10%)

APPROVED BY
 P. ELANGOYAN, AGM/Q&MS



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2.2	Stubs & Attachment Welding	Location +, Orientation & EP	Major	Measurement	100%	Drawing	Drawing	History card	P	W*/V+	Stubs/attachments shall be 150 mm away from butt joints with 25 mm min clearance between welds.
2.2.1	Marking for Stub Hole drilling / attachments										
2.2.2	NDE on EP a) For P91 b) For P22, GrB, GrC	Discontinuities Discontinuities	Major Major	MPI LPI/MPI	100% 100%	ASME Sec V / ASME B31.1 cl.136.4.3 ASME Sec V / ASME B31.1 cl.136.4.4/cl.136.4.3		Report Report	V V	P W	NDE procedures shall be submitted for BHEL approval
2.2.3	Weld fit up							History card	V	P	
2.2.4	Stubs & Attachments	Location, Orientation, Dimensions.	Major	Measurement	100%	Drawing			V	P	
2.2.5	Welding										
2.2.6	Welding Qualifications	Procedure Qualification Personnel Qualification	Major Major	Verification Verification	100% 100%	ASME SEC. IX, WPS approved by BHEL IBR		WPS WQR	V V	P W	WPS/PQR, WQR shall be approved by BHEL
2.2.7	Weld Inspection	Weld profile, Size & Surface quality	Major	Measurement & Visual	100%	Drawing / SIP:PP:02		Report	V	P	
2.2.8	NDE before PWHT										
2.2.9	Carrier plate Root back gouging/grinding	Discontinuities	Critical	MPI @	100%	ASME Sec V / ASME B31.1 cl.136.4.3		Report	V	P	@:For P91 before HT dry MPI
2.3	Post Weld Heat Treatment	ROH, ROC, Soaking temp & Soaking time	Critical	Review of HT charts	100%	Note 3(a)		Report	V	P	
2.3.1	NDE after PWHT										
2.3.2	All branch/Stub Welds (Filler weld)	Soundness	Critical	MPI / Wet MPI @	100%	ASME Sec V / ASME B31.1 cl.136.4.3		Report	V	P	@:For P91 after HT Wet MPI

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2.3.3	Carrier plate & Attachment welds	Soundness	Critical	MPI / Wet MPI @	100%	ASME Sec V / ASME B31.1 cl.136.4.3		Report	√	P	V	@ :For P91 after HT Wet MPI
2.3.4	Full penetration nozzle joints (OD > 114.3mm)	Soundness (for P91) Soundness (for others)	Critical Critical	UT Wet MPI RT / UT	100% 100%	AD 2000 Merkblatt HP 5/3-2002 (ref. Note 16) ASME Sec V / ASME B31.1 cl.136.4.3 ASME Sec V / ASME B31.1 cl.136.4.5 / 136.4.6 (Procedure to be appd. By BHEL)		Report Report Report	√ √ √	P P P	W W R/W	Review of RT films/ Witness for UT
2.3.5	Hardness for P91 welds	Hardness	Critical	Measurement	100%	Max 300 for P91 (HV10)		Report	√	P	W	
2.4	Butt welding											
2.4.1	NDE on EP a) For P91 b) For P22, GrB, GrC	Discontinuities Discontinuities	Major Major	MPI LPI/MPI	100% 100%	ASME Sec V / ASME B31.1 cl.136.4.3 ASME Sec V / ASME B31.1 cl.136.4.4 / cl.136.4.3		Report Report	√ √	P P	V V	NDE procedures shall be submitted for BHEL approval
2.4.2	Weld fit up											
2.4.3	Welding Qualifications	Procedure Qualification Personnel Qualification	Major Major	Verification Verification	100% 100%	ASME SEC. IX, WPS approved by BHEL IBR		WPS WQR	√ √	P P	W W	WPS/PQR, WQR shall be approved by BHEL
2.4.4	Weld Inspection	Weld profile, Size & Surface quality	Major	Measurement & Visual	100%	Drawing / SIP:PP-02		Report	√	P	V	
2.4.5	Post Weld Heat Treatment	ROH, ROC, Soaking temp & Soaking time	Critical	Review of HT charts	100%	Note 3(b)		Report	√	P	V	
2.4.6	NDE after PWHT	Soundness	Critical	RT UT for P91 MPI / Wet MPI @	100%	ASME Sec V / ASME B31.1 cl.136.4.5 AD 2000 Merkblatt HP 5/3-2002 (ref. Note 16) ASME Sec V / ASME B31.1 cl.136.4.3		Report Report Report	√ √ √	P P P	R W W	Review of RT films @ :Wet MPI for P91
2.4.7	Hardness	Hardness	Critical	Measurement	100%	Max 300 for P91 & 225 for P22 (HV10)		Report	√	P	W	
2.5	NDE on site weld edge preparation	Discontinuities	Minor	LPI	100%	ASME Sec V / ASME B31.1 cl.136.4.4		Report	√	P	V	

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3.0	FINAL INSPECTION										
3.1	Dimensional Inspection	a) Bend angle, Arm length, Radius of bend, Ovality, Thinning & Wrinkles b) EP, End to end dimn, Land Weld end dia c) Orientations & height of Stubs / Attachments d) Flange rotation e) Face out	Major	Measurement	100%	As per BHEL Drawing, Note 1 & 4		Report	✓	P	W
			Major	Measurement	100%	As per BHEL Drawing		Report	✓	P	W
			Major	Measurement	100%	Drawing, +/- 3mm		Report	✓	P	W
			Major	Measurement	100%	Drawing, +/- 2mm		Report	✓	P	W
			Major	Measurement	100%	1.2 per 300 mm		Report	✓	P	W
3.2	Positive Material Identification for Alloy Steel	Chemical check	Major	Spectro/X-Ray fluorescence	100%	As per Required Material (ASME) Specn.		Report	✓	P	W
3.3	Identification & Painting	Identification, Appearance & DFT.	Major	Visual & Measurement	100%	Painting as per contract specific Painting scheme; Refer Note 13 for marking.		Report	✓	P	W
3.4	Preservation & Protection	End protection	Major	Visual	100%	BHEL Drawing, PO & Note 14.		IR	✓	P	W
4.00	Documentation	Verification of Records	Major	Compilation of Records.	100%	As per QPG 73		IBR TC, RM TC, Reports(NDE, Hardness, PMD), HT Charts, IR	✓	P	V

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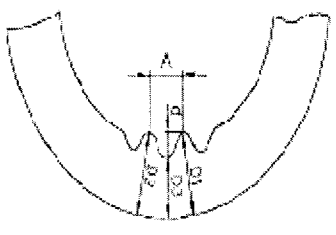
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NOTES :

1.0 **WRINKLES** : Acceptance limits for wrinkles are as given below: (Refer Figure 1).

- a). The depth of valley / OD (d/D) shall be $< or = 3\%$
- b). Pitch of valley / Depth (A/d) shall be $> or = 12$



0 - NOMINAL OD OF PIPE

2.0 **POST FORMING HEAT TREATMENT :-**

- a) For SA106 GrB/Grc : Normalise at 870 - 900 deg C
 - b) For SA335 P22 : Normalise at 920 - 960 deg C & Temper at 695+/-15
 - c) For SA335 P91 : Normalise at 1040 - 1060 deg C & Temper at 750-770 deg C
- For P91, normalizing and tempering shall be carried out within 72 hours after completion of bending. The bends shall be kept dry and stress free. The temperature shall be brought down to room temperature after hot bending before normalizing and also after normalizing before tempering. Tempering shall not be clubbed with PWHT. Normalising and tempering of P91 shall be done encompassing the entire component. P91 soaking shall be 2Hrs minimum for thickness upto 50mm and 4Hrs minimum for thickness 51-100mm
- d) Bends shall not be kept one over the other (to avoid deformation).

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3.0 POST WELD HEAT TREATMENT


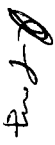
(a) Preheat, Post heat and Post weld heat treatment (PWHT) temperatures (Deg. C) for Piping Stubs & Attachment welds

Base Material	Thickness (mm)	Stub / Attachment material	Preheat (deg C)	Post Heat (deg C)	PWHT (deg C)	
					Weld thickness ≤ 19mm	Weld thickness > 19mm
SA106 GrB/GrC	t ≤ 19	SA106 GrB/GrC	Nil	Nil	Nil	610+-15
	t > 19 & ≤ 25	SA106 GrB/GrC	150	150 for 2 hrs	Nil	610+-15
	t > 25 & ≤ 75	SA106 GrB/GrC	150	150 for 2 hrs	Nil	610+-15
	t > 75	SA106 GrB/GrC	150	150 for 2 hrs	610+-15	610+-15
SA335 P22	All	SA335 P11, P22	150	250 for 2 hrs	All 695 +/- 15	
		SA335 P91	150	250 for 2 hrs	All 745 +/- 15	
SA335 P91	All	SA335 P22, P91	220 ##	280 for 2 hrs	All 760 +/- 10 ##	

(b) Preheat, Post heat and Post weld heat treatment (PWHT) temperatures (Deg. C) for Piping Butt welds

Base Material	Thickness (mm)	Preheat (deg C)	Post Heat (deg C)	PWHT (deg C)
		t ≤ 19	Nil	Nil
SA106 GrC	t > 19 & ≤ 25	150	150 for 2 hrs	610+-15
	t > 25	150	150 for 2 hrs	610+-15
SA335 P22	All	150	250 for 2 hrs	695 +/- 15
SA335 P91	All	220 ##	280 for 2 hrs	760 +/- 10 ##
SA335 P91 + P22	All	220 ##	280 for 2 hrs	745 +/- 15 ##

: Pre heat shall be maintained for P91 till welding is completed. After Post heating, P91 weldments shall be brought to a temperature of 80-100 deg C and kept for minimum one hour. The PWHT shall commence immediately thereafter.

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4.0 TOLERANCES FOR BENDS

- a) Bend angle : ± 0.5°
- b) Bend radius: ± 5.0 mm
- c) Arm length (ends): +5.0/-2.0 mm
- d) Twist (gap observed using straight edge plumb) : 1mm/mtr. 10mm Max.
- e) Ovality shall be within 20 D/R subjected to max. of 8%.
 Where R = Radius of bend & D = Diameter of the pipe
 % Ovality = ((Dmax - Dmin)/D nominal)*100

f) Thinning: Thinning shall be limited to as calculated below or as indicated in the drawing whichever is minimum.
 % Thinning = ((T nominal - T minimum) / T nominal) X 100

- (i) R/D ≤ 2
 For ID controlled pipes : 20%
 For OD controlled pipes : 30% (since a negative tolerance of 12.5 % on thickness is considered in design)
- (ii) R/D > 2 and ≤ 4
 For ID controlled pipes : 10%
 For OD controlled pipes : 21.5%
- (iii) R/D > 4
 For ID controlled pipes : 5%
 For OD controlled pipes : 17%

- 5.0 The items shall be manufactured as per BHEL drawing.
- 6.0 P91 bends shall be visually checked. No hard scales shall be present on inside & outside surfaces.
- 7.0 Gas cutting & Plasma cutting are prohibited for SA335 P91 material.
- 8.0 Pre heating of SA335 P91 material by Oxy-acetylene is not permitted.
- 9.0 Welding Electrodes and Paints used shall be of BHEL approved make
- 10.0 All items shall be inspected and cleared by BHEL / BHEL authorised Inspection agency & IBR authorities.
- 11.0 If Customer inspection is involved as per Contract requirements, the Vendor shall get despatch clearance from the BHEL's customer also before despatch of finished material.

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12.0 Necessary IBR Requirements shall be fulfilled and IBR documents to be submitted.

13.0 The finished components shall be punched with DU code (14 digit work order DU details), Heat number, material specification, maker's emblem, Inspectors seal & statutory authority's seal. In addition, the DU code, Heat no. and Material specification shall also be paint stencilled.

Colour coding : Red for SA106 Gr B ; Blue for SA106 GrC ; Blue & Red for SA335 P22; Brown & Red for SA335 P91.

14.0 Machined ends shall be well protected using end caps and suitably packed to avoid transit & other damages: Tack welding is prohibited on P91 material.

15.0 The vendor shall carry out UT as per their procedure approved by BHEL. The procedure shall include the following.
 (a) UT shall be done as per ASTM E 213 in both clockwise and anticlockwise directions for longitudinal discontinuities and in both axial direction for transverse discontinuities. Calibrations to be done on both longitudinal and transverse notches of 50mm length and a depth of 5% of wall thickness (Min 0.3 mm ; Max 1.5 mm) placed on both internal and external surfaces. The calibration block shall be a section of the Pipe of same size, heat treatment and specification.
 (b) Acceptance norms : Cracks of any dimension and the indications exceeding the reference level as per para 15(a) are not acceptable
 (c) Report : A detailed report duly signed by a minimum Level II NDE personnel shall be issued



16.0 The vendor shall carry out UT as per their procedure approved by BHEL. The procedure shall also include the following.

- (i) The examination shall be conducted by Pulse Echo contact testing. The following digital equipments or its equivalent models with A-scan presentation that generates and receives frequencies in the range of 1 MHz to 5 MHz, shall be used for examination: GE Inspection Technology (Krautramer make), Olympus (EPOCH IV, XT), Sonatest (Master scan series-350M/380M) U.K
- (ii) The calibration blocks used shall be of same material specification, diameter & thickness. The UT equipment shall be calibrated at the beginning of each period of use or every 3 months whichever is less.
- (iii) All recordable indications will be stored in memory of either the digital flaw detector or a PC for review at a later period
- (iv) The equipment calibration data for specific weld as well as the hard copy of 'Static echo-trace pattern' - showing the flaw-echo amplitude with respect to DAC, flaw depth, projection surface distance (probe position) and beam-path shall be attached to UT test report. This hard-copy of echo-trace with equipment calibration data will form part of test documentation.
- (v) Qualified Level II NDE personnel shall conduct the test and NDT report shall be issued

Records of Revn 01 : Sl.No. 1,2, 1,3 included, Note 3 & 7 are corrected.

Records of Revn 02 : Sl.No. 2,1,3 corrected and Note 15 included.

Records of Revn 03 : Title changed; Sinos 2,1, 2,2, 2,3,2, 3,1a, Note 2 (c), 15b are corrected; Sino 2,3,4,2,3,5, 2,4 and Note 3(b) & 16 are included; Sino 2,3,4 changed to 2,5.

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