

 BHEL – BAP- RANIPET VELLORE DIST. TAMIL NADU-632 406 RANIPET		MANUFACTURING QUALITY PLAN ITEM: PACKING BOXES			QP NO	ESP 299 REV.00 DT. 28.05.2019				
					PROJECT	STANDARD				
					PAGE	1 OF 1				
SI No 1	Component & operation 2	Characteristics 3	Type of Check 4	Quantum of Check 5	Reference Documents 6	Acceptance Norms 7	Format Of Records 8	Agency		Remarks 10
								M	B	
								9		

1.0										
1.1	Raw material	Chemistry & Mechanical	Chem & Mech. properties	Each Heat	Respective Material spec	TC	P	V		
2.0	In- process control	Size, Visual	Measurement	Random	Drawing					
2.1	Welding	NDE	LPI/MPI*	10% in each box*	BHE: NDT:RP:PT:01 (Latest) BHE: NDT:RP:MT:01 (Latest)	R	P	W		*LPI/MPI- 100% for Manufacturer & 10% for BHEL/BHEL's AIA for each box
3.0	Final inspection	Overall Dimension	Measurement	10%#	Drawing & BHEL specification					#100% for Manufacturer and 10% for BHEL/BHEL's AIA
3.1	Packing Boxes					R	P	W		Balance nos- review of reports
3.2	Preservation	Painting	Visual	100%	BHEL Standard	--	P	V		

Notes:

- 1) This QP shall be read along with relevant PO, BHEL specifications, approved drawing and applicable standards.
- 2) Raw material TCs to be provided for all plates and rolled sections for verification.
- 3) Document package should include TCs, NDE reports, Final dimension report and Painting certificate.

LEGENDS: M - MANUFACTURER / SUB CONTRACTOR B - BHEL /BHEL' s AUTHORIZED INSPECTION AGENCY (AIA) P - PERFORMED, V - VERIFICATION, W - WITNESS, R - REPORT C - CUSTOMER T C - TEST CERTIFICATE	Prepared By  (Rajamanickam. M) Dy. Manager/ QA	Reviewed & Approved By  (K.C. Gandhi Parimalam) DGM/QA
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BHARAT HEAVY ELECTRICALS LIMITED
TIRUCHIRAPPALLI - 620 014
QUALITY ASSURANCE DEPARTMENT

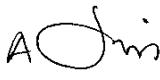
AMENDMENT TO QUALITY WORK INSTRUCTIONS (QWI)

QWI NO: QCP002 REV.: 04 Dt. 08.12.2011

AMENDMENT SL NO: A1 DATE: 13.06.13

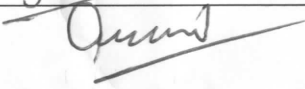
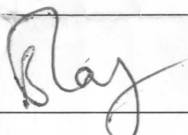
Page 1 of 1

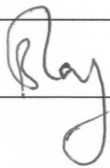
DESCRIPTION:

Clause No	The existing points	Amended as...				Basis for amendment
4.6	4.6 Post weld heat treatment Note-1: All fabricated components of P4 materials with any member above 16mm thickness, the entire assembly shall be Post weld heat treated. However when the size of fillet weld is less than 12mm PWHT is not required for non load carrying members..	4.6 Post weld heat treatment In respect of the fabricated components of P4 Materials , PWHT requirement of entire assembly is detailed in the tabulated columns.				CE M&P and collobarator practice.
		Plate thick	Load carrying members (PWHT)		Non-Load carrying members (PWHT)	
			Fillet size >12mm	Fillet size =<12mm	Fillet size >12mm	Fillet size =<12mm
		>16mm	YES	YES	YES	NO
		16mm & below	NO	NO	NO	NO
NOTE	The above-mentioned changes will be incorporated in the relevant QWI during the next revision of the document.					
 Prepared by: A.Francis			 Approved by: Bikramoditya Roy			
Dt: 13-06-2013			Dt: 13-06-2013			

BHARAT HEAVY ELECTRICAL LIMITED**TIRUCHIRAPALLI****QUALITY CONTROL PROCEDURE****For
Non Pressure parts****QCP:002/04**Prepared by A.Francis
Quality assurance

A. Francis

Reviewed by	SIGNATURE
Engineering (Shri.V.Sridharan)	
Out sourcing (Shri.S.Mohanram)	
Quality control (Shri.Amitroy)	
Quality Assurance (Shri.Bikramodityaroy)	

Revision No	Date	Approved	Signature
00	01-04-1993	--SM/QA	--Sd--
01	01.01.1995	SM/QA	--Sd--
02	24.04.2004	SDGM/QA	--Sd--
03	10.06.2010	SM/QA	--Sd--
04	08.12.2011	DGM/QA	

Proprietary data - For internal use

ECORD OF REVISIONS

Rev No...	Clause No	Details of revision
00	--	This document consolidates all the general requirements and technical disciplines covered in the various previous
01	--	All amendments issued has been regularized and editorial correction made for better clarity. Scope of machining added in this document.
02		Editorial correction made for better clarity. Scope of machining added in this document.
03		Shaded clauses & Type of joints for base plates incorporated. Pwht temperature for P4 matl.revised.
04		P91&92 Bar process requirements added (Shaded clauses)

1.0 SCOPE

- 1.1 This procedure details out the process control and quality requirements for manufacture of Non Pressure Parts.

2.0 REFERENCE DOCUMENTS

- 2.1 AWS D.1.1, D1.6, IS 7215 and CE: M&P 5.11.1.1, 5.11.2.1 & 5.11.2.2 as guidelines.

3.0 MATERIALS

- 3.1 CLASSIFICATION OF MATERIALS (commonly used):

<u>P No. Group</u>	<u>Specifications</u>
P1 - Group 1 - SA 515 Gr 60.	Carbon steel IS 2062/ E250A & E250B , IS 1239, IS 1161, A 36,
P1 - Group 2 -	H.Strength CS :SA105, SA 515 Gr 70, SA 299, SA 516 Gr 70,.
P4 - Alloy Steel	SA 387 Gr 11 & Gr 12, SA 182 Gr F 11 & F 12.
P5A – Gr 1(LAS),	SA 387 Gr 22 Cl.1 &Cl.2, SA 182 Gr F 22
P5B-Gr.1 (AS)	SA387 Gr5 Cl.1 & SA387 Gr9 CL.2
P15E Gr1	SA182F91, F92 , SA387 Gr.91,GR.92, SA335 P91, P92
P6 -	SA213T91, T92, SA234WP91, WP92&SA336F91, F92
P8 - Stainless steel	SA 240-410,429
Any other materials as specified in the drawings.	SA 240 - 304 ,309,310, 316, 321, 347 & 253MA

- 3.2 Raw materials used shall conform to the relevant specification as given in drawings and applicable TDC/PO. Any substitution of materials shall be done only with prior approval of engineering through applicable documents. Where subcontractors procure the raw materials, the same shall have valid test certificates.
- 3.3 Raw materials shall be free from visual defects like cracks, seams, laps, laminations, heavy pitting etc. When defects are noticed in visual inspection the same shall be confirmed using appropriate NDE techniques and repaired using applicable approved process .
- 3.4 All materials are procured with permitted dimensional tolerances of the material specifications and / or TDC. Wherever required, the raw materials shall be corrected prior to fabrication to achieve the required product tolerances.
- 3.5 Customer supplied materials are to be verified as per SP 0626.
- 3.6 The requirements of material traceability shall be as indicated in the respective drawings.
- 3.6.1 Product Attest “P” items indicated as in drawings are traceable to the test certificates and identified with material Specification, grade and melt number by stamping.
- 3.6.2 CERTIFIED items indicated as "C" in drawings are traceable to material Specification / grade only and identified by stamping / engraving / stenciling / painting.
- 3.6.3 Raw materials not covered by the above shall be identified by its W.O.No / material code / Specification / grade by painting / stenciling / engraving.
- 3.6.4 All subdeliveries shall be identified by its material code by painting or through name plates / tags.
- 3.7 When materials (including stock) are to be upgraded for special contract requirements QC shall ensure that the respective specification/ contract TDC (as applicable) are complied.

4.0 FABRICATION

4.1 MARKING, CUTTING AND PREPARATION

- 4.1.1 Raw material shall be marked and cut to size by shearing, machining, saw cutting, flame or plasma (for SS materials) cutting. Flame cut edges shall be cleaned to remove slag. Uneven edges shall be dressed by grinding. Gas cutting notches shall be filled up by grinding the notches smoothly for welding using compatible electrodes and ground before taking up for further fabrication.
- 4.1.2 Wherever raw materials supplied / available are not sufficient for the sizes required, the same can be built up using the splicing either by groove weld/fillet weld sufficient to hold the parts in place instructions given in the respective SQPs/ Drawings/DCN (Incl. Production Notes)
- 4.1.3 Layout for size and shape shall be marked before cutting (for other than CNC applications). The tolerance for marking shall be maintained within + 2mm unless otherwise specified. The diagonal difference shall be within 3 mm.
- 4.1.4 The markings shall be punched at convenient intervals and bordered with white paint.
- 4.1.5 Stainless Steel (SS) materials shall be cut using plasma cutting or shearing only. Any further dressing/ grinding of cut surfaces should be done with separate and clean abrasive wheels.
- 4.1.5.1 The cut edges should be smoothly ground.
- 4.1.5.2 Notches above 3 mm or 20 % 'T' shall be thoroughly cleaned and welded by using a qualified WPS and examined visually and by LPI. The repaired surfaces are to be cleaned to bright metal surface.
- 4.1.6 Clip / Cleat angles above 10mm thick used for beam connections which are sheared to length shall require heat treatment.
- 4.1.7 Heat treatment shall be done after shearing for P4 materials $t > 12.5\text{mm}$ and for P5 materials $t > 10\text{mm}$.
- 4.1.8 Shearing /Flame/gas cutting is prohibited on Gr 91 and Grade 92 materials.
- 4.1.9 Use only bandsaw for cutting of Gr91&92 materials. However for plates use plasma/waterjet/bandsaw only
- 4.1.10 The requirements of preheat for gas cutting are as follows:
- | | | |
|--------------------------|----------------------------|---------------------|
| Carbon steel | $t \leq 50\text{mm}$ | Nil |
| Carbon steel | $t > 50\text{mm}$ | 100 ° C.min. |
| Alloy steel (P4) | $t \leq 25\text{mm}$ | Nil |
| Alloy steel (P4) | $t > 25\text{mm}$ | 150 ° C |
| Alloy steel (P5A,B Gr.1) | All | 150 ° C |
| Stainless steel | | Not applicable..... |

4.1.11 Stress relieving for gas cut edges shall be as follows.

Material	Thickness	Heat treatment cycle
P1	> 50 mm	600 ° - 650 ° C for 30 minutes . Furnace cool (Alternatively, the cut surface can be ground / machined upto 3 mm to remove HAZ)
P4	> 16 mm	650 ° – 700 ° C for 30 minutes . Furnace cool
P5	All	680 ° - 730 ° C for 30 minutes . Furnace cool
SS (plasma)	Any	Not required

4.1.11.1 For materials other than P5, P15E Gr 1(Grade 91) and Grade 92 this heat treatment may be clubbed with the final heat treatment of the product.

4.1.12 The prepared plates shall be visually inspected and repaired if required as per SIP:NP:06.

4.1.13 The raw materials after cutting shall be identified with relevant WO No., DU No., Part No. and Material Spec / Grade (transferred).

4.2 FORMING

4.2.1 Before forming , proper cutting plan (Drawing dimensions with process allowances) shall be prepared and cleared by the concerned agency. Forming shall be done using proper tooling free from damages. Method of forming and work centre shall be identified in OPS / relevant QWI referred in PO.

4.2.2 Built up (Forming) operations for Beams and columns shall be done by suitable Fixtures,Machines ,WPS & other accessories required for forming. All the Forming operations of sheets / plates shall be done by rolling / pressing. For shell formed components Circularity of rolled shells shall be checked using templates (of length > ¼ of ID).

4.2.3 Suitable nonmetallic padding shall be provided while forming of stainless steels to avoid contamination.

4.2.4 All formed /Built up components shall be checked for orientation, angle, and other dimensions as per drg. All formed parts shall have smooth finish and shall be free from bends, folds and sudden transitions.

4.2.5 Minimum thickness after forming shall be ensured whenever specified in drg.

4.2.6: **Forming of U-ROD(Gr 91 &92)**

4.2.6.1 Identify, mark and cut the rod using bandsaw to a length of equivalent to the arc length indicated in the drawing with two arm length(upto butt joint) +20mm .

4.2.6.2 Mark the centre of the rod with a heat resistant chalk to be visible after heating. For temperature and other details refer the SQP:NP:15(Latest)

4.2.6.3 Remove the “U”rod and air cool to room temperature .

4.2.6.4 Visually inspect the bend surface and check dimensions and ensure no surface imperfections.

- 4.2.6.5 Normalizing and tempering of “U” Rods to be done within 72 hours after pressing/bending operation.(Ref.SQP:NP:15(latest))
- 4.2.6.6 Shot blast the “U” Rod to remove scaling and check the dimension. Conduct LPI/Wet MPI and ensure no surface indications.
- 4.2.6.7 Mark and cut the limbs of “U” rods such that the straight portion shall be as per drawing from the tangent point.
- 4.2.6.8 Edge prepare the “U” rods for butt joint preparation as shown in the drawing by machining. No gouging and grinding is allowed.
- 4.2.6.9 For Detailed operation of cold and hot forming of Gr 91 & Gr 92 materials refer SQP:NP:15(latest)
- 4.2.7 Threading of “U” Rods
- 4.2.7.1 Mark and cut the rods equivalent to the straight portions as shown in the drawings.
- 4.2.7.2 Threading to be done on one end of the rod to thread size as mentioned in the drawing/SQP: NP15(latest).
- 4.2.7.3 Edge prepare the other end of the rods by machining for butt welding as shown in the drawing.
- 4.2.8 Tolerances for formed components when not specified in drg. /SQP:NP15(latest). Shall be as follows
- a) St.Length / Dia, : + 1 mm/M, 5 mm Max
 - Width & Height
 - b) Verticality : 1 mm / M, 5 mm Max
 - c) Squareness : 1 mm / M of length / Dia
 - d) Straightness : 1 mm / M, 5 mm Max
 - e) Radius : ± 5 mm
 - f) Bend Angle : $+ 2^\circ$
 - g) Ovality : 1%
 - h) E.P Angle : $+ 5^\circ / - 2.5^\circ$
 - i) Diagonal diff : 3 mm

4.3 WELDING

4.3.1 WELDING CONSUMABLES

- 4.3.1.1 Welding consumables conforming to the qualified welding procedures shall be used. However the following guide lines are provided.
- 4.3.1.2 Only Basic coated electrodes (E 7018) shall be used in the following cases:-
- a. All Strength welds in ceiling girders, flange/web butt welds and in other beams, columns etc.
 - b. For all structural welds, or when thickness of any one member of the weld joint is > 12

mm (unless otherwise indicated in the drawings / Qualified WPS).

c. For welding of high tensile steels like BSEN 10025 E250A & B, SA299, SA515 Gr.70, SA516 Gr.70.

- 4.3.1.3 Rutile electrodes may be used for other weld joints.
- 4.3.1.4 All low hydrogen electrodes (EXX 16 & EXX 18) shall be dried in the baking oven at 250-300 deg.C for 2 hours and the electrodes shall be held at 120 deg.C until they are used. Electrodes shall not be re-baked more than once and use of electrodes in wet condition is prohibited.
- 4.3.1.5 All rutile electrodes (EXX 13) shall be dried at 120 deg. C for 1 hour min. and held at 120 deg.C till use.
- 4.3.1.6 Fluxes for SAW shall be dried at 250 deg.C for 1 hour min. before use. Height of flux bed while drying in pan or oven, shall not be more than 100mm.
- 4.3.1.7 Unless otherwise specified, SS consumable shall be baked as per Electrode manufacturer's recommendations and stored at 120 ° - 150 ° C until use.
- 4.3.1.8 The type of welds employed in the structural fabrications (Girders, Columns, Beams & Base plates etc) are identified in the annexure –A along with sketch for better clarity and understanding. For further details the fabricator can refer the engg.dwg. no.3-35-110-00995/00

4.3.2 FIT UP

- 4.3.2.1 Proper fit up shall be ensured before welding as per Drawing. Tack welding or mechanical clampings shall be used to maintain the fit up requirements before and during welding. Bridge pieces used during fit up shall be of ferritic for ferritic materials and stainless for stainless steel materials. However for P15E Gr.1.(F91 & F92) prepare a fixture for fit-up of butt joint of 'U' rod with Straight rods.
- 4.3.2.2 Dimensions of the cross sections of groove welded joint shall be within the following tolerances w.r.t . drawing requirements:

	Root not back gouged	Root back gouged
1. Root face of joint(land)	± 2 mm	Not limited
2. Root opening of joint (with out backing)	± 2 mm	+ 2 mm - 3 mm
Root opening of joint* with backing)	+ 6 mm - 2 mm	Not Applicable
3. Groove angle of of joint	+ 10° - 5°	+ 10° - 5°

*(NOTE): Root opening wider than permitted by above tolerances but not greater than twice the thickness of the thinner part or 19mm, whichever is less may be corrected by edge buildup to acceptable dimensions prior to welding. Such buildup edge shall be MPI / LPI checked.

- 4.3.2.3 For C. S. fillet welds, the parts shall be as close as practicable and gap shall be limited to 5 mm (If gap exceeds 2 mm, the leg of fillet shall be increased by the amount of gap but in no case shall exceed 4.8 mm). For thickness 75 mm and above gap up to 8 mm can be permitted provided suitable backing is used.
- 4.3.2.4 For S. S. fillet welds, the parts shall be as close as practicable. Gaps 2 mm and above upto 5mm are acceptable if the fillet size is increased by an amount equal to the gap.
- 4.3.2.4 Parts to be joined by butt welds shall be properly aligned. An offset not exceeding 10% of the thickness of the thinner part joined can be permitted, but in no case more than 3.2 mm, is permitted.
- 4.3.2.5 The types of weld joints indicated in the fabrication of structural components are identified with symbols in ANNEXUR -A & B .For further details refer the Engg standard drawing no.3-35-110-00995(Latest)

4.3.3 PRE HEATING

- 4.3.3.1 Pre heating requirements for welding shall be as per Clause 4.6.7 and controls shall be exercised as detailed below. No preheating is required for stainless steels.
- 4.3.3.2 Preheating shall be maintained during the entire process of welding.
- 4.3.3.3 Preheating is to be done using gas burner or induction / resistance heating. The temperature must be uniform and verified using thermal chinks or thermocouples prior to start of welding as well as during welding for a width of 't' (maximum) or (100)75 mm whichever is less.
- 4.3.3.4 Where interpass temperature control is required during welding, the temperature must be ensured using thermal chinks / thermocouples with recorder . Inter pass nitrogen / air cooling can be adopted to maintain inter pass temperature in case of stainless steels.
- 4.3.3.5 Wherever post heating is specified after welding, the preheating shall be continued till attaining the post heat temperature and maintained for the required time and cooled slowly by wrapping suitable insulating blankets like asbestos.
- 4.3.4 Welding shall be performed using qualified procedures and qualified personnel. Edge preparation and welding details shall be as per drawing.
- 4.3.5 For items to be manufactured at subcontractor's works (including away centre fabrication) , for requirements of procedure and personnel qualification SIP:NP: 07 (Latest) shall be followed.
- 4.3.6 When double bevel welding is adopted, back gouging and grinding is to be done. Back gouged groove shall be checked with PT / MT before welding from second side. However for P15E Gr.1.(F91 & F92) Only back grinding to be done after interstage PWHT.
- 4.3.7 Proper sequence of welding shall be adopted to minimise distortion. The distortion of the finished jobs, if any may be corrected by mechanical means / hot correction.
- 4.3.7.1 For welding of SS extreme care is to be taken in weld sequencing to minimize the weld distortion and shrinkage. For complex weldments a weld sequence instructions may be prepared by contractor prior to work commencement. Weld joints likely to have high shrinkage should be welded (with minimum restraints) before welding other joints providing allowance for shrinkage.For further details ref.SQP:NP:20

- 4.3.7.2 While cutting long web plates suitable camber may be provided /required to compensate for the distortion during cutting and welding.
- 4.3.8 All butt welds of divider plate and guide vanes in ducts shall be flush ground inside.
- 4.3.9 The use of jigs and fixtures is recommended where ever practicable. Suitable allowances shall be provided for weld shrinkage. Proper sequence of welding shall be followed to control the distortion during welding.
- 4.3.10 All temporary attachments shall be welded with the required preheat. After their removal welded spots shall be ground flush and LPI checked.
- 4.3.11 Groove welds shall preferably be made with minimum reinforcement unless and otherwise specified in drawing / SQP. In case of butt welds, reinforcement shall not exceed 3.2 mm. and shall have gradual transition to the plane of the base material surface.
- 4.3.12 The surface of the welds shall be free from coarse ripples, overlaps, undercuts and abrupt ridges to avoid stress raisers.
- 4.3.13 Where parts of different thicknesses are welded or surface offset is more, the transition shall be made gradual by grinding / machining with 1: 2.5 taper.
- 4.3.14 Stray arcs shall be avoided to the extent possible. Arc spots if noticed shall be ground and checked by LPI / MPI. Thickness requirements shall be ensured after grinding.
- 4.3.15 Pre heating of Gr 91 & Gr 92 shall be 220 Deg.C .For other process parameters refer the applicable WPS.

4.4 WELD REPAIRS

- 4.4.1 Removal of defective weld / portions of the base material may be done by machining, grinding, chipping, gas cutting, oxygen gouging or carbon arc gouging. Defective portions of the weld shall be removed without substantial removal of sound base metal.
- 4.4.2 For under sized welds additional weld metal shall be deposited using an electrode preferably smaller than that used for making original weld limited to 4mm in diameter. The surfaces shall be cleaned thoroughly before deposition.
- 4.4.3 Defective welds/base metal shall be repaired by removing or/and rewelding as follows:
 - 4.4.3.1 Overlap / excess weld metal shall be removed by grinding.
 - 4.4.3.2 For excess concavity, crater, undersize & undercuts, deposit additional weld metal after cleaning the weld surface.
 - 4.4.3.3 For Cracks in weld or base metal, ascertain the extent of crack by suitable NDE / acid etching, remove the crack to sound metal upto each end of the crack by arresting the ends for further propagation and reweld.
 - 4.4.3.4 For weld porosity, slag inclusions & lack of fusion remove defective portions & reweld

4.5 HOT CORRECTION

- 4.5.1 Members which require hot correction are to be supported at suitable locations and mark the locations for heating.
- 4.5.2 Heat the locations marked by using neutral flame. Torches used for heating shall be moved continuously & uniformly over selected area to avoid localised over heating.

- 4.5.3 For Carbon steels the maximum temperature shall not exceed 650 ° C and shall be ensured using thermal chinks / thermocouples.
- For alloy steels P4 – 705° C , P5 – 735° C temperatures are to be maintained for hot corrections
- 4.5.3.1 For Austenitic stainless steels the maximum temperature shall not exceed 430 ° C and shall be made known to inspection authorities . Otherwise , after hot correction solution annealing at 1050 – 1100 deg C is to be done.
- 4.5.3.2 For Ferritic/Martensitic/Duplex stainless steels the maximum temperature shall not exceed 315° C and shall be made known to inspection authorities . The temperature shall be ensured using thermal chinks / thermocouples.
- 4.5.4 Additional dead weights may be placed over the positive side of the bend depending upon the requirement to accelerate hot correction.
- 4.5.5 Allow for natural cooling. Accelerated cooling shall not be adopted. Remove the dead weights used after cooling.
- 4.5.6 Wherever the correction for distortion affects the weld joints, applicable NDE shall be repeated after the correction.

4.6 POST WELD HEAT TREATMENT (PWHT)

- 4.6.1 The process controls (temperature control and recording) for heat treatment shall cover the activities before, during and after heat treatment.
- 4.6.2 The weldment shall be cleaned to free of grease, oil etc. prior to heat treatment.
- 4.6.3 PWHT shall be done in a furnace or by local heating a band (including the entire weld and adjacent area of the base metal) .
- 4.6.4 The thermocouples and recording instruments shall be calibrated as per applicable standards and records maintained. The furnace shall have been qualified and calibrated.
- 4.6.5 All materials to be heat treated in furnace shall be loaded in such a way that they shall not be subjected to direct flame impingement. Jobs shall be preferably loaded on raised plat forms so that no material projects into the plane of burners. Alternatively flame deflectors may be provided in front of the burners to avoid direct flame impingement. Ensure loading of test coupons wherever applicable. The furnace temperature shall not exceed 315 ° C at the time of loading material / weldment.
- 4.6.6 Number of thermocouples and their location shall be decided covering maximum and minimum thickness and covering all the zones. The temperature variation within 5 meters shall not exceed 140 ° C during heating period (above 315 ° C).
- 4.6.7 The **temperature requirements** for Pre heating, Post Weld Heat Treatment(PWHT) & temperatures are as below.(Unless otherwise specified.)

Material	Thickness	Pre heating	PWHT Temp.	Remarks
P1 Gr 1&2	t < 38	Nil	625 +/- 25 ° C	a) For all butt welds in plate welded girders when t > 50mm.
	T= 39-62	100 ° C		
	t> 63	150 ° C		

P4 Gr 1&2	All	150	665 +/- 15 ° C	a)All butt welds in tension member b)All fabricated components when t>16mm(Note1)
P5A Gr 1& P5BGr2	All	150 ° C (Note2)	705+/- 25 ° C	All welds (Note 3)
P15E Gr1	All	220 ° C	760+/- 10 ° C	After welding, cool to below 95 ° C before PWHT. PWHT to be done within 72hrs after completion of welding. (Post heat as perWPS)
P8	300 type 400type	120 ° C 205 ° C	- -	

Note 1 All fabricated structural components of P4 materials with any member above 16mm thickness, the entire assembly shall be post weld heat treated. However when size of fillet weld is less than 12 mm, PWHT is not required for non load carrying members.

Note 2 All welds on P5 material shall be post heated at 250 ° C for 2 hrs or 150 ° C for 4 Hrs, immediately following welding.

Note 3 All welds of P5 material shall be post weld heat treated. In case where the size of fillet is less than 12 mm, PWHT is not required for non load carrying members.

4.6.7.1 The **soaking time** shall be as follows:

- For P1 materials the soaking time shall be 1 hr/inch of thickness(t) (2.5 mts / mm) upto 2" and 2 hrs + 15 minutes for each additional inch for t > 2".
- For P4 & P5 materials the soaking time shall be 1 hr/inch of thickness (2.5 mts / mm) upto 5" and 5 hrs + 15 minutes for each additional inch for t > 5".
- For combination cycles mentioned above, calculate the minimum soaking time for individual components as 2.5 minutes/mm of the thickness of weld/material whichever is applicable. Soaking time selected for the cycle shall not exceed the limits given below:

Material	Thickness (mm)	Max. soaking time (minutes)
P1 (A,B,C), P4, P5A, P1 (A,B) + P4, P1C + P4, P1 + P3 P4 + P5A, P15E Gr1	Up to 25 mm	125
	26 - 50 mm	200
	51 - 80 mm	250
	81 - 150mm	375

4.6.7.2 Unless otherwise specified, in case of mixed loads of materials not covered under simulation HT, the following heat treatment temperatures shall be followed. In such cases, guidelines for soaking can be taken from Clause 4.6.9.

For components having butt joint between P1 & P4, or P3 & P4, the cycle shall be 630 - 670° C.

Where a component has a butt joint between P4 & P5A, the cycle shall be 680 - 710° . C.

Where a component has a butt joint between P1 & P3, the cycle shall be 620-660 ° . C

For P1+P5A material combination, follow the WPS requirements

The following jobs shall not be combined in the same cycle during PWHT.

Separate jobs of P1 and P4 Separate jobs of P4 and P5

- 4.6.7.3 For PWHT of P15E Gr 1 (Grade 91) & Grade 92 materials, soaking time shall be 1 hour per/inch with minimum soaking of 1 hour. The hardness of the weld metal or heat affected zone after PWHT shall be within 181 BHN to 303 BHN.
- 4.6.8 The following rules shall apply to establish the thickness to be used in determining the soaking time for PWHT.
- 4.6.8.1 For Butt welds, the thickness shall be the thickness of the material at the weld. For bar stock, the thickness shall be the diameter.
- 4.6.8.2 For fillet welds, the thickness shall be the throat thickness. If a fillet weld is used in conjunction with a groove weld, the thickness shall be the greater of the depth of the groove or the throat thickness.
- 4.6.8.3 For partial penetration branch welds, the thickness shall be the depth of the groove prior to welding.
- 4.6.8.4 For repairs, thickness shall be the depth of the groove as prepared for repair welding.
- 4.6.8.5 For combination of different welds in a component, maximum thickness of weld shall govern.
- 4.6.9 Requirements of Rate of Heating (ROH) above loading temperature 315 ° C and Rate of Cooling (ROC) are as given below. During heating and cooling, variation in temperature between thermocouples shall be 85 ° C maximum, unless otherwise specified.

Thickness	ROH / ROC (Max) Above / upto 315 ° C
Up to 25mm	220 ° C / hour
26 - 50 mm	95 ° C / hour
50 – 75 mm	70° C / hour
Above 75 mm	55 ° C/hour
For S.S Matl	200 ° C / hour min (Forced air cooling)
GR 91 &92	Furnace cooling upto 350 ° C

- 4.6.10 In case of interruption during Heat treatment the following action has to be taken depending on the stage of occurrence:

Type of Heat treatment	Stage of interruption	Action
Annealing & stress relieving	Heating	Heat treat subsequently as specified
	Soaking	Heat treat subsequently for balance soaking
	Cooling	If the ROC during interruption period meets the specified rate, cool subsequently at required rate upto 400° C. Otherwise, reheat to the soaking temperature, hold for 15 minutes and then cool at the specified rate

Normalising(N) Tempering (T) & Soln. annealing (S)	Heating	Heat treat subsequently as specified
	Soaking	Heat treat subsequently for full soaking(N,S) / Balance soaking (T)
	Cooling	Not applicable

- 4.6.11 Local heat treatment can be carried out by Resistance heating or Induction heating. For local heat treatment of weld joints, width of the heated band on either side of the weld must be at least 3 times the width of the weld groove of the thickest part or 3 times the highest section thickness, whichever is greater.
- 4.6.11.1 The width of the insulation band beyond the heating band shall be at least twice the total width of the heating band.
- 4.6.11.2 A minimum of three thermocouples shall be placed such that at least one is on the weldment and the other two on the base material on either side of the weldment.
- 4.6.11.3 The winding arrangement shall be established to attain the required temperature. The initial rate of heating shall be minimum such that it stabilises at the required rate of heating before reaching 400 deg C.
- 4.6.12 After heat treatment, the charts shall be correlated with the job and cleared by QC. The chart shall contain cycle no, Date, W.O and DU details. Temperature, ROH, ROC and soaking time shall be calculated, entered in the chart and signed off by QC.
- 4.6.13 Wherever applicable the test coupons shall be tested and reports obtained to complete the clearance of heat treatment operation.

5.0 NON-DESTRUCTIVE TESTING

- 5.1 The requirement of NDE, extent and type of examination shall be as per respective product SQP and / or CQP .Wherever product SQP is not existing the following requirements shall apply.
- 5.2 Visual inspection shall be performed as per SIP:NP:06
- 5.3 RADIOGRAPHY.
- All Butt welds of Carbon steel for thickness $t > 32\text{mm}$
 - All butt welds of alloy steels for thickness $t > 12.0\text{mm}$ for P5 and $T > 16\text{mm}$ for P4.
 - All butt welds in monorails.
 - SS butt welds of $T > 16\text{mm}$ unless otherwise specified.
- 5.3.1 All radiographic films shall possess Firm code , RT agency, Cust. No, Part No, RT reference Number. and weld location reference number. The job shall be numbered with Radiograph number.
- 5.4 MPI / LPI BEFORE PWHT
- All flame cut edges of Carbon steel for $t \geq 38\text{ mm}$ and alloy steels for $t > 12\text{mm}$.
 - All butt welds joining plate members in which one of the plate member is over 25 mm thick for Carbon steel and over 12 mm thick for alloy steel.
 - All fillet welds between tension flange and web.
 - All fillet welds joining plate members in which both the plate members are over 25 mm thick for Carbon steel and over 12 mm thick for alloy steel.
 - For all butt welds of CS & AS weld groove after back chipping prior to welding from

second side.

f. All main fillet welds for SS require LPI

g. MPI/LPI for all fillet welds & HAZ of SA387 Gr.22 materials after HT.

- 5.5 All NDE shall be carried out by qualified personnel as per BHEL NDT procedures. Where subcontractors use their own procedures for NDE the same shall have the approval of BHEL NDTL.

6.0 MACHINING

6.1 GENERAL

- 6.1.1 Ensure of raw material identification throughout the machining process. Traceability to the contract shall be ensured by stamping or marking / painting or by tags(WO No.and DU / Part no.)
- 6.1.2 Where the material identification is likely to be removed during cutting or machining , the transfer of material identification shall be ensured.
- 6.1.3 In case of components / part processed items received from Subcontracting / other shops, ensure the completeness and clearance by QC / Customer Inspector through Inspection Reports / OPS.
- 6.1.4 Proper care shall be taken during handling of materials at all stages of manufacture. Items stored in the shop floor shall be properly identified and preserved to prevent mixup and damages / rusting / warpages.
- 6.1.5 All Machined surfaces shall be properly protected and stored. Wherever long storage is envisaged, they shall be preserved with grease / rust preventive oils and protected suitably with polythene / gunny bag or plastic peel off coatings.

6.2 MARKING

- 6.2.1 The marking on machined components shall be in such a location which will not be detrimental to the surface finish requirements of the component.
- 6.2.2 Purpose of marking is to:
1. Ensure availability of machining allowance.
 2. Identify locations for machining.
 3. Provide reference for setting and inspection.

6.3 PROCESS CONTROLS

- 6.3.1 The following shall be ensured for selection of work centers, tools, jigs and fixtures:
- a The work centre for machining shall be identified in OPS / loading sheet based on the process capability of the machine or Machine accuracy established to suit the tolerances.
 - b Test hardware (Jigs, Fixtures and Templates) used as a means of inspection / process control shall have been qualified through first off trials and shall be regulated through valid number. The same shall be reflected in the OPS / loading sheet .
 - c Softwares used in case of CNC / NC machines shall have been validated through trials or inspection of similar components produced and accepted.

- d All cutting tools shall have been ensured for its correctness before use. In case of regrinding of tools they shall be verified after regrinding.
- 6.3.2 The following shall be ensured before setting the job on the machine, during processing and after completion of machining:
 - a Ensure the verticality and flatness of the job after clamping by using the reference markings or dialing the surfaces. Ensure the adequacy of clamping.
 - b Ensure proper clamping of the correct tool in to the tool holders.
 - c After machining the machined surfaces shall be cleaned and all corners shall be deburred. After removing from the machine they shall be properly stored.
 - d Before starting reaming ensure proper material allowance for finish operation.
 - e During drilling, reaming and tapping the removal of chips shall be done periodically to prevent clogging of chips. For deep drilling ensure that run out and drill travel are verified in free condition and ensure proper clamping of the tools.

.4 INSPECTION

- 6.4.1 Ensure completeness of all final machining operations. Dimensional inspection shall be done with relevant drawings. Ensure use of calibrated instruments / gauges.
- 6.4.2 Unless otherwise specified in the drawing or SQP, the following tolerances can be used for untoleranced dimensions.

1.Linear Tolerance (:millimeters) - Medium

PERMISSIBLE DEVIATIONS FOR BASIC SIZE RANGE						
Up to 6	From 6 TO 30	from 30-120	From 120-400	From 400-1000	From 1000-2000	Above 2000
± 0.1	± 0.2	± 0.3	± 0.5	± 0.8	± 1.2	± 2.0

2. Angular Tolerance

- a. Assembly characteristics ± 0.5°
- b. Other characteristics ± 1°

7.0 FINAL INSPECTION

- 7.1 All dimension shall be inspected as per relevant drawings. Tolerances for fabricated items when not specified in drawings shall be as per clause 4.2.6.

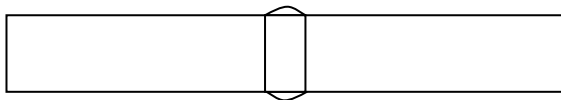
8.0 CLEANING AND PAINTING

- 8.1 All the temporary cleats, bridge pieces shall be removed carefully so as to avoid damage to parent material. Temporary tack welds shall be ground smooth. Complete assembly shall be cleaned to remove mill scales, spatter, slag, rust, oil or grease. Surfaces shall be prepared and painted as per SIP:PP:22 (latest). Site EPs shall be applied with weldable primer. All site EP shall be protected suitably from mechanical damage.
- 8.2 All temporary stiffeners / attachments used for transportation and handling that are removed after site assembly shall be painted with yellow paint.

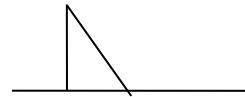
- 8.3 Match marking and flow direction for applicable components shall be as per the respective product SQP./Drawing
- 8.4 The following details shall be clearly marked with relevant details by paint, bordered and covered by one coat of transparent varnish
- Project Name :
 Work order number , DU NO. Weight & Sub-contractor Name/Code:
 Component / Assly. Designation :
- 8.5 Tension flanges in girders are to be identified by hard punching indicating 'TENSION FLANGE'
- 8.6 Apply grease on the threaded portion of "U"Rod and protect the threaded portion from damage with suitable plastic end caps.
- 8.7 For subcontracted items the firm code shall be punched and bordered with white paint.

ANNEXURE - A

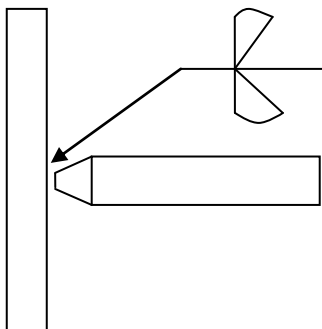
SQUARE BUTT WELD



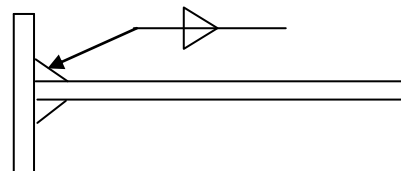
BEVEL WELD



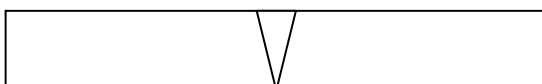
K WELD



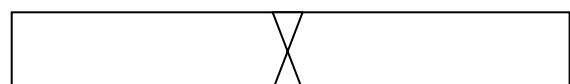
FILLET WELD



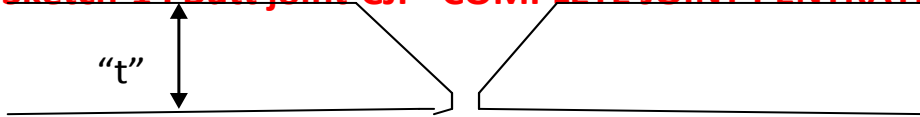
SINGLE V JOINT



DOUBLE V JOINT

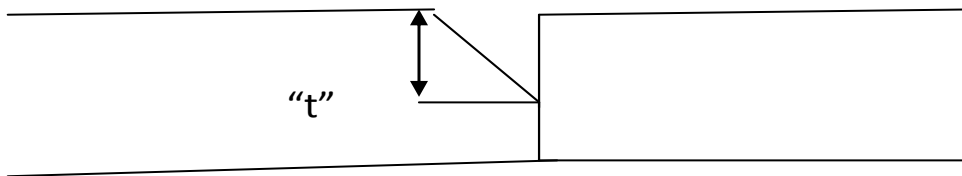


ANNEXURE-B

Sketch-1 : Butt joint-CJP- COMPLETE JOINT PENTRATION

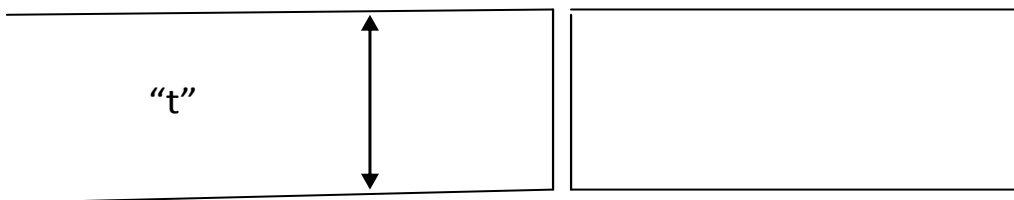
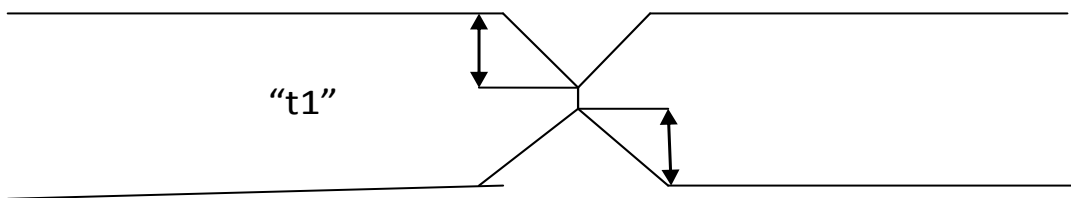
Where “t” is base metal thickness . If “t” is > 50mm PWHT to be done.

If “t” is > 32mm RT to be done.

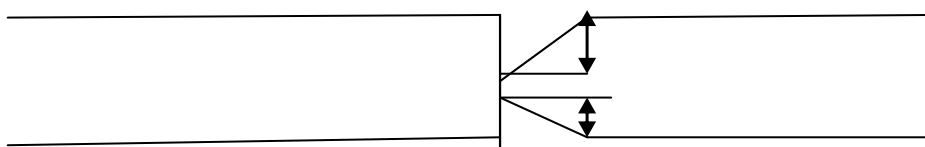
Sketch: 2 GROOVE Butt joint-PJP- PARTIAL JOINT PENTRATION

Where “t” is weld metal thickness. If weld depth is >50mm PWHT to be done

RT: is not applicable.

Sketch:3 - SQUARE BUTT JOINT PWHT & RT is not applicable in this case**Sketch:4 - DOUBLE “V” GROOVE BUTT JOINT –PARTIAL PENTRATION JOINT**

Where “ t” is equal to t_1+t_2 . If “t” is > 50mm PWHT to be done. RT is not applicable

Sketch:5 – “K” GROOVE WELD BUTT JOINT –PJP-PARTIAL PENTRATION JOINT



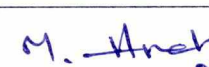
BHARAT HEAVY ELECTRICALS LIMITED

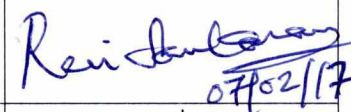
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Guidelines for procurement of raw materials by OVM Firms

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Revision No.	Date	Approved by	Signature
01	07/02/2017	AGM /QA &BE	 07/02/17
00	04/06/2013	AGM /QA	-sd-

Rev. No.	Clause No.	Details of revision
00	--	New release
01	1.0	Scope modified
	2.0	Products operating only in OVM mode are included. The products Which are not operated in OVM mode had been removed.
	3.1	Table -II columns are modified to as per material specification and TDC. Note modified.
	4.2	BRAMAS mode of material sourcing added. Annexure-I & II Included
	4.4&4.5	scope for material sourcing defined.
	5.4	Color coding for E350 plates specified.

1.0 SCOPE :

1.1 This document details out the following modes of sourcing of raw materials by OVM vendors and associated Quality Documentation requirements for Non-NTPC projects

1. Mills /Suppliers approved by BHEL-Trichy
2. BRAMAS
3. Consignee
4. Traders/Agents
5. Inter Vendor Material Transfer

1.2 For NTPC projects, the guidelines given in CIP:653(Latest) shall be followed

2.0 PRODUCTS / MATERIALS SPECIFICATIONS / SIZE:

Table-I

SL No.	PRODUCT	PG OR PGMA	MATERIAL SHAPES AND SPECIFICATION
1	DUCTS AND SUPPORTS, THREADED CLEVIS AND TAPPING POINTS.	48 & 48-XX5	Plates and sheets: IS 2062 E250 A/BR, IS 1079, IS 513 Type D, SA 387 Gr 12 & 22, SA 204 Gr B, ASTM A588 Gr A, ASTM A240 TP 316 & TP 321, SA 515 Gr 70, SA 387 Gr 12/22. Forgings and Fittings: SA 105, IS 2062, SA 182 F12/22 Bolts: SA 193 B7 Pipes: ASTM A53 GrB, IS 3589, SA 106 Gr B, API 5L Gr B. Tubes: IS 1161, IS 1239, IS 1161 Yst 240,
2	STRUCTURES (Other than Ceiling Girders)	34,35,36,38,39, 86-XXX	Plates: IS 2062 E250A, BO, BR&C, IS 2062 E350A, BR, BO, C, & E410, ASTM A36, BSEN10025-3 Gr S420N, ASTM A 572 Gr 50
3	COAL BUNKER	67,68 –XXX	Plates: IS2062 E250 A & BR, SS LINER -SA240 TY 304 Grade 2B.

3.0 TECHNICAL DELIVERY CONDITIONS for the materials covered under Table-1

3.1 Technical Delivery Conditions for various material specifications sourced under the modes specified under Clause-4 are given in the following Table-II

Table-II

Table 11						
Matl Spec.	HT *	Microstructure Grain Size (ASTM E112)	CHEM	MECH	UT	Remarks
SA 105	As per material specification and Grade.					Rolled bars are permitted upto Dia 114.3mm. Dia>114.3 mm shall only be a forging.
SA 182 F12/F22	As per material specification and Grade.					
SA 193 B7	As per material specification and Grade.					Shall be in quenched and tempered condition as per the material specification.

Matl Spec.	HT*	Microstructure Grain Size (ASTM E112)	CHEM	MECH	UT	Remarks
SA 515 Gr 70		As per material specification and Grade.				
SA204 Gr B		As per material specification and TDC 0: 208 (latest).				
SA 387 Gr 12 /Gr 22		As per material specification and Grade				
SA 240 TY 304 Grade 2B		As per material specification and Grade				
SA106 GR B		As per material specification and Grade				
ASTM A53 Gr B		As per material specification and Grade				
ASTM A 588 Gr A		As per material specification and Grade				
ASTM A 240 TP 316 &TP 321		As per material specification and Grade				
ERW TUBE IS1161 YST240		As per material specification and Grade				
ERW PIPE IS1239		As per material specification and Grade				
IS 1079		As per material specification and Grade				
IS 513		As per material specification and Grade				
API 5L Gr B – ERW		As per material specification and (TDC 0: 109 latest)				
ERW :IS 3589 Fe 410		As per material specification and Grade				
IS 2062 E250 Gr A,BR&BO.		As per material specification and TDC 0: 301(latest)				Normalized rolling accepted for thickness above 40 upto 63mm.
IS 2062 E350 Gr A,BR,BO&C		As per material specification and TDC 0: 301(latest)				
BSEN10025-3 Gr S420N , IS 2062 E410,ASTM A572 Gr50		As per material specification and TDC 0: 301(latest)				

Note for Table II:

- The grain size determination wherever specified shall be as per ASTM E112.
- The TDC no specified in the table-II is to be followed unless otherwise contract specified TDC is given.
- *For carbon steel plates $t \geq 40$ mm shall be in normalized condition only and Alloy steel shall be normalized and tempered as per specification unless otherwise specified in table -II .Stainless steel shall be solution annealed.

4.0 MODES OF SOURCING BY OVM VENDORS

4.1 Mills /Suppliers approved by BHEL-Trichy

The materials shall be procured directly from BHEL-Approved suppliers or from the stock yards of BHEL approved suppliers. The original invoice and TC in the name of the OVM vendor or TC copy endorsed by the mill stockyard authorized personnel with identification shall be submitted to BHEL-QC-OLI for verification and clearance as per table-II for further processing.

4.2 BRAMAS:

This mode can be operated by procuring materials from BRAMAS or their stockyards meeting the requirements of Table-II. BRAMAS can procure the materials from BHEL-Approved suppliers for non- NTPC projects and the general process of material procurement & issue to vendors is detailed below:

- 4.2.1 The original Invoice shall be in the name of BRAMAS and TC copy shall be endorsed by the mill stockyard authorized personnel.
- 4.2.2 The materials thus procured i.e., plates, rolled beams, angles, channels etc. shall be stocked maintaining the identification. This process will be periodically audit checked by BHEL.
- 4.2.3 The documents pertaining to inward materials shall be verified as per BHEL TDC/ respective specification by BHEL. The Inward receipt no./DB no, melt no. and plate no shall be stamped on the plates and inward receipt no. /DB no shall be stenciled on other materials by BRAMAS. In case of plates upto 10 mm thickness stenciling may be done instead of hard stamping. Inward Receipt registers shall be maintained by BRAMAS as per the Format given in Annexure-1. This process will be periodically audit checked by BHEL.
- 4.2.4 These materials thus stocked shall be issued to various approved OVM firms through Delivery challan / Invoice indicating inward receipt no. of BRAMAS. The Delivery challan / Invoices / TC copy shall be certified and signed by an AIA appointed by BRAMAS out of BHEL approved list of AIAs.
- 4.2.5 Wherever part quantity is issued to OVM vendors, BRAMAS shall stamp the inward receipt no., melt no., plate no., on the plates issued as well as on the balance materials. Issue details are to be recorded in the format as per Annexure-II in the inward receipt register as mentioned in clause 4.2.3. The AIA appointed by BRAMAS shall verify the same and affix the stamp on the plates. Inward receipt no. shall be stenciled on other materials. This process shall be periodically audit checked by BHEL.
- 4.2.6 The OVM firms receiving material from BRAMAS shall maintain the traceability of the materials at their works. The TC along with Invoice will be verified by BHEL QC/OLI and the Material clearance Report will be verified and signed by BHEL QC/OLI. Subsequently, physical verification and stamping shall be done by BHEL AIA at OVM Firms before processing.

4.3 Consignee mode

In this mode, the materials shall be procured from BRAMAS/Traders/Agents complying to the requirements of Table-II with consignment directly addressed to OVM firm without unloading the materials physically at BRAMAS/Trader/Agents' premises. In this mode, the original TC shall be in the name of BRAMAS/Trader/Agents. The Mill or Mill Stockyard invoice in the name of BRAMAS/Trader/Agent shall however have the consignee address of OVM vendors. The vendor shall submit TC and invoice copies to BHEL-QC-OLI for verification and clearance.

4.4 From Traders/Dealers

The materials upto 5 tons of rolled sections, pipes, tubes, plates & fittings can be procured directly from the stock yards of traders/agents which will be identified by hard stamping /stenciling with day book number, material specification and heat number physically verified as recorded in the day receipt register of the OVM vendor by BHEL-QC-OLI/AIA. The random samples melt wise and size wise shall be selected with inspector's seals and shall be tested at any NABL accredited lab complying to the requirements of Table-II. In addition, UT tests for thickness above 10mm shall be conducted. All the above test results along with TC copy shall be submitted to BHEL-QC-OLI for verification and clearances.

4.5 Inter Vendor Material Transfer

The materials procured under modes 4.1, 4.2 and 4.3 can be transferred by an OVM vendor (hereinafter called main OVM vendor) to other OVM Vendor (hereinafter called Receiving OVM Vendor) for up to 5 tons of rolled sections, pipes, tubes, plates & fittings. However, in case of transfer of plates under this mode, one full size plate /off-cut plate of specific grade and thickness weighing beyond 5 MT is also acceptable, subject to a condition that the plate/part of plate under transfer shall have original Mill stamping.

- 4.5.1 The Receiving OVM Vendor shall not transfer the material to other OVM vendors.
- 4.5.2 The main OVM vendor shall maintain issue control register such that material reconciliation for each Day Book can be demonstrated for BHEL projects.
- 4.5.3 The issue control number will be allotted by the main OVM.
- 4.5.4 The Receiving OVM vendor shall submit TC and invoice copies to BHEL-QC-OLI for verification and clearances as per table-II.
- 4.5.5 BHEL AIA shall stamp/stencil the material in main OVM vendors' works and endorse the Material Transfer Form, as per Annexure-III, which will be verified and signed by BHEL/QC/OLI with the particulars of both Main OVM vendor and receiving OVM vendor.
- 4.5.6 Material traceability shall be ensured by BHEL-QC /AIA in terms of Main OVM Vendor's Day Book Number Reference, Material Specification, Size and Melt Number by hard stamping /stenciling the material to be issued to receiving OVM Vendor.
- 4.5.7 The receiving OVM vendor will maintain the traceability of the transferred materials at their works as per the clause number 5.0 of this procedure.

5.0 TRACEABILITY OF RAW MATERIALS AT OVM VENDOR WORKS:

5.1 A day book number shall be allotted on receipt of materials. Hard stamping & stenciling of the day book number, material specification, plate number and heat number shall be carried out on plates. For Rolled sections (beams, angles, channels etc), stenciling of DB no. shall be done. In case of pipes/tubes/fittings of

-thickness greater than 10mm, the DB number shall be hard stamped and

-thickness less than or equal to 10mm stenciling of DB number is to be done.

5.2 The scanned copy of the day book details along with TC and invoice or Material test results wherever applicable shall be sent to BHEL-QC-OLI for review. The material shall be further processed only after acceptance of the material by BHEL-QC-OLI and physical verification by BHEL authorized inspection agency.

5.3 Subsequent transfer by hard stamping/stenciling of day book number, material specification and heat number on the plates shall be meticulously followed before further cutting, processing and the same shall be subjected to witness inspection by AIA. The stamp of AIA shall be put while transferring the details.

5.4 E350 material shall be separately identified to avoid mix up with E250 by painting the plate thickness on all sides using weldable primer of the respective color shades as indicated below:

- E350 BR - Golden brown
- E350 B0 - Silver
- E350 C - Yellow

It is the responsibility of the vendor to transfer the color codes in all cutout plates subsequently.

5.5 The material shall be subjected to Positive Material Identification (PMI) for materials other than carbon steel during fit up stage and certified by BHEL-QC-OLI or AIA and further review by QC-OLI before starting full welding. The PMI instrument shall be calibrated in a NABL accredited lab and instrument identification shall be included in the PMI report.

Annexure-1

[illegible]

Note : Receipt details shall appear on LHS of the Register

Annexure-II

[illegible]

Note : Issue details shall appear on RHS of Register

Annexure-III

MATERIAL TRANSFER FORM

TRANSFER OF MATERIALS FROM MAIN OVM VENDOR TO RECEIVING OVM VENDOR (TEST CERTIFICATE SHALL BE IN THE NAME OF THE MAIN OVM VENDOR)		CONTROL NUMBER.	
		DATE	
PARTICULARS	MAIN OVM VENDOR	RECEIVING OVM VENDOR	
DETAILS OF THE FIRM			
PO DETAILS			
WORK ORDER NUMBER.			
DESCRIPTION OF MATERIAL			
SIZE			
SPECIFICATION			
QTY.			
WEIGHT			
TEST CERTIFICATE NUMBER			
DB NUMBER.			
1. The above materials were identified against TCs, and the test certificates were scrutinized as per TDC and found satisfactory. 2. Copies of TCs & Invoices are enclosed with this.(TC is duly certified by the main OVM vendor) 3. Hard stamp by AIA-details-“Thickness, specification, heat number & plate number”-AIA stamp			
Main OVM Vendor- QC	AIA	Receiving OVM Vendor- QC	BHEL /QC/OLI

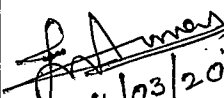
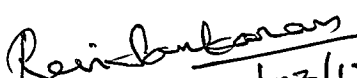


BHARAT HEAVY ELECTRICALS LIMITED
TIRUCHIRAPALLI 620 014
QUALITY ASSURANCE

SIP: NP: 06/02

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PROCEDURE FOR VISUAL INSPECTION OF NON PRESSURE PARTS

REV.	DATE	PREPARED BY	REVIEWED BY	APPROVED BY
00	15/07/96	-Sd- P.S.Narayanan	-Sd- A.R.Reddy	-Sd- V.Raghavendran
01	28/03/04	-Sd- A Francis	-Sd- G S N Murthy	-Sd- C R Raju
02	11/03/2017	 11/03/2017 K.Nagarajan, Sr.Engineer/QA	 11/03/2017 J.V.V.Aruna Kumar, DGM/QA	 11/03/17 U.Revisankaran, AGM/QA&BE

Record of Revisions

Revision No.	Clause No.	Details of revision
00		PR:QE:021/02renumbered as SIP:NP:06
		Editorial corrections for clarity
		Clause 3.1 modified
01	3.1	Code related change
	3.2	For better clarity
	3.2.1	For better clarity
	3.2.3	Code related change
	3.2.5	For better clarity
	4.4	Code related change
02	3.2.2,3.2.4, 4.4 (3),4.4 (5)	<i>Clauses modified based on AWS D 1.1 /D1.1M:2015 Standard.</i>

1.0 SCOPE

This procedure details out the visual inspection of all base metal surfaces and weld joints of Non Pressure Parts.

2.0 REFERENCE DOCUMENTS

AWS D 1.1 /D1.1M:2015 & relevant drawings.

3.0 VISUAL INSPECTION OF GAS CUT EDGES

3.1 Limits on acceptability and repair of mill induced laminar discontinuities in cut surfaces

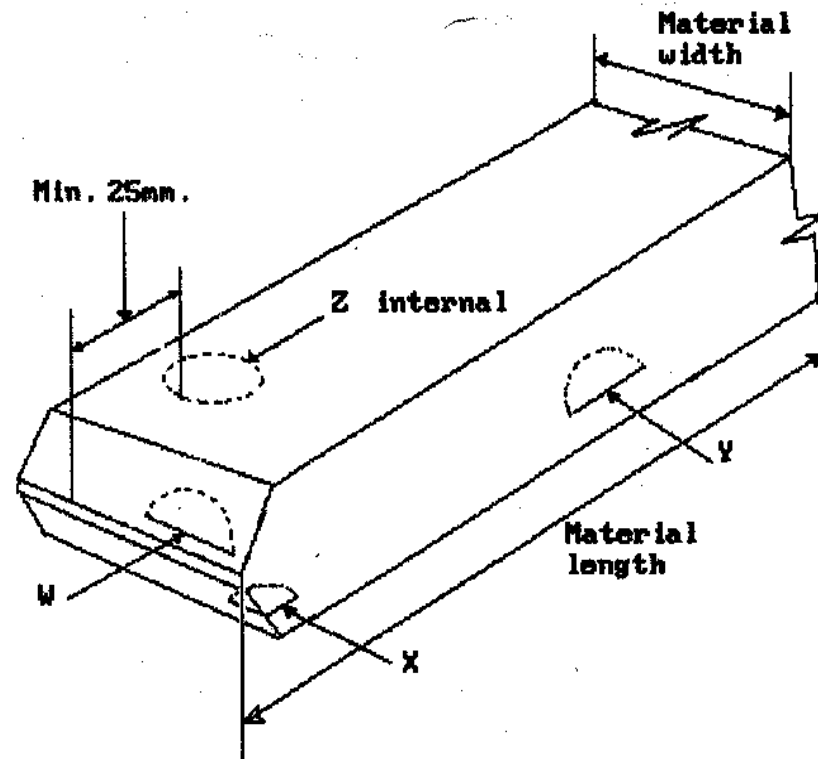
Description of Discontinuity	Repair Required
Any discontinuity 25mm in length or less	No repair required
Any discontinuity over 25mm in length and 3mm max. depth (after grinding & confirmation of depth on 10% of total such locations)	No repair required
Any discontinuity over 25mm in length with depth over 3mm but not greater than 6mm	Remove by grinding and weld.
Any discontinuity over 25mm in length with depth over 6mm but not greater than 25mm	Completely remove and weld.
Any discontinuity over 25mm in length with depth greater than 25mm.	Refer Clause 3.2

3.2 For discontinuities over 25mm in length with depth greater than 25mm, discovered by visual inspection (and subsequent grinding for depth assessment) of plate cut edges/ bevel edges before welding or during examination of welded joints by radiography or ultrasonic inspection, following procedure shall be followed:

3.2.1 Where discontinuities such as W, X or Y in Fig.1 are observed prior to completing the joint, the size, shape and area of the discontinuity shall be determined by UT.

3.2.2 The repair of the discontinuity by welding shall be allowed in case area of discontinuity does not exceed 4% of the cut area with the following exceptions: if the *length* of the discontinuity or the aggregate width of discontinuities on any transverse section, as measured perpendicular to the plate length, exceeds 20% of the plate width, the limit of 4% area shall be reduced by percentage amount of the width exceeding 20% (e.g., if the discontinuity is 30% of plate width, the area of discontinuity cannot exceed 3.6% of the plate area). The discontinuity on the cut edge of the plate shall be gouged out to a depth of 25mm beyond its intersection of the surface by chipping, or carbon arc gouging, or grinding and blocked off by welding with manual shielded metal arc process in layers not exceeding 3mm in thickness.

Fig.1

EDGE DISCONTINUITIES IN CUT PLATE

- 3.2.3 If discontinuity (Z) not exceeding the allowable area in Clause 3.2.2, is discovered after the joint has been completed and is determined to be 25mm or more away from the face of the weld, as measured on the plate surface, no repair of discontinuity is required. If the discontinuity (Z) is less than 25mm away from the weld, it shall be removed to a distance of 25mm from the fusion zone of the weld by chipping, air carbon arc gouging or grinding. It shall then be blocked off by welding with low hydrogen SMAW process in layers not exceeding 3mm in thickness for at least four layers. Submerged arc or other welding process may be used for remaining layers.
- 3.2.4 If the area of discontinuity (W), (X), (Y) or (Z) exceeds the allowable limits of Clause 3.2.2, the plate or sub-component shall be rejected and *replaced*.
- 3.2.5 The aggregate length of weld repair shall not exceed 20% of length of plate surface being repaired.

4.0 VISUAL INSPECTION OF WELDS

- 4.1 Visual examination of welds shall be performed after completion of welding and subsequent cooling to room temperature. However for ASTM A514 and A517 steels (*whenever used*), visual examination of welds shall be performed only after 48 hours of completion of welding.

4.2 All welds shall be cleaned to remove slag, spatter etc. and visually examined for defects like crack, undercut, porosity, lack of fusion etc.

4.3 The welds shall also be examined for size, shape and reinforcement.

4.4 **ACCEPTANCE CRITERIA AND DISPOSITION DETAILS ARE AS FOLLOWS:**

Sl.No.	Nature of defects	Acceptance norms	Disposition
1.	Crack, Lack of fusion, Overlap	Not accepted	Confirm by LPI/MPI, repair and retest.
2.	Crater (Except at the ends of stitch welds outside the required length)	Not accepted	Fill by weld deposit.
3.	<u>Under cut:</u> For T < 25 mm For T => 25 mm	Up to 1.0 mm accepted. (Up to 2.0 mm if within 50mm for any 300 mm weld Length.) Up to 2.0 mm accepted.	To be ground and merged/welded. >2.0mm to be ground and merged/welded.
4.	<u>Porosity:</u> Transverse Butt welds Porosity for other Groove/Fillet welds	Piping porosity not permitted. One pore of ≤ 2.5 mm for each 100 mm of Weld length is permitted (*). *sum of diameters of piping porosity in fillet welds in web to stiffener: 10mm for 25 mm weld & 20mm for 300mm weld is however acceptable.	
5.	<u>Weld profile:</u> (i) Face of fillet (ii) Size (Minimum) (iii) Reinforcement (groove)	Flat or concave (meeting the throat) accepted. convexity is acceptable as below: 2mm for weld width ≤ 8 mm 3mm for weld width > 8 mm < 25 mm 5mm for weld width ≥ 25 mm As per drawing. Under size permitted as below(#) 2mm for nominal size < 5mm 2.5mm for nominal size 6mm 3mm for nominal size > 8 mm #In all case, undersized weld length shall not exceed 10% of the total weld length. <i>3mm (max.) for $t \leq 25$mm ; 5mm(max.) for $t > 25$mm</i> <i>t= thickness of thicker plate for CJP; t= weld size for PJP</i>	

BHARAT HEAVY ELECTRICALS LIMITED

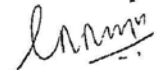
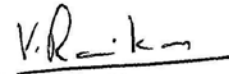
TIRUCHIRAPALLI 620 014

QUALITY ASSURANCE

QUALITY ASSURANCE

SIP: NP: 07/02

WELDING/WELDER QUALIFICATION FOR STRUCTURAL APPLICATIONS

REV.	DATE	PREPARED	REVIEWED	APPROVED
00	15/07/96	P.S.Narayanan	A.R.Reddy	V.Raghavendran
01	13/10/03	 A Francis	 GSN Murthy	 C R Raju
02	25/11/09	 T. Palanisamy	 Bikramaditya Roy	 Ravikumar V

Revision no	Clause no	Revision details
00	--	--
01	--	1.PR:QE:172/00 Renumbered as SIP:NP:07 2.Editorial corrections for better clarity
02	--	1.Completely modified

1.0 SCOPE

1.1 This procedure details out the requirements of Welding procedure qualification/ Performance Qualification tests for welders and welding operators/ Welding procedure specification and maintenance of records for the same at sub Vendor works for structural application.

1.2 REFERENCE DOCUMENTS

1.2.1 AWS D1.1/D1.1M:2008.

2.0 WELDING PROCESS

- a. SMAW -Shielded Metal Arc Welding.
- b. SAW --Submerged Arc Welding.
- c. GMAW -Gas Metal Arc welding. (Note 1to3 to be strictly followed)

#Note,

1. Prior approval for GMAW to be obtained from BHEL/quality.
2. Gas Mixture of 80% Argon & 20% CO2 to be ensured.
3. All Production welds shall be done inside the closed shed only.

3.0 WELDING PROCEEDURE QUALIFICATION

3.1 Prepare draft WPS and get it approved by BHEL WTC.

3.2 Consumable selected for draft WPS shall be as per BHEL approved brand.

3.2.1 All NDE and pre treatment for plate before/after cutting & during/ after welding shall be as per the respective QCP & SQP.

3.3 Test plate of size 180x380mm of Specified thickness-2 nos for all butt (fig 5), corner (Fig 9) & fillet (fig 2) weld joints.

3.4 Minimum procedure qualification test requirement for Structural Fabrication : Carbon Steel to IS 2062 E250 GR A OR B.

Sl. NO	Process	PL. thick	Pre-heat	PWHT	Type of Jt.	Test-position	Position qualified
1	SMAW	25mm	NIL	NIL	Groove butt weld	1G	1G,1F
2	SMAW	40mm	YES 100deg.C	NIL	Groove butt Weld	2G	1G,2G,1F,2F
3	SMAW	56mm	Yes 100deg.C	Yes	Groove Butt weld	1G	1G,1F
4	SMAW	10mm	NIL	NIL	Corner weld	3G	3G, 3F
5	SMAW	*	NIL	NIL	Fillet	3F	3F
6	SAW	25mm	NIL	NIL	Butt weld	1G	1G,1F
7	SAW	25	Yes 100deg.C	NIL	Butt weld	1G	1G & 1F
8	SAW	56mm	YES 100deg.C	NIL	Corner weld	1G	1G & 1F
9	SAW	*	NIL	NIL	Fillet	1F	1F
10	SAW	*	NIL	NIL	Fillet	1F	1F
11	GMAW	10mm	NIL	NIL	fillet	3F	1F
12	GMAW	10mm	NIL	NIL	Groove butt weld	2G	1G,2G,1F,2F

Note:

1.0 * Ref fig 8 for size of test plates for fillet welds.

- 2.0 For all other material combinations separate procedure to the relevant code/standard shall be qualified before start of production welds.
- 3.0 SAW corner groove weld qualification with 15°+30° groove angle (ref fig9) shall be done along with plate groove butt weld.
- 4.0 For pipe WPS qualification Dia. 2 inch of schedule 80 and 6 inch of schedule 120 are to be welded in 5G & 2G position respectively. This qualifies for all sizes, positions and unlimited thickness of pipes and tubes.

3.5 Base material other than Carbon steel, applicable welding process is SMAW only. In such cases PQR shall be qualified as per AWS D.1.1.

3.6 Test shall be done in presence of BHEL/ QC or BHEL nominated AIA.

4.0 **BASE MATERIAL.**

4.1 Test plate base material shall match with drawing or other engineering Documents.

4.2 Test plate weld surface shall be ground smooth and free from Oil & scales.

5.0 **WELDING REQUIREMENT**

5.1 Weld groove configuration and dimensions shall be as shown in the Draft WPS, drawing or Sketch authorized by engineering for processing.

5.2 All Procedure qualification and production welds of SAW process shall be done in 1G/1F position only.

5.3 Details of process and consumable used for welding such as Preheat, consumable size, brand name, AWS classification for electrode, Wire and flux, Shielding gas etc shall be recorded and maintained.

5.4 Details of the welding parameters Such as Welding current, voltage, travel speed, wire feed, shielding gas mixture & gas flow rate etc shall be recorded and maintained.

5.5 Details of number of layers and passes of groove or fillet welds (fig6) shall be recorded.

5.6 Back gouge/grind the second side as applicable and ensure weld soundness by MT/PT before second side weld.

5.7 Complete the weld and ensure weld soundness by applicable NDE (MT, PT, and RT or UT).

5.8 Necessary PWHT (as per draft WPS) shall be done before marking the test Specimen for mechanical test.

5.9 The defective portion of the welds in the test plate shall be discarded and not repaired

6.0 **Test plate Specimen & test requirement:**

6.1 Test Specimen for butt welded test plate as per fig 5 and Fillet/ corner welded test plate as per fig 7 shall be punched with inspecting engineer's stamp before cutting the test specimen. (No. of test specimen shall be as per table-2)

6.2 WPS test specimen requirement for mechanical test are as follows:

Table 2

Test pl. thickness & dia. In mm	Reduced Section tensile	Bend test 4t, 180°			Macro	thick qualified		Dia. Qualified
		Root	face	Side		Min.	Max.	
T 3 to 10	2	2	2	*	--	3mm	2T	--
T>10 T < 25	2	--	--	4	--	3mm	2T	--
T25 & over	2	--	--	4	----	3mm	Unlimited	--
Dia. 50 & t6	2	2	2	-	--	3mm	20mm	Dia. 20-100
Dia. 150 t12	2	2	2	-	--	5mm	Unlimited	Dia. >100mm
Corner/ fillet weld	--	--	--	--	3	5mm	Unlimited	--

*For 10mm plate or wall thickness, a side bend test may be substituted for each of the required face- and root- bend tests.

7.0 **Mechanical test**

7.1 Prepare the test specimen as per AWS D1.1 and move to BHEL Lab or NABL accredited lab for mechanical testing.

7.2 Mechanical test to be done in presence of BHEL/QC or BHEL nominated AIA.

8.0 **Preparation of PQR & WPS**

8.1 Generate qualified WPS and PQR (as per the format enclosed in page 9 and 10) indicating all process parameters, Mechanical/ NDE test results, reports as applicable and submit to inspection engineer for verification and approval.

9.0 **Welder/ Welding operator qualification (WQ)**

9.1 The welder/ welding operators engaged for procedure qualification tests are automatically qualified for production welding.

9.2 Test material: for carbon and alloy steel respective materials shall be used for test.

9.3 Test plate size: 200x200x25 mm or 200x200 and respective plate thicknesses.

9.4 WQ Test and production position qualified are as follows.

Table 3.

Weld type	Test Position	Production position qualified
Plate Groove	3G	1G, 2G, 3G, 1F, 2F & 3F
Plate groove	1G	1G & 1F
Plate fillet	1F	1F
Plate Fillet	3F	1F, 2F & 3F
Pipe Groove	2G & 5G	All position.
Pipe fillet	4F	1F, 2F & 4F

Note: Additional position can be qualified if required. Only qualified personnel shall be engaged in respective positions for production weld.

9.5 WQ Test requirement: Two Nos of side bend tests or 100% RT for butt welded test piece. Macro examination at three faces for fillet welds as per fig 7.

9.6 On successful test results WQR (as per the format enclosed in page 8) to be prepared & countersigned by inspection engineer and maintained for verification.

9.7 **WQ period of effectiveness:**

Qualification is effective unless : 1) The operator or welder is not engaged in welding for a period exceeding six months or unless 2) There is a specific reason to question his ability.

10 **Documentation:**

10.1 Prepare consolidated list of qualified WPS, Welder and Welding operator qualification records and maintain.

11 **Qualification-Types & Limitations**

11.1 Requalification of WPS is required in the following cases

S1. No	Welding variable	SMAW	SAW	GMAW
1.	Change from Low hydrogen to non low hydrogen electrode	Yes	--	--
2.	Change from wire & flux combination	--	Yes	--
3.	Change in nominal filler metal diameter by	>0.8mm	Increase	yes
4.	>7% Change in voltage each dia. used	--	Yes	Yes
5.	% change in travel speed	--	>15	>25
6.	Change in position qualified	Yes	Yes	Yes
7.	A decrease in Groove angle	Yes	Yes	Yes
8.	A decrease in Root gap	Yes	Yes	Yes
9.	An increase in root face	Yes	Yes	Yes
10.	Addition or deletion of PWHT	Yes	Yes	Yes

12 **PQR/ WPS requirement for Different strength Base materials**

12.1 For dissimilar composition of Low strength to high strength welded connections separate PQR and WPS shall be qualified.

12.2 In such cases Low hydrogen electrodes shall only be used.
(Preheat, Post heat and PWHT as per applicable SQP and draft WPS).

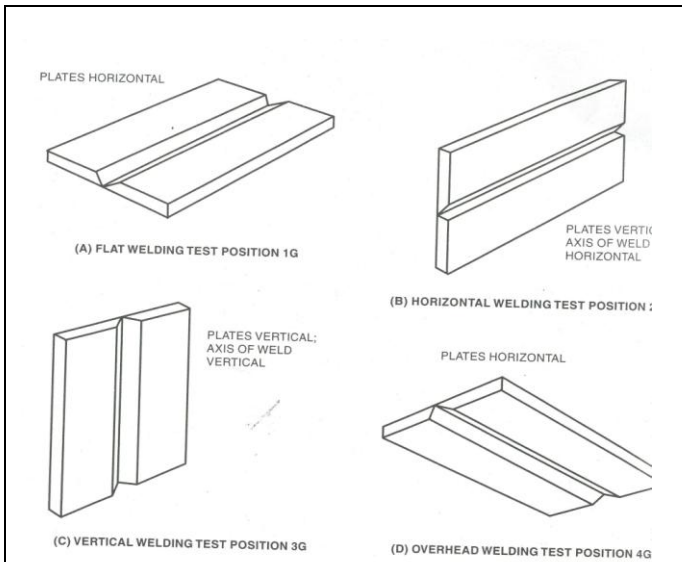


Figure 1

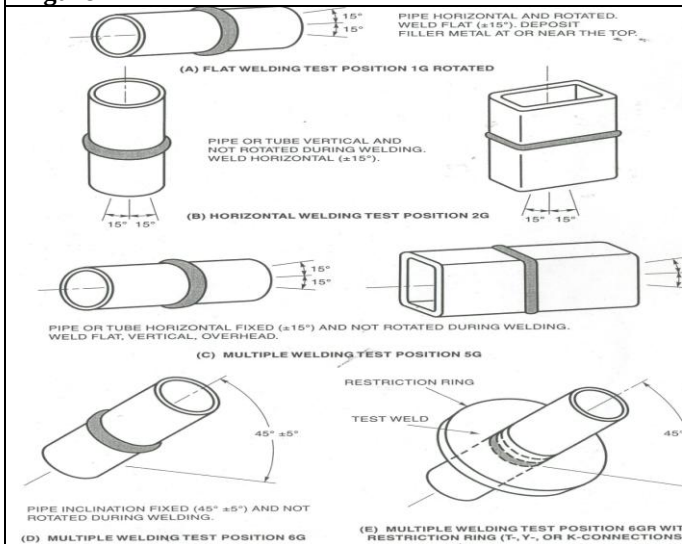


Figure 3

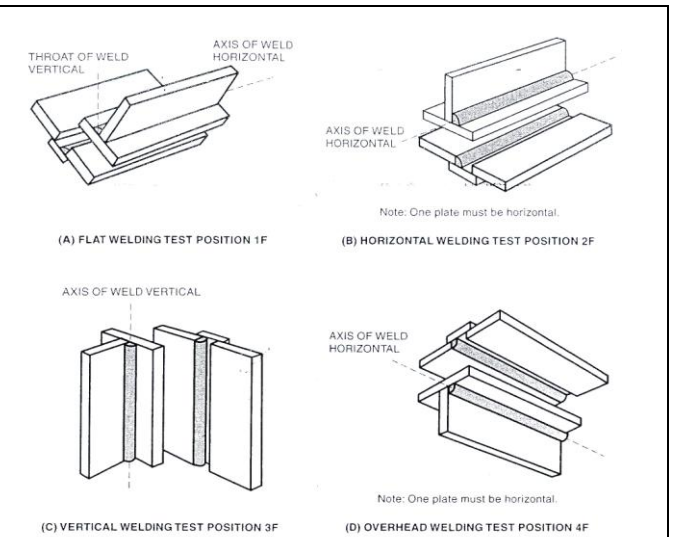


Figure 2

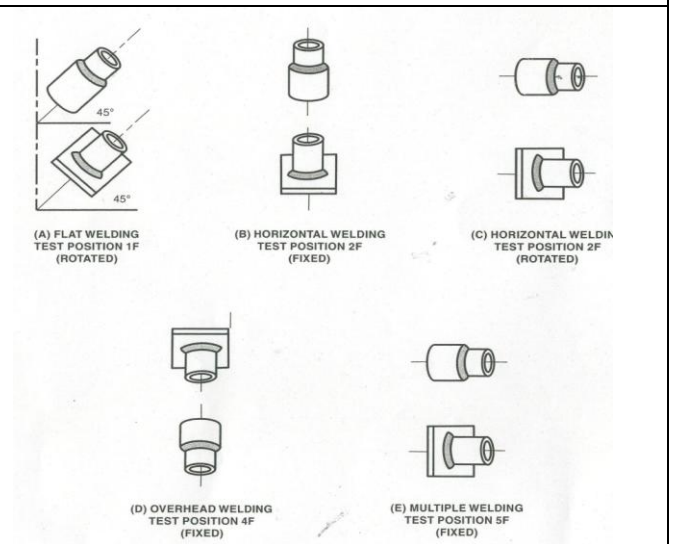


Figure 4

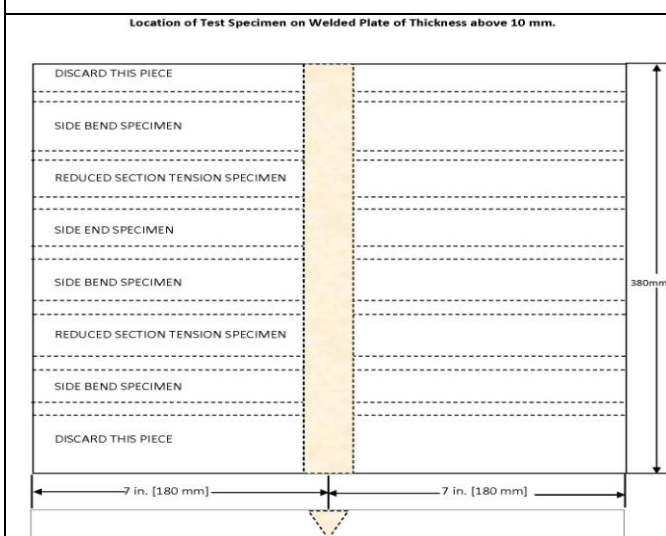
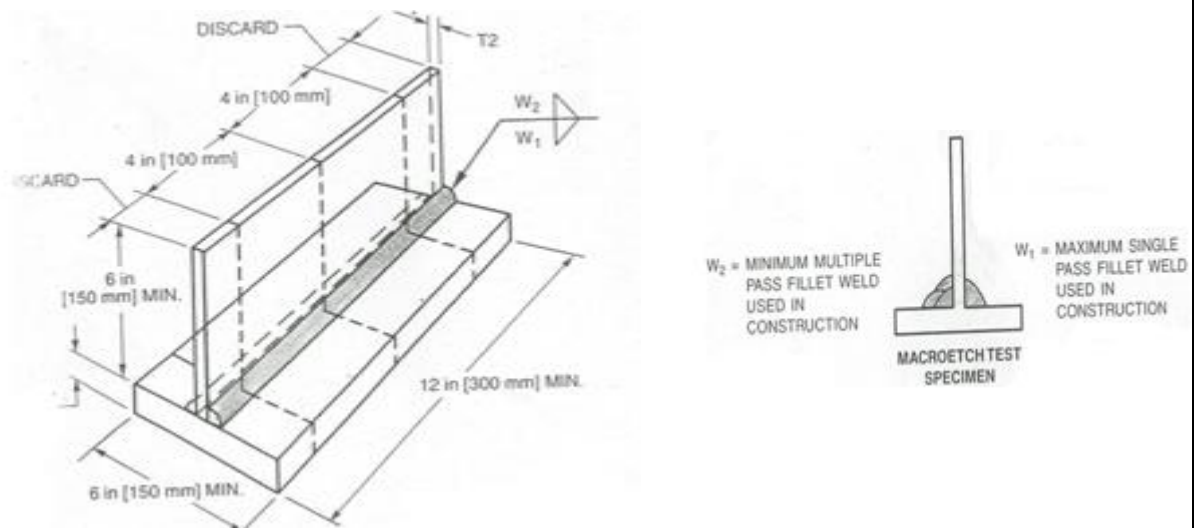


Figure 5

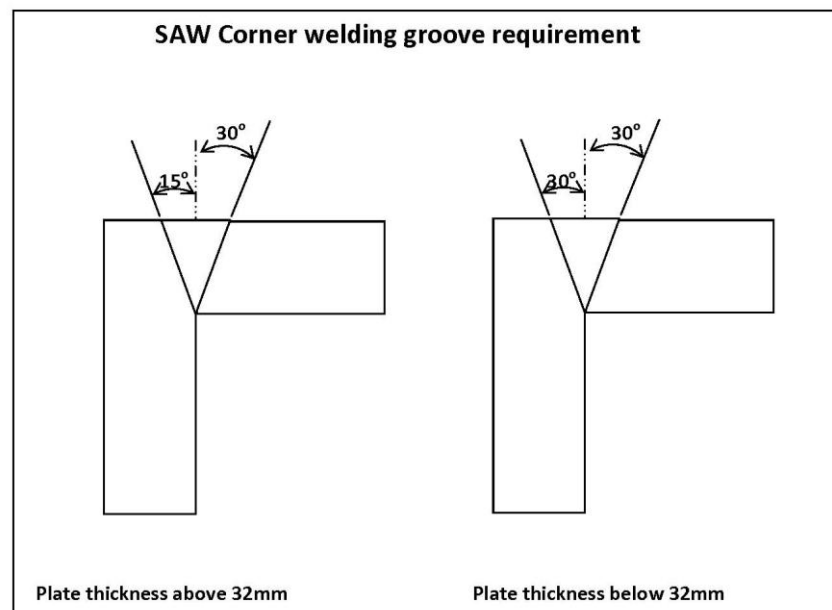
Fillet size	No. of layer	No. of Passes	Joint layer & passes
Up to 10mm	1	1	
12	1 2	1 2	
16	1 2 2	1 2 3	
20	1 2 3 3	1 2 3 4	
25	1 2 3 3 4 4 4	1 2 3 4 5 6 7	

Figure 6

Figure 7 Fillet weld test specimen Details**Figure 8 Fillet weld Test plate Selection details**

Weld Size in mm	T1 minimum	T2 minimum
5	12	5
6	20	6
8	25	8
10	25	10
12	25	12
16	25	16
20	25	20
>20	25	25

Note: Where the maximum plate thickness used in Production is less than the value shown above, the Maximum thickness of the production plates may be Substituted for T1 & T2.

Figure 9

WELDER, WELDING OPERATOR, OR TACK WELDER QUALIFICATION TEST RECORD

Type of Welder _____
 Name _____ Identification No. _____
 Welding Procedure Specification No. _____ Rev _____ Date _____

Variables	Record Actual Values Used in Qualification	Qualification Range
Process/Type [Table 4.12, Item (1)]	_____	_____
Electrode (single or multiple) [Table 4.12, Item (7)]	_____	_____
Current/Polarity	_____	_____
Position [Table 4.12, Item (4)]	_____	_____
Weld Progression [Table 4.12, Item (5)]	_____	_____
Backing (YES or NO) [Table 4.12, Item (6)]	_____	_____
Material/Spec.	_____ to _____	_____
Base Metal	_____	_____
Thickness: (Plate)	_____	_____
Groove	_____	_____
Fillet	_____	_____
Thickness: (Pipe/tube)	_____	_____
Groove	_____	_____
Fillet	_____	_____
Diameter: (Pipe)	_____	_____
Groove	_____	_____
Fillet	_____	_____
Filler Metal (Table 4.12)	_____	_____
Spec. No.	_____	_____
Class	_____	_____
F-No. [Table 4.12, Item (2)]	_____	_____
Gas/Flux Type (Table 4.12)	_____	_____
Other	_____	_____

VISUAL INSPECTION (4.8.1)

Acceptable YES or NO _____

Guided Bend Test Results (4.30.5)

Type	Result	Type	Result
_____	_____	_____	_____
_____	_____	_____	_____

Fillet Test Results (4.30.2.3 and 4.30.4.1)

Appearance _____ Fillet Size _____
 Fracture Test Root Penetration _____ Macroetch _____
 (Describe the location, nature, and size of any crack or tearing of the specimen.)

Inspected by _____ Test Number _____
 Organization _____ Date _____

RADIOGRAPHIC TEST RESULTS (4.30.3.2)

Film Identification Number	Results	Remarks	Film Identification Number	Results	Remarks
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

Interpreted by _____ Test Number _____
 Organization _____ Date _____

We, the undersigned, certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in conformance with the requirements of Clause 4 of AWS D1.1/D1.1M, (_____) *Structural Welding Code—Steel*.
 (year)

Manufacturer or Contractor _____ Authorized By _____
 Form N-4 Date _____

WELDING PROCEDURE SPECIFICATION (WPS) Yes ☐ PREQUALIFIED _____ QUALIFIED BY TESTING _____ or PROCEDURE QUALIFICATION RECORDS (PQR) Yes ☐								
Company Name _____ Welding Process(es) _____ Supporting PQR No.(s) _____				Identification # _____ Revision _____ Date _____ By _____ Authorized by _____ Date _____ Type—Manual ☐ Semiautomatic ☐ Machine ☐ Automatic ☐				
JOINT DESIGN USED Type: Single ☐ Double Weld ☐ Backing: Yes ☐ No ☐ Backing Material: _____ Root Opening _____ Root Face Dimension _____ Groove Angle: _____ Radius (J-U) _____ Back Gouging: Yes ☐ No ☐ Method _____				POSITION Position of Groove: _____ Fillet: _____ Vertical Progression: Up ☐ Down ☐				
BASE METALS Material Spec. _____ Type or Grade _____ Thickness: Groove _____ Fillet _____ Diameter (Pipe) _____				ELECTRICAL CHARACTERISTICS Transfer Mode (GMAW) Short-Circuiting ☐ Globular ☐ Spray ☐ Current: AC ☐ DCEP ☐ DCEN ☐ Pulsed ☐ Power Source: CC ☐ CV ☐ Other _____ Tungsten Electrode (GTAW) Size: _____ Type: _____				
FILLER METALS AWS Specification _____ AWS Classification _____				TECHNIQUE Stringer or Weave Bead: _____ Multi-pass or Single Pass (per side) _____ Number of Electrodes _____ Electrode Spacing Longitudinal _____ Lateral _____ Angle _____ Contact Tube to Work Distance _____ Peening _____ Interpass Cleaning: _____				
SHIELDING Flux _____ Gas _____ Composition _____ Electrode-Flux (Class) _____ Flow Rate _____ Gas Cup Size _____				POSTWELD HEAT TREATMENT Temp. _____ Time _____				
PREHEAT Preheat Temp., Min. _____ Interpass Temp., Min. _____ Max. _____								
WELDING PROCEDURE								
Pass or Weld Layer(s)	Process	Filler Metals		Current		Volts	Travel Speed	Joint Details
		Class	Diam.	Type & Polarity	Amps or Wire Feed Speed			

Form W-1 (Front)

Procedure Qualification Record (PQR) # _____**Test Results****TENSILE TEST**

Specimen No.	Width	Thickness	Area	Ultimate Tensile Load, lb	Ultimate Unit Stress, psi	Character of Failure and Location

GUIDED BEND TEST

Specimen No.	Type of Bend	Result	Remarks

VISUAL INSPECTION

Appearance _____
 Undercut _____
 Piping porosity _____
 Convexity _____
 Test date _____
 Witnessed by _____

Radiographic-ultrasonic examination

RT report no.: _____ Result _____
 UT report no.: _____ Result _____

FILLET WELD TEST RESULTS

Minimum size multiple pass Maximum size single pass
 Macroetch Macroetch
 1. _____ 3. _____ 1. _____ 3. _____
 2. _____ 2. _____

Other Tests**All-weld-metal tension test**

Tensile strength, psi _____
 Yield point/strength, psi _____
 Elongation in 2 in, % _____
 Laboratory test no. _____

Welder's name _____

Clock no. _____ Stamp no. _____

Tests conducted by _____ Laboratory

Test number _____

Per _____

We, the undersigned, certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in conformance with the requirements of Clause 4 of AWS D1.1/D1.1M, (_____) *Structural Welding Code—Steel*
 (year)

Signed _____
 Manufacturer or Contractor

By _____

Title _____

Date _____

	BHEL – Tiruchirappalli - 620014, India. Quality Assurance Department TECHNICAL DELIVERY CONDITIONS	DOC No: TDC:0:301 Rev: 11 Effective Date: 15/11/2017 Page: 1 of 2
Product: STRUCTURAL QUALITY PLATES FOR BOILER STRUCTURES		

Revision record:

- Rev 01: Text Modified. IS 8500Fe 540, IS 2062 Gr B added.
- Rev 02: Shapes removed. UT>40mm IS 2062 Gr A introduced.
- Rev 03: 06/10/06 Cl.2.0, 3.0 & 4.0 modified.
- Rev.04: Revised in entirety merging IS 8500 with IS 2062 as per IS 2062-2006 and replacing BSEN 10113 with BS EN: 10025
- Rev.05: 01/10/09 - Cl.3.0, 4.0, 8.0: Normalized rolled clause included.
- Rev 06: 27/10/14 - TDC 313 Rev 02 merged with TDC 301, IS 2062 Gr E350, E450 and its requirements added in Cl1, Cl 2, 3, 4. Cl 7 modified, Note added.
- Rev 07: 20/12/14 - Cl 1, 4, 5, 7, 8 and note modified.
- Rev 08: 23/07/2016 - Cl 2, 3, 4, 7 and 8 modified.
- Rev 09: 23/09/2016 - Cl 2, 3 modified to include IS 2062 E350 Gr A; Cl 4(c), 8(e) modified to bring clarity regarding grain size.
- Rev 10: 01/08/2017 - Cl 2, 3 modified to include IS 2062 E250 Gr B0, C
- Rev 11: 15/11/2017 - Cl 3.a.i – thickness and heat treatment condition modified
Cl 3.a.ii – class removed
Cl 4.c – grain size specified for all grades of Normalised rolled condition

1. MATERIAL SPECIFICATION: {Latest on date of Purchase Order (PO)}

- PLATES : ASTM A 36, IS 2062, BS EN 10025-2, BSEN 10025-3 [applicable grades as per drawing]
- Additional Requirement** : **As listed below (Supplementary to Specification)**
- Size and Qty. : As per Purchase order (PO)

2. CHEMICAL COMPOSITION AND PROCESS:

- ASTM A36 shall be procured in killed condition.
- IS 2062 E250 A, B0, BR, E350 A, B0, BR up to 20mm thickness shall be in killed or semi killed condition. IS 2062 E250 A, B0, BR, E350 A, B0, BR 20mm and above thickness shall be in killed condition.
- IS 2062 E250 C and IS 2062 E350 C shall be in killed condition.
- BS EN 10025-2 S355 J2+N shall be in killed condition with Carbon: 0.20% max (in Product Analysis).
- IS 2062 E410 BR / BS EN 10025-3 S420N shall be in killed condition. Vanadium: 0.15% max; Carbon: 0.20% max (in Product Analysis).

3. HEAT TREATMENT:

- ASTM A36, IS 2062 E250 A, B0, BR, C and E350 A, B0, BR, C:
 - Thickness up to and including **20mm** in rolled condition. Thickness more than **20mm** shall be Normalized/ Normalized rolled.
- IS 2062 E410 BR/ BSEN 10025-3-S420N, BS EN 10025-2 Gr S355 J2 +N: Normalized condition.

4. MECHANICAL TESTS:

- All mandatory tests shall be as per the applicable materials specifications.
- Additionally, microstructure analysis for Grain size shall be carried out for Normalizing rolling plates above **20mm** thickness at the same frequency as the mechanical tests. Grain size: ≥ 5 at 100X magnification.

5. NON DESTRUCTIVE TEST:

Ultrasonic Test: For plates of thickness > 40 mm as per ASTM A435 or ASTM A578 (Acceptance Level A or B).

6. FINISH AND REPAIR:

Plates shall be free from all mill scales, edge crack and other injurious defects. Repairs by fusion welding is prohibited. Mechanical removal of defects permitted subject to meeting minimum thickness and smooth surface.

7. MARKING (by mill):

- Specification (IS specification designation for IS 2062 grades), 2. Grade, 3. Melt number, 4. Maker's emblem/Code/ Identification and 5. Plate number. PO No (BHEL PO only), buyer name & Weight to be painted on the product. Marking shall be done as indicated below:
 - All plates of thickness > 10mm: 1 to 4 shall be maintained by hard stamping and 5 by paint stenciling.

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Product: STRUCTURAL QUALITY PLATES FOR BOILER STRUCTURES		

- ii. All plates of thickness $\leq 10\text{mm}$ (except made from strip in coil form): 1, 2, 3, 4 shall be maintained by paint stenciling.
- iii. Plates of thickness $\leq 10\text{mm}$ (produced from strip in coil form): 1, 2, 3, 4 by paint stenciling on the top of each pile/ packet.

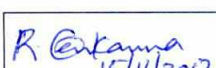
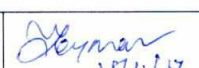
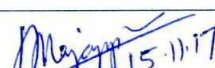
8. INSPECTION AND CERTIFICATION:

Products must be inspected & tested at supplier's works. Test certificate, in English, shall accompany each product with the following details:

- a) Purchase Order No. (BHEL PO only), TDC No. & its Revision No., Test certificate No. & Date, Size, Plate number and Quantity-Melt wise.
- b) Material Specification and Grade with applicable year of code, Heat Number, Steel making process, de-oxidation process.
- c) Chemistry, Carbon equivalent and Heat Treatment details.
- d) Mechanical test values, including impact values (where applicable), shall be reported.
- e) Grain size at 100X magnification for Normalizing rolling Plates of thickness above 20mm (Refer Cl. 4(b) of this TDC).
- f) NDE results with reference and acceptance standards.

Note:

1. This TDC shall be read along with SIP:NP:14 (latest revision), for POs placed by Outsourcing department on OVM/ACF vendors.

 15/11/2017	 15/11/17	 15/11/17	 15/11/17	 15/11/17	 15/11/17
Venkanna Rupani	M. Jeyaram	S Krishna Kumar	R Rajappan	N Vanangamudi	Amit Roy
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Prepared By	Reviewed By				Approved By