

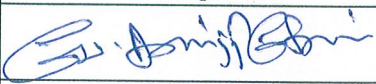
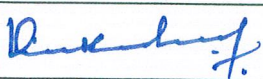
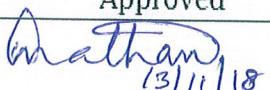


**BHARAT HEAVY ELECTRICALS LIMITED,
PIPING CENTRE, CHENNAI - 600017.**

**QUALITY CONTROL PROCEDURE FOR
FABRICATION OF PIPE CLAMPS**

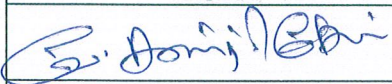
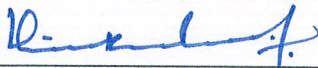
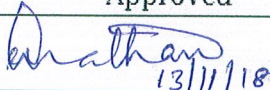
QCP No: 06

REV No: 07

Prepared	Checked	Approved
		
Karthikeyan V (Dy.Engr/QA)	Vivekananda Yellu (Dy.Manager/QA)	Vaithianathan C (AGM/Quality)

Proprietary Data of BHEL - For Internal Use Only

REV No	Date	Revised Clause	Description
07	13.11.2018	All	Fabrication requirement of Gr.91/92, Stainless Steel added and full QCP revised for better clarity.

Prepared	Checked	Approved
 Karthikeyan V (Dy.Engr/QA)	 Vivekananda Yellu (Dy.Manager/QA)	 13/11/18 Vaithianathan C (AGM/Quality)

1.0 SCOPE:

- 1.1 This Quality Control Procedure covers the quality requirements in fabrication/manufacturing of pipe clamps. (Rod type Clamp, U-Rod Clamp, Horizontal Clamps, Shock absorber Clamps, Trunnion Clamps, Riser Clamps, Bearing Clamps, Tube clips etc.,)

2.0 MATERIALS:

- 2.1 Raw Materials shall conform to the grades specified in drawings.
- 2.2 The Heat treatment condition of Rods & Plates shall be as follows:

Carbon Steel (P1 Group - SA105, SA515 Gr.60/70, SA 516 Gr.60/70.etc) - Normalised.

Alloy Steel (P4 Group - SA182 F11/F12, SA 387 GR 11/12, P5A Group - SA182F22, SA387 Gr 22, P15E Group - SA182 F91/92, SA387 Gr 91/92 etc.) - Normalised and Tempered.

Stainless Steel (P8Group - SA182F304/316/316L, SA240TP304/316/316L etc.)-Solution Annealed.

3.0 FABRICATION:**3.1 Marking & Identification:**

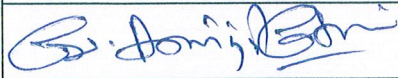
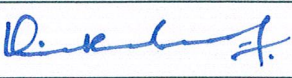
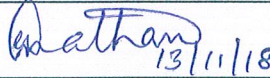
- a) Marking shall be done by scribing / light punching free of notch.
- b) Specification punching and Heat no transfer to be done for Carbon steel, Alloy steel and Stainless steel plates/rods prior to cutting and recorded in cutting plan.

3.2 Cutting:

- a) Plates shall be cut by shearing, saw cutting, Water jet cutting or gas cutting. Gas Cutting is PROHIBITED for Gr.91/92 materials.
- b) For Plates of Gr.91/92 cutting shall be done along the grains.
- c) Preheating shall be done as per TABLE - 1 during gas cutting. Gas cut edges shall be ground smooth up to depth of 6 mm minimum from cutting edge and then MPI/LPI (refer NDE clause) shall be conducted out to ensure defect free edges.
- c) Rods shall be machined to the required length.

3.3 Forming:

- a) All manufacturing operations shall be carried out by BHEL approved firms/vendors only.

Prepared	Checked	Approved
		
Karthikeyan V (Dy.Engr/QA)	Vivekananda Yellu (Dy.Manager/QA)	Vaithianathan C (AGM/Quality)

b) Clamps shall be formed using non-striking dies (Forming by hammering is PROHIBITED).

c) Plates/Rods shall be Cold or Hot formed depending upon the radius of bend/ plate thickness / rod diameter.

d) Refer TABLE - 2 for Post Forming Heat treatment and TABLE - 4 for Rate of heating and Cooling.

e) Heat Treatment shall be done for full component.

3.4 Holes:

a) Holes/Slots shall be made only by drilling/boring/slotting.

b) Making holes by gas cutting is PROHIBITED.

c) Holes shall be drilled in similar to assembly condition, to avoid misalignment of holes during assembly.

3.5 Welding:

a) Welding shall be done using qualified WPS and welders qualified by BHEL as per AWS D1.1 or ASME Sec IX.

b) Weld edges shall be free from scale, slag, rust, moisture, grease or other foreign materials.

c) Pre heating, Electrode selection, welding parameters, post weld heating, shall be as per BHEL- Piping Centre qualified WPS.

e) Required Electrodes shall be baked in oven as per electrode manufacturer's recommendations before welding and kept in a thermal flask during welding.

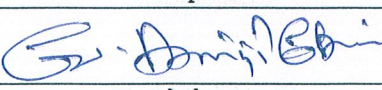
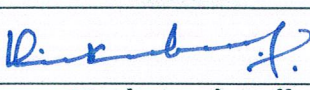
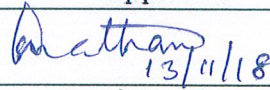
3.6 Tolerance:

Dimensional tolerances shall be as per drawing,

4.0 POST WELD HEAT TREATMENT:

4.1 Clamps shall be Heat treated after welding as per TABLE - 3 (Post Welding) and rate of heating and cooling shall be as per TABLE - 4 as applicable.

4.2 Heat Treatment shall be done by BHEL approved Heat Treatment Agency. Heat Treatment by Resistance Heating is PROHIBITED for Gr91/92 materials.

Prepared	Checked	Approved
		 13/11/18
Karthikeyan V (Dy.Engr/QA)	Vivekananda Yellu (Dy.Manager/QA)	Vaithianathan C (AGM/Quality)

4.3 Clamps made of Gr91/92 materials shall be brought to a temperature of 80~100°C after post heating and kept for minimum one hour. PWHT shall commence immediately thereafter.

5.0 **NDE - NON DESTRUCTIVE EXAMINATION:**

5.1 All NDE shall be carried out by BHEL approved agencies/Certified Level-II personnel as per SNT-TC-IA in the required NDE method.

5.2 Quantum of NDE is 10% for Carbon steels and 100% for Alloy Steels/Stainless Steel Clamps. NDE shall be done only after Heat Treatment wherever applicable.

5.3 All Clamps (Except Clamps of SS Material) shall be subjected to MPI on Weld area, Bend portion and Edges. For Gr91/92 clamps, Wet MPI method shall be used.

5.4 All Stainless Steel (SS) Clamps shall be subjected to LPI on Weld area, Bend portion and Edges.

5.5 MPI shall be as per ASME Sec V and evaluation as per ASME B31.1 CL.136.4.3.
LPI shall be as per ASME Sec V and evaluation as per ASME B31.1 CL.136.4.4.

5.6 Clamps made of Gr91/92 materials shall be tested for Hardness on bend area and weld area randomly covering whole area of bending and welding. The value of hardness shall be 190 to 250 BHN.

5.7 Photo-Micrographic test shall be done for Gr91/92 clamps to conform microstructure as per ASME Material specification (Tempered Martensite). Test shall be done with photo micrographs 500X resolution minimum (actual magnification shall be indicated) and 3 replicas shall be taken in bend portion of one clamp per heat treatment batch.

6.0 **INSPECTION:**

6.1 **Welding Inspection:**

a) Welds shall be free from undercuts, ripples, valleys and notches.

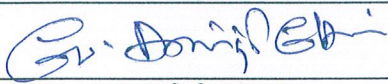
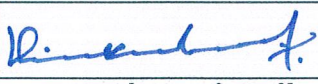
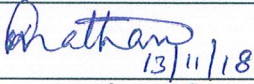
b) Weld profile shall be dressed to suit NDE requirements.

c) Fillet weld sizes shall be checked with profile gauges.

6.2 **Visual & Dimension Inspection:**

a) All Clamps after Forming / Heat Treatment shall be visually inspected to ensure crack free surface.

b) All dimensions shall be as per BHEL drawing.

Prepared	Checked	Approved
		
Karthikeyan V (Dy.Engr/QA)	Vivekananda Yellu (Dy.Manager/QA)	Vaithianathan C (AGM/Quality)

c) Clamp profile/Final Clamp assembly shall be ensured by using layout checking method.

7.0 **REPAIR:**

7.1 Defective welds shall be removed by grinding completely (ensured by NDE-LPI) and rewelded.

7.2 All the precautions, heat treatment and inspection as in the case of main weld shall be applicable for repair weld also.

8.0 **IDENTIFICATION:**

8.1 Pipe clamps shall be identified as specified in P.O.

8.2 **If not specified in P.O**, pipe clamps sent to BHEL stores as **stock** shall be punched and stenciled with Firm code, Material code and Material spec alone **otherwise** Firm code, 14-digit WO/Du code, Material Spec, Quantity, Weight shall be Punched and stenciled. Punched area shall be highlighted by applying a coat of Aluminum paint or by bordering by Black paint.
Small Clamps like Tube clips, Rod clamps etc. of diameter/width less than 76.1mm and/or thickness less than 6mm, Material specification alone shall be punched, other details may be bundled and shall be stenciled by non-removable paint.

8.3 In Stainless Steel Clamps identification shall be by engraving/stenciling.

9.0 **SURFACE PREPARATION, PAINTING AND COLOR CODING:**

9.1 Pipe clamps shall be Surface prepared and painted as per Project specific customer approved painting scheme.

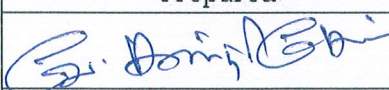
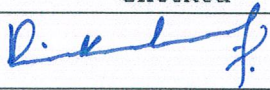
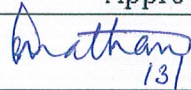
9.2 Pipe clamps shall be painted as below **when not specified in Project specific Painting scheme / P.O/ Drawings**.

a) Surface preparation of the clamp except 91/92 and SS Clamps shall be as per SSPC-SP3 (Power tool cleaning).

b) Carbon Steel Clamps:

Shall be painted with one coat (1x30 microns) of Red-Oxide Zinc Phosphate Primer (Alkyd Base) to IS:12744 by brush/spray followed by two coats (2x20 microns) of Synthetic enamel paint to IS 2932 - SMOKE GREY COLOUR (Shade No.692 of IS 5).

c) Alloy Steel Clamps (Except 91/92 and SS Clamps):

Prepared	Checked	Approved
		 13/11/18
Karthikeyan V (Dy.Engr/QA)	Vivekananda Yellu (Dy.Manager/QA)	Vaithianathan C (AGM/Quality)

Shall be painted with one coat (1x30 microns) of Red-Oxide Zinc Phosphate Primer (Alkyd Base) to IS:12744 by brush/spray followed by two coats (2x20 microns) of Synthetic enamel paint to IS 2932 - WHITE COLOUR.

d) Gr.91/92 Clamps:

Shall be surface prepared by Blast cleaning (SA2 ½) and shall be painted with two coat (2x20 microns) of Heat Resistant Aluminum paint to IS13183 Gr. I.

e) SS Clamps:

Shall be surface treated by pickling & passivation as per ASTM A380. No painting shall be done for SS clamps

9.3 Threaded portion of clamps shall be applied with rust preventive oil to avoid rusting.

9.4 Color Coding: **If not specified in P.O**, Clamps shall be Color coded as per the table below.

P. No Group	Material Specification	Color 1	Color 2	Color 3
P1	SA515 Gr.60 SA515 Gr.70/ SA105	Red Blue		
P4	SA387 Gr11 / SA182 F11 SA387 Gr12 / SA182 F12	Green Black	White Red	
P5A	SA387 Gr22 / SA182 F22	Blue	Red	
P15E	SA387 Gr91 / SA182 F91	Brown	Red	
P8	SA240 TP304 / SA182 F304 SA240 TP316 / SA182 F316 SA240 TP316L / SA182 F316L	Blue Black Blue	Yellow Green Brown	Yellow

Note: Each color band shall be of minimum 25mm, applied at visible ends preferably beyond packing.

TABLE - 1

Pre Heating for Various materials

Material	Plate Thickness (t)	Preheat Temperature
P1 Group	Below 25 mm 25 mm to 75 mm Above 75 mm	Nil 100 °C 150 °C
P4 Group	75mm and below Above 75mm	120 °C 150 °C
P5A Group	Below 13 mm 13mm to 25 mm Above 25mm	120 °C 150 °C 200 °C

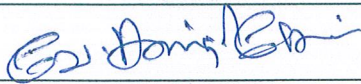
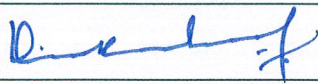
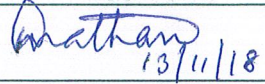
Prepared	Checked	Approved
		 13/11/18
Karthikeyan V (Dy.Engr/QA)	Vivekananda Yellu (Dy.Manager/QA)	Vaithianathan C (AGM/Quality)

TABLE - 2

Forming and Post Forming Heat Treatment**a) Forming**

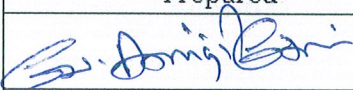
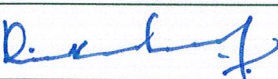
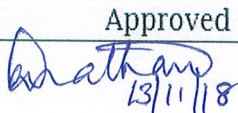
Process of Forming	Rod Dia (D) or Plate Thk (t) in mm	Radius of Bend ** (R) in mm	Forming Temp				
			Carbon Steel P1 Group	Alloy Steel P4 Group	Alloy Steel P5A Group	Alloy Steel P15E Group (Gr.91/92)	Stainless Steel P8 Group
Cold Forming	All	All	Room Temp	Room Temp	Room Temp	No Cold Forming	Room Temp
Hot Forming - Controlled Temp (Furnace Heating)	All	All	Forming Temp 620~980 °C	Forming Temp 720~1010 °C	Forming Temp 720~1010 °C	Forming Temp not less than 950 °C	Forming Temp not less than 1000 °C
Hot Forming - Uncontrolled Temp	All	All	Un Controlled Temp	Un Controlled Temp	Un Controlled Temp	Prohibited	Prohibited

b) Post Forming Heat Treatment (PFHT)

Process of Forming	Rod Dia (D)/ Plate Thk (t) in mm	Radius of Bend ** (R) in mm	Heat Treatment (PFHT) Temp with minimum Soaking time				
			Carbon Steel P1 Group	Alloy Steel P4 Group	Alloy Steel P5A Group	Alloy Steel P15E Group (Gr.91/92)	Stainless Steel P8 Group
Cold Forming	D ≤ 19 D > 19 t ≤ 12.7 t > 12.7	R ≥ 0.5D R > 2.5D R > t R > 2.5t	No PFHT	No PFHT	No PFHT	Prohibited	No PFHT
	D ≤ 19 D > 19 t ≤ 12.7 t > 12.7	R < 0.5D R < 2.5D R < t R < 2.5t	* SR at 595~625 °C (Min 1Hr soaking)	* SR at 650~680 °C (Min 1Hr soaking)	* SR at 680~720 °C (Min 1Hr soaking)		No PFHT
Hot Forming - Controlled Temp (Furnace Heating)	All	All	No PFHT	* SR at 650~680 °C (Min 1Hr soaking)	* SR at 680~720 °C (Min 1Hr soaking)	Normalise at 1040~ 1060 °C (Min 0.5Hr soaking) & Temper at 750~770 °C (Min 1Hr soaking)	Solution Anneal at 1050~ 1100 °C (Min 15 minutes soaking)
Hot Forming - Uncontrolled Temp	All	All	Normalise at 880~ 900 °C (Min 0.5Hr soaking)	Normalise at 920~ 950 °C (Min 0.5Hr soaking) & Temper at 650~680 °C (Min 1Hr soaking)	Normalise at 920~ 950 °C (Min 0.5Hr soaking) & Temper at 680~720 °C (Min 1Hr soaking)	Prohibited	Prohibited

* - If welding is involved in these clamps, post forming Tempering/SR may be combined with PWHT.

** - Radius of bend to be measured at neutral axis of bend (R = smaller of R1 or R2 radius of clamps).

Prepared	Checked	Approved
		
Karthikeyan V (Dy.Engr/QA)	Vivekananda Yellu (Dy.Manager/QA)	Vaithianathan C (AGM/Quality)

Proprietary Data of BHEL - For Internal Use Only

Table -2 Notes:

- 1) No holding time required for forming.
- 2) Forming is not permitted on threaded areas.
- 3) Soaking or Holding time for SR/Tempering shall be calculated as 1 hour per 25mm thickness.
- 4) Soaking or Holding time for Normalising/Solution annealing shall be calculated as 0.5 hour per 25mm thickness.

TABLE - 3***Post Welding Heat Treatment (PWHT)***

Material Group	Thickness for Soaking Time Calculation (T)	PWHT Temperature and Min Soaking
Carbon Steel P1Group	Less than 19 mm	No HT
	19 mm and above	* Stress Reliving at 595~625°C (Min 1Hr soaking)
Alloy Steel P4Group (Gr.11/12)	All	* Stress Reliving at 650~680°C (Min 1Hr soaking)
Alloy Steel P5AGroup (Gr.22)	All	* Stress Relieving at 680~720°C (Min 1Hr soaking)
Alloy Steel P15EGroup (Gr.91/92)	All	Stress Reliving at 750~770°C (Min 1Hr soaking)
Stainless Steel P8Group (SS)	All	No HT

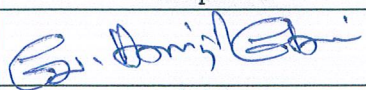
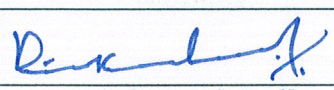
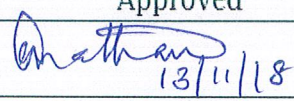
* - Post forming Tempering/SR may be combined with PWHT.

Notes:

- 1) Soaking or Holding time shall be calculated as 1 hour per 25mm thickness (T).
- 2) T = Thickness for calculating Soaking or Holding time shall be taken as the greater value of Material Thickness or Rod Diameter or Weld Size in mm.

TABLE - 4***Rate of Heating and Rate of Cooling***

Material Thickness	Rate of Heating	Rate of Cooling
Upto 25mm	220°C/Hr	220°C/Hr
Over 25mm to 50mm	110°C/Hr	110°C/Hr
Over 50mm to 75mm	75°C/Hr	75°C/Hr
Over 75mm	55°C/Hr	55°C/Hr

Prepared	Checked	Approved
		 13/11/18
Karthikeyan V (Dy.Engr/QA)	Vivekananda Yellu (Dy.Manager/QA)	Vaithianathan C (AGM/Quality)