BHEL	TD-215 Rev.00	**AMENDMENT-NOTIFICATION**	HY 064 07 63 REV.NO.03 PAGE 1 OF 1

PROCESS SPECIFICATION FOR POST WELD HEAT TREATMENT OF CARBON STEEL AND LOW ALLOY STEEL PRESSURE VESSELS PARTS & OTHER COMPONENTS

The following clause shall be added in page no. 3 of 11, after clause 3.4.

Clause 3.4.1 Threaded portion of the weldments / components shall be protected or preserved by applying "ERPEDOL" compound

(Material Code no. is HY5510062002).

REF: HY:Tech:001	AMD.NO.	APPROVED	ISSUED	DATE	CUM. Sl.No.
	01	MANAGER, STDS. ENGG.	STDS. ENGG.	29.9.2001	A 0351

RESTRICTED USE

BHEL-HYD EDAS INFORMATICS CENTRE

PROCESS SPECIFICATION FOR POST WELD HEAT TREATMENT OF CARBON STEEL AND LOW ALLOY STEEL PRESSURE VESSELS PARTS & OTHER COMPONENTS

1.0 GENERAL:

1.1 This procedure outlines precautions/general guide lines to Technologists/Heat treatment personnel to ensure code requirements are fully met with during Post Weld Heat Treatment (PWHT) and is written in line with clauses UW-40, UCS-56 and UCS - 85.

1.2 For complete code requirements, relevant clauses/Tables shall be referred to.

1.3 Code requirements /' code cases shall over rule this procedure in case of any discrepancy.

1.4 This procedure is applicable for coded vessels constructed with carbon steel and low alloy steels singularly stress relieved (whole or local) clubbed with other coded/non-coded vessels/weldments.

1.5 This standard stipulates guidelines for applications as per ASME Section VIII div.1. Specific jobs shall be postweld heat treated in consultation with welding engg dept.

1.6 The components/products for which the material specification is in accordance with National/ International codes such as IBR/BS/DIN/ASTM/ANSI/API, the post weld heat treatment requirements stipulated in the relevant codes shall be applicable.

2.0 COMPLIANCE WITH STANDARD:

This standard is based on ASME SECTION VIII, Division 1, Clauses UCS-56, UCS-85 and UW-40.

3.0 EQUIPMENT AND ITS CALIBRATION:

3.1 Heat treatment furnaces operating on electric power or gas or oil are suitable.

3.1.1 In case of thermocouple not placed on component, uniformity of temperature in the working zone shall be maintained within ±14°C during the operation.

3.2 Furnace shall be provided with suitable controller/recorder for temperature measurement. All controlling furnace instruments shall be calibrated as per QMI 001.

COPYRIGHT AND CONFIDENTIAL
The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED.
It must not be used directly or indirectly in any way detrimental to the interest of the company.

PLANT STANDARD
HYDERABAD

3.3 Location of the thermocouple shall be as per the guide lines given below (applicable for ASME coded vessels/ parts) and as per the details given in the technology process sheet of relevant part.

3.3.1 Placement of thermocouples must represent realistic temperature spread expected in the furnace both vertically and axially.

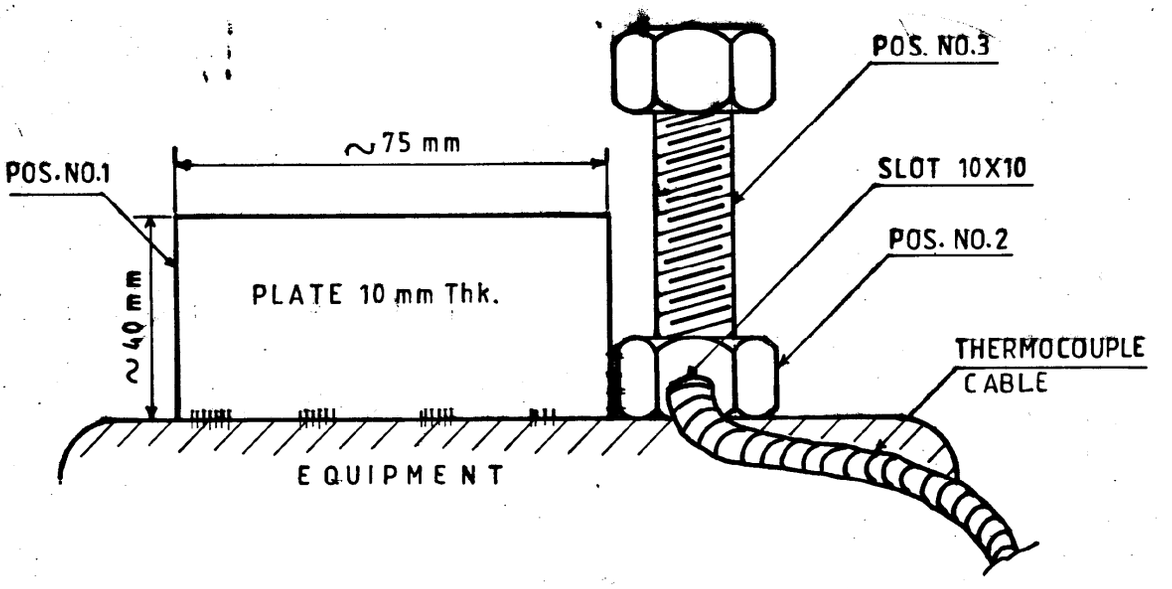
3.3.2 Two thermocouples are required on every single charge upto 5 meters long (zone). An additional thermocouple is required for every additional 5 meter or fraction there of. No two thermocouples may be placed more than 5 meters apart.

3.3.3 When more than one pressure vessel or pressure vessel parts are postweld heat treated in one furnace charge, each such vessel part shall be represented by atleast one thermocouple. Pressure vessels shall be so located such that it satisfies the requirement of clause 3.3.2.

3.3.4 Closure seams of pressure vessels locally or wholly heat treated will have two thermocouples placed 180° apart around the out side of the seam, on top and bottom or on the sides. In case of tube sheet to Hemihead joint (C1 joint) one thermocouple will be placed in tube hole near to center of the tube plate. However, for carbon steel tubed Heat exchanger, thermocouple at the centre is not required.

3.3.5 Fixing of themocouple prior to PWHT on the job shall conform to the procedure for fixing thermocouples as given below:

a) Thermocouple shall be fixed on the equipment with the help of fixing arrangement shown in figure below.



b) Material for Pos. No.1 shall be cut from pressure vessel quality carbon steel plates.

COPYRIGHT AND CONFIDENTIAL
The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED.
It must not be used directly or indirectly in any way detrimental to the interest of the company.

c) Plate Pos.No.1 shall be tackwelded to the nut Pos.No.2 which is provided with a slot of 10x10 mm to facilitate insertion of thermocouple cable. Ensure the nut (Pos.No.2) bottom surface is flush with the plate (Pos.No.1) before tackwelding.

d) Pos. No.1 shall be tackwelded to the equipment by qualified welder with approved WPS. The nut shall not be tackwelded to the equipment.

e) Thermocouple cable shall be secured to the equipment by tightening bolt Pos.No.3 as shown in the fig. above.

f) After PWHT, plate Pos.No.1 shall be removed from the equipment by grinding the tacks.

Do not hammer to break the tacks. Flush grind the tacks after removing the plate.

3.4 Components/pressure vessels shall be protected from the direct impingement of flame.

3.5 Quality control shall ensure conformity of the requirement stipulated in clause 3.1 to 3.4.

4.0 Simulated test coupons shall be proved wherever necessary for all materials used in the ASME code vessels except as permitted in UCS-85(d), (e), (f) and (g). The total time at temperature during simulation shall be atleast 80% of the total time at temperature during actual heat treatment of the product and may be performed in a single cycle. Material of P.No.1, Gr.No.1 & 2 and all carbon steels and low alloy steels used in annealed condition are exempted from this requirement.

5.0 POST WELD HEAT TREATMENT (PWHT) CYCLE:

5.1 All materials in the PWHT charge shall be categorised as per 'P' number and group no. according to ASME Section IX - Clause QW-422. For weldments involving non ASME materials, P numbers and group no. shall be assigned based on nearest equivalent ASME material specification.

5.2 Outline special requirements/instructions if any from drgs/Route cards/material specifications. Necessary information shall be filled in Furnace loading sheet No. PD-316 enclosed.

5.3 Clubbing of non ASME material with coded vessels shall be considered only when such requirements are acceptable to code specified PWHT Cycle.

5.3.1 For assembly of materials of different P nmumbers, the postweld heat treatment shall be the lowest range of the material requiring the higher postweld heat treatment temperature after giving due consideration to the mass of the material involved.

5.4 The temperature of the furnace shall not exceed 425°C at the time of loading.

COPYRIGHT AND CONFIDENTIAL
The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED.
It must not be used directly or indirectly in any way detrimental to the interest of the company.

PLANT STANDARD
HYDERABAD

5.5 Rate of heating:

5.5.1 Rate of heating above 425°C shall not be more than 222°C/hr divided by the maximum metal thickness of the shell or head plate in inches, but in no case more than 222°C/hr. Maximum metal thickness in coded vessel or other weldments in the charges, whichever is maximum shall be used in the calculation. During the heating period there shall not be greater variation in temperature throughout the portion of the vessel being heated than 138°C within any 4.6 M interval of length.

5.5.1.1 The rate of heating and cooling need not be less than 55°C/hr. However, the reduced rates of heating and cooling for closed chambers and complex structures may be considered to avoid distortion due to excessive thermal gradient.

5.6 Soaking Temperature and Time:

5.6.1 Minimum holding time and temperature shall be as per table UCS-56 as given in annexure-1.

A temperature range of 50°C shall be specified starting from code specified minimum normal holding temperature which may be relaxed to 60°C range to facilitate clubbing with vessels constructed to codes other than ASME Sec.viii Div.1.

5.6.2 Wherever impracticable, PWHT at minimum normal holding temperature can be considered as permitted by table UCS 56.1 as given in the annexure-2.

5.6.3 For assessing min. holding time, the nominal thickness shall be the thickness of weld joint as defined in UW-40 (f).

5.6.4 For combined charge the min. holding temperature is the max. of the min. normal holding temperatures of the applicable materials in the charge as per 5.6.1 above. Holding temperatures lower than the min. normal holding temperatures (clause 5.6.2) can be considered only when such temperature is acceptable for all materials in the charge.

5.6.5 For combined charge, the min. holding time is the max. of the min. holding times for various weldments as calculated in applicable clauses 5.6.1, 5.6.2 and 5.6.3 above.

5.6.6 For vessels requiring notch toughness properties (low temp. application, customer requirement etc.) which are post weld heat treated singularly or clubbed with other components/vessels; Soaking time shall be specified in consultation with welding engineering.

COPYRIGHT AND CONFIDENTIAL
The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED.
It must not be used directly or indirectly in any way detrimental to the interest of the company.

5.7 Rate of Cooling:

5.7.1 Above 425°C, cooling shall be done in a closed furnace or cooling chamber at a rate (vide clause 5.5.1.1 also) not greater than 278°C/hr divided by the maximum metal thickness of the shell or head plate in inches, but in no case more than 278°/hr. From 425°C the vessel may be cooled in still air.

6.0 LOCAL POSTWELD HEAT TREATMENT:

6.1 Wherever not practicable, circumferential joints may be locally post weld heat treated by gas fired split furnace or by electrical heating which shall ensure required uniformity.

6.2 The width of the heated band on each side of the greatest width of finished weld shall be not less than two times the shell thickness.

6.3 The portion outside the heating device shall be protected so that the temperature gradient is not harmful.

7.0 POWER/GAS FAILURE DURING PWHT CYCLE:

7.1 Safety precautions on power / gas failure.

7.1.1 Ensure isolation of gas line by closing gate valve on gas inlet line.

7.1.2 Fully open all dampers.

7.1.3 Close all burners.

7.2 Safety precautions before recharging.

7.2.1 Open main door.

7.2.2 Purge residual gases in furnace, by operating air blower.

7.3 Record time and date of gas / power failure and restart of the furnace on the chart.

7.4 Repeat PWHT cycle as per loading chart. Starting temperature for the cycle shall be the existing job temperature.

8.0 INSPECTION AND CERTIFICATION:

8.1 Heat treatment chart shall be certified by Shop QC/third party inspection as per Route card/Quality plan requirements.

9.0 **REFFERED STANDARDS:**

ASME Sec.VIII Div.I

COPYRIGHT AND CONFIDENTIAL
The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED.
It must not be used directly or indirectly in any way detrimental to the interest of the company.

PLANT STANDARD
HYDERABAD

ANNEXURE – 1

TABLE UCS – 56.1

ALTERNATIVE PWHT REQUIREMENTS FOR CARBON AND LOW ALLOY STEELS
(Applicable only when permitted in table UCS-56)

Decrease in temperature below the min. specified temperature °C	Minimum holding time [Note (1)] at decreased temperature (hrs)	Note
28°C	2	--
56°C	4	--
84°C	10	(2)
112°C	20	(2)

Note: (1) Minimum holding time for 25mm thickness or less, Add 15 minutes per 25mm for thickness greater than 25 mm.

(2) The above lower PWHT temperatures permitted only for P No.1 Gr. No.1 and 2 materials.

COPYRIGHT AND CONFIDENTIAL
The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED.
It must not be used directly or indirectly in any way detrimental to the interest of the company.

COPYRIGHT AND CONFIDENTIAL
The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED.
It must not be used directly or indirectly in any way detrimental to the interest of the company.

ANNEXURE - II

POSTWELD HEAT TREATMENT REQUIREMENTS FOR CARBON AND LOW ALLOY STEELS

Sl. No.	P No.	BHEL Specification (Base Standard)	ASME Equivalent	Product Form	Nominal Holding Temp °C Minimum	Minimum Holding Time at Normal Temperature For Thickness(mm) (See UW-40(f))			Remarks
						≤ 50	> 50 ≤ 125	> 125	
1.	P1 or equivalent (Low Carbon Steels	AA 10108 (IS 2062,Gr.A)	--	Sheet	600	1hr/25mm 15minutes minimum	2 hr + 15minutes for each additional 25 mm over 50 mm	2 hr + 15 minutes for each additional 25 mm over 50 mm	Refer Notes 1, 2, 3 of table UCS-56 also
2.		AA 10112 (IS 9550,Gr.20)	--	Bars section	600	"	"	"	"
3.		AA 10119 (IS 2062,Gr.B)	--	Pl, Sh, section bars	600	"	"	"	"
4.	-	AA 10122 (IS 961 Gr. Fe 540 W.Hr)	--	Plates	600	"	"	"	"
5.	-	AA 10152 (IS 1239 pt.1 ERW)	--	Tubes	600	"	"	"	"
6.	-	AA 10156 (ASTM A 179)	SA 179	Tubes	600	"	"	"	"
7.	-	AA 10157 (ASTM A 179)	SA 179	Tubes	600	"	"	"	"

PLANT STANDARD
HYDERABAD

Sl. No.	P No.	BHEL Specification (Base Standard)	ASME Equivalent	Product Form	Nominal Holding Temp °C Minimum	Minimum Holding Time at Normal Temperature For Thickness(mm) (See UW-40(f))				Remarks
8.	-	HY10192 (DIN:2391) Gr.St35-NBK		Tubes		"	"	"	"	
9.	-	HY 10193 (DIN:2391) St52-NBK		Tubes		"	"	"	"	
10.	-	HY 10194 (IS 3601 CDS-430)		Tubes		"	"	"	"	
11.	-	HY 10198 (ASTM A 36)	SA 36	Section		"	"	"	"	
12.	-	HY 10199 (IS1570 pt.II Gr.15C8)		Bars		"	"	"	"	
13.	-	HY 10408 (ASME SA 516 Gr.70)	ASME SA516 Gr.70	Plates	600	"	"	"	"	
14.	-	AA 10455	SA106 Gr.B	Pipes	600	"	"	"	"	
15.	-	HY 10470	SA516 Gr.70	Pipes	600	"	"	"	"	

COPYRIGHT AND CONFIDENTIAL
The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED.
It must not be used directly or indirectly in any way detrimental to the interest of the company.

COPYRIGHT AND CONFIDENTIAL
The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED.
It must not be used directly or indirectly in any way detrimental to the interest of the company.

Sl. No.	P No.	BHEL Specification (Base Standard)	ASME Equivalent	Product Form	Nominal Holding Temp °C Minimum	Minimum Holding Time at Normal Temperature For Thickness(mm) (See UW-40(f))				Remarks
16.	P1 Gr.1	AA 19931 IS 2004 Cl.2	-	Forging	600	"	"	"	"	
17.	-	AA 19341 (IS4367 20C15)	SA105	Forging	600	"	"	"	"	
18.	-	HY 19361	SA105	Forging	600	"	"	"	"	
19.	-	HY 19364	SA350 LF2	Forging	600	"	"	"	"	
20.	Gr.2	HY 19366	SA266 Cl.2	Forging	600	"	"	"	"	
21.	-	AA 19511 (ASTM A 216 WCC	SA216 Gr.WCC	Casting	600	"	"	"	"	
22.	-	AA 19521 (IS 2708 Gr.1)	--	Casting	600	"	"	"	"	
23.	-	HY 19561 (ASTM A 352 LCB	(SA352 LCB	Casting	600	"	"	"	"	
24.	-	HY 19562 (ASTM A 216 WCA	SA216 Gr.WCA	Casting	600	"	"	"	"	
25.	-	HY 19569 (DIN17245 GS-C25)	SA216 Gr.WCA	Casting	580	"	"	"	"	

Sl. No.	P No.	BHEL Specification (Base Standard)	ASME Equivalent	Product Form	Nominal Holding Temp °C Minimum	Minimum Holding Time at Normal Temperature For Thickness(mm) (See UW-40(f))			Remarks
26.	-	HY 19570 (DIN17245 GS-C25)	SA216 Gr.WCA	Casting	580	"	"	"	"
27.	P3 (C-Mo Steel)	HY 19571 (DIN 17245) GS-22Mo4		Casting	660	1h/25mm 15 min. minimum	2h + 15 minutes for each additional 25mm over 50 mm	2h + 15 min for each additional 25mm over 50mm	Refer 1, 2, 3, 4 of table Ucs-56
28.	P4 (1Cr 1/2Mo)	AA 10632	SA335 P11	Plates	600	1hr/25mm 15 min. minimum	1hr/25mm	5hr + 15 min. for each additional 25mm over 125mm	Refer 1, 2 of table UCS-56
29.	P4(1Cr 1/2Mo)	HY 19387	SA182 F11	Forging	600	"	"	"	"
30.	P5 (2¼Cr 1 Mo Gr.1	AA 10630	SA335 P22	Pipes	680	"	"	"	Refer notes 1, 2, 3 of table UCS-56
31.	-	ASME SA387 Gr.5	SA 387 Gr.5	Plates	680	"	"	"	"

COPYRIGHT AND CONFIDENTIAL
The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED.
It must not be used directly or indirectly in any way detrimental to the interest of the company.

COPYRIGHT AND CONFIDENTIAL
The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED.
It must not be used directly or indirectly in any way detrimental to the interest of the company.

Sl. No.	P No.	BHEL Specification (Base Standard)	ASME Equivalent	Product Form	Nominal Holding Temp °C Minimum	Minimum Holding Time at Normal Temperature For Thickness(mm) (See UW-40(f))				Remarks
32.	P6 (13%Cr Stain-less steel)	BS1504 Gr.425 C11	--	Casting	540-560	"	"	"	"	

Note: Maximum holding temperature shall be 30°C below the actual tempering temperature of the parts/components.

FURNACE LOADING SHEET

1. HEAT TREATMENT DETAILS:

CYCLE NO:

DATED:-

1.1 TYPE OF TREATMENT : STRESS RELIEVING (FURNACE/LOCAL)

1.2 RATE OF HEATING ABOVE 425°C:

1.2.1 AS PER CODE : (MAXIMUM) :

1.2.2 RESTRICT TO : (MAXIMUM) :

1.3 SOAKING TEMPERATURE :

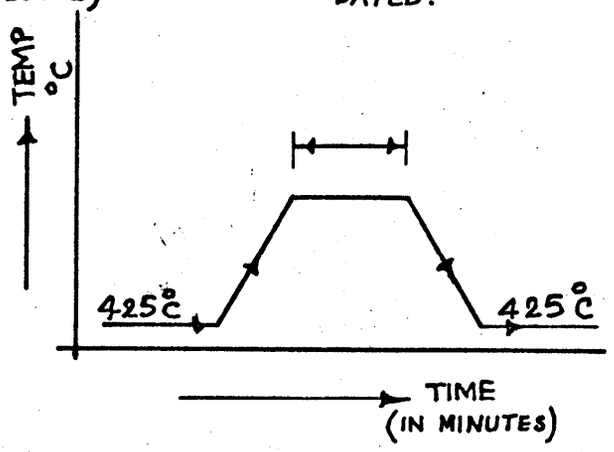
1.4 SOAKING TIME (MINIMUM) : ; MAXIMUM :

1.5 RATE OF COOLING UPTO 425°C

1.5.1 AS PER CODE (MAXIMUM) :

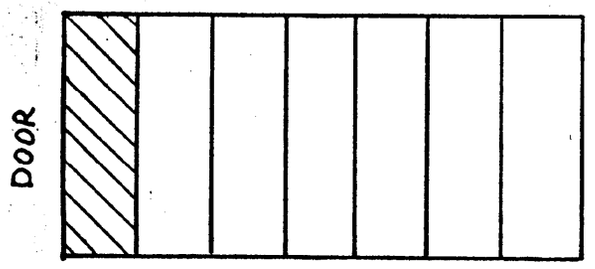
1.5.2 RESTRICT TO (MAXIMUM) :

1.6 TYPE OF COOLING : FURNACE COOLING



SL. NO.	WORK ORDER	PART NO:	DESCRIPTION	QTY.	TOTAL WEIGHT	P.NO TO P.NO	WPS NO.	GOVERNING THK FOR	
								HEATING/ COOLING RATES	SOAKING

THERMO COUPLE POSITION



REMARKS

APPROVED

(FABRICATION TECHNOLOGY)

CLEARANCE BEFORE STARTING THE CYCLE

(QUALITY CONTROL)

DATE OF LOADING;

DATE OF CHARGING;

DT. & SHIFT	OPERATION INCHARGE	ACTUAL TIME		REMARKS
		STARTING	COMPLETION	
				HEATING SOAKING COOLING

THERMOCOUPLE INDICATION:

SNO.	CALIBRATION DUE DATE	COLOUR	SNO.	CALIBRATION DUE DATE	COLOUR
1.			4.		
2.			5.		
3.			6.		

RECORDER NO. DUE DATE OF CALIBRATION.

(PRODUCTION INCHARGE)

H.T. CHART REF. NO.

REVIEWED AND ACCEPTED. RELEASED FOR FURTHER OPERATIONS.

(QUALITY CONTROL)