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

STANDARD QUALITY PLAN FOR PIPE BENDS WITH BHEL MATERIAL (INCREMENTAL, INDUCTION BENDING)

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

QP NO : QPG 73
REV.NO : 01
DATE : 15.11.2010

Sl.No	COMPONENT & OPERATIONS	CHARACTRISTICS	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	Verfication	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	Verfication	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	Verfication	100%	Material issue doc. by BHEL, BHEL Drawing		$$	√	P	V	$$ -Material issue doc. by BHEL
2.0	**INPROCESS CONTROL**											
2.1	**Bending**	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	Major	MPI @	100%	ASME Sec V / ASME B31.1 cl.136.4.3 Also refer Note 6 for P91		Report	√	P	W	@ :For P91 before HT dry MPI, after HT
		b) Soundness (For FOT only)	Major	UT	100%	No abnormal indication		Report	√	P	W*	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.

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

PREPARED BY
G. PANNEER SELVAM DGM/QA

APPROVED BY
P.ELANGOVAN , AGM /QA

SIGNATURE

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2.2	**Attachment Welding**											
2.2.1	Marking for Stub Hole drilling / attachments	Location +, Orientation & EP	Major	Measurement	100%	Drawing		History card		P	W*/V	+ : Stubs/attachments shall be 150 mm away from butt joints with 25 mm min clearance between welds.
2.2.2	NDE on EP											
	a) For P91	Discontinuities	Major	MPI	100%	ASME Sec V / ASME B31.1 cl.136.4.3		Report	√	P	W	
	b) For P22, GrB, GrC	Discontinuities	Major	LPI/MPI	100%	ASME Sec V / ASME B31.1 cl.136.4.4/cl.136.4.3		Report	√	P	V	NDE procedures shall be submitted for BHEL approval
2.2.3	Weld fit up											
2.2.4	Stubs & Attachments	Location, Orientation, Dimensions.	Major	Measurement	100%	Drawing		History card	√	P	V	
2.2.5	Welding											
2.2.6	Welding Qualifications	Procedure Qualification	Major	Verfication	100%	ASME SEC. IX, WPS approved by BHEL		WPS	√	P	W	WPS/PQR, WQR shall be approved by BHEL
		Personnel Qualification	Major	Verfication	100%	IBR		WQR	√	P	W	
2.2.7	Weld Inspection	Weld profile, Size & Surface quality	Major	Measurement & Visual	100%	Drawing & SIP:PP:02		Report	√	P	V	
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	√	P	V	@ :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 4		Report	√	P	V	
2.3.1	NDE after PWHT											
2.3.2	All branch/Stub 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

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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	NDE on site weld edge preparation	Discontinuities	Minor	LPI	100%	BHE:NDT:PB:PT - 01		Report	√	P	V	
3.0	**FINAL INSPECTION**											
3.1	Dimensional Inspection	a) Bend angle, Arm length, Radius of bend, Ovality, Thinning & Wrinkles.	Major	Measurement	100%	As per BHEL Drawing , Note 1 & 4		Report	√	P	W	
		b) EP, End to end dimn, Land Weld end dia	Major	Measurement	100%	As per BHEL Drawing		Report	√	P	W	
		c) Orientations & height of Stubs / Attachments	Major	Measurement	100%	Drawing, +/- 3mm		Report	√	P	W	
		d) Flange rotation	Major	Measurement	100%	Drawing, +/- 2mm		Report	√	P	W	
		e) Face out	Major	Measurement	100%	1.2 per 300 mm		Report	√	P	W	
3.2	Possitive 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	IR : Inspection Report
4.00	**Documentation**	Verification of Records	Major	Compilation of Records.	100%	As per QPG 73		IBR TC, RM TC, Reports(NDE, Hardness, PMI), HT Charts, IR	√	P	V	

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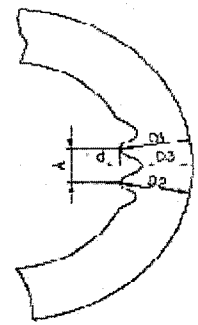
NOTES :

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



D = 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 760-780 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

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

Base Material	Thickness	Stub / Attachment material	Preheat	Post Heat	PWHT	
					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 ##	

: 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 minmum one hour. The PWHT shall commence immediately thereafter.

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

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f) **Thinning** Thinning shall be limited to as calculated below or as indicated in the drawing whichever is minimum.

% Thinning = ((T nominal - Tminimum) / 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.**

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 & staturatory 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.

Records of Revn 01 : Sl.No. 1.2, 1.3 included, Note 3 & 7 are corrected.

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