355-005/A	ERECTION WELDING SCHEDULE	P.G. NO.:-	21
	WELDING CODE : I.B.R / ASME		
	PRESSURE PARTS/~~NON PRESSURE PARTS~~	SYSTEM DESCRIPTION.:-	SOOT BLOWER PIPING
	PROJECT :- KOTHAGUDAM TPS- 1 X 800 MW	CUST. No :- 1810	

SL. NO	DRG NO. FOR WELD LOCATION & IDENTIFICATION MARK	DESCRIPTION OF PARTS TO BE WELDED	MATERIAL SPEC.	DIMENSIONS		PROCESS OF WELDING	TYPE OF WELD	ELECTRODE FILLER SPEC				WPS NO/REV NO.	MIN. PRE HEAT TEMP. in °C	PWHT TEMP. in °C	NDT METHOD/ QUANTUM	* REF-.		REMARKS
								GTAW	SMAW									
				SIZE	THICK		Qty in Nos.	Qty in gms	Qty in Nos.					TIME in mins		SPEC. NO	ACC NORM REF.	
									Ø2.5	Ø3.15	Ø4.0							
01	0-21-600-00480	PIPE WITH STUB+VALVE	SA335P91+ SA234C12A	127.00	20.00	GTAW+SMAW	20 ▽▽	ER90S-B9	E9015-B91			1050/06	220	755±10	100% RT /UT 10%HC/300HB(MAX)			NDE METHOD REVISED(REV.01)
							2	62	24	28	6			60				
02	0-21-600-00480 0-21-600-00483	PIPE+PIPE BEND(OR)FE(OR) PIPE WITH STUB(OR) SV STUB(OR)REDUCER	SA335P22+ SA335P22(OR) SA182F22CL3	127.00	12.50	GTAW+SMAW	12.50 ▽	ER90S-B3	E9018-B3			1014/3	150	680-720	10% R.T SUBJECT TO A MINIMUM OF 1 WELD/ WELDER/ SHIFT			
							15	399	180	255	-			60				
03	0-21-600-00480	PIPE+VALVE	SA234C12A+ SA335P22	127.00	12.50	GTAW+SMAW	12.50 ▽	ER90S-B3	E9018-B3			1038/4	220	730-770	100% RT 10%HC/300HB(MAX)			NDE METHOD REVISED(REV.01)
							1	27	12	17	-			60				
04	0-21-600-00480 0-21-600-00481 0-21-600-00482 0-21-600-00483	PIPE+PIPE(OR) REDUCER	SA335P22+ SA335P22(OR) SA234WP22CL1	60.30	5.54	GTAW+SMAW	5.54 ▽	ER90S-B3	E9018-B3			1013/2	150	-	10% R.T SUBJECT TO A MINIMUM OF 1 WELD/ WELDER/ SHIFT			
							380	4788	3800	-	-			-				
05	0-21-600-00480 0-21-600-00483	PIPE+EQ.TEE	SA335P22+ SA182F22CL3	60.30	5.54	SMAW	5.54 ◺	-	E9018-B3			1020/1	150	-	100%LPI OR MPI			
							20	-	57	-	-			-				
06	0-21-600-00480	PIPE+PIPE(OR)FE(OR) REDUCER	SA335P22+ SA335P22(OR SA335P22 (OR) SA182F22CL3	88.90	5.49	GTAW+SMAW	5.49 ▽	ER90S-B3	E9018-B3			1013/2	150	-	10% R.T SUBJECT TO A MINIMUM OF 1 WELD/ WELDER/ SHIFT			
							16	314	240	-	-			-				
07	0-21-600-00480	PIPE+VALVE	SA335P22+ SA182F22	60.30	5.54	SMAW	5.54 ◺	-	E9018-B3			1020/1	150	-	100%LPI OR MPI			
							8	-	23	-	-			-				
08	0-21-600-00480	PIPE+ REDUCER	SA335P22+ SA234WP22CL1	33.40	4.55	GTAW+SMAW	4.55 ▽	ER90S-B3	E9018-B3			1013/2	150	-	10% R.T SUBJECT TO A MINIMUM OF 1 WELD/ WELDER/ SHIFT			
							4	26	20	-	-			-				
09	0-21-600-00480 0-21-600-00483	PIPE+VALVE	SA335P22+ SA182F22	33.40	4.55	SMAW	4.55 ◺	-	E9018-B3			1020/1	150	-	100%LPI OR MPI			
							12	-	14	-	-			-				
10	0-21-600-00480	VALVE+REDUCER	SA182F22 +SA234WPPCL2	33.40	4.55	SMAW	4.55 ◺	-	E9018-B3			1020/1	150	-	100%LPI OR MPI			
							8	-	9	-	-			-				

PREPARED	CHECKED (DESIGN)	CHECKED (W.T.C)	APPROVED	DATE	DRAWING NO.	REV NO.
P.DEEPAK	A JAI GANESH	LAKAVATH PRAVEEN KUMAR	K.SRIDHARAN	10/01/18	*4-21-992-02927*	*01*

* REFER NDE MANUAL No.PS:CMX:002 REV.No.01/12-98

355-005/A

ERECTION WELDING SCHEDULE

WELDING CODE : I.B.R / ASME

PRESSURE PARTS/~~NON PRESSURE PARTS~~

PROJECT :- KOTHAGUDAM TPS- 1 X 800 MW | **CUST. No :- 1810**

P.G. NO.:- 21

SYSTEM DESCRIPTION.:- SOOT BLOWER PIPING

SL. NO	DRG NO. FOR WELD LOCATION & IDENTIFICATION MARK	DESCRIPTION OF PARTS TO BE WELDED	MATERIAL SPEC.	DIMENSIONS		PROCESS OF WELDING	TYPE OF WELD	ELECTRODE FILLER SPEC				WPS NO/REV NO.	MIN. PRE HEAT TEMP. in °C	PWHT TEMP. in °C	NDT METHOD/ QUANTUM	* REF-.		REMARKS
								GTAW	SMAW									
				SIZE	THICK		Qty in Nos.	Qty in gms	Qty in Nos.					TIME in mins		SPEC. NO	ACC NORM REF.	
									Ø2.5	Ø3.15	Ø4.0							
11	0-21-600-00480	COND.PIPE+ REDUCER	SA335P22+ SA234WP22CL1	21.30	4.78	GTAW+SMAW	4.55 ▽	ER90S-B3	E9018-B3			1013/2	150	-	10% R.T SUBJECT TO A MINIMUM OF 1 WELD/ WELDER/ SHIFT			
							4	60	-	-	-			-				
12	0-21-600-00480	PIPE+REDUCER	SA335P22+ SA182F22CL3	73.00	5.16	GTAW+SMAW	5.16 ▽	ER90S-B3	E9018-B3			1013/2	150	-	10% R.T SUBJECT TO A MINIMUM OF 1 WELD/ WELDER/ SHIFT			
							1	16	11	-	-			-				
13	0-21-600-00480	PIPE+VALVE	SA335P22+ SA217WC9	73.00	5.16	GTAW+SMAW	5.16 ▽	ER90S-B3	E9018-B3			1013/2	150	-	10% R.T SUBJECT TO A MINIMUM OF 1 WELD/ WELDER/ SHIFT			
							4	64	44	-	-			-				
14	0-21-600-00480	PIPE+REDUCER	SA335P22+ SA182F22CL3	60.30	5.54	GTAW+SMAW	5.54 ▽	ER90S-B3	E9018-B3			1013/2	150	-	10% R.T SUBJECT TO A MINIMUM OF 1 WELD/ WELDER/ SHIFT			
							4	50	40	-	-			-				
15	0-21-600-00480 0-21-600-00483	PIPE+PIPE	SA335P22+ SA335P22	33.40	4.55	GTAW+SMAW	4.55 ▽	ER90S-B3	E9018-B3			1013/2	150	-	10% R.T SUBJECT TO A MINIMUM OF 1 WELD/ WELDER/ SHIFT			
							17	109	85	-	-			-				
16	0-21-600-00480	SV STUB+FLANGE	SA182F22CL3+ SA182F22CL3	88.90	12.70	GTAW+SMAW	12.7 ▽	ER90S-B3	E9018-B3			1014/3	150	680-720	10% R.T SUBJECT TO A MINIMUM OF 1 WELD/ WELDER/ SHIFT			
							1	17	8	10	-			60				
17	0-21-600-00480 0-21-600-00483	PIPE+PIPE(OR)BEND	SA335P22+ SA335P22	73.00	5.16	GTAW+SMAW	5.16 ▽	ER90S-B3	E9018-B3			1013/2	150	-	10% R.T SUBJECT TO A MINIMUM OF 1 WELD/ WELDER/ SHIFT			
							125	2013	1375	-	-			-				
18	0-21-600-00480	PIPE+PIPE	SA335P91+ SA335P91	33.40	9.09	GTAW+SMAW	9.09 ▽	ER90S-B9	E9015-B91			1036/08	220	745±15	10% R.T SUBJECT TO A MINIMUM OF 1 WELD/ WELDER/ SHIFT			
							2	7	28	-	-			30				
19	0-21-600-00480	PIPE+VALVE	SA335P91+ F91	33.40	9.09	SMAW	9.09 ◺	-	E9015-B91			1118/00	220	745±15	100%LPI OR MPI 10%HC/300HV(MAX)			
							3	-	-	6	-			30				
20	0-21-600-00480	VALVE+REDUCER	SA182F91+ SA234WP91	33.40	9.09	SMAW	9.09 ◺	-	E9015-B91			1118/00	220	745±15	100%LPI OR MPI 10%HC/300HV(MAX)			
							1	-	-	2	-			30				

PREPARED	CHECKED (DESIGN)	CHECKED (W.T.C)	APPROVED	DATE	DRAWING NO.	REV NO.
P.DEEPAK	A JAI GANESH	LAKAVATH PRAVEEN KUMAR	K.SRIDHARAN	10/01/18	*4-21-992-02928*	*00*

* REFER NDE MANUAL No.PS:CMX:002 REV.No.01/12-98

355-005/A

ERECTION WELDING SCHEDULE

WELDING CODE : I.B.R / ASME

PRESSURE PARTS/~~NON PRESSURE PARTS~~

PROJECT :- KOTHAGUDAM TPS- 1 X 800 MW | **CUST. No :- 1810**

P.G. NO.:- 21

SYSTEM DESCRIPTION.:- SOOT BLOWER PIPING

SL. NO	DRG NO. FOR WELD LOCATION & IDENTIFICATION MARK	DESCRIPTION OF PARTS TO BE WELDED	MATERIAL SPEC.	DIMENSIONS		PROCESS OF WELDING	TYPE OF WELD	ELECTRODE FILLER SPEC				WPS NO/REV NO.	MIN. PRE HEAT TEMP. in °C	PWHT TEMP. in °C / TIME in mins	NDT METHOD/ QUANTUM	* REF-.		REMARKS
								GTAW	SMAW									
				SIZE	THICK		Qty in Nos.	Qty in gms	Qty in Nos. Ø2.5	Qty in Nos. Ø3.15	Qty in Nos. Ø4.0					SPEC. NO	ACC NORM REF.	
21	0-21-600-00480	COND. LOOP+REDUCER	SA213TP347H+ SA234WP91	26.70	7.82	GTAW+SMAW	7.82 ▽	ERNicr-3	ENicrFe-3			1047/1	220	730-770 / 60	100% RT /UT 10%HC/300HB(MAX)			NDE METHOD REVISED(REV.01)
							1	5	7	-	-							
22	0-21-600-00480 0-21-600-00481 0-21-600-00482 0-21-600-00483	PIPE+PIPE(OR) ORIFICE PLATE	SA335P22+ SA335P22	33.40	4.55	GTAW+SMAW	4.55 ▽	ER90S-B3	E9018-B3			1013/2	150	- / -	10% R.T SUBJECT TO A MINIMUM OF 1 WELD/ WELDER/ SHIFT			
							20	128	100	-	-							
23	0-21-600-00481 0-21-600-00482	PIPE+TEE (OR) SB FLANGE	SA335P22+ SA182F22CL3 (OR) SA234WP22CL1	60.30	5.54	SMAW	5.54 ◺	-	E9018-B3			1020/1	150	- / -	100%LPI OR MPI			
							624	-	1778	-	-							
24	0-21-600-00481 0-21-600-00482 0-21-600-00483	PIPE+TEE	SA335P22+ SA182F22CL3	33.40	4.55	SMAW	4.55 ◺	-	E9018-B3			1020/1	150	- / -	100%LPI OR MPI			
							40	-	46	-	-							
25	0-21-600-00481 0-21-600-00482 0-21-600-00483	PIPE+REDUCER	SA335P22+ SA234WP22CL1	60.30	5.54	GTAW+SMAW	5.54 ▽	ER90S-B3	E9018-B3			1013/2	150	- / -	10% R.T SUBJECT TO A MINIMUM OF 1 WELD/ WELDER/ SHIFT			
							10	126	100	-	-							
26	0-21-600-00483	EQ.TEE+REDUCER	SA234WP22CL1+SA182F22CL3	127.00	12.50	GTAW+SMAW	12.5 ▽	ER90S-B3	E9018-B3			1014/3	150	680-720 / 60	10% R.T SUBJECT TO A MINIMUM OF 1 WELD/ WELDER/ SHIFT			
							4	106	48	68	-							
27	0-21-600-00483	PIPE+REDUCER	SA335P22+ SA182F22CL3	73.00	5.16	GTAW+SMAW	5.16 ▽	ER90S-B3	E9018-B3			1013/2	150	- / -	10% R.T SUBJECT TO A MINIMUM OF 1 WELD/ WELDER/ SHIFT			
							12	193	132	-	-							
28	0-21-600-00483	PIPE+EQ.TEE	SA335P22+ SA234WP22CL1	127.00	12.50	GTAW+SMAW	12.5 ▽	ER90S-B3	E9018-B3			1014/3	150	680-720 / 60	10% R.T SUBJECT TO A MINIMUM OF 1 WELD/ WELDER/ SHIFT			
							2	53	24	34	-							
29	0-21-600-00483	EQ.TEE+REDUCER	SA234WP22CL1+SA182F22CL3	88.90	11.13	GTAW+SMAW	11.13 ▽	ER90S-B3	E9018-B3			1014/3	150	680-720 / 60	10% R.T SUBJECT TO A MINIMUM OF 1 WELD/ WELDER/ SHIFT			
							18	328	144	162	-							
30	0-21-600-00483	REDUCER+REDUCER	SA182F22CL3+ SA182F22CL3	73.00	5.16	GTAW+SMAW	5.16 ▽	ER90S-B3	E9018-B3			1013/2	150	- / -	10% R.T SUBJECT TO A MINIMUM OF 1 WELD/ WELDER/ SHIFT			
							2	32	22	-	-							

PREPARED	CHECKED (DESIGN)	CHECKED (W.T.C)	APPROVED	DATE	DRAWING NO.	REV NO.
P.DEEPAK	A JAI GANESH	LAKAVATH PRAVEEN KUMAR	K.SRIDHARAN	10/01/18	*4-21-992-02929*	*01*

* REFER NDE MANUAL No.PS:CMX:002 REV.No.01/12-98

355-005/A

ERECTION WELDING SCHEDULE

WELDING CODE : I.B.R / ASME

PRESSURE PARTS/~~NON PRESSURE PARTS~~

PROJECT :- KOTHAGUDAM TPS- 1 X 800 MW | CUST. No :- 1810

P.G. NO.:- 21

SYSTEM DESCRIPTION.:- SOOT BLOWER PIPING

SL. NO	DRG NO. FOR WELD LOCATION & IDENTIFICATION MARK	DESCRIPTION OF PARTS TO BE WELDED	MATERIAL SPEC.	DIMENSIONS		PROCESS OF WELDING	TYPE OF WELD	ELECTRODE FILLER SPEC				WPS NO/REV NO.	MIN. PRE HEAT TEMP. in °C	PWHT TEMP. in °C / TIME in mins	NDT METHOD/ QUANTUM	* REF-.		REMARKS
								GTAW	SMAW									
				SIZE	THICK		Qty in Nos.	Qty in gms	Qty in Nos. Ø2.5	Qty in Nos. Ø3.15	Qty in Nos. Ø4.0					SPEC. NO	ACC NORM REF.	
31	0-21-600-00483	PIPE+ REDUCER	SA335P22+ SA182F22CL3	33.40	4.55	GTAW+SMAW	4.55 ▽	ER90S-B3	E9018-B3			1013/2	150	-	10% R.T SUBJECT TO A MINIMUM OF 1 WELD/ WELDER/ SHIFT			
							2	13	10	-	-			-				
32	0-21-600-00483	REDUCER+VALVE	SA234WP22CL1+SA182F22	33.40	4.55	SMAW	4.55 ◺	-	E9018-B3			1020/1	150	-	100%LPI OR MPI			
							2	-	2	-	-			-				
33	0-21-600-00483	PIPE+VALVE	SA335P22+F22	33.40	4.55	SMAW	4.55 ◺	-	E9018-B3			1020/1	150	-	100%LPI OR MPI			
							4	-	5	-	-			-				
34	0-21-600-00483	REDUCER+VALVE	SA182F22CL3+ SA182F22	60.30	5.54	SMAW	5.54 ◺	-	E9018-B3			1020/1	150	-	100%LPI OR MPI			
							4	-	11	-	-			-				

PREPARED	CHECKED (DESIGN)	CHECKED (W.T.C)	APPROVED	DATE	DRAWING NO.	REV NO.
P.DEEPAK	A JAI GANESH	LAKAVATH PRAVEEN KUMAR	K.SRIDHARAN	10/01/18	*4-21-992-02930*	*00*

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* REFER NDE MANUAL No.PS:CMX:002 REV.No.01/12-98

355-005/A
(09-09-2016)

ERECTION WELDING SCHEDULE

WELDING CODE : I.B.R / ASME

PRESSURE PARTS/~~NON PRESSURE PARTS~~

PROJECT :- Kothagudam TPS- 1 X 800 MW | **CUST. Nos :- 1810**

P.G. NO.:- 24

SYSTEM DESCRIPTION.:- BOILER TRIM PIPING - DRAINS

SL. NO	DRG NO. FOR WELD LOCATION & IDENTIFICATION MARK	DESCRIPTION OF PARTS TO BE WELDED	MATERIAL SPEC.	DIMENSIONS		PROCESS OF WELDING	TYPE OF WELD	ELECTRODE FILLER SPEC				WPS NO/REV NO.	MIN. PRE HEAT TEMP. in °C	PWHT TEMP. in °C	NDT METHOD/ QUANTUM	* REF-.		REMARKS
								GTAW	SMAW									
									Qty in Nos.									
				SIZE	THICK		Qty in Nos.	Qty in gms	Ø2.5	Ø3.15	Ø4.0			TIME in mins		SPEC. NO	ACC NORM REF.	
01	1-00-047-48123	PIPE + PIPE (OR) BEND	SA106 GR.C + SA106 GR.C	D60.3	11.07	GTAW+SMAW	11.07 ▽	ER70S-A1	E7018-1			1003/03	NIL	-	10%RT SUBJECTED TO A MINIMUM OF 1 WELD/WELDER			
							25	248	300	125	-			-				
02	1-00-047-48123	PIPE + EQ.TEE (OR) VALVE (OR) DRAIN STUB	SA106 GR.C + SA234 WPC (OR) SA105	D60.3	11.07	SMAW	12 ◺	-	E7018-1			1021/01	NIL	-	10%LPI OR MPI			
							15	-	-	29	40			-				
03	1-00-047-48123	EQ.TEE+REDUCER	SA105 + SA182F12CL2	D60.3	11.07	SMAW	12 ◺		E7018-A1			1026/1	125	-	10%LPI OR MPI			
							1			2	3			-				
04	1-00-047-48124,	PIPE + PIPE (OR) PIPE WITH STUB (OR) ELBOW (OR) EQ.TEE (OR) STUB FOR DRAIN (OR) VALVE (OR) FLAT END COVER	SA106 GR.C + SA106 GR.C (OR) SA234 WPC (OR) SA105 (OR) SA216WCC (OR)SA105	D168.3	26.00	GTAW+SMAW	26 ▽▽	ER70S-A1	E7018-A1			1005/05	100	635±15	10%RT SUBJECTED TO A MINIMUM OF 2 WELD/WELDER			
							50	2250	700	1200	1000			65				
05	1-00-047-48124	PIPE + ELBOW (OR) REDUCER (OR) VALVE	SA106 GR.C + SA234 WPC (OR) SA216WCC	D114.3	17.12	GTAW+SMAW	17.12 ▽▽	ER70S-A1	E7018-A1			1005/05	NIL	635±15	10%RT SUBJECTED TO A MINIMUM OF 1 WELD/WELDER			
							7	224	84	98	21			43				
06	1-00-047-48125	VALVE + PIPE	SA105 + SA106 GR.C	D33.4	6.35	SMAW	7 ◺	-	E7018-1			1021/01	NIL	-	10% LPI or MPI			
							5	-	11	-	-			-				
07	1-00-047-48125	PIPE + BEND (OR) PIPE	SA106 GR.C + SA106 GR.C	D33.4	6.35	GTAW+SMAW	7 ▽	ER70S-A1	E7018-1			1003/03	NIL	-	10%RT SUBJECTED TO A MINIMUM OF 1 WELD/WELDER			
							3	13	21					-				
08	1-00-047-48125	PIPE + PIPE (OR) PIPE WITH STUB (OR) ELBOW (OR) EQ.TEE (OR) STUB FOR DRAIN (OR) VALVE (OR) FLAT END COVER	SA106 GR.C + SA106 GR.C (OR) SA234 WPC (OR) SA105 (OR) SA216WCC (OR)SA105	D168.3	26.00	GTAW+SMAW	26 ▽▽	ER70S-A1	E7018-A1			1005/05	100	635±15	10%RT SUBJECTED TO A MINIMUM OF 2 WELD/WELDER			
							25	1125	350	600	500			65				
09	1-00-047-48126	PIPE + PIPE (OR) BEND (OR) VALVE	SA335P22 + SA335P22 (OR) SA217WC9	D73	14.02	GTAW+SMAW	14.02 ▽	ER90S-B3	E9018-B3			1014/03	150	700±20	10%RT SUBJECTED TO A MINIMUM OF 1 WELD/WELDER			
							170	2091	1870	1530	-			60				
10	1-00-047-48126	PIPE + DRAIN STUB	SA335P22 + SA182F12CL2	D73	14.02	GTAW+SMAW	14.02 ▽	ER80S-B2	E8018-B2			1012/04	150	700±20	10%RT SUBJECTED TO A MINIMUM OF 1 WELD/WELDER			
							4	49	44	36	-			60				

PREPARED	CHECKED (DESIGN)	CHECKED (W.T.C)	APPROVED	DATE	DRAWING NO.	REV NO.
P.DEEPAK	P.SAJI	LAKAVATH PRAVEEN KUMAR	K.SRIDHARAN	05/06/2017	4-24-992-10276	00

* REFER NDE MANUAL No.PS:CMX:002 REV.No.01/12-98

355-005/A
(09-09-2016)

ERECTION WELDING SCHEDULE

WELDING CODE : I.B.R / ASME

PRESSURE PARTS/~~NON PRESSURE PARTS~~

PROJECT :- Kothagudam TPS- 1 X 800 MW | **CUST. Nos :- 1810**

P.G. NO.:- 24

SYSTEM DESCRIPTION.:- BOILER TRIM PIPING - DRAINS

SL. NO	DRG NO. FOR WELD LOCATION & IDENTIFICATION MARK	DESCRIPTION OF PARTS TO BE WELDED	MATERIAL SPEC.	DIMENSIONS		PROCESS OF WELDING	TYPE OF WELD	ELECTRODE FILLER SPEC				WPS NO/REV NO.	MIN. PRE HEAT TEMP. in °C	PWHT TEMP. in °C	NDT METHOD/ QUANTUM	* REF-.		REMARKS
								GTAW	SMAW									
				SIZE	THICK		Qty in Nos.	Qty in gms	Qty in Nos.					TIME in mins		SPEC. NO	ACC NORM REF.	
									Ø2.5	Ø3.15	Ø4.0							
11	1-00-047-48127	PIPE (OR) REDUCER + EQ.TEE (OR) VALVE	SA106 GR.C + SA234 WPC (OR) SA216WCC	D88.90	15.24	GTAW+SMAW	15.24	ER70S-A1	E7018-A1			1003/03	NIL	-	10%RT SUBJECTED TO A MINIMUM OF 1 WELD/WELDER			
							7	168	56	70	35			-				
12	1-00-047-48127	PIPE + PIPE (OR) BEND	SA106 GR.C + SA106 GR.C	D60.3	11.07	GTAW+SMAW	11.07	ER70S-A1	E7018-1			1003/03	NIL	-	10%RT SUBJECTED TO A MINIMUM OF 1 WELD/WELDER			
							35	347	420	175	-			-				
13	1-00-047-48127	PIPE + REDUCER	SA106 GR.C + SA105	D60.3	11.07	GTAW+SMAW	11.07	ER70S-A1	E7018-A1			1003/03	NIL	-	10%RT SUBJECTED TO A MINIMUM OF 1 WELD/WELDER			
							2	20	24	10	-			-				
14	1-00-047-48127	REDUCER (OR) PIPE + EQ.TEE (OR) VALVE (OR) DRAIN STUB	SA234 WPC (OR) SA106 GR.C + SA234 WPC (OR) SA105	D60.3	11.07	SMAW	12	-	E7018-1			1021/01	NIL	-	10%LPI OR MPI			
							12	-	-	23	32			-				
15	1-00-047-48128	PIPE + BEND (OR) PIPE	SA335P22 + SA335P22	D60.3	11.07	GTAW+SMAW	12	ER90S-B3	E9018-B3			1014/03	150	700±20	10%RT SUBJECTED TO A MINIMUM OF 1 WELD/WELDER			
							18	175	216	90	-			60				
16	1-00-047-48128	VALVE + PIPE (OR) BEND	SA182F22 + SA335P22	D60.3	11.07	SMAW	12	-	E9018-B3			1020/01	150	-	100% LPI or MPI			
							4	-	-	14	-			-				
17	1-00-047-48128	HEADER NOZZLE + PIPE (OR) BEND	SA182F12CL2 + SA335P22	D60.3	11.07	SMAW	12	-	E8018-B2			1019/00	NIL	700±20	100% LPI or MPI			
							1	-	-	3	-			60				
18	1-00-047-48129	PIPE + PIPE (OR)BEND	SA335 P22 + SA335 P22	D88.9	15.24	GTAW+SMAW	15.24	ER90S-B3	E9018-B3			1014/03	150	700±20	10%RT SUBJECT TO A MINIMUM OF 1 WELD/WELDER			
							30	720	240	300	150			60				
10	1-00-047-48126	PIPE + DRAIN STUB	SA335P22 + SA182F12CL2	D88.9	15.24	GTAW+SMAW	15.24	ER80S-B2	E8018-B2			1012/04	150	700±20	10%RT SUBJECTED TO A MINIMUM OF 1 WELD/WELDER			
							2	48	16	20	10			60				
20	1-00-047-48129	PIPE + VALVE	SA335P22 + SA217WC9	D88.90	15.24	GTAW+SMAW	15.24	ER90S-B3	E9018-B3			1014/03	150	700±20	10%RT SUBJECT TO A MINIMUM OF 1 WELD/WELDER			
							8	192	64	80	40			60				

PREPARED	CHECKED (DESIGN)	CHECKED (W.T.C)	APPROVED	DATE	DRAWING NO.	REV NO.
P.DEEPAK	P.SAJI	LAKAVATH PRAVEEN KUMAR	K.SRIDHARAN	05/06/2017	4-24-992-10277	00

* REFER NDE MANUAL No.PS:CMX:002 REV.No.01/12-98

355-005/A
(09-09-2016)

ERECTION WELDING SCHEDULE

WELDING CODE : I.B.R / ASME

PRESSURE PARTS/~~NON PRESSURE PARTS~~

PROJECT :- Kothagudam TPS- 1 X 800 MW | **CUST. Nos :- 1810**

P.G. NO.:- 24

SYSTEM DESCRIPTION.:- BOILER TRIM PIPING - DRAINS

SL. NO	DRG NO. FOR WELD LOCATION & IDENTIFICATION MARK	DESCRIPTION OF PARTS TO BE WELDED	MATERIAL SPEC.	DIMENSIONS		PROCESS OF WELDING	TYPE OF WELD	ELECTRODE FILLER SPEC				WPS NO/REV NO.	MIN. PRE HEAT TEMP. in °C	PWHT TEMP. in °C	NDT METHOD/ QUANTUM	* REF-.		REMARKS
								GTAW	SMAW									
				SIZE	THICK		Qty in Nos.	Qty in gms	Qty in Nos.					TIME in mins		SPEC. NO	ACC NORM REF.	
									Ø2.5	Ø3.15	Ø4.0							
21	1-00-047-48130	PIPE + BEND (OR) ELBOW (OR) VALVE (OR) STUB (OR) PIPE WITH STUB	SA106 GR.C + SA134WPB (OR) SA216WCC (OR)SA105(OR)SA 106GR.C	D88.90	15.24	GTAW+SMAW	15.24 ▽▽	ER70S-A1	E7018-A1			1005/05	NIL	635±15	10%RT SUBJECTED TO A MINIMUM OF 1 WELD/WELDER			
							20	480	160	200	100			38				
22	1-00-047-48130	PIPE+VALVE (OR) STUB	SA106 GR.C +SA105	D33.4	6.35	SMAW	7 ◺	-	E7018-1			1021/01	NIL	-	10% LPI or MPI			
							3	-	6		-			-				
23	1-00-047-48130	PIPE + BEND (OR) PIPE	SA106 GR.C + SA106 GR.C	D33.4	6.35	GTAW+SMAW	7 ▽	ER70S-A1	E7018-1			1003/03	NIL	-	10%RT SUBJECTED TO A MINIMUM OF 1 WELD/WELDER			
							12	67	84	-	-			-				

PREPARED	CHECKED (DESIGN)	CHECKED (W.T.C)	APPROVED	DATE	DRAWING NO.	REV NO.
P.DEEPAK	P.SAJI	LAKAVATH PRAVEEN KUMAR	K.SRIDHARAN	05/06/2017	4-24-992-10278	00

* REFER NDE MANUAL No.PS:CMX:002 REV.No.01/12-98

355-005/A
(09-09-2016)

ERECTION WELDING SCHEDULE

WELDING CODE : I.B.R / ASME

PRESSURE PARTS/~~NON PRESSURE PARTS~~

PROJECT :- KOTHAGUDAM TPS- 1 X 800 MW | **CUST. Nos :- 1810**

P.G. NO.:- 24

SYSTEM DESCRIPTION.:- BOILER FILL PIPING , START-UP VENT LINK & SOOT BLOWER FEED LINK

SL. NO	DRG NO. FOR WELD LOCATION & IDENTIFICATION MARK	DESCRIPTION OF PARTS TO BE WELDED	MATERIAL SPEC.	DIMENSIONS		PROCESS OF WELDING	TYPE OF WELD	ELECTRODE FILLER SPEC				WPS NO/REV NO.	MIN. PRE HEAT TEMP. in °C	PWHT TEMP. in °C	NDT METHOD/ QUANTUM	* REF-.		REMARKS
								TIG	ARC SPEC.									
				SIZE	THICK		Qty in Nos.	Qty in gms	Qty in Nos. Ø2.5	Qty in Nos. Ø3.15	Qty in Nos. Ø4.0			TIME in mins		SPEC. NO	ACC NORM REF.	
01	1-24-350-01193	PIPE + PIPE(OR)PIPE WITH STUB (OR) ELBOW (OR) EQ.TEE (OR) VALVE	SA106 GR.B + SA106 GR.B (OR) SA234WPB (OR) WCC	D168.3	7.11	GTAW+SMAW	7.11 V	ER70S-A1	E7018-1			1002/03	-	-	10% RT MINIMUM OF 2 WELDS/ WELDER/ SHIFT			
							21	1113	315	189	-							
02	1-24-350-01193	PIPE + PIPE (OR)PIPE WITH STUB(OR) ELBOW (OR) TEE (OR) VALVE	SA106 GR.B + SA106 GR.B (OR) SA234 WPB (OR) WCC	D114.3	6.02	GTAW+SMAW	6.02 V	ER70S-A1	E7018-1			1002/03	-	-	10% RT MINIMUM OF 2 WELDS/ WELDER/ SHIFT			
							20	532	420	-	-							
03	1-24-350-01193	PIPE + FLANGE	SA106 GR.B + SA105	D168.3	7.11	SMAW	7 ◺	-	E7018-1			1022/00	-	-	10%LPI OR MPI			
							2	-	40	-	-							
04	0-00-047-16012	PIPE+PIPE(OR)ELBOW	SA335P91+ SA335P91(OR) SA234WP91(OR)SA234C12A	D141.3	29.30	GTAW+SMAW	29.30 VV	ER90S-B9	E9015-B91			1050/06	220	755±15	100% RT /UT 10%HC/300HB(MAX)			NDE METHOD REVISED(REV.01)
							40	1320	560	760	1000			75				
05	0-00-047-16012	PIPE+REDUCING STAGE ASSY.	SA335P91+ SA182F22CL3	D141.3	29.30	GTAW+SMAW	29.30 VV	ER90S-B3	E9018-B3			1035/04	220	755±15	100% RT /UT 10%HC/300HB(MAX)			NDE METHOD REVISED(REV.01)
							2	66	28	38	50			75				
06	0-00-047-16128	PIPE+PIPE(OR)ELBOW (OR)REDUCER	SA335P91+ SA335P91(OR) SA234WP91(OR)SA234WP91	D88.9	15.24	GTAW+SMAW	15.24 VV	ER90S-B9	E9015-B91			1036/08	220	745±15	100% RT /UT 10%HC/300HB(MAX)			NDE METHOD REVISED(REV.01)
							27	648	216	270	135			60				
07	0-00-047-16128	PIPE+PIPE(OR)ELBOW (OR)EQ.TEE(OR) REDUCER	SA335P91+ SA335P91(OR) SA234WP91(OR)SA234WP91	D127	20.00	GTAW+SMAW	20 VV	ER90S-B9	E9015-B91			1050/06	220	755±15	100% RT /UT 10%HC/300HB(MAX)			NDE METHOD REVISED(REV.01)
							33	1155	396	561	198			60				

PREPARED	CHECKED (DESIGN)	CHECKED (W.T.C)	APPROVED	DATE	DRAWING NO.	REV NO.
P.DEEPAK	A JAI GANESH	LAKAVATH PRAVEEN KUMAR	K.SRIDHARAN	10/01/18	4-24-992-10282	01

* REFER NDE MANUAL No.PS:CMX:002 REV.No.01/12-98

355-005/A
(09-09-2016)

ERECTION WELDING SCHEDULE

WELDING CODE : I.B.R / ASME

PRESSURE PARTS/~~NON PRESSURE PARTS~~

PROJECT :- Kothagudam TPS- 1 X 800 MW | **CUST. Nos :- 1810**

P.G. NO.:- 24

SYSTEM DESCRIPTION.:- BOILER TRIM PIPING - INSTRUMENTATION

SL. NO	DRG NO. FOR WELD LOCATION & IDENTIFICATION MARK	DESCRIPTION OF PARTS TO BE WELDED	MATERIAL SPEC.	DIMENSIONS		PROCESS OF WELDING	TYPE OF WELD	ELECTRODE FILLER SPEC				WPS NO/REV NO.	MIN. PRE HEAT TEMP. in °C	PWHT TEMP. in °C	NDT METHOD/ QUANTUM	* REF-.		REMARKS
								GTAW	SMAW									
									Qty in Nos.									
				SIZE	THICK		Qty in Nos.	Qty in gms	Ø2.5	Ø3.15	Ø4.0			TIME in mins		SPEC. NO	ACC NORM REF.	
01	0-00-047-16075	PIPE + PIPE (OR) BEND	SA335P22 + SA335P22 (OR) SA182F22	D33.4	9.09	GTAW+SMAW	9.09 ▽	ER90S-B3	E9018-B3			1014/03	150	700±20	10% RT SUBJECT TO A MINIMUM OF 1 WELD/WELDER			
							300	1290	3300	-	-			60				
02	0-00-047-16075	PIPE (OR) REDUCER + VALVE	SA335P22 (OR) SA234WP22CL1 + SA182F22	D33.4	9.09	SMAW	10 △	-	E9018-B3			1020/01	150	-	100% LPI or MPI			
							140	-	-	279	-			-				
03	0-00-047-16075	PIPE + PIPE (OR) BEND(OR) ELBOW	SA335P91 + SA335P91(OR) SA182F91	D33.4	9.09	GTAW+SMAW	9.09 ▽	ER90S-B9	E9015-B91			1036/08	220	745±15	10%RT SUBJECT TO A MINIMUM OF 1 WELD/WELDER			
							25	108	325	-	-			60				
04	0-00-047-16075	PIPE + VALVE	SA335P91 + SA182F22	D33.4	9.09	SMAW	10 △	-	E9018-B3			1038/04	220	745±15	100% LPI or MPI			
							10	-	-	20	-			60				
05	0-00-047-16076	PIPE + PIPE (OR) BEND	SA106 GR.C + SA106 GR.C	D33.4	9.09	GTAW+SMAW	9.09 ▽	ER70S-A1	E7018-1			1003/03	NIL	-	10%RT SUBJECT TO A MINIMUM OF 1 WELD/WELDER			
							100	430	1100	-	-			-				
06	0-00-047-16076	PIPE + VALVE	SA106 GR.C + SA105	D33.4	9.09	SMAW	10 △	-	E7018-1			1021/01	NIL	-	10% LPI or MPI			
							38	-	-	76	-			-				
07	0-00-047-16076	CONNECTOR + PIPE (CONDENSING LOOP ASSY.) (OR) IMPULSE PIPE	SA105 + SA106 GR.C	D21.3	4.78	SMAW	5 △	-	E7018-1			1021/01	NIL	-	10% LPI or MPI			
							2	-	-	4	-			-				
08	0-00-047-16075	VALVE + CONNECTOR	SA182F22 + SA182F91	D33.4	9.09	SMAW	10 △	-	E9018-B3			1038/04	220	745±15	100% LPI or MPI			
							2	-	-	4	-			60				

PREPARED	CHECKED (DESIGN)	CHECKED (W.T.C)	APPROVED	DATE	DRAWING NO.	REV NO.
P.DEEPAK	P.SAJI	LAKAVATH PRAVEEN KUMAR	K.SRIDHARAN	05/06/2017	4-24-992-10279	00

* REFER NDE MANUAL No.PS:CMX:002 REV.No.01/12-98

355-005/A
(09-09-2016)

ERECTION WELDING SCHEDULE

WELDING CODE : I.B.R / ASME

PRESSURE PARTS/~~NON PRESSURE PARTS~~

PROJECT :- Kothagudam TPS- 1 X 800 MW

CUST. Nos :- 1810

P.G. NO.:- 24

SYSTEM DESCRIPTION.:- BOILER TRIM PIPING - VENTS

SL. NO	DRG NO. FOR WELD LOCATION & IDENTIFICATION MARK	DESCRIPTION OF PARTS TO BE WELDED	MATERIAL SPEC.	DIMENSIONS		PROCESS OF WELDING	TYPE OF WELD	ELECTRODE FILLER SPEC				WPS NO/REV NO.	MIN. PRE HEAT TEMP. in °C	PWHT TEMP. in °C	NDT METHOD/ QUANTUM	* REF-.		REMARKS
								GTAW	SMAW									
				SIZE	THICK		Qty in Nos.	Qty in gms	Qty in Nos.					TIME in mins		SPEC. NO	ACC NORM REF.	
									Ø2.5	Ø3.15	Ø4.0							
01	0-00-047-49935	PIPE + BEND (OR) PIPE(OR)REDUCER	SA335P22 + SA335P22 +SA182F22CL3	D48.3	10.16	GTAW+SMAW	10.16 ▽	ER90S-B3	E9018-B3			1014/03	150	700±20	10%RT SUBJECT TO A MINIMUM OF 1 WELD/WELDER			
							42	323	336	126	-			60				
02	0-00-047-49935	PIPE + PIPE (OR) BEND(OR) REDUCER	SA106 GR.C + SA106 GR.C(OR)SA105	D60.3	11.07	GTAW+SMAW	11.07 ▽	ER70S-A1	E7018-1			1003/03	NIL	-	10%RT SUBJECTED TO A MINIMUM OF 1 WELD/WELDER			
							8	79	96	40	-			-				
03	0-00-047-49935	PIPE + TEE (OR) VALVE	SA335P22 + SA182F22	D48.3	10.16	SMAW	11 ◺	-	E9018-B3			1020/01	150	-	100% MPI OR LPI			
							20	-	-	70	-			-				
04	0-00-047-49935	PIPE + EQ.TEE (OR) VALVE	SA106 GR.C + SA105	D60.3	11.07	SMAW	12 ◺	-	E7018-1			1021/01	NIL	-	10%LPI OR MPI			
							5	-	-	10				-				
05	0-00-047-49935	PIPE + TEE (OR) VALVE	SA335P22 + SA182F22	D33.4	9.09	SMAW	10 ◺	-	E9018-B3			1020/01	150	-	100% MPI OR LPI			
							20	-	-	40	-			-				
06	0-00-047-49935	PIPE + BEND (OR) PIPE(OR)STUB	SA335P22 + SA335P22	D33.4	9.09	GTAW+SMAW	9.09 ▽	ER90S-B3	E9018-B3			1014/03	150	700±20	10%RT SUBJECT TO A MINIMUM OF 1 WELD/WELDER			
							140	602	1540	-	-			60				
07	0-00-047-49935	PIPE + PIPE WITH STUB (OR) FLAT ENDCOVER(OR)ELBOW (OR)VALVE	SA335 P22 + SA335 P22 (OR) SA182 F22(OR) SA234WP22CL1 (OR)WC9	D114.3	20.00	GTAW+SMAW	20.0 ▽▽	ER90S-B3	E9018-B3			1014/03	150	700±20	10%RT SUBJECT TO A MINIMUM OF 1 WELD/WELDER			
							60	1860	720	840	360			60				
08	0-00-047-49935	PIPE + PIPE WITH STUB (OR) FLAT ENDCOVER(OR)ELBOW (OR)VALVE	SA335 P22 + SA335 P22 (OR) SA182 F22(OR) SA234WP22CL1 (OR)WC9	D88.9	15.24	GTAW+SMAW	15.24 ▽▽	ER90S-B3	E9018-B3			1014/03	150	700±20	10%RT SUBJECT TO A MINIMUM OF 1 WELD/WELDER			
							44	1100	352	440	220			60				
09	0-00-047-49935	PIPE + BEND (OR) PIPE (OR)STUB	SA335P91 + SA335P91	33.4	9.09	GTAW+SMAW	9.09 ▽	ER90S-B9	E9015-B91			1036/08	220	745±15	10%RT SUBJECT TO A MINIMUM OF 1 WELD/WELDER			
							31	133	341	-	-			30				
10	0-00-047-49935	PIPE + TEE (OR) VALVE	SA335P91 + SA182F91	33.4	9.09	SMAW	10 ◺	-	E9015-B9			1118/00	220	745±15	100% MPI OR LPI			
							12	-	-	24	-			30				

PREPARED	CHECKED (DESIGN)	CHECKED (W.T.C)	APPROVED	DATE	DRAWING NO.	REV NO.
P.DEEPAK	P.SAJI	LAKAVATH PRAVEEN KUMAR	K.SRIDHARAN	08/06/17	4-24-992-10280	00

* REFER NDE MANUAL No.PS:CMX:002 REV.No.01/12-98

355-005/A
(09-09-2016)

ERECTION WELDING SCHEDULE

WELDING CODE : I.B.R / ASME

PRESSURE PARTS/~~NON PRESSURE PARTS~~

PROJECT :- Kothagudam TPS- 1 X 800 MW | **CUST. Nos :- 1810**

P.G. NO.:- 24

SYSTEM DESCRIPTION.:- BOILER TRIM PIPING - VENTS

SL. NO	DRG NO. FOR WELD LOCATION & IDENTIFICATION MARK	DESCRIPTION OF PARTS TO BE WELDED	MATERIAL SPEC.	DIMENSIONS		PROCESS OF WELDING	TYPE OF WELD	ELECTRODE FILLER SPEC				WPS NO/REV NO.	MIN. PRE HEAT TEMP. in °C	PWHT TEMP. in °C	NDT METHOD/ QUANTUM	* REF-.		REMARKS
								GTAW	SMAW									
				SIZE	THICK		Qty in Nos.	Qty in gms	Qty in Nos.					TIME in mins		SPEC. NO	ACC NORM REF.	
									Ø2.5	Ø3.15	Ø4.0							
11	0-00-047-49935	PIPE + PIPE (OR) BEND	SA106 GR.B + SA106 GR.B	D48.3	10.16	GTAW+SMAW	10.16 ▽	ER70S-A1	E7018-1			1003/03	NIL	-	10%RT SUBJECTED TO A MINIMUM OF 1 WELD/WELDER			
							50	385	400	150	-			-				
12	0-00-047-49935	PIPE + REDUCER	SA106 GR.B + SA234 WPC	D48.3	10.16	GTAW+SMAW	10.16 ▽	ER70S-A1	E7018-A1			1005/05	NIL	635±15	10%RT SUBJECTED TO A MINIMUM OF 1 WELD/WELDER			
							1	8	8	3	-			30				
13	0-00-047-49935	PIPE + STUB	SA106 GR.B + SA105	D48.3	10.16	SMAW	11 △	-	E7018-1			1021/01	NIL	-	10%LPI OR MPI			
							2	-	-	7	-			-				
14	0-00-047-49935	VALVE + PIPE	SA105 + SA106 GR.C	D33.4	9.09	SMAW	10 △	-	E7018-1			1021/01	NIL	-	10% LPI or MPI			
							4	-	-	8	-			-				
15	0-00-047-49935	PIPE + BEND (OR) PIPE	SA106 GR.C + SA106 GR.C	D33.4	9.09	GTAW+SMAW	9.09 ▽	ER70S-A1	E7018-1			1003/03	NIL	-	10%RT SUBJECTED TO A MINIMUM OF 1 WELD/WELDER			
							3	13	36	-	-			-				
16	0-00-047-49935	PIPE + BEND (OR) PIPE	SA335P22 + SA335P22	D48.3	7.14	GTAW+SMAW	7.14 ▽	ER90S-B3	E9018-B3			1013/02	150	-	10%RT SUBJECT TO A MINIMUM OF 1 WELD/WELDER			
							18	139	144	54	-			-				
17	0-00-047-49935	PIPE + VALVE(OR)EQ.TEE (OR)STUB	SA335P22 + SA182F22 (OR) SA182F22CL3	D48.3	10.16	SMAW	11 △	-	E9018-B3			1020/01	150	-	100% MPI OR LPI			
							10	-	-	35	-			-				

PREPARED	CHECKED (DESIGN)	CHECKED (W.T.C)	APPROVED	DATE	DRAWING NO.	REV NO.
P.DEEPAK	P.SAJI	LAKAVATH PRAVEEN KUMAR	K.SRIDHARAN	08/06/17	4-24-992-10281	00

* REFER NDE MANUAL No.PS:CMX:002 REV.No.01/12-98

355-005/A

ERECTION WELDING SCHEDULE

WELDING CODE : I.B.R / ASME

PRESSURE PARTS/~~NON PRESSURE PARTS~~

PROJECT :-KOTHAGUDAM TPS- 1 X 800 MW | CUST. No :- 1810

P.G. NO.:- 24

SYSTEM DESCRIPTION.:- BOILER TRIM PIPING -PUMP LP COOLER PIPING SYSTEM

SL. NO	DRG NO. FOR WELD LOCATION & IDENTIFICATION MARK	DESCRIPTION OF PARTS TO BE WELDED	MATERIAL SPEC.	DIMENSIONS		PROCESS OF WELDING	TYPE OF WELD	ELECTRODE FILLER SPEC				WPS NO/REV NO.	MIN. PRE HEAT TEMP. in °C	PWHT TEMP. in °C	NDT METHOD/ QUANTUM	* REF-.		REMARKS
								GTAW	SMAW									
				SIZE	THICK		Qty in Nos.	Qty in gms	Qty in Nos.					TIME in mins		SPEC. NO	ACC NORM REF.	
									Ø2.5	Ø3.15	Ø4.0							
01	0-00-047-16103	PIPE+PIPE(OR)BEND (OR)PIPE WITH STUB(OR)VALVE(OR) EQ.TEE(OR)REDUCER	SA106 GR.B + SA216WCB(OR) SA234WPB(OR) SA234WPC	D88.9	5.49	GTAW+SMAW	5.49 ▽	ER70S-A1	E7018-1			1003/03	NIL	-	10%RT SUBJECTED TO A MINIMUM OF 1 WELD/WELDER			
							72	1411	1080	-	-			-				
02	0-00-047-16103	PIPE+PIPE (OR)REDUCER	SA106 GR.B + SA106 GR.B(OR) SA234WPB	D33.4	3.38	GTAW+SMAW	3.38 ▽	ER70S-A1	E7018-1			1003/03	NIL	-	10%RT SUBJECTED TO A MINIMUM OF 1 WELD/WELDER			
							15	428	-	-	-			-				
03	0-00-047-16103	PIPE + VALVE(OR)EQ.TEE(OR) FLANGE	SA106 GR.B + SA105(OR) SA105	D33.4	3.38	SMAW	3.38 ◺	-	E7018-1			1021/02	NIL	-	10% LPI or MPI			
							25	-	18	-	-			-				
04	0-00-047-16103	PIPE+PIPE(OR) REDUCER	SA106 GR.C + SA106 GR.C(OR) SA105	D21.3	4.78	SMAW	4.78 ◺	-	E7018-1			1021/02	NIL	-	10% LPI or MPI			
							4	-	29	-	-			-				
05	0-00-047-16103	REDUCER+FLANGE	SA234WPC+ SA105	D73	9.53	SMAW	10 ◺	-	E7018-1			1021/02	NIL	-	10% LPI or MPI			
							2	-	-	9	-			-				
06	0-00-047-16103	PIPE+FLANGE	SA106GRB+ SA105	D88.9	5.49	GTAW+SMAW	5.49 ▽	ER70S-A1	E7018-1			1003/03	NIL	-	10%RT SUBJECT TO A MINIMUM OF 1 WELD/WELDER			
							8	157	120	-	-			-				
07	0-00-047-16103	PIPE+PIPE (OR)WELD NECK FLANGE	SA106 GR.B + SA106 GR.B(OR) SA515 GR70	D33.4	6.35	GTAW+SMAW	6.35 ▽	ER70S-A1	E7018-1			1003/03	NIL	-	10%RT SUBJECTED TO A MINIMUM OF 1 WELD/WELDER			
							10	56	70	-	-			-				
08	0-00-047-16103	PIPE + VALVE(OR)EQ.TEE(OR) FLANGE	SA106 GR.B + SA105(OR) SA105	D33.4	6.35	SMAW	6.35 ◺	-	E7018-1			1021/02	NIL	-	10% LPI or MPI			
							35	-	74	-	-			-				
09	0-00-047-16103	EQ.TEE+REDUCER	SA105+ SA234WPB	D60.3	5.54	SMAW	5.54 ◺	-	E7018-1			1021/02	NIL	-	10% LPI or MPI			
							2	-	6	-	-			-				
10	0-00-047-16103	REDUCER+FLANGE	SA234WPB+ SA105	D48.3	3.68	SMAW	3.68 ◺	-	E7018-1			1021/02	NIL	-	10% LPI or MPI			
							2	-	2	-	-			-				

PREPARED	CHECKED (DESIGN)	CHECKED (W.T.C)	APPROVED	DATE	DRAWING NO.	REV NO.
P.DEEPAK	P.SAJI	LAKAVATH PRAVEEN KUMAR	K.SRIDHARAN	27/01/18	*4-24-992-10288*	*00*

* REFER NDE MANUAL No.PS:CMX:002 REV.No.01/12-98

355-005/A

ERECTION WELDING SCHEDULE

WELDING CODE : I.B.R / ASME

PRESSURE PARTS/~~NON PRESSURE PARTS~~

PROJECT :-KOTHAGUDAM TPS- 1 X 800 MW | **CUST. No :- 1810**

P.G. NO.:- 24

SYSTEM DESCRIPTION.:- WARM KEEPING SYSTEM

SL. NO	DRG NO. FOR WELD LOCATION & IDENTIFICATION MARK	DESCRIPTION OF PARTS TO BE WELDED	MATERIAL SPEC.	DIMENSIONS		PROCESS OF WELDING	TYPE OF WELD	ELECTRODE FILLER SPEC				WPS NO/REV NO.	MIN. PRE HEAT TEMP. in °C	PWHT TEMP. in °C	NDT METHOD/ QUANTUM	* REF-.		REMARKS
								GTAW	SMAW									
				SIZE	THICK		Qty in Nos.	Qty in gms	Qty in Nos.					TIME in mins		SPEC. NO	ACC NORM REF.	
									Ø2.5	Ø3.15	Ø4.0							
01	0-00-047-16007	PIPE+PIPE(OR)BEND (OR)REDUCER(OR) EQ.TEE	SA106 GR.C + SA106 GR.C(OR) SA105	D60.3	11.07	GTAW+SMAW	11.07 ▽	ER70S-A1	E7018-1			1003/03	NIL	-	10%RT SUBJECTED TO A MINIMUM OF 1 WELD/WELDER			
							85	842	1020	425	-			-				
02	0-00-047-16007	PIPE+PIPE(OR)BEND (OR)REDUCER(OR) EQ.TEE	SA106 GR.C + SA106 GR.C(OR) SA105	D48.3	10.16	GTAW+SMAW	10.16 ▽	ER70S-A1	E7018-1			1003/03	NIL	-	10%RT SUBJECTED TO A MINIMUM OF 1 WELD/WELDER			
							113	870	904	339	-			-				
03	0-00-047-16007	PIPE+PIPE(OR) REDUCER	SA106 GR.C + SA106 GR.C	D33.4	6.35	GTAW+SMAW	7 ▽	ER70S-A1	E7018-1			1003/03	NIL	-	10%RT SUBJECTED TO A MINIMUM OF 1 WELD/WELDER			
							3	13	21					-				
04	0-00-047-16007	PIPE+PIPE(OR)BEND	SA106 GR.C + SA106 GR.C	D33.4	9.09	GTAW+SMAW	9.09 ▽	ER70S-A1	E7018-1			1003/03	NIL	-	10%RT SUBJECTED TO A MINIMUM OF 1 WELD/WELDER			
							3	13	36	-	-			-				
05	0-00-047-16007	PIPE+VALVE(OR) WARM UP COUPLING	SA106 GR.C + SA105	D60.3	11.07	SMAW	12 ◺	-	E7018-1			1021/01	NIL	-	10%LPI OR MPI			
							4	-	-	17	11			-				
06	0-00-047-16007	PIPE+VALVE(OR) WARM UP COUPLING	SA106 GR.C + SA105	D48.3	10.16	SMAW	11◺	-	E7018-1			1021/01	NIL	-	10%LPI OR MPI			
							18	-	-	63	-			-				
07	0-00-047-16007	PIPE+VALVE	SA106 GR.C + SA105	D33.4	9.09	SMAW	10 ◺	-	E7018-1			1021/01	NIL	-	10% LPI or MPI			
							4	-	-	8	-			-				
08	0-00-047-16007	PIPE+PIPE WITH STUB	SA335P91 + SA335P91	D60.3	12.50	GTAW+SMAW	12.5 ▽	ER90S-B9	E9015-B91			1036/08	220	745±15	100% RT /UT 10%HC/300HB(MAX)			NDE METHOD REVISED(REV.01)
							1	9	13	7	-			30				
09	0-00-047-16007	PIPE+VALVE	SA335P91 + SA182F91	D60.3	12.50	SMAW	12.5 ◺	-	E9015-B91			1118/00	220	745±15	100%LPI OR MPI 10%HC/300HV(MAX)			
							2	-	-	4	5			30				
10	0-00-047-16007	PIPE+CONNECTOR	SA106 GR.C + SA182F12CL2	D60.3	11.07	GTAW+SMAW	11.07 ▽	ER70S-A1	E7018-1			1017/03	125	-	10%RT SUBJECTED TO A MINIMUM OF 1 WELD/WELDER			
							1	10	12	5	-			-				

PREPARED	CHECKED (DESIGN)	CHECKED (W.T.C)	APPROVED	DATE	DRAWING NO.	REV NO.
P.DEEPAK	A JAI GANESH	LAKAVATH PRAVEEN KUMAR	K.SRIDHARAN	10/01/18	*4-24-992-10283*	*01*

CAUTION :

* REFER NDE MANUAL No.PS:CMX:002 REV.No.01/12-98

355-005/A	ERECTION WELDING SCHEDULE	P.G. NO.:-	24
	WELDING CODE : I.B.R / ASME	SYSTEM DESCRIPTION.:-	WARM KEEPING SYSTEM
	PRESSURE PARTS/~~NON PRESSURE PARTS~~		
	PROJECT :-KOTHAGUDAM TPS- 1 X 800 MW	CUST. No :- 1810	

SL. NO	DRG NO. FOR WELD LOCATION & IDENTIFICATION MARK	DESCRIPTION OF PARTS TO BE WELDED	MATERIAL SPEC.	DIMENSIONS		PROCESS OF WELDING	TYPE OF WELD	ELECTRODE FILLER SPEC				WPS NO/REV NO.	MIN. PRE HEAT TEMP. in °C	PWHT TEMP. in °C	NDT METHOD/ QUANTUM	* REF-.		REMARKS
				SIZE	THICK			GTAW	SMAW					TIME in mins		SPEC. NO	ACC NORM REF.	
							Qty in Nos.	Qty in gms	Qty in Nos.									
									Ø2.5	Ø3.15	Ø4.0							
11	0-00-047-16007	CONNECTOR+ELBOW	SA182F12CL2 + SA182F22CL2	D60.3	11.07	SMAW	12 ◺	-	E8018-B2			1107/02	150	-	10% LPI or MPI			
							1	-	-	2	3			-				
12	0-00-047-16007	PIPE+ELBOW	SA335P91 + SA182F22CL2	D60.3	11.07	GTAW+SMAW	11.07 ▽	ER90S-B3	E9018-B3			1038/04	220	755±15	100% RT /UT 10%HC/300HB(MAX)			NDE METHOD REVISED(REV.01)
							1	10	12	5	-			60				
13	0-00-047-16007	PIPE+COUPLING	SA106 GR.C + SA105	21	4.78	SMAW	4.78 ◺	-	E7018-1			1021/01	NIL	-	10% LPI or MPI			
							80	-	590	-	-			-				

PREPARED	CHECKED (DESIGN)	CHECKED (W.T.C)	APPROVED	DATE	DRAWING NO.	REV NO.
P.DEEPAK	A JAI GANESH	LAKAVATH PRAVEEN KUMAR	K.SRIDHARAN	10/01/18	*4-24-992-10284*	*01*

* REFER NDE MANUAL No.PS:CMX:002 REV.No.01/12-98

355-005/A

ERECTION WELDING SCHEDULE

WELDING CODE : I.B.R / ASME

PRESSURE PARTS/~~NON PRESSURE PARTS~~

PROJECT :-KOTHAGUDAM TPS- 1 X 800 MW | **CUST. No :- 1810**

P.G. NO.:- 24

SYSTEM DESCRIPTION.:- SAFETY VALVE & ERV

SL. NO	DRG NO. FOR WELD LOCATION & IDENTIFICATION MARK	DESCRIPTION OF PARTS TO BE WELDED	MATERIAL SPEC.	DIMENSIONS		PROCESS OF WELDING	TYPE OF WELD	ELECTRODE FILLER SPEC				WPS NO/REV NO.	MIN. PRE HEAT TEMP. in °C	PWHT TEMP. in °C	NDT METHOD/ QUANTUM	* REF-.		REMARKS
								GTAW	SMAW									
				SIZE	THICK		Qty in Nos.	Qty in gms	Qty in Nos.					TIME in mins		SPEC. NO	ACC NORM REF.	
									Ø2.5	Ø3.15	Ø4.0							
01	0-00-047-16082	S-01 SV NOZZLE+SEPARATOR SAFETY VALVE	SA182F12CL2 + SA182F22	D223	70.40	GTAW+SMAW	73.4 ▽▽	ER80S-B2	E8018-B2			1012/04	150	680-720	100% RT			
							8	400	144	200	704			176				
02	0-00-047-16121	MS LINE STUB+ MS SAFETY VALVE	SA182F91 + SA182F91	D220	68.70	GTAW+SMAW	68.7 ▽▽	ER90S-B9	E9015-B91			1050/06	220	740-770	100% UT 10%HC/300HB(MAX)			
							4	200	72	100	352			172				
03	1-00-047-48149	CRH LINE SV STUB+ CRH SAFETY VALVE	SA105 + SA105	D223	32.10	GTAW+SMAW	32.1 ▽▽	ER70S-A1	E7018-A1			1005/05	100	620-650	100% RT			
							4	248	72	100	176			80				
04	0-00-047-16121	HRH LINE SV STUB+ HRH SAFETY VALVE	SA182F91+ SA182F91	222.30	31.75	GTAW+SMAW	31.75 ▽▽	ER90S-B9	E9015-B91			1050/06	220	740-770	100% UT 10%HC/300HB(MAX)			
							6	372	108	150	264			80				
05	0-00-047-16121	MS LINE ERV SV STUB(OR)MS ERV+ ISOLATING GATE VALVE	SA182F91 + SA217C12A	127	32.50	GTAW+SMAW	32.5 ▽ ▽	ER90S-B9	E9015-B91			1050/06	220	740-770	100% UT 10%HC/300HB(MAX)			
							4	108	48	88	64			80				
06	0-00-047-16121	HRH LINE ERV SV STUB+ ISOLATING GATE VALVE	SA182F91 + SA217C12A	D223	26.55	GTAW+SMAW	26.55 ▽▽	ER90S-B9	E9015-B91			1050/06	220	740-770	100% UT 10%HC/300HB(MAX)			
							2	132	34	50	54			80				

PREPARED	CHECKED (DESIGN)	CHECKED (W.T.C)	APPROVED	DATE	DRAWING NO.	REV NO.
P.DEEPAK	P.J.SAJI	LAKAVATH PRAVEEN KUMAR	K.SRIDHARAN	27/01/18	*4-24-992-10289*	*00*

CAUTION :

* REFER NDE MANUAL No.PS:CMX:002 REV.No.01/12-98

355-005/A	ERECTION WELDING SCHEDULE	P.G. NO.:-	24
	WELDING CODE : I.B.R / ASME	SYSTEM DESCRIPTION.:-	BOILER TRIM PIPING - SH SPRAY PIPING
	PRESSURE PARTS/~~NON PRESSURE PARTS~~		
	PROJECT :- KOTHAGUDAM TPS- 1 X 800 MW CUST. No :- 1810		

SL. NO	DRG NO. FOR WELD LOCATION & IDENTIFICATION MARK	DESCRIPTION OF PARTS TO BE WELDED	MATERIAL SPEC.	DIMENSIONS		PROCESS OF WELDING	TYPE OF WELD	ELECTRODE FILLER SPEC				WPS NO/REV NO.	MIN. PRE HEAT TEMP. in °C	PWHT TEMP. in °C	NDT METHOD/ QUANTUM	* REF-.		REMARKS
				SIZE	THICK			GTAW	SMAW					TIME in mins		SPEC. NO	ACC NORM REF.	
							Qty in Nos.	Qty in gms	Qty in Nos.									
									Ø2.5	Ø3.15	Ø4.0							
01	0-00-047-49199	PIPE+PIPE (OR)BEND	SA106 GR.C + SA106 GR.C	D33.4	6.35	GTAW+SMAW	7	ER70S-A1	E7018-1			1003/03	NIL	-	10%RT SUBJECT TO A MINIMUM OF 1 WELD/WELDER			
							20	112	140	-	-			-				
02	0-00-047-49199	VALVE + REDUCER	SA105 + SA234WPC	D33.4		SMAW	7	-	E7018-1			1021/01	NIL	-	10% LPI or MPI			
							4	-	-	8	-			-				
03	0-00-047-49933, 0-00-047-49934	PIPE + PIPE (OR) ELBOW (OR) STUB	SA106GR.C + SA106GR.C (OR) SA234WPC (OR) SA105	D168.3	21.95	GTAW+SMAW	21.95	ER70S-A1	E7018-A1			1005/05	NIL	635±15	10%RT SUBJECT TO A MINIMUM OF 2 WELD/WELDER			
							94	4606	1316	2256	1222			55				
04	0-00-047-49199	EQ.TEE+PIPE WITH STUB(OR)PIPE (OR) REDUCER	SA234 WPC+ SA106 GR.C (OR)SA234WPC	D168.3	21.95	GTAW+SMAW	21.95	ER70S-A1	E7018-A1			1005/05	NIL	635±15	10%RT SUBJECT TO A MINIMUM OF 2 WELD/WELDER			
							9	441	126	216	117			55				
05	0-00-047-49199	PIPE+REDUCER(OR) ELBOW	SA106 GR.C + SA234WPC	D114.3	17.12	GTAW+SMAW	17.12	ER70S-A1	E7018-1			1003/03	NIL	-	10%RT SUBJECT TO A MINIMUM OF 1 WELD/WELDER			
							9	288	108	126	27			-				
06	0-00-047-49199	ELBOW+VALVE	SA234WPC+ SA216WCC	D114.3	17.12	GTAW+SMAW	17.12	ER70S-A1	E7018-1			1003/03	NIL	-	10%RT SUBJECT TO A MINIMUM OF 1 WELD/WELDER			
							4	128	48	56	12			-				
07	0-00-047-49199	VALVE+PIPE WITH STUB (OR)PIPE(OR)ELBOW	SA216WCC+ SA106 GR.C (OR) SA234WPC	D168.3	21.95	GTAW+SMAW	21.95	ER70S-A1	E7018-A1			1005/05	NIL	635±15	10%RT SUBJECT TO A MINIMUM OF 2 WELD/WELDER			
							2	98	28	48	26			55				
08	0-00-047-49199	PIPE WITH STUB+VALVE	SA182F12CL2+ SA216WCC	D114.3	17.12	GTAW+SMAW	17.12	ER70S-A1	E7018-1			1033/03	150	650-670	10%RT SUBJECTED TO A MINIMUM OF 1 WELD/WELDER			
							4	124	48	56	12			60				
09	0-00-047-49199	PIPE +VALVE	SA335P22+ SA217WC6	D114.3	17.12	GTAW+SMAW	17.12	ER80S-B2	E8018-B2			1012/04	150	700±20	10%RT SUBJECTED TO A MINIMUM OF 1 WELD/WELDER			
							4	124	48	56	12			60				
10	0-00-047-49199	PIPE+VALVE	SA335P22+ SA234C12A	D114.3	17.12	GTAW+SMAW	17.12	ER90S-B3	E9018-B3			1038/04	220	755±15	100% RT /UT 10%HC/300HB(MAX)			NDE METHOD REVISED(REV.01)
							4	124	48	56	12			60				

PREPARED	CHECKED (DESIGN)	CHECKED (W.T.C)	APPROVED	DATE	DRAWING NO.	REV NO.
P.DEEPAK	A JAI GANESH	LAKAVATH PRAVEEN KUMAR	K.SRIDHARAN	10/01/18	*4-24-992-10285*	*01*

CAUTION :

* REFER NDE MANUAL No.PS:CMX:002 REV.No.01/12-98

355-005/A	ERECTION WELDING SCHEDULE	P.G. NO.:-	24
	WELDING CODE : I.B.R / ASME		
	PRESSURE PARTS/~~NON PRESSURE PARTS~~	SYSTEM DESCRIPTION.:-	BOILER TRIM PIPING - SH SPRAY PIPING
	PROJECT :- KOTHAGUDAM TPS- 1 X 800 MW	CUST. No :- 1810	

SL. NO	DRG NO. FOR WELD LOCATION & IDENTIFICATION MARK	DESCRIPTION OF PARTS TO BE WELDED	MATERIAL SPEC.	DIMENSIONS		PROCESS OF WELDING	TYPE OF WELD	ELECTRODE FILLER SPEC				WPS NO/REV NO.	MIN. PRE HEAT TEMP. in °C	PWHT TEMP. in °C	NDT METHOD/ QUANTUM	* REF-.		REMARKS
								GTAW	SMAW									
				SIZE	THICK		Qty in Nos.	Qty in gms	Qty in Nos.					TIME in mins		SPEC. NO	ACC NORM REF.	
									Ø2.5	Ø3.15	Ø4.0							
11	0-00-047-49199	PIPE+EQ.TEE(OR)VALVE	SA335P91+ SA234WP91(ORSA234C12A	D114.3	17.12	GTAW+SMAW	17.12 ▽▽	ER90S-B9	E9015-B91			1050/06	220	755±15	100% RT /UT 10%HC/300HB(MAX)			NDE METHOD REVISED(REV.01)
							8	248	96	112	24			60				
12	0-00-047-49199	PIPE+VALVE	SA106 GR.C + SA234WCC	D114.3	13.49	GTAW+SMAW	13.49 ▽	ER70S-A1	E7018-1			1003/03	NIL	-	10%RT SUBJECT TO A MINIMUM OF 1 WELD/WELDER			
							4	136	44	60	-			-				
13	0-00-047-49199	PIPE+EQ.TEE	SA106 GR.C + SA234WPC	D114.3	13.49	GTAW+SMAW	13.49 ▽	ER70S-A1	E7018-1			1003/03	NIL	-	10%RT SUBJECT TO A MINIMUM OF 1 WELD/WELDER			
							14	476	154	210	-			-				
14	0-00-047-49199	ELBOW+VALVE	SA234WPC+ SA234WCC	D114.3	13.49	GTAW+SMAW	13.49 ▽	ER70S-A1	E7018-1			1003/03	NIL	-	10%RT SUBJECT TO A MINIMUM OF 1 WELD/WELDER			
							4	136	44	60	-			-				
15	0-00-047-49199	PIPE WITH STUB+VALVE	SA182F12CL2+ SA234WCC	D114.3	13.49	GTAW+SMAW	13.49 ▽	ER70S-A1	E7018-1			1033/03	150	650-670	10%RT SUBJECTED TO A MINIMUM OF 1 WELD/WELDER			
							4	136	44	60	-			60				
16	0-00-047-49199	PIPE WITH STUB+VALVE	SA182F12CL2+ SA217WC6	D114.3	13.49	GTAW+SMAW	13.49 ▽	ER80S-B2	E8018-B2			1010/06	150	650-670	10% R.T SUBJECT TO A MINIMUM OF 1 WELD/ WELDER			
							4	136	44	60	-			35				
17	0-00-047-49199	PIPE+VALVE	SA335P22+ SA217WC6	D114.3	13.49	GTAW+SMAW	13.49 ▽	ER80S-B2	E8018-B2			1012/04	150	695±15	10%RT SUBJECTED TO A MINIMUM OF 1 WELD/WELDER			
							4	136	44	60	-			60				
18	0-00-047-49199	PIPE+VALVE	SA335P22+ SA234C12A	D114.3	13.49	GTAW+SMAW	13.49 ▽	ER90S-B3	E9018-B3			1036/08	220	745±15	100% RT /UT 10%HC/300HB(MAX)			NDE METHOD REVISED(REV.01)
							8	248	88	120	-			60				
19	0-00-047-49199	PIPE+EQ.TEE	SA335P22+ SA234WP22CL1	D114.3	28.00	GTAW+SMAW	28 ▽	ER90S-B3	E9018-B3			1014/3	150	680-720	10% R.T SUBJECT TO A MINIMUM OF 1 WELD/ WELDER			
							4	100	48	60	52			70				
20	0-00-047-49199	PIPE+STUB (OR)VALVE	SA106GRC + SA106GRC(OR) A105	D33.4	6.35	SMAW	7 ◺	-	E7018-1			1021/01	NIL	-	10% LPI or MPI			
							46	-	-	92	-			-				

PREPARED	CHECKED (DESIGN)	CHECKED (W.T.C)	APPROVED	DATE	DRAWING NO.	REV NO.
P.DEEPAK	A JAI GANESH	LAKAVATH PRAVEEN KUMAR	K.SRIDHARAN	10/01/18	*4-24-992-10286*	*01*

* REFER NDE MANUAL No.PS:CMX:002 REV.No.01/12-98

355-005/A

ERECTION WELDING SCHEDULE

WELDING CODE : I.B.R / ASME

PRESSURE PARTS/~~NON PRESSURE PARTS~~

PROJECT :- KOTHAGUDAM TPS- 1 X 800 MW | **CUST. No :- 1810**

P.G. NO.:- 24

SYSTEM DESCRIPTION.:- BOILER TRIM PIPING - SH SPRAY PIPING

SL. NO	DRG NO. FOR WELD LOCATION & IDENTIFICATION MARK	DESCRIPTION OF PARTS TO BE WELDED	MATERIAL SPEC.	DIMENSIONS		PROCESS OF WELDING	TYPE OF WELD	ELECTRODE FILLER SPEC				WPS NO/REV NO.	MIN. PRE HEAT TEMP. in °C	PWHT TEMP. in °C / TIME in mins	NDT METHOD/ QUANTUM	* REF-.		REMARKS
				SIZE	THICK		Qty in Nos.	GTAW Qty in gms	SMAW Qty in Nos. Ø2.5	SMAW Qty in Nos. Ø3.15	SMAW Qty in Nos. Ø4.0					SPEC. NO	ACC NORM REF.	
21	0-00-047-49929 0-00-047-49930	PIPE+PIPE(OR) PIPE WITH STUB(OR)ELBOW (OR)VALVE	SA335P91+ SA335P91(OR) SA234WP91(OR)SA234C12A	D114.3	17.12	GTAW+SMAW	17.12 ▽▽	ER90S-B9	E9015-B91			1050/06	220	745±15	100% RT /UT 10%HC/300HB(MAX)			NDE METHOD REVISED(REV.01)
							96	2976	1152	1344	288			60				
22	0-00-047-49929 0-00-047-49930	PIPE + PIPE WITH STUB (OR) PIPE (OR) BEND	SA335P91 + SA335P91	D33.4	9.09	GTAW+SMAW	9.09 ▽	ER90S-B9	E9015-B91			1036/08	220	745±15	100% RT /UT 10%HC/300HB(MAX)			NDE METHOD REVISED(REV.01)
							40	172	520	-	-			30				
23	0-00-047-49929 0-00-047-49930	PIPE (OR) BEND + VALVE	SA335P91 + SA182F91	D33.4	9.09	SMAW	10 ◺	-	E9015-B91			1118/00	220	745±15	100%LPI OR MPI 10%HC/300HV(MAX)			
							16	-	-	32	-			30				
24	0-00-047-49931 0-00-047-49932	PIPE + PIPE(OR) PIPE WITH STUB (OR) ELBOW(OR)REDUCER	SA335 P22 + SA335 P22 (OR) SA234WP22CL1	D114.3	28.00	GTAW+SMAW	20.0 ▽▽	ER90S-B3	E9018-B3			1014/03	150	680-720	10%RT SUBJECT TO A MINIMUM OF 1 WELD/WELDER			
							120	3000	1440	1800	1560			70				
25	0-00-047-49931 0-00-047-49932	PIPE+VALVE	SA335P22+ SA234C12A	D114.3	28.00	GTAW+SMAW	20 ▽▽	ER90S-B3	E9018-B3			1035/04	220	730-770	100% RT 10%HC/300HB(MAX)			NDE METHOD REVISED(REV.01)
							8	200	96	120	104			70				
26	0-00-047-49931 0-00-047-49932	PIPE + BEND (OR) PIPE	SA335P22 + SA335P22	D33.4	9.09	GTAW+SMAW	9.09 ▽	ER90S-B3	E9018-B3			1014/03	150	680-720	10%RT SUBJECT TO A MINIMUM OF 1 WELD/WELDER			
							40	172	520	-	-			60				
27	0-00-047-49931 0-00-047-49932	PIPE+VALVE	SA335P22 + SA182F91	D33.4	9.09	SMAW	10 ◺	-	E9018-B3			1113/02	220	745±15	100%LPI OR MPI 10%HC/300HV(MAX)			
							8	-	-	16	-			30				

PREPARED	CHECKED (DESIGN)	CHECKED (W.T.C)	APPROVED	DATE	DRAWING NO.	REV NO.
P.DEEPAK	A JAI GANESH	LAKAVATH PRAVEEN KUMAR	K.SRIDHARAN	10/01/18	*4-24-992-10287*	*01*

* REFER NDE MANUAL No.PS:CMX:002 REV.No.01/12-98

TELANGANA POWER GENERATION CORPORATION LIMITED
(A Govt. Of Telangana Undertaking)
VidyutSoudha, Hyderabad - 500082.
Phone: 040 – 23499321 Fax: 040 – 23499323.

From:	To:
The Executive Director Thermal Projects Construction, TSGENCO, 2rd Floor, A-Block, VidyutSoudha, Khiarathabad Hyderabad-500 082. edtpctgenco@gmail.com	M/s BHEL, High Pressure Boiler Plant, Tiruchirapalli -620 014 Ph:(0431) 25777156, Fax: (0431) 2576809 E-mail: rtoppo@bhel.in

Kind Attention:Sri Rahul Toppo, Dy.Manager-Commercial

Lr.No.ED/TPC/CE/SE-3/EME-14/YTPS(5X800MW)/F.Trichy/D.No.51/18,Dt: 14.05.2018

Sir,

Sub:- TSGENCO – YTPS(5x800 MW) –Painting Schedule for Boiler Components- Approval-Reg.

Ref:-
1) M/s BHEL Ref No:TP/11497/PS/0, dt: 02-03-2018
2) M/s TCE Email dt: 21-03-2018
3) Lr.No.ED/TPC/SE-3/EME-14/YTPS(5x800MW)/F.QAPs/D.No.14/18, Dt.24-03-2018
4) M/s BHEL Ref No: TP/11497/PS/01, dt:03-04-2018
5) Lr.No.ED/TPC/SE-3/EME-14/YTPS(5x800MW)/F.Trichy/D.No.29/18, Dt.09-04-2018
6) M/s TCE Email dt: 11-04-2018
7) Lr.No.ED/TPC/SE-3/EME-14/YTPS(5x800MW)/F.Trichy/D.No.36/18, Dt.25-04-2018
8) M/s BHEL Email dt: 28-04-2018
9) M/s TCE Email dt: 09-05-2018

*****

Please refer to the letter 8th cited above, wherein M/s BHEL/Trichy submitted the Painting Schedule for Boiler Components pertaining to Yadadri TPS (5x800 MW) for review & approval.

Sl.No	Document No	Rev	Description
1.	PL-C3-PS/1823/00	00	Painting Schedule

The above Painting Schedule furnished by M/s BHEL/Trichy is herewith reviewed and approved. An approved copy of the above Painting Schedule is enclosed herewith for taking further necessary action at your end.

However, approval of the above Painting Schedule does not absolve the responsibility of supplying the above equipments to the specifications and relevant standards and to ensure satisfactory performance of the above equipment as per the terms of the contract.

It is requested to upload the approved Painting Schedule in PEDM Portal.

Encl: As above

Yours faithfully,

EXECUTIVE DIRECTOR/TPC

Copy Communicated to:

1) Chief Engineer/Construction/YTPS Site/Damaracherla/Nalgonda Dist.
2) Sri Y.A.Srinivas Rao, BHEL/PMG Camp Office, Vidyut Soudha, Hyderabad.
3) DE/Tech to Director/Projects/TSGENCO/VS/Hyderabad.
4) M/s Tata Consulting EngineersLimited,73/1,Sheriff Centre, St. Marks road, Bangalore-560 001.
5) M/s TCE /Room No.323 /Site Office/VidyutSoudha/Hyderabad

BHARAT HEAVY ELECTRICALS LIMITED
Tiruchirappalli - 620 014

TELANGANA STATE POWER GENERATION CORPORATION LIMITED (TSGENCO) YADRADRI DIST., TELANGANA
YADRADRI TPS 5 X 800 MW CUSTOMER NO: U8/1823 to 1827, UNIT – I to V
PAINTING SCHEDULE

Prepared by	**K. Srinivasan** **Senior Engineer/ Plant Lab**		**Document No: PL: C3 - PS / 1823**
Reviewed by	**D. Vijayakumar** **SM /PE/FB**		**Revision No: 00 Dated: 01.01.2018**
Approved by	**Dr. Anbazhagan. V** **SDGM / Plant Lab**		**Sheet No. 01 of 12.**

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Executive Director
Thermal Projects Construction
TSGENCO, Vidyut Soudha,
Khairatabad, Hyderabad-500 082.

RECORD OF REVISIONS

Rev. No	Date	Details of revision	Remarks
00	01.01.2018	New	**Prepared in line with approved painting schedule meant for 1 X 800 MW TSGENCO - KOTHAGUDEM - Cust. No. U8/1810 and BHEL standard painting scheme.**

Executive Director
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Khairatabad, Hyderabad-500 082.

Sl. No.	PGMA / Description	Surface Preparation & Surface Profile	Primer coat		Intermediate coat		Finish coat			Total DFT µm (min)
			Paint	No. of coats	Paint	No. of coats	Paint	No. of coats	Shade	
1 PS1JO	Collector & Separator Vessels (Except Internals), Supports 04 - 147,321,323,547;	SSPC-SP3/ Power Tool Cleaning	Red Oxide Zinc phosphate Primer (Alkyd Base) to IS 12744 DFT= 35µm per coat	2	--	--	#Synthetic Enamel paint (Long Oil Alkyd) to IS 2932 DFT= 25µm per coat #Synthetic Enamel paint (Long Oil Alkyd) to IS 2932 DFT= 20µm per coat	2* 1	International orange shade No:592 of IS 5	140
2 PS5	Collector & Separator Vessels internals and Dd items 04-347; 07-302,303, 331,360,361,362; 09-303, 304;12-306,314,317,324,327, 12-328,344,348,354,393; 17-304,306,319; 19-306,307;21-602,605;24-352,803,813 24-818,827,842;28-700;35-190,700,701; 36-700,701; 41-710; 42-710; 43-710; 45-710;47-710;48-700; 65-710;67-710 Foundation materials: 35-010, 39-012	SSPC-SP1/ or SSPC – SP3 Solvent / Power Tool Cleaning	Rust Preventive Fluid to PR: CHEM: 09 – 04 DFT=25µm per coat	1	--	--	--	--	--	25
3 PS 31D	Buck stays 08 – 001, 003,006,007, 111; 08 - 380, 501,503,901, 910; Bunker structures 34-100,200,300,390,400,500 Boiler supporting structures, Columns, Girders, Bracings 35- 111,112,121,122,130,140,150, 35- 211,212,213,214,221,222,231,232 35- 311,312,321,322,331,332,341,342 35- 351, 352,361,362,381 to 387,390, 35- 441 to 447, 451 to 457, 511 to 517, 35- 521 to 527, 531 to 537	Blast cleaning to SA2 ½ or SSPC-SP10 (Near white metal) with surface profile 35µ	Epoxy based Zinc Phosphate Primer to IS13238 DFT 30µm	1	Epoxy based MIO pigmented intermediate coat DFT 75µm	1	Epoxy based Finish paint to IS14209 DFT 30µm Aliphatic acrylic Polyurethane paint to IS 13213 DFT 30µm	1 1	Smoke grey to shade no. 692 of IS 5 Light Grey Shade No: 631 of IS 5	165

 # Out of 3 coats of finish paint, *first coat of synthetic enamel finish paint to 25 microns shall be given at shop / subcontracting works. Second coat of synthetic enamel finish to 25 microns and third coat of synthetic enamel paint to 20 microns shall be applied at site.

Executive Director
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Sl. No.	PGMA / Description	Surface Preparation & Surface Profile	Primer coat		Intermediate coat		Finish coat			Total DFT µm (min)
			Paint	No. of coats	Paint	No. of coats	Paint	No. of coats	Shade	
3 PS 31D (Contd.)	Galleries, Stair-ways & inter connecting Walkways 36-110,150,311,312,313,314,315,316,321,322; 36-323,324,325,326,331,332,333,334,335,336; 36-337,341,342,343,344,345,346,347,351,352; 36-353,354,355,356,361,362,363,364,365,366; 36-371,372,373,374,375,376,391,392,393,394; 36-395,610,620,621,740;38-210,299,310,381; 38-410,510,610,611,710; ID system structures. 39-101,102,141,142,150,299,300,301; 39-304,305,306; Duct supports 48-015,115,145,205,225, 265,385; 48-435,465,485,495,665;	Blast cleaning to SA2 ½ or SSPC-SP10 (Near white metal) with surface profile 35µ	Epoxy based Zinc Phosphate Primer to IS13238 DFT 30µm	1	Epoxy based MIO pigmented intermediate coat DFT 75µm	1	Epoxy based Finish paint to IS14209 DFT 30µm Aliphatic acrylic Polyurethane paint to IS 13213 DFT 30µm	1 1	Smoke grey to shade no. 692 of IS 5 Light Grey Shade No: 631 of IS 5	165
4 PS3	Components >95° C Insulated other than components in Sl.No.7 & 9 Ring Headers, Down Comers, Hot air Headers outside the gas path etc. 05-155,227,231,251,327,330,350; 07-102,110,125,223,231,232,317; 10-135,174,178,191,195,235,274,278,283; 10-284,285,291,295,315,687;12-178,850,852; 12-900;15-136,178,236,278;17-476; 18-001,002,010,701;19-701,702,903; 21-600,602; 24-800,803,805,806,807,808, 24-809, 811,815,823,840,842 42-020,030,070,120,128,158;	SSPC-SP3/ Power Tool Cleaning	Red Oxide Zinc phosphate Primer (Alkyd Base) to IS 12744 DFT= 30µm per coat	2	--	--	No paint	No paint	Red oxide	60

Executive Director
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Sl. No.	PGMA / Description	Surface Preparation & Surface Profile	Primer coat		Intermediate Coat		Finish coat			Total DFT µm (min)
			Paint	No. of coats	Paint	No. of coats	Paint	No. of coats	Shade	
4 PS3 (Contd.)	Hot Air: 48-018, 202,204,207,208,212,214, 222,224, 262,264,662,664,667. Flue Gas: 48-342,344,352,354,362,364,372,382,384,386, 48- 432,434,462,464,482, 484 ,492,494, 498;	SSPC-SP3/ Power Tool Cleaning	Red Oxide Zinc phosphate Primer (Alkyd Base) to IS 12744 DFT= 30µm per coat	2	--	--	No paint	No paint	Red oxide	60
5 PS 9	<u>Components uninsulated other than components coming in gas path.</u> Temp: >95°C & <400°C 20-511; 24-820,822,824,827,835; 42-200; Instrument tappings, doors 48-200,915;	SSPC-SP3/ Power Tool Cleaning	Heat Resistant Aluminium Paint to IS 13183 Gr. II DFT 20 µm per coat	1	--	--	Heat Resistant Aluminium Paint to IS 13183 Gr. II DFT 20 µm per coat	1	Aluminum	40
6 PS10	<u>Components uninsulated other than components coming in gas path.</u> Temp: >400°C & <600°C 09-003,004,005; 28-220;	SSPC-SP3/ Power Tool Cleaning	Heat Resistant Aluminium Paint to IS 13183 Gr. I DFT 20 µm per	1	--	--	Heat Resistant Aluminium Paint to IS 13183 Gr. I DFT 20 µm per coat	1	Aluminum	40
7 PS2	<u>Loose tubes, SH, RH & Eco. coils</u> 11– 074,078, 374,378,406, 11 - 416,467,469,478,484,487,491,494, 11 - 606,608, 684,694,716, 11 - 717,718,767,768, 769,787,791,916,917, 11 - 918,967, 968,969,987,991; 12 - 184,187,368,403,405,514,515,524,544, 12 - 554,803,805,903,914,917,924,927,928,944; 12 - 948,954,968;16-079,201,202,203,403,379; 17 – 476; 19 - 814,824, 884,914,924,984;	SSPC – SP2 or SSPC – SP3 Hand tool / Power tool cleaning	Red Oxide Zinc Phosphate Dip coat primer to PR: CHEM: 09 – 03 DFT=35µm per coat	1*	--	--	No paint	No paint	Red Oxide	35

*-In lieu of dip painting, 2 coats of brush painting of Red oxide Zinc Phosphate primer to a coating thickness of 60µ is also permitted in line with Sr.No.9.

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Sl. No.	PGMA / Description	Surface Preparation & Surface Profile	Primer coat		Intermediate Coat		Finish coat			Total DFT µm (min)
			Paint	No. of coats	Paint	No. of coats	Paint	No. of coats	Shade	
8 PS73	**Components < 95° C –Other than components in Sl.No.3.** 07-409,431,460,461,462, 07-502,503, 531, 560; 12-906, 916,907; 17-919; 21-601,604; 24-350, 351, 352, 353,801,804, 24-813, 817, 818 24-825, 826, 836, 841, 842, 950; 30-233,234; 35-995; 36-396, 613; 39- 302; 41- 350,390, 500; 42-001,002,005,010,046,065,070,120,128, 42-152,154,157; 43-004,104,200; 45-200,801,802,804,805,858; 47-261,263,858; 48 – 022, 345, 355, 365; 65-736; 67-204,272,276,277, 283, 67-801,802,803; 95-088,089,091,485; 96-186; 97-097, 585,591,592; Duct plates, expansion joints 48-911,912; **Handling equipments:** 99-100,300, 400, 502,600; **Impulse lines: 24-800** **Seal air ducting: 43-005, 105;** Cold Air:48-012,014, 112,114, 141 Tempering Air: 48-142,144;	SSPC-SP3/ Power Tool Cleaning	Red Oxide Zinc phosphate Primer (Alkyd Base) to IS 12744 DFT= 30µm per coat	2	--	--	Synthetic Enamel paint (Long Oil Alkyd) to IS 2932 DFT= 30µm per coat	2	Smoke Grey Shade No: 692 of IS5	120

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Sl. No.	PGMA / Description	Surface Preparation & Surface Profile	Primer coat		Intermediate coat		Finish coat			Total DFT µm (min)
			Paint	No. of coats	Paint	No. of coats	Paint	No. of coats	Shade	
9 PS3	Components >95° C coming in the gas path, Headers, Commissioning Spares &erection Materials etc., 05-137,147;06-400,401, 451, 500,501; 06-731,732,734,737,741,744, 747; 06-751,752,753,755; 07-315,316,318,423,993; 10-182,183,184,185; 12 - 993; 17-174,504,506,900,903,993; 19-753,763,783,793,802, 19-850, 851,852; 20-988,998;21-987,988; 24-960,987, 989,993; 30-103, 215,219,223,224,235; 31-010,104,993; 32-010,210; 35-993;37- 010, 810; 39-993; 41-988; 42-858, 988; 48-993; 96-193; 97-282,590; 99-099;	SSPC-SP3/ Power Tool Cleaning	Red Oxide Zinc phosphate Primer (Alkyd Base) to IS 12744 DFT= 30µm per coat	2	--	--	No paint	No paint	Red oxide	60
10 PS6	Hand rails and posts, ladders / rungs 34 - @820, 850;35 – @821,822, @823,851; 36 – 820,821,851,852,853; 38 – @820,850; 39 – @820,850; Floor Grills, Step treads 34-810; 35 – 811,812;36-811,812,813,814 38 – 810, 39 – 810	Hot dip Galvanizing to a coating weight of 610 g/m^2 (minimum) and to a coating thickness of 85.0 microns (minimum). **Refer Notes given below ****								

Notes **: The Guard plates, Hood Ladders and Stringer channels shall be painted as per painting scheme prescribed in Sl. No: 03

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PAINTING SCHEME FOR VALVES

Sl.No.	PGMA / Description	Surface Preparation & Surface Profile	Primer coat		Intermediate coat		Finish coat			Total DFT µm (min)
			Paint	No. of coats	Paint	No. of coats	Paint	No. of coats	Shade	
11 PS 10 PS 9	Cast carbon steel valves (Conventional) Cast alloy steel valves (Conventional) All API valves, QCNRV, SV & SRV Silencers, 21-800; 24-885; Safety valves & ERV 21-850; 24-880, 883; 24-860; 42-300,358;	SSPC-SP3/ Power Tool Cleaning	Heat Resistant Aluminium Paint to IS 13183 Gr.I Heat Resistant Aluminium Paint to IS 13183 Gr.II	1 DFT= 20µm per coat	--	--	Heat Resistant Aluminium Paint to IS 13183 Gr.I Heat Resistant Aluminium Paint to IS 13183 Gr.II	1 DFT = 20 µm per coat	Aluminum	40
	Forged valves	Phosphating	To a coating weight of 1500 mg per Sq.ft.	--	--	--	--	--	--	--
1AS2	Soot Blower components 20-051,054,201,204,794,962.	SSPC-SP3/ Power Tool Cleaning	Red Oxide Zinc phosphate Primer (Alkyd Base) to IS 12744 DFT= 30µm per coat	2	--	--	Syn. Enamel paint (Long Oil Alkyd) to IS 2932 DFT= 20µm per coat	2	Verdigris Green Shade No. 280 of IS5	100
	HP / LP system	SSPC-SP3/ Power Tool Cleaning	Heat Resistant Aluminium Paint to IS 13183 Gr.I DFT= 20µm per coat	1	--	--	Heat Resistant Aluminium Paint to IS 13183 Gr.I DFT= 20µm per coat	1	Aluminum	40

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Sl. No.	PGMA / Description	Surface Preparation & Surface Profile	Primer coat		Intermediate coat		Finish coat			Total DFT µm (min)
			Paint	No. of coats	Paint	No. of coats	Paint	No. of coats	Shade	
12 PS15C	<u>For CLH & VLH*</u> PGs 07,08,12,17,19,21,24,47,48 &80 07-402,403, 405,505; 17-904,906 19-506,507,904,905, 906,907; 24-801,810; 48-206,395;	Blast cleaning to SA2 ½ (Near white metal) with surface profile 35-50 µm	Epoxy zinc rich primer To IS 14589 Gr. II %VS=35, (min) DFT=50 microns per coat	1	--	--	Aliphatic acrylic Poly-urethane paint %VS=40.0 (min) DFT= 35.0 microns per coat	2	Phirozi Blue Shade No. 176 of IS5	120
13 PS8A	<u>Components > 95°C, un-insulated Fuel pipes</u> 47-266,267,268,269;	SSPC-SP3/ Power Tool Cleaning	General purpose Aluminium paint to IS 2339 DFT= 20µm per coat	1	--	--	General purpose Aluminium paint to IS 2339 DFT= 20µm per coat	1	Aluminum	40

*- For components other than CLH & VLH, Painting scheme shall be as given in Sl. No. 8.

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NOTES:

1. Rust Preventive Coating should be given on HSFG Bolt and nut threads.
2. Machined surfaces and all retainers are to be applied with a coating of Temporary Rust Preventive oil.
3. All threaded and other surfaces of foundation bolts and its materials, insulation pins, Anchor channels, Sleeves shall be coated with Temporary Rust Preventive Fluid and during execution of civil works; the dried film of coating shall be removed using organic solvents.
4. Ground shade/colour of Finish paints & identification tag/Band for equipments, pipings pipe service, boiler supporting structures and other boiler components shall be followed as per tender/ approved painting schedule.
5. PGMAs under Sub-Vendor items are not indicated. For all bought-out and sub-vendors items including PGMAs mentioned above falling under the scope of BHEL the same scheme as for main equipment as covered in this document shall be followed.
6. This painting Schemes is valid for only Customer No: U8/1823 to U8/1827, Yadradri TPS-5X800 MW.
7. No painting is required for Stainless Steel, non-ferrous & galvanized components.
08. Wherever inside surfaces of components under PGMA 48 – XXX & others, need protection till erection, two coats of Red-oxide zinc phosphate primer paint to IS12744 to a DFT of 60 microns shall be applied, after power tool cleaning.
09. The Temporary Rust Preventive coating that already been applied on any components, tubes, pipes etc., shall be visually inspected for good adherence. If the coating is intact, direct coating of alkyd based red oxide paints over the coating is permitted. In case, the coating has peeled off over a large area, then the coating is to be removed by suitable solvents / heating to 350 –400 °C for an hour before primer paint application –but, in this case, it should be ensured that the minimum surface cleanliness required for primer paint application shall be SSPC – SP2 (equivalent – Hand Tool cleaning).
10. In components, wherever plates / sheets of thickness less than or equal to 5 mm and rods of <25mm/tubes/drain pipes are used, power tool / hand tool cleaning to SSPC – SP3 / SP2 shall be followed and the painting shall be done as described in Sl.No.8.
11. For all commissioning components-erection materials (xx-993) two coats of Red oxide Zinc Phosphate Primer shall be applied to meet the temporary protection till erection, after power tool cleaning.
12. Touch-up painting of damaged areas shall be carried out as per clause 3.4.0, of Vol. VII-C, Section-X Technical Specification for erection of structural steel work– TSGENCO, KOTHAGUDEM TPS- I (1x800MW).
13. All components covered under different PGMA's are to be painted. In case any component is left out, the same shall be deemed to be included under the relevant section based on paint logic approved.
14. For very small components like clamps etc. Sl.No.8 shall be followed.
15. For very small components with weldable primer at edges, the entire component shall be applied with weldable primer.
16. Painting scheme for all temporary structures like 04-196 shall be PS 1AE i.e. 1 coat of Red oxide Zinc Phosphate primer (Alkyd Base) to IS 12744-DFT-30µ and 2 coats of Synthetic Enamel paint (Long Oil Alkyd) to IS 2932-DFT-2X20µ Shade Yellow –Shade No. 356 of IS 5- Total DFT 70µ. These are to be cut & removed at site after erection. (It excludes components covered under Sr. No. 3 & 10 of description table)
17. For internal protection of Pipes, tubes, headers and other pressure parts, Volatile Corrosion Inhibitor (VCI) pellets shall be put (after sponge testing/ draining/ or drying) and subsequently end capped. The dosage of VCI pellets shall be approximately 100 g/ Cu.m. For tubes typically 4 – 5 tablets per end are to be put. For C & I items the dosage of self-indicating Silica Gel (colourless) shall be 250 g/ cu.m. (About 2 to 3 bags weighing approximately 100 grams each). VCI pellets shall not be used for stainless steel components and its composite associates.
18. All threaded components of spring assemblies and turnbuckles shall be galvanized and achromatized to 15 microns minimum thickness.
19. Soot blower components i.e Valve head assembly having high surface temperature (> 200 and <600 deg. C) shall be applied with protective coating as per PS9 (up to 400 deg.C) and PS10 (up to 600 deg.C)
20. Corner plate, sheet channel and fixing pins of PGMA 32-510 shall be painted as per scheme PS3 to total DFT of 60 microns.
21. It is mandatory that for finish coat each layer shall have a permanent DFT and free from any paint defects like sags, wrinkles etc. Total DFT of a component correspond to respective painting scheme has to be ensured and recorded by inspection agency as per QP.

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22. Handrails of PGMA under Sl. No. 3 shall be hot dip galvanized as per PS6 – Sl. No. 10.
23. Inside surfaces of fabricated structure (e.g. Box type column) shall be painted with two coats of red oxide primer paint during fit up stage.
24. For DD items, DUs other than threaded/ machined surfaces shall be painted as per scheme of Sl. No. 8, PS73.
25. For chequered plates having thickness <=5mm, surface preparation can be power tool cleaning to St3 and painting shall be in line with Sl. No. 8.
26. All Columns below '0' level (embedded in concrete) PGs 34,35,36,38 39 – two coats of temporary Rust preventive fluid to PR: CHE: 09 – 04. DFT= 40µ.
27. Faying surfaces of bolted connection (Friction Grip, Slip- Critical) shall be masked to prevent application of coating except primer. Only primer shall be used on all friction grip type (Slip-Critical) bolted connections for all structural steel. After bolting this area shall be coated in accordance with the specified painting system.

Durability of paint system

1. The durability of the coating system is only a typically expected to be as per ISO 12944-5, clause 5.5.
2. It is to be noted that the durability (as noted in ISO) is not a guarantee time.
3. The Durability is indicated in this document only as a technical consideration that can help the owner to plan a maintenance painting programme.
4. It is emphasized that ISO guidelines of durability can be met only if painted components are stored properly; taking due care of all the precautions to ensure that components are not directly in contact with soil & (rain) water (or) any corrosion medium and are stacked properly without damaging the paint coating.
5. The durability is linked to the painting system essentials, which encompasses the condition of the surface painted; surface preparation methodology; type of paint system and coating thickness; care with which the surfaces are handled; the care with which they are stored. Hence due care has to be taken in all aspects. When there is a local damage is done, and maintenance coating is done; it is to be noted that the durability as originally stated cannot be expected.
6. As a good practice, considering the above, it is suggested that sites should inspect the paint condition of the components every three months till erection and do the needful to protect any damaged regions, by suitable maintenance coating. It is necessary for sites to define and adhere to a methodology for proper storage.
7. The durability expected for painting scheme of structures (Sl. No.3) is 5 years against medium corrosive environment. Painting scheme "1JO, 73 & 1AS2" falls under Low durability category (L), 2 to 5 years in similar environment. Expected life of PS3 & PS2 is from six months to one year. 15C is having durability 5 years minimum under medium corrosive environment.

Executive Director
Thermal Projects Construction
TSGENCO, Vidyut Soudha,
Khairatabad, Hyderabad-500 082.

Painting Scheme – Details for procurement & application purposes

Sl.No.	Generic nature of paint	Theoretical Covering Capacity Sq.m per Litre.	No. of pack	Volume solids, % (min)**	DFT in microns per coat (approx.)	Shade	Shade No. to IS5	Mode of appln.	Over coating interval, Hrs.
1	Epoxy Zinc rich primer to IS14589 Gr.II	8	2	35	40	Grey	--	Spray	24
2	Aliphatic acrylic polyurethane paint to IS 13213	12	2	40	30	Phirozi – Blue/ Light Grey	176/ 631	Spray	24
3	Heat resistant Aluminium paint to IS 13183 Grade I/II	10	1	-	20	--	--	Brush / Spray	24
4	Red oxide zinc phosphate primer paint to IS 12744	10	1	--	30	-	--	Brush / Spray	12
5	Red oxide Zinc Phosphate Dip coat primer paint to PR: CHEM: 09-03	10	1	--	35	--	---	Dip	12
6	Long oil alkyd synthetic enamel finish paint to IS2932	10	1	--	20-30	Reqd. shade	Corrpdg. Shade no.	Brush / Spray	12
7	Temporary Rust preventive fluid to PR: CHE: 09 – 04	10	1	--	25	--	--	--	12
8	General purpose Aluminium paint to IS 2339	10	2	--	20	Aluminum	--	Brush	12
9	HB Chlorinated Rubber Based Zinc Phosphate Primer-Colour Grey	8	1	40	50	Grey	--	Brush / Spray	12
10.	Epoxy based polyamide cured MIO pigmented intermediate coat.	8	2	50	75	Brown	--	Spray	24
11	Epoxy based polyamide cured finish paint to IS14209.	13	2	40	30	Smoke grey	692	Spray	24
12	Epoxy based zinc phosphate primer to IS13238	11	2	40	30	Grey	--	Spray	24

Brush painting is accepted, if recommended by the Paint suppliers. The covering capacity of paints specified is only approximate.
The paints and Rust Preventive fluid shall be procured from BHEL's approved suppliers. ** Values are indicative.

Executive Director
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TELANGANA STATE POWER GENERATION CORPORATION LIMITED
TSGENCO CORPORATE OFFICE
VIDYUTH SOUDHA, HYDERABAD

From:	To:
The Chief Engineer(Thermal Projects Construction) A-Block,TSGENCO,Vidyuth Soudha, Hyderabad-500 082,Telangana, CST No. :36280126964 (CENTRAL) TIN No. :36280126964 PAN NO. :AAFCT0257Q CIN No. :U40102AP2014SGC094070	The Additional General Manager/Commercial M/s Bharat Heavy Electricals Limited, Heavy Power Equipment Plant, 3rd floor Admin building, Ramachandrapuram, Hyderabad, Ph No:040-2318-2337, Fax-040-2318-6089. E-Mail ID:msrao930@bhelhyd.co.in.

Lr NO : CE/TPC/SE-1/TPC/EME 1/122/ F.Painting /D.No. 83 /15,Dt:25.05.2015

Sir,

Sub: KTPS Stage-VII – I x 800 MW – Painting schedule of HP 1103 Bowl Mill - approval – Issued - Reg.

Ref: 1. Contract No. 3000000003, Dt: 31.12.2014
2. M/s BHEL Lr. No: HYD/MPA1048/32;Dt:05.05.2015

* * * *

Please refer to the letter 2nd cited, where in painting schedule for Bowl Mills HP 1103 (Rev 01) was submitted against the purchase order 1st cited, for TSGENCO's approval.

After careful examination, the painting schedule for Bowl Mills HP 1103 (Rev 01) is here by approved. A copy of the approved painting schedule is here with enclosed.

It may please be noted that the approval of the painting schedule does not absolve you of your responsibility of supplying the above equipment conforming to relevant specifications and standards and to ensure satisfactory performance of the equipment as per the terms & conditions of the contract.

Encl: A/a

Yours faithfully

25/05/15

CHIEF ENGINEER / TPC

CC to:

1. The Chief Engineer/O&M/KTPS / Paloncha /Khammam(Dist)-507 115
2. The Superintending Engineer/E&M/ / KTPS VII / Paloncha /Khammam(Dist) -507 115
3. Addl General Managrer / PMG, M/s BHEL, Power Sector/Project Management Group,Advant Navis Business Park , Sector 142 Noida.
4. General Manager , Development Consultants Pvt., Ltd. Block DG-4 Sector II , Salt lake City ,Kolkata – 700 091

भारत हेवी इलेक्ट्रिकल्स लिमिटेड
Bharat Heavy Electricals Limited
Ramachandrapuram, Hyderabad

PULVERISERS ENGINEERING

1x800 MW TSGENCO, KOTHAGUDEM

HP 1103 Bowl Mill

May 5, 2015

PAINTING SCHEDULE OF BOWL MILL Drawing. No. BA-PS-KOTHAGUDEM-00, R0

Sl. No.	CUSTOMER COMMENTS (Ref No.13A06/DCH-4/0178 Dt. 04/05/2015)	HYD (MILLS) REPLY
1	As per Specification Vol. IIA/S-10 : 2 Clause No. 4.00.00 Total minimum DFT for surfaces subject to weathering shall be 140 micron and for surface inside building shall be 120 micron.	The minimum DFT envisaged as per our as well as collaborator's practice keeping the requirement of Mill surface.
2	Colour shade of all items shall be as per V.IIA/S-10 Annx-1	The colour shade for Mills are envisaged as per our as well as collaborator's practice.
3	Shall be 50 micron as per section 6 paint Schedule, page 5 of 6 of this document.	Revised.
4	Shall be 225+50 =275 micron. Please correct.	Revised.

PAINTING SCHEDULE FOR BOWL MILLS Drawing. No. BA-PS-KOTHAGUDEM-00, R0 is revised to Rev 01 and is being submitted for approval, please.

25/05/15
Chief Engineer
Thermal Projects Construction
TSGENCO, Vidyut Soudha,
Khairatabad, Hyderabad-82

BHARAT HEAVY ELECTRICALS LIMITED
RAMACHANDRAPURAM: HYDERABAD: 502032
PULVERISERS ENGINEERING

HP 1103 BOWL MILLS – 8 NOS. / BOILER

PAINTING SCHEDULE FOR BOWL MILLS

PREPARED BY	RAJESH RANJAN	Rajesh Ranjan	OWNER: **TELANGANA STATE POWER GENERATION CORPORATION LIMITED (TSGENCO)**
REVIEWED BY	AMAN SURIN	Aman Surin	CONSULTANT: DEVELOPMENT CONSULTANTS PRIVATE LIMITED, CONSULTING ENGINEERS, 24B PARK STREET, KOLKATA - 700 016, INDIA
APPROVED BY	SATISH GHATGE	Satish Ghatge	PROJECT: **KOTHAGUDEM THERMAL POWER STATION STAGE-VII**, UNIT# 12, (1x800 MW)

DOCUMENT NO: BA-PS-KOTHAGUDEM-00

REV. NO: 01

DATED: 05.05.2015

Record of Revisions:
Rev 00: Initial Submission

Rev 01: Revised in line with Customer comments Ref No.13A06/DCH-4/0178 Dt. 04/05/2015. Reply Sheet enclosed.

Chief Engineer
Thermal Projects Construction
TSGENCO, Vidyut Soudha,
Khairatabad, Hyderabad-82

TABLE OF CONTENTS

25/05/15
Chief Engineer
Thermal Projects Construction
TSGENCO, Vidyut Soudha,
Khairatabad, Hyderabad-82

SECTION 1: SCOPE

This painting specification schedule covers all parts and assemblies of HP 1103 Pulverisers manufactured by BHEL and its sub-vendors including Sister Units for Kothagudem TPP Stage-VII, Unit#12 1x800 MW contract of M/s TSGENCO.

SECTION 2: ALL INTERIOR SURFACES OF THE MILL

Interior surfaces:

Those surfaces inside the pulverizer exposed to the mill airflow and coal. Also included are those surfaces inside the pulverizer and not exposed to mill airflow and coal such as the inside of the Spring Housing.

A) **Surface preparation**: Commercial Blast SSPC-SP 10 (Swedish Std SA 2.5)

B) **Primer**: Self curing inorganic zinc silicate primer (solids by volume 60% min) Minimum DFT 75 microns. Shop applied immediately after blast cleaning by airless spray technique.

Note: *No primer application is envisaged on the inside of the Planetary Gearbox and the Journal Housing.*

SECTION 3: EXTERIOR SURFACES OF THE MILL WITH SURFACE TEMPERATURE GREATER THAN 95°C AND INSULATED

Exterior surfaces:

Those surfaces visible by someone outside the fully assembled pulverizer.

Components with Surfaces Greater Than 95 °C:

Mill Side Housing Assembly (Externally Insulated).

A) **Primer**: High temperature primer & Aluminium Silicone paint (additional). Total DFT 65-85 microns.

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SECTION 4: EXTERIOR SURFACES OF THE MILL WITH SURFACE TEMPERATURES LESS THAN 95 °C

Exterior surfaces:

Those surfaces visible by someone outside the fully assembled pulverizer.

Components with Surfaces Less Than 95 C:

All mill components, except the Mill Side Housing Assembly and Bowl and Bowl Hub Assembly.

A. **Primer**: Self curing inorganic zinc silicate primer (solids by volume 60% min) Minimum DFT 75 microns. Shop applied immediately after blast cleaning by airless spray technique.

B) **Intermediate Coat**: Polyamide cured pigmented titanium dioxide (TiO2) or Micaceous iron oxide (MIO) epoxy based paint. (solids by volume 60% min) Minimum DFT 75 microns. Paint applied by airless spray technique.

C) **Finish Coat (Shop)**: Polyamide cured color pigment epoxy based paint. (solids by volume 60% min) Minimum DFT 75 microns.

D) **Finish –Finish Coat (After Erection)**: of 50 micron DFT (minimum) of Polyurethane based colour pigmented paint (solids by volume minimum 40%).

SECTION 5: GENERAL NOTES

A. Grease and Oil Removal: Special care shall be taken to remove grease and oil by means of suitable solvents.

B. Brush Off Blast Swedish Std Sa 2.5 preparation: Brush Off Blast (SSPC-SP10): All oil, grease, dirt, mill scale, rust, corrosion products, oxides, paint or other foreign matter have been completely removed from the surface by abrasive blasting, except for very light shadows, very light streaks or slight discolorations caused by rust stain, mill scale oxides or slight, tight residues of paint or coating. At least 95% of each square inch of surface area shall be free of all visible residues and the remainder shall be limited to light discolorations mentioned above. Work to the Sa 2.5 requirements.

C. Machined surfaces are not painted.

D. Bought-out & other miscellaneous items shall be as per BHEL standard painting. This painting scheme shall be applicable for Mills components as mentioned.

25/05/11
Chief Engineer
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SECTION 6: PAINT SCHEDULE

Sl No	Surface Location	Surface Preparation	Primer		Intermediate		Finish Coat			Total DFT
			Paint	No. of Coats	Paint	No. of Coats	Paint	No. of Coats	Shade	µm min
01	Interior Surfaces of Mill (All surfaces, including surfaces above 95°C and surfaces below 95°C.) Ref Section-2.	Commercial blast Swedish Std SA 2.5	Inorganic Zinc Silicate	2 coats 75 µm min DFT total	NA	-	NA	-	-	75 µm min.
02	Exterior Surfaces of Mill above 95°C (Mill Side Assembly) Exterior Surface of the Mill Side Assembly is insulated.	Commercial blast Swedish Std SA 2.5	Inorganic Zinc Silicate (High temperature primer)	1-2 coats 40 µm-50 µm DFT Total	Aluminum Silicone (High temperature paint)	2 coats 25-35 µm DFT Total	NA		Gray RAL 9002	65-85 µm DFT

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03	Exterior Surfaces of Mill below 95 °C (All surfaces except the Mill Side Assembly) Includes: Separator Body Assembly, Journal Opening Cover, Spring Assembly, Separator Top, Discharge Valve Components, Outlet Pipes, Seal Air Piping, Planetary Gearbox, Pulveriser Top Platform, Lube Oil System)	Commercial blast Swedish Std SA 2.5	Inorganic Zinc Silicate	2 coats 75 µm min DFT total	Polyamide cured pigmented titanium dioxide (TiO2) or Micaceous iron oxide (MIO) epoxy based paint	1-2 coats 75 µm min DFT total	Finish (Shop) Polyamide cured color pigment epoxy based paint ---------- Finish (after erection) Polyurethane based color Pigment paint (solids by volume 40% min)	1-2 coats 75 µm min DFT Total ------ 1 coat 50 µm min DFT	Grey RAL 9002	225 µm DFT min. ---------- 275 µm DFT min. (total after erection paint)

Chief Engineer
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RANIPET	Bharat Heavy Electricals Limited Boiler Auxiliaries Plant Ranipet – 632 406 Tamil Nadu	BHEL DOC.NO.	PS:YADA:R827&R4L4
		REV. NO.	02
		DATE	04-05-2018

TELANGANA STATE POWER GENERATION CORPORATION LTD.,

Yadadri TPS

5X800 MW- EPCPackage

Near Veerlapalem Village, Dameracherla mandal, Nalgonda District, Telangana

PAINTING SCHEDULE FOR APH, FANS, GATES & DAMPERS, ESP

BHEL Customer No(s).: R827-R831&R4L4 (5 X 800 MW) EPC - Package

Prepared & Reviewed By	Approved By
	
(Rajamanickam M)	(R. Arunachalam)

SL NO	PGMA / DECRIPTION	SURFACE PREPARATION & SURFACE PROFILE	PRIMER COAT		INTERMEDIATE COATE		FINISH COAT		TOTAL DFT. µm (min.)
			PAINT	NO OF COATS	PAINT	NO OF COATS	PAINT	NO OF COATS	

RECORD OF REVISION

REV NO	DATE	DETAILS OF RECORD OF REVISION
00	01.03.2018	Original Issue – First Submission
01	13.04.2018	Revised Issue after incorporating customer/ consultant comments
02	04.05.2018	Revised Issue- Revised based on the customer comments

SL NO	PGMA / DECRIPTION	SURFACE PREPARATION & SURFACE PROFILE	PRIMER COAT		INTERMEDIATE COATE		FINISH COAT		TOTAL DFT. µm (min.)
			PAINT	NO OF COATS	PAINT	NO OF COATS	PAINT	NO OF COATS	
1.0	Steel Structures (External Coatings) *ESP* – 79-X81 Supporting Structure, 79-X65 Hopper Approach Platform, Stair Stringer Channels, Brackets, Supp Brackets, Frames, Loose Channels, Toe Plates, Stiffener Plates & Angles *Gate&Damper* - Hood Ladders and other loose structural items for platform.	Blast Cleaning – Near White Metal as per SA 2 ½ Surface area is free from all rust, mill scales and visible residues, foreign materials – Surface roughness min. 35 to 50 µm	Epoxy Zinc Rich Primer to IS: 14589 Gr.II - DFT = 40 µm per coat *Note: Columns below "0.0" level – Two coats of primer as per sl.no. 1, of this Painting Schedule shall be applied since this item will be embedded inside the concrete pedestal.*	2	--	--	Epoxy polyamide cured finish paint to IS: 14209 DFT = 30 µm per coat Colour shade: Light Grey – Shade no.631 of IS:5 Aliphatic Acrylic polyurethane paint to IS 13213 Colour shade: Light Grey – Shade no.631 of IS:5 (To be applied at site after erection)	2 1	140 35# #- To be applied at site after erection Total DFT- **175µ**
2.0	Components > 95 º C Insulated / Coming in Gas path, Commg Spares & Erection Materials of APH, FAN, ESP, & Tools & fixture of FD fan(Aux.Blr)	Power Tool Cleaning to St3 (SSPC – SP3)	Red Oxide Zinc Phosphate Primer (Alkyd Base) to IS: 12744 DFT = 30 µm per coat - Colour shade – Red Oxide	2	--	--	--	--	60
3.0 3.1	Equipments (External Surfaces) – APH: 52 100,101 Rotor Drive Assy, 52 211 Air Seal pipe, 52 261 Guide Bearing Assy, 52 262 Support Bearing Assy, 52 301, 52 302 Wash pipe assy, Cleaning Equipment & Drive Unit	Power Tool Cleaning to St3 (SSP52C – SP3)	Red Oxide Zinc Phosphate Primer (Alkyd Base) to IS: 12744 DFT = 35 µm per coat	2	--	--	Synthetic Enamel paint (long oil alkyd) to IS: 2932 – DFT = 25 µm per coat – Colour shade – *Smoke Grey Shade no. 692 of IS:5*	2	120

SL NO	PGMA / DECRIPTION	SURFACE PREPARATION & SURFACE PROFILE	PRIMER COAT		INTERMEDIATE COATE		FINISH COAT		TOTAL DFT. µm (min.)
			PAINT	NO OF COATS	PAINT	NO OF COATS	PAINT	NO OF COATS	
3.2	FAN: 55-216,227, 335 FD/PA/ID Rotor, 55-810, 820, 830, 56-810, 870 Coupling for PA, ID & SA /GR & FD, 55-911, 931 – FD/PA Silencer (un-insulated area), 55-155 GR Fan Rotor, 56-161 Ventilation Fan – Radial, 56-173 Seal Air fan Rotor, 56113 FD Fan rotor (Aux,Blr)	Power Tool Cleaning to St 3 (SSPC – SP3)	Red Oxide Zinc Phosphate Primer (Alkyd Base) to IS: 12744 DFT = 35 µm per coat	2	--	--	Synthetic Enamel paint (long oil alkyd) to IS: 2932 – DFT = 35 µm per coat – *Colour shade – Smoke Grey Shade no. 692 of IS:5*	2	140
		Note: All static parts of fan – two coats red oxide zinc phosphate primer to be applied both sides since it will be insulated.(alkyd base) to IS: 12744 DFT=30 µm per coat – Total DFT = 60 µm.							
3.3	ESP - Inspection Door Outer Roof ESP Performance Test adopter,	Power Tool Cleaning to St 3 (SSPC – SP3)	Red Oxide Zinc Phosphate Primer (Alkyd Base) to IS: 12744 DFT = 35 µm per coat	2	--	--	Synthetic Enamel paint (long oil alkyd) to IS: 2932 – DFT = 35 µm per coat – *Colour shade – Smoke Grey Shade no. 692 of IS:5*	2	140
3.4	Out Door Equipments (External Surfaces) – APH- 52 271, 52 272 Oil Piping, 52 274 Lub Oil Circulation Units Fans- Lub oil circulation Units- 55910,920,930 ESP- GD Drive Arrangmt Drive Arrangmt EE CE Rapp drive 79X10, 79X17& 79X26	Blast cleaning to Sa 2½ (Near White metal) with surface profile 35-50µm	Epoxy Zinc Rich Primer to IS: 14589 Gr.II - DFT = 60 µm per coat	1	--	--	Epoxy polyamide cured finish paint to IS: 14209 DFT = 35 µm per coat Colour shade: Smoke Grey – Shade no.692 of IS:5	1	95

SL NO	PGMA / DECRIPTION	SURFACE PREPARATION & SURFACE PROFILE	PRIMER COAT		INTERMEDIATE COATE		FINISH COAT		TOTAL DFT. µm (min.)
			PAINT	NO OF COATS	PAINT	NO OF COATS	PAINT	NO OF COATS	
4.0	Gates & Dampers > 95° C Insulated / Un-Insulated surfaces: 57-063, 57 203, 57 223 57 270, 57 273, 57-363, 57 413, 57 430, 57 460 57 470, 57 480 ,57 490, 57 603, 57 613, 57 623	Power tool cleaning to St3(SSPC-SP3)	HR Aluminium Paint to IS: 13183 Gr. II (up to 400 ° C) DFT = 20 µm per coat	1	--	--	HR Aluminium Paint to IS: 13183 Gr. II (up to 400 ° C) DFT = 20 µm per coat	1	40
4.1	Gates & Dampers < 95 ° C Insulated / Un-Insulated surfaces: 57 010, 57 013, 57 033, 57 063 57 083, 57 110, 57 141 57 143, 57 160, 57 173, 57 209, 57-491, 57 497	Power tool cleaning to St3(SSPC-SP3)	Red Oxide Zinc Phosphate Primer (Alkyd Base) to IS: 12744 DFT = 30 µm per coat	2	--	--	Synthetic Enamel paint (long oil alkyd) to IS: 2932 – DFT = 20 µm per coat – *Colour shade – Smoke Grey Shade no. 692 of IS:5*	2	100
5.0	Foundation Materials for all Fans, Collecting Electrode, Hook for EE, Gate Blades, Pins & Pin Rack for APH and all other machined components	All Threaded and other surfaces of foundation bolts and its materials shall be coated with Temporary Rust Preventive Fluid. During execution of civil works, the dried film of coating shall be removed using organic solvents.							
6.0	Hand Rail Post, Bend, ERW Tubes, Floor Grills and Step Treads for ESP & Gates	Hot Dip Galvanizing to a coating weight of 610 g/m^2 (minimum) and to a coating thickness of 85.0 microns (minimum) ***Note:*** *The guard plates, hood ladders and stringer channels shall be painted as per SL.No.1 of this painting scheme prescribed*							

SL NO	PGMA / DECRIPTION	SURFACE PREPARATION & SURFACE PROFILE	PRIMER COAT		INTERMEDIATE COATE		FINISH COAT		TOTAL DFT. µm (min.)
			PAINT	NO OF COATS	PAINT	NO OF COATS	PAINT	NO OF COATS	

PAINTING OF DAMAGED AREAS

SL NO	PGMA / DECRIPTION	SURFACE PREPARATION & SURFACE PROFILE	PRIMER COAT		INTERMEDIATE COATE		FINISH COAT		TOTAL DFT. µm (min.)
			PAINT	NO OF COATS	PAINT	NO OF COATS	PAINT	NO OF COATS	
1	Paint damaged components fall under Sl.no.1	Power tool cleaning to bare metal	Epoxy Zinc Rich Primer to IS: 14589 Gr.II - DFT = 40 µm per coat	2	--	--	Epoxy polyamide cured finish paint to IS: 14209 DFT = 30 µm per coat Colour shade: Light Grey – Shade no.631 of IS:5	2	140
2	Paint damaged components fall under Sl.no.2, 3, 4 & 4.1	Power tool cleaning to bare metal	As per this painting schedule as refered in sl.nos mentioned against each as applicable		--	--	As per this painting schedule as refered in sl.nos mentioned against each as applicable		

General Notes

a) Surfaces not easily accessible after shop assembly shall be treated before –hand and protected for life of the equipment as per this painting scheme as applicable.
b) Heating Element of APH shall be dipped in Rust Preventive Oil (Non Dry Type)
c) Paint damage – any areas where paint got damaged shall be applied with primer and finish as given in this painting schedule.
d) No painting is required for Galvanized, non ferrous and stainless steel items except as indicated above.
e) Machined items are to be applied with one coat of temporary rust preventive oil.
f) All the components covered under different PGMAs are to be painted. In case any component is left out, the same shall be deemed to be included under the relevant PGMA.
g) PGMAs and its items coming under BOI are not indicated in this painting schedule. However, respective Engg document for all BOIs shall be referred. Wherever it is not specified, it shall be as per the painting schedule of the applicable PGMA.
h) The paint DFT has to be ensured by taking average of 15 readings ie., in a close circle of 30mm three readings have to be noted, like wise five different locations for a given single job have to be selected and total 15 readings – average have to be noted in the DR with paint peel off test evidence in the DR which has to be pasted for BHEL review and compliance.
i) Typical Painting product data sheets will be furnished to customer for records.

GUIDELINES
FOR
WELDING

IMPORTANT NOTE

THIS GUIDELINES FOR WELDING PROVIDES BROAD BASED GUIDELINES FOR CARRYING OUT WELDING WORK AT SITES. HOWEVER, SITES SHALL ENSURE ADHERENCE TO THE PRIMARY DOCUMENTS LIKE CONTRACT DRAWINGS, FIELD WELDING SCHEDULES, WELDING PROCEDURE SPECIFICATIONS, PLANT / CORPORATE STANDARDS, STATUTORY DOCUMENTS, CONTRACTUAL OBLIGATIONS,AS APPILCABLE ANDSPECIAL INSTRUCTIONS, IF ANY, ISSUED BY RESPECTIVE MANUFACTURING UNITS SPECIFIC TO THE PROJECTS.

INDEX

CHAPTER–A1
WELDING - GENERAL

A1: WELDING-GENERAL

1.0 SCOPE:

1.1 This manual deals with activities and information related to welding at site. Where specific documents are supplied by the Manufacturing Units (MUs)/Engineering Centers (ECs), the same shall be adopted.

2.0 DOCUMENTS REFERRED:

2.1 The following documents are referred in preparation of this manual.

1. AWS D1.1
2. AWS D1.6
3. ASME sections I, II (A&C), V & IX
4. ASME B31.1
5. IBR
6. BHEL Manufacturing Units/Engineering Centers Standards & practices

3.0 PROCEDURE:

3.1 The following documents shall be referred as primary documents

1. Contract drawings
2. Field Welding Schedule or equivalent
3. Plant / Corporate standards, wherever applicable
4. Statutory documents
5. Welding Procedure Specifications
6. Contractual obligations, if any.

4.0 WELDER QUALIFICATION:

4.1 Ensure, personnel qualified as per statutory requirements are engaged, where required.

4.2 For welding not under the purview of statutory requirements, qualification of welders shall be as in this manual.

4.3 Monitor performance of qualified butt welders as in this manual.

4.4 Ensure selection, procurement, storage, drying & issue of welding consumables, as detailed in this manual.

4.5 List of approved vendors of general purpose welding electrodes as provided by BHEL-Tiruchy Unit shall be used for selection of brands at sites. Alternatively specific contractual requirements, if any may be followed.

4.6 Where Tiruchy list does not cover site requirements, such specific cases may be referred toconcerned unit and Head (Quality) of the region.

4.7 Welding in-charge shall assign a unique identification for all the butt welds coming under the purview of statutory regulations. Such identification may be traceable through documents like drawings, sketches etc.

4.8 A welding “job card” incorporating the welding parameters and heat treatment requirements is recommended to be issued for all critical welds like pressure part welds, piping welds and

ceiling girder welds. The formats of the job card are enclosed for illustration in Annexure I, II, III and IV.

5.0 SELECTION OF ARGON GAS FOR GTAW:

5.1 USE OF ARGON GAS AT SITES:

In the welding process, Argon is used for **SHIELDING** and **PURGING** (**BACKING)** purpose. The welding process when exposed to air, most metals exhibit a strong tendency to combine with Oxygen, and to lesser extent with Nitrogen, especially when in the molten condition. The rate of oxide formation will vary with different metals, but even a thin film of oxide on the surface of metals to be welded can lead to difficulties. For the most part, the oxides are relatively weak, brittle materials that in no way resemble the metal from which they are formed. A layer of oxide can easily prevent the joining of two pieces by welding.

Argon is a shielding gas used in Gas Tungsten Arc Welding (GTAW). It is also used for purging (backing) during the root welding of Gr.91/Gr.92/Stainless steel materials. Argon protects welds against oxidation as well as reduces fume emissions during welding. The compressed argon is supplied in cylinders. The cylinder used for argon will have the body colour of BLUE without band, size of 25 cm dia. &1.5 m length, capacity of 6.2 m^3 and pressure of 137 Kg/Cm^2 when fully charged at 15°C (approximately).

5.2 PURITY LEVEL OF ARGON

As per IS 5760: 1998 there are 3 grades of argon, namely:

• **Grade 1:** Ultra high purity argon for use in electronics and allied industries and indirect reading vacuum spectrograph.

• **Grade 2:** High purity argon for use in lamp and allied industries.

• **Grade 3:** Commercial grade argon for use in welding industry and for other metallurgical operations.

Accordingly the argon shall comply with the requirements given below:

Sl. No.	CHARACTERISTIC	REQUIREMENT		
		Grade 1	Grade 2	Grade 3
i.	Oxygen, ppm, Max.	0.5	5.0	10.0
ii.	Nitrogen, ppm, Max.	2.0	10.0	300
iii.	Hydrogen, ppm, Max.	1.0	2.0	5.0
iv.	Water vapors, ppm. Max.	0.5	4.0	7.0
v.	Carbon dioxide, ppm, Max.	0.5	0.5	3.0
vi.	Carbon monoxide, ppm, Max.	0.5	0.5	2.0
vii.	Hydrocarbons, ppm, Max.	0.2	0.5	-

5.3 PURCHASE SPECIFICATION FOR ARGON:

Argon gas as per Grade 2 of IS-5760: 1998 with Argon purity level of min. 99.99%. The supply should accompany Test Certificate for the batch indicating compliance to the above requirements.

5.4 HEAT TREATMENT:

5.4.1 Preheat, inter pass, post heat and Post Weld Heat Treatment (PWHT) requirements shall be as per applicable documents; where these are not supplied, reference may be made to Welding / Heat Treatment Manual.

5.4.2 Prior to PWHT operation, a "job card" containing material specification, weld reference, size, rate of heating, soaking temperature, soaking time and rate of cooling shall be prepared referring to applicable documents, and issued.

5.4.3 The PWHT chart shall contain the chart number,Weld Joint No., Temperature recorder details (like Sl. No. make, range, chart speed), date of PWHT, start and end time of operation.

5.4.4 The chart shall be evaluated and results recorded on the PWHT job card. Refer Heat Treatment Manual (Document No. AA/CQ/GL/011/ Part II-HTM- Latest) for details.

6.0 EQUIPMENT & INSTRUMENTS:

6.1 Equipment/accessories used shall be assessed for fitness prior to use.

6.2 Use calibrated thermocouples, temperature measuring instruments and recorders.

6.3 Preheating shall be checked and ensured using temperature indicating crayons.

7.0 INSPECTION:

7.1 Inspection of welding shall be done as per Chapter A5 of this manual and records maintained as appropriate.

7.2 Weld log containing the following information shall be prepared for all completed systems.

Project / Unit reference
Drawing No.
Weld Joint No.
FWS/ Equivalent
Material specification
Consumable used
Welder code
Date of welding
NDE report No. and results (including repair details)
PWHT Chart No. and results
Remarks, if any.

8.0 SAFETY:

8.1 Safe access to weld area shall be provided.

8.2 Adequate protection shall be provided against wind and rain water entry during welding.

9.0 RECORDS:

9.1 All records, as required, shall be maintained by welding in-chargeand handed over to the appropriate authority at the end of the project closure.

Annexure – I: Welding Job Card

Welding Job Card

Project	:		
Unit No.	:	Area: Boiler/TG/PCP:	
Job Card No.	:	Date	:
FWS Number	:		
Joint No.	:		
Drawing No.	:		
System Description	:		
Size (Dia. x thick)	:		
Material Specification	:		
Consumable used	:		
Welder No.(s)	:		
Date of welding	:		
Filler wire Specification	:		
Electrode Specification	:		
Preheat temperature	:		
Inter pass temperature	:		
Post Heat temperature	:		
PWHT temperature	:		

Welding engineer

Filler wire/Electrode consumption

SMAW	ϕ 2.5 mm	:
	ϕ 3.15 mm	:
	ϕ 4.0 mm	:
Date of LPI for RG Plug		:
Remarks		:
Date of Return		:

Annexure – II: Welding Job Card for P91/P92 Welds

JOB CARD (WELDING, HEAT TREATMENT & ND EXAMINATION) FOR P91/P92 WELDS												
Card No.:									**Date:**			
Project:				**Unit No.**					**Contractor:**			
System:							Drawing No.					
PGMA:							DU No.:			Joint No.:		
Material Specification:			+				OD (mm):			Thick(mm)		
Filler metal:	GTAW						SMAW					
Joint fit-up:	Min. WT:		Root gap:		Root mismatch:			Log sheet filled:	Y / N			
No. of T/Cs:		Location:					Distance from EP edge:			mm		
Welders' ID:							M/c No.:					
Preheat Temp.:	°C Minimum						Rate of heating:			°C per hour		
Purging flow rate:		Litres / min.					Purging time:			Minutes		
Shielding flow rate:		Litres / min. for GTAW					Distance bet. dams:			Metres		
Interpass Temp.:	° C Maximum						Rate of cooling:			°C per hour		
Holding Temp. before PWHT:	° C for min. 1 hour											
PWHT:	° C						Rate of heating / cooling:			°C per hour		
Soaking time		Minutes (2.5 minutes per mm)					Cooling to:			300° C		
Preheating started at Hrs. on							Preheating completed at Hrs.					
Root welding started at Hrs.							Root welding completed at Hrs.					
Welding started at Hrs.							Welding completed at Hrs.					
Interpass temp. maintained between °C and °C												
Holding temp. reached at Hrs.							Holding completed at Hrs.					
No. of T/Cs:		Location										
PWHT started at Hrs. on .							Soaking started at Hrs.					
Soaking completed at Hrs.							300°C reached at Hrs.					
UT Equipment used:							Calibration validity:					
UT carried out on							Result : OK / Not OK					
MPI Equipment used:							Calibration validity:					
MPI carried out on							Result: OK / Not OK					
Hardness test Equipment used:							Calibration validity:					
Hardness test carried out on							Value:					
History of interruption if any, with time:												
Contractor				**BHEL**					**Customer**			

Annexure – III: Welding Job Card for T91/T92 Welds

JOB CARD
(WELDING, HEAT TREATMENT & ND EXAMINATION)
FOR T91/T92 WELDS

Card No.:								**Date:**			
Project				**Unit No.**				**Contractor:**			
System:						Drawing No.					
PGMA:						DU No.:			Joint No.:		
Material Specification:			+			OD (mm):			Thick(mm)		
Filler metal:	GTAW					SMAW					
Joint fit-up:	Min. t:		Root gap:			Root mismatch:			Log sheet filled:	Y / N	
No. of T/Cs:		Location :				Distance from EP edge:				mm	
Welders' ID:						M/c No.:					
Preheat Temp.:	°C Minimum					Rate of heating:			°C per hour		
Purging flow rate:		Litres / min.				Purging time:				Minutes	
Shielding flow rate:		Litres / min. for GTAW				Distance bet. dams:				Metres	
Interpass Temp.:	° C Maximum					Rate of cooling:			°C per hour		
PWHT:	° C					Rate of heating / cooling:			°C per hour		
Soaking time		Minutes (2.5 minutes per mm)				Cooling to:			300° C		
Preheating started at Hrs.		Hrs. on				Preheating completed at					
Root welding started at Hrs.		Hrs.				Root welding completed at					
Welding started at Hrs.		Hrs.				Welding completed at					
Interpass temp. maintained between °C and °C											
Holding temp. reached at Hrs.						Holding completed at Hrs.					
No. of T/Cs:		Location									
PWHT started at Hrs. on .						Soaking started at Hrs.					
Soaking completed at Hrs.						300°C reached at Hrs.					
RT carried out on						Result : OK / Not OK					
Hardness test Equipment used						Calibration validity:					
Hardness test carried out on						Value:					
History of interruption if any, with time:											
Contractor				**BHEL**					**Customer**		

Annexure – IV: Welding Job Card for T23 Welds

JOB CARD
(WELDING, HEAT TREATMENT & ND EXAMINATION)
FOR T23 WELDS

Card No.:							**Date:**				
Project:				**Unit No.**			**Contractor:**				
System:							Drawing No.				
PGMA:							DU No.:			Joint No.:	
Material Specification:			+				OD (mm):			Thick(mm)	
Filler metal:	GTAW						SMAW				
Joint fit-up:	Min. t:		Root gap:		Root mismatch:			Log sheet filled:	Y / N		
No. of T/Cs:		Location:					Distance from EP edge:			mm	
Welders' ID:							M/c No.:				
Preheat Temp.:		°C Minimum					Rate of heating:		°C per hour		
Purging flow rate:			Litres / min.				Purging time:				Minutes
Shielding flow rate:			Litres / min. for GTAW				Distance bet. dams:				Metres
Interpass Temp.:		° C Maximum					Rate of cooling:		°C per hour		
Holding Temp.:		° C for min. 1 hour. for post heating									
PWHT:		° C					Rate of heating / cooling:		°C per hour		
Soaking time			Minutes (2.5 minutes per mm)				Cooling to:		300° C		
Preheating started at		Hrs. on					Preheating completed at			Hrs.	
Root welding started at		Hrs.					Root welding completed at			Hrs.	
Welding started at		Hrs.					Welding completed at			Hrs.	
Interpass temp. maintained between		°C and		°C							
Holding temp. reached at		Hrs.					Holding completed at		Hrs.		
No. of T/Cs		Location									
PWHT started at		Hrs. on		.			Soaking started at		Hrs.		
Soaking completed at		Hrs.					300°C reached at		Hrs.		
RT carried out on							Result : OK / Not OK				
Hardness test Equipment used							Calibration validity:				
Hardness test carried out on							Value:				
							Result:	OK / Not OK			
History of interruption if any, with time:											

Contractor	**BHEL**	**Customer**

CHAPTER–A2
BASE MATERIALS

1.0 SCOPE:

1.1. This chapter contains tabulations of chemical compositions and mechanical properties of various materials generally used at BHEL sites.

2.0 CONTENTS:

CHEMICAL COMPOSITION AND MECHANICAL PROPERTIES

3.0 The data are for general information purposes. The corresponding P numbers are also indicated.

4.0 For materials not covered in this chapter,refer the relevant Material Specification Standard. In case it is not available at site, same shall be referred to Head quality of the region.

TABLE-A2.1: PIPES (ASME)

Sl. No.	P. No. /Group No.	MaterialSpecification	Chemical Composition (%)										Mechanical Properties (Min.)		
			C	Mn	P	S	Si	Ni	Cr	Mo	V	W	T.S MPa	Y.S MPa	% E Min.
1	P 1 / 1	SA 106 Gr. B (Remarks: Carbon restricted to 0.25% Max.)	0.30 Max.	0.29-1.06	0.035 Max.	0.035 Max.	0.10 Min.	0.40 Max.	0.40 Max.	0.15 Max.	0.08 Max	-	415	240	30
2	P 1 / 2	SA 106 Gr. C (Remarks: Carbon restricted to 0.25% Max.)	0.35 Max.	0.29-1.06	0.035 Max.	0.035 Max.	0.10 Min.	0.40 Max.	0.40	0.15 Max.	-	-	485	275	30
3	P4/1	SA 335 P 11	0.15 Max	0.30–0.60	0.025	0.025	0.50–1.00	-	1.00–1.50	0.44–0.65	-	-	380	205	30
4	P 4 / 1	SA 335 P 12	0.15 Max.	0.30-0.61	0.025 Max.	0.025 Max.	0.50 Max.	-	0.80-1.25	0.44-0.65	-	-	415	220	30
5	P 5A / 1	SA 335 P 22	0.15 Max.	0.30-0.60	0.025 Max.	0.025 Max.	0.50 Max.	-	1.90-2.60	0.87-1.13	-	-	415	205	30
6	P 15E /1	SA 335 P91	0.08-0.12	0.30-0.60	0.02 Max.	0.01 Max.	0.20-0.50	0.40 Max.	8.00-9.50	0.85-1.05	0.18-0.25	-	585	415	20
7	P15E/1	SA 335 P 92	0.13 Max	0.30-0.60	0.020	0.010	0.50 max	0.40 max	8.50-9.50	0.0-	0.15-0.25	1.5-2.0	620	400	20

TABLE-A2.2: TUBES(ASME)

Sl. No.	P. No. /Group No.	MaterialSpecification	Chemical Composition (%)										Mechanical Properties (Min.)		
			C	Mn	P	S	Si	Ni	Cr	Mo	V	W	T.S MPa	Y.S MPa	% E Min.
1	P 1 / 1	SA 192	0.06-0.18	0.27-0.63	0.035 Max.	0.035 Max.	0.25 Max.	-	-	-	-	-	325	180	35
2	P 1 / 1	SA 210 Gr A1 (Remarks: Carbon restricted to 0.25% Max.)	0.27 Max.	0.93 Max.	0.035 Max.	0.035 Max.	0.10 Max.	-	-	-	-	-	415	255	30
3	P 1 / 1	SA 179	0.06-0.18	0.27-0.63	0.035 Max.	0.035 Max.	-	-	-	-	-	-	325	180	35
4	P 1 / 2	SA 210 Gr C (Remarks: Carbon restricted to 0.30% Max.)	0.35 Max.	0.29-1.06	0.035 Max.	0.035 Max.	0.10 Max.	-	-	-	-	-	485	275	30
5	P 3 / 1	SA 209 T1	0.10-0.20	0.30-0.80	0.025 Max.	0.025 Max.	0.10-0.50	-	-	0.44-0.65	-	-	380	205	30
6	P 4 / 1	SA 213 T11	0.05-0.15	0.30-0.60	0.025 Max.	0.025 Max.	0.50-1.00	-	1.00-1.50	0.44-0.65	-	-	415	205	30
7	P 4 / 1	SA 213 T12	0.05-0.15	0.30-0.61	0.025 Max.	0.025 Max.	0.50 Max.	-	0.80-1.25	0.44-0.65	-	-	415	220	30
8	P 5 A / 1	SA 213 T22	0.05-0.15	0.30-0.60	0.025 Max.	0.025 Max.	0.50 Max.	-	1.90-2.60	0.87-1.13	-	-	415	205	30

TABLE-A2.2: TUBES(ASME) (Contd…)

Sl. No.	P. No. / Group No.	Material Specification	Chemical Composition (%)										Mechanical Properties (Min.)		
			C	Mn	P	S	Si	Ni	Cr	Mo	V	W	T.S MPa	Y.S MPa	% E Min.
9	P 5 B / 1	SA 213 T5	0.15 Max.	0.30-0.60	0.025 Max.	0.025 Max.	0.50 Max.	-	4.00-6.00	0.45-0.65	-	-	415	205	30
10	P 5 B / 1	SA 213 T9	0.15 Max.	0.30-0.60	0.025 Max.	0.025 Max.	0.25-1.00	-	8.00-10.00	0.90-1.10	-	-	415	205	30
11	P 1 5 E / 1	SA 213 T91	0.07-0.14	0.30-0.60	0.02 Max.	0.01 Max.	0.20-0.50	0.40 Max.	8.00-9.50	0.85-1.05	0.18-0.25	-	585	415	20
12	P 8 / 1	SA 213 TP 304 H	0.04-0.10	2.00 Max.	0.045 Max.	0.03 Max.	1.00 Max.	8.00-11.00	18.00-20.00	-	-	-	515	205	35
13	P8/1	SA 213 TP 321H	0.04-0.10	2.00 Max.	0.045 Max.	0.03 Max.	1.00 Max.	9.00-12.00	17.00-19.00	-	-	-	515	205	35
15	P 8 / 2	SA 213 TP 347 H	0.04-0.10	2.00 Max.	0.045 Max.	0.03 Max.	1.00 Max.	9.00-13.00	17.00-19.00	-	-	-	515	205	35
15	Code case 2199	SA213 T23	0.04-0.10	0.10-0.60	0.030	0.010	0.050	--	1.90-2.60	0.05-0.30	0.20-0.30	1.45-1.75	510	400	20
16	15E/1 (Code case 2169)	SA213 T92	0.07-0.13	0.30-0.60	0.020	0.010	0.50	0.40	8.5-9.5	0.30-0.60	0.15-0.25	1.5-2.0	620	440	20
17	P8/1 (Code case 2328 - S30432)	SA 213 UNS S30432 (Super 304H)	0.07-0.13	1.00	0.040	0.010	0.30	7.5-10.5	17.0-19.0	-	-	-	590	235	35

TABLE A2.3: FORGINGS (ASME)

Sl. No.	P. No. / Group No.	Material Specification	Chemical Composition (%)										Mechanical Properties (Min.)		
			C	Mn	P	S	Si	Ni	Cr	Mo	V	W, Cb	T.S MPa	Y.S MPa	% E Min.
1	P 1 / 2	SA 105 (Remarks: Carbon restricted to 0.25% Max.)	0.35 Max.	0.60-1.05	0.035 Max.	0.04 Max.	0.1 - 0.35	0.40 Max.	0.30 Max.	0.12 Max.	0.08 Max	-	485	250	30
2	P 4 / 1	SA 182 F11 Class 3	0.10-0.20	0.30-0.80	0.04 Max.	0.04 Max.	0.50 - 1.00	-	1.00-1.50	0.44-0.65	-	-	515	310	20
3	P 4 / 1	SA 182 F 12 Class 2	0.10-0.20	0.30-0.80	0.04 Max.	0.04 Max.	0.10 - 0.60	-	0.80-1.25	0.44-0.65	-	-	485	275	20
4	P 5 A / 1	SA 182 F 22 Class 3	0.15 Max.	0.30-0.60	0.04 Max.	0.04 Max.	0.50 Max.	-	2.00-2.50	0.87-1.13	-	-	515	310	20
5	P 1 5 E / 1	SA 182 F91	0.08-0.12	0.30-0.60	0.02 Max.	0.01 Max.	0.20 - 0.50	0.40 Max.	8.00-9.50	0.85-1.05	0.18-0.25	-	620	415	20
6	P 1 5 E / 1	SA 182 F92	0.7-0.13	0.30-0.60	0.02 Max.	0.01 Max.	0.50 Max.	0.40 Max.	8.50-9.50	0.30-0.60	0.15-0.25	W:1.50-2.00; Cb: 0.04-0.09	620	440	20

TABLE A2.4: CASTINGS (ASME)

Sl. o.	P. No. /Group No.	Material S e fi a on	Chemical Composition (%)								Mechanical Properties (Min.)		
			C	Mn	P	S	Si	Ni	Cr	Mo	. MPa	. MPa	% EMi n.
1	P 1 / 2	SA 216 WCB (Remarks: Carbon restricted to 0.25% Max.)	0.30 Max.	1.00 Max.	0.04 Max.	0.045 Max.	0.60 Max.	0.50 Max.	0.50 Max.	0.20 Max.	485	250	22
2	P 1 / 2	SA 216 WCC	0.25 Max.	1.20 Max.	0.04 Max.	0.045 Max.	0.60 Max.	0.50 Max.	0.50 Max.	0.20 Max.	485	275	22
3	P 4 / 1	SA 217 WC6	0.20 Max.	0.50-0.80	0.04 Max.	0.045 Max.	0.60 Max.	-	1.00-1.50	0.45-0.65	485	275	20
4	P 5 A / 1	SA 217 WC 9	0.18 Max.	0.40-0.70	0.04 Max.	0.045 Max.	0.60 Max.	-	2.00-2.75	0.90-1.20	485	275	20
5	P 8 / 1	SA 351 CF 8	0.08 Max.	1.50 Max.	0.04 Max.	0.04 Max.	2.00 Max.	8.00-11.00	18.00-21.00	0.50 Max.	485	205	35
6	P 8 / 1	SA 351 CF 8M	0.08 Max.	1.50 Max.	0.04 Max.	0.04 Max.	1.50 Max.	9.00-12.00	18.00-21.00	2.00-3.00	485	205	30
7	P 8 / 1	SA 351 CF 8C	0.08 Max.	1.50 Max.	0.04 Max.	0.04 Max.	2.00 Max.	9.00-12.00	18.00-21.00	0.50 Max.	485	205	30
8	P 8 / 2	SA 351 CH 20	0.04-0.20	1.50 Max.	0.04 Max.	0.04 Max.	2.00 Max.	12.00-15.00	22.00-26.00	0.50 Max.	485	205	30
9	P15E / 1	SA 217 C12A	0.08-0.12	0.30-0.60	0.030 Max.	0.010 Max.	0.20-0.50	0.40 Max.	8.00-10.00	0.85-1.05	585	415	18

TABLE A2.5: PLATES/SHEETS

Sl. No.	P. No./ Group No.	Material Specification	Thickness mm	C	Mn	P	S	Si	Ni	Cr	Mo	V	T.S (MPa)	Y.S (MPa)	%E Min.
1	P 1 / 1	ASTM A36	20 incl.	0.25	-	0.04	0.05	0.40	-	-	-	-	400	250	20
			20-40 incl.	0.25	0.80-1.20			0.40	-	-	-	-			
			40-65 incl.	0.26	0.80-1.20			0.40	-	-	-	-			
			65-100 incl.	0.27	0.85-1.20			0.15-0.40	-	-	-	-			
			over 100	0.29	0.85-1.20			0.15-0.40	-	-	-	-			
2	P 1 / 1	SA 516 Gr 60	12.5 incl	0.21	0.55-0.98	0.035	0.035	0.13-0.45	-	-	-	-	415	220	25
			12.5-50 incl	0.23	0.79-1.30				-	-	-	-			
			50-100 incl	0.25					-	-	-	-			
			100-200 incl	0.27					-	-	-	-			
			over 200	0.27					-	-	-	-			
3	P 1 / 2	SA516 Gr70	12.5 incl	0.27	0.79-1.30	0.035	0.035	0.13-0.45	-	-	-	-	485	260	21
			12.5-50 incl	0.28					-	-	-	-			
			50-100 incl	0.3					-	-	-	-			
			100-200 incl	0.31					-	-	-	-			
			over 200	0.31					-	-	-	-			
4	P 1 / 2	SA299 Gr.A	<25	0.26	0.84-1.52	0.035	0.035	0.13-0.45	-	-	-	-	515	275	19
			>25	0.28	0.84-1.62				-	-	-	-			
5	P 1 / 2	SA515 Gr70	<25	0.31	1.30	0.035	0.035	0.13-0.45	-	-	-	-	485	260	21
			25-50 incl	0.33					-	-	-	-			
			50-100 incl	0.35					-	-	-	-			
			100-200 incl	0.35					-	-	-	-			
			>200	0.35					-	-	-	-			
6	P311	SA204 Gr A	<25 incl	0.18	0.98	0.025	0.025	0.13-0.45	-	-	0.41-0.64	-	450	255	23
			>50 incl	0.21					-	-		-			
			>100 incl	0.23					-	-		-			
			>100	0.25					-	-		-			
7	P312	SA204 Gr B	<25 incl	0.20	0.98	0.025	0.025	0.13-0.45	-	-	0.41-0.64	-	485	275	21
			>50 incl	0.23					-	-		-			
			>100 incl	0.25					-	-		-			
			>100	0.27					-	-		-			
8	P411	SA 387 Gr 12 Class 2	<125 incl	0.04-0.17	0.35-0.73	0.025	0.025	0.13-0.45	-	0.74-1.21	0.40-0.65	-	450	275	22
			>125	0.17											
9	P5N1	SA387 Gr 22 Class 2	<125 incl	0.04-0.15.	0.25-0.66	0.025	0.025	0.50.		1.88-2.62	0.85-1.15	-	515	310	18
			>125	0.17											
10	P15El1	SA387 Gr 91	all thickness	0.06-0.15	0.25-0.66	0.025	0.012	0.18-0.56	0.43	7.90-9.60	0.80-1.10	0.16-0.27	585	415	18

TABLE A2.5: PLATES/SHEETS (Contd...)

Sl. No.	P.No./ Group No.	Material Specification	Thickness mm	C	Mn	P	S	Si	Ni	Cr	Mo	V	T.S (MPa)	Y.S (MPa)	%E Min.
11	P811	SA240 TYPE 304	all thickness	0.07	2	0.045	0.03	0.75	8.00-10.50	17.5.-19.5.0	-		515	205	40
12	P 1 / 1	ASTM A572 Gr50	<40 incl	0.23	1.35	0.04	0.05	0.4 0	-	-	-	-0.01-0.1	450	345	17
			>40					0.15-0.40	-	-					
13	P 1 / 1	IS 2062 E250 Gr.A	all thickness	0.23	1.5	0.045	0.045	0.4	-	-	-	-	410	230	23
14	P 1 / 1	IS 2062 E250 Gr.BR BO	all thickness	0.22	1.5	0.045	0.045	0.4	-	-	-	-	410	230	23
15	P 1 / 1	IS 2062 E250 GrC	all thickness	0.2	1.5	0.04	0.04	0.4	-	-	-	-	410	230	23
16	P 1 / 1	IS 2062 E350 Gr A.BR,BO	all thickness	0.2	1.55	0.045	0.045	0.45	-	-	-	-	490	320	22
17	P 1 / 1	IS 2062 E350 GrC	all thickness	0.2	1.55	0.04	0.04	0.45	-	-	-	-	490	320	22
18	P 1 / 1	IS 2062 E450BR	all thickness	0.22	1.65	0.045	0.045	0.45	-	-	-	-	570	450	20
19	P 1 / 1	BSEN10025 Gr 420N	all thickness	0.2	1.0-1.7	0.03	0.025	0.6	0.8	0.3	0.1	0.2	500	320	18

TABLE A2.6: PIPES (OTHER SPECIFICATION)

Sl. No.	Equivalent P. No. /Group No.	Material Specification	Chemical Composition (%)									Mechanical Properties (Min.)		
			C	Mn	P	S	Si	Ni	Cr	Mo	V	T.S Kg / mm^2	Y.S Kg / mm^2	% EMin.
1	P1/1	DIN St. 35.8	0.17 Max.	0.40-0.80	0.04 Max.	0.04 Max.	0.10-0.35	-	-	-	-	36.70-48.96	24	25
2	P1/1	DIN St. 45.8	0.21 Max.	0.45-1.20	0.04 Max.	0.04 Max.	0.10-0.35	-	-	-	-	41.80-54.10	26	21
3	P1/1	BS 3602 / 410	0.21 Max.	0.40-1.20	0.045 Max.	0.045 Max.	0.35 Max.	-	-	-	-	41.82-56.10	25	22
4	P1/1	BS 3602 / 460	0.22 Max.	0.80-1.40	0.045 Max.	0.045 Max.	0.35 Max.	-	-	-	-	46.90-61.20	28.60	21
5	P4/1	BS 3604 620-460 HFS or CDS 620-440	0.10-0.15	0.40 Max.	0.04 Max.	0.04 Max.	0.10-0.35	-	0.70-1.10	0.45-0.65	-	46.90- 62.22	18.36	22
			0.10-0.18	0.40-0.70	0.04 Max.	0.04 Max.	0.10-0.35	-	0.70-1.10	0.45-0.65	-	44.90- 60.20	29.58	22
6	P5/1	BS 3604 622 HFS or CDS	0.08-0.15	0.40-0.70	0.04 Max.	0.04 Max.	0.50 Max.	-	2.00 2.50	0.90-1.20	-	48.80	26.80	17
7	-	BS 3604 HFS 660 Or CDS 660	0.15 Max.	0.40-0.70	0.04 Max.	0.04 Max.	0.10-0.35	-	0.25-0.50	0.50-0.70	0.22-0.30	47.30	30	17
8	P5B/2	X20CrMoV121D IN17175	0.17-0.23	≤ 1.00	0.030 Max.	0.030 Max.	≥ 0.50	0.30-0.80	10.00-12.50	0.80-1.20	0.25-0.35	70-86	50	17

TABLE A2.7: TUBES (OTHER SPECIFICATIONS)

Sl. No.	Equivalent P. No. /Group No.	Material Specification	Chemical Composition (%)									Mechanical Properties (Min.)		
			C	Mn	P	S	Si	Ni	Cr	Mo	V	T.S Kg / mm^2 (MPa)	Y.S Kg / mm^2 (MPa)	% E Min.
1	P1/1	DIN St. 35.8	0.17 Max.	0.40-0.80	0.04 Max.	0.04 Max.	0.10-0.35	-	-	-	-	36.70-48.96	24	25
2	P1/1	DIN St. 45.8	0.21 Max.	0.40-1.20	0.04 Max.	0.04 Max.	0.10-0.35	-	-	-	-	41.80-54.06	26	21
3	P1/1	BS 3059 / 360	0.17 Max.	0.40-0.80	0.045 Max.	0.045 Max.	0.35 Max.	-	-	-	-	36.70-51.00	22	24
4	P1/1	BS 3059 / 440	0.12-0.18	0.90-1.20	0.040 Max.	0.035 Max.	0.10-0.35	-	-	-	-	44.88-59.20	25	21
5	P3/1	15 Mo3 DIN17175	0.12-0.20	0.40-0.80	0.035 Max.	0.035 Max.	0.10-0.35	-	-	0.25-0.35	-	45.90-61.20	27.50	22
6	P4/1	13 Cr Mo 4-5DIN17175	0.10-0.18	0.40-0.70	0.035 Max.	0.035 Max.	0.10-0.35	-	0.70-1.10	0.45-0.65	-	44.88-60.18	29.60	22
7	P4 /1	BS 3059 / 620	0.10-0.15	0.40-0.70	0.040 Max.	0.040 Max.	0.10-0.35	-	0.70-1.10	0.45-0.65	-	46.90-62.20	18.40	22
8	P5/1	10 Cr Mo 9-10DIN17175	0.08-0.15	0.40-0.70	0.035 Max.	0.035 Max.	0.50 Max.	-	2.00-2.50	0.90-1.20	-	45.90-61.20	28.60	20
9	P5/1	BS 3059 (622) - 440	0.08-0.15	0.40-0.70	0.04 Max.	0.04 Max.	0.50 Max.	-	2.00-2.50	0.90-1.20	-	44.90-60.18	17.85	20
10	P5/1	BS 3059 (622) - 490	0.08-0.15	0.40-0.70	0.040 Max.	0.040 Max.	0.50 Max.	-	2.00-2.50	0.90-1.20	-	49.98-65.00	28.05	20
11	-	14 Mo V 63 DIN17175	0.10-0.18	0.40-0.70	0.035 Max.	0.035 Max.	0.10-0.35		0.30-0.60	0.50-0.70	0.22-0.32	46.90-62.22	32.60	20
12	P5B/2	X20CrMoV121 DIN17175	0.17-0.23	≤ 1.00	0.030 Max.	0.030 Max.	≥ 0.50	0.30-0.80	10.00-12.50	0.80-1.20	0.25-0.35	70-86	50	17

CHAPTER A3: WELDING MATERIAL SPECIFICATION AND CONTROL

SECTION A3.1-WELDING MATERIAL SPECIFICATION AND CONTROL

1.0 SCOPE:

1.1. This chapter details out the welding material specification and controls at sites.

2.0 CONTENTS:

3.0 For welding consumables not covered in this chapter, relevant details may be obtained from the concerned Manufacturing Units.

Table-A3.1
WELD METAL CHEMICAL COMPOSITION

Electrode/ Consumable	SFA No.	Weight, %										Other Elements %[a]
		C	Mn	Si	P	S	Ni	Cr	Mo	V	Cu	
E 6010	5.1	0.20	1.20	1.00	NS	NS	0.30	0.20	0.30	0.08	NS	Combined Limit for Mn+Ni+Cu+Mo+V=1.75
E 6013	5.1	0.20	1.20	1.00	NS	NS	0.30	0.20	0.30	0.08	NS	
E 7018	5.1	0.15	1.60	0.75	0.035	0.035	0.30	0.20	0.30	0.08	NS	
E 7018-1	5.1	0.15	1.60	0.75	0.035	0.035	0.30	0.20	0.30	0.08	NS	
E 7018-A1	5.5	0.12	0.90	0.80	0.03	0.03	NS	NS	0.40-0.65	NS	NS	
E 8018-B2	5.5	0.05-0.12	0.90	0.80	0.03	0.03	NS	1.00-1.50	0.40-0.65	NS	NS	
E 9018-B3	5.5	0.05-0.12	0.90	0.80	0.03	0.03	NS	2.00-2.50	0.90-1.20	NS	NS	
E 9015-B91	5.5	0.08-0.13	1.20	0.30	0.01	0.01	0.80	8.00-10.50	0.85-1.20	0.15-0.30	0.04 - 0.25	
E9015-B92	5.5	0.08-0.15	1.20	0.60	0.020	0.015	1.0	8.0-10.0	0.30-0.70	0.15-0.30	0.25	W: 1.50-2.00; Nb: 0.02-0.08 B:0.006; Al: 0.04; N: 0.03-0.08
E9018-B23/ E9015-B23	5.5	0.04-0.12	1.00	0.60	0.015	0.015	0.5	1.9-2.9	0.30	0.15-0.30	0.25	W: 1.50-2.00; Nb: 0.02-0.10 B:0.006; Al: 0.04; N: 0.05
E 308	5.4	0.08	0.50-2.50	1.00	0.04	0.03	9.00-11.00	18.00-21.00	0.75	NS	0.75	
E 308-L	5.4	0.04	0.50-2.50	1.00	0.04	0.03	9.00-11.00	18.00-21.00	0.75	NS	0.75	

Table-A3.1 (Contd…)
WELD METAL CHEMICAL COMPOSITION

Electrode/ Consumable	SFA No.	Weight, %										Other Elements %[a]
		C	Mn	Si	P	S	Ni	Cr	Mo	V	Cu	
E 309	5.4	0.15	0.50-2.50	1.00	0.04	0.03	12.00-14.00	22.00-25.00	0.75	NS	0.75	
E 309-L	5.4	0.04	0.50-2.50	1.00	0.04	0.03	12.00-14.00	22.00-25.00	0.75	NS	0.75	
E 347	5.4	0.08	0.50-2.50	1.00	0.04	0.03	9.00-11.00	18.00-21.00	0.75	NS	0.75	Cb+Ta 8XC Min. to 1.00 Max.
E316	5.4	0.08	0.5-2.5	1.00	0.04	0.03	11.0-14.0	17.0-20.0	2.0-3.0	NS	0.75	
E2209-16	5.4	0.04	0.5-2.0	1.00	0.04	0.03	7.5-9.5	21.5-23.5	2.5-3.5	NS	0.75	N:0.08-0.20
ENiCrFe-3	5.11	0.10	5.0-9.5	1.00	0.03	0.015	59.0 min	13.0-17.0	NS	NS	0.50	Fe: 12.0; Ta+ Cb: 1.0-2.5; Ti: 1.0; others: 0.5
ENiCrFe-7	5.11	0.05	5.0	0.75	0.03	0.015	Rem	28.0-31.5	0.5	NS	0.50	Fe: 7.0-12.0; Ta+ Cb: 1.0-2.5; others: 0.5
ENi-CI	5.15	2.00	2.50	4.00	NS	0.03	85[d] min	NS	NS	NS	2.5[e]	Fe 8.0 Al 1.0 others Total 1.0
ENiFe-CI	5.15	2.00	2.50	4.00	NS	0.03	45[d]-60	NS	NS	NS	2.5[e]	Fe Rem[f] Al 1.0 others Total 1.0
ER70S-2	5.18	0.07	0.90-1.40	0.40-0.70	0.025	0.035	0.15	0.15	0.15	0.03	0.50[b]	Ti 0.05-0.15 Zr 0.02-0.12 Al 0.05-0.15
ER70S-A1	5.28	0.12	1.30	0.30-0.70	0.025	0.025	0.20	NS	0.40-0.65	NS	0.35	Others : 0.50
E8018-G	5.5	0.08	1.0-1.8	0.5	0.025	0.025	0.5-1.20	NS	0.5	NS	NS	

Table-A3.1 (Contd…)
WELD METAL CHEMICAL COMPOSITION

Electrode/ Consumable	SFA No.	Weight, %										Other Elements % [a]
		C	Mn	Si	P	S	Ni	Cr	Mo	V	Cu	
ER80S-B2	5.28	0.07-0.12	0.40-0.70	0.40-0.70	0.025	0.025	0.20	1.20-1.50	0.40-0.65	NS	0.35 [c]	Total other Elements 0.50
ER90S-B3	5.28	0.07-0.12	0.40-0.70	0.40-0.70	0.025	0.025	0.20	2.30-2.70	0.90-1.20	NS	0.35 [c]	Total other Elements 0.50
ER80S-D2	5.28	0.07-0.12	1.60-2.10	0.50-0.80	0.025	0.025	0.15	NS	0.40-0.60	NS	0.50 [c]	Total other Elements 0.50
ER90S-B9	5.28	0.07-0.13	1.20	0.15-0.30	0.01	0.01	0.80	8.00-10.50	0.80-1.20	0.15-0.23	0.20	Total other Elements 0.50
ER 308	5.9	0.08	1.00-2.50	0.30-0.65	0.03	0.03	9.00-11.00	19.50-22.00	0.75	NS	0.75	
ER 309	5.9	0.12	1.00-2.50	0.30-0.65	0.03	0.03	12.00-14.00	23.00-25.00	0.75	NS	0.75	
ER 309-L	5.9	0.03	1.00-2.50	0.30-0.65	0.03	0.03	12.00-14.00	23.00-25.00	0.75	NS	0.75	
ER316L	5.9	0.03	1.0-2.5	0.30-0.65	0.03	0.03	11.0-14.0	18.0-20.0	2.0-3.0	NS	0.75	---
ER 347	5.9	0.08	1.00-2.50	0.30-0.65	0.03	0.03	9.00-11.00	19.00-21.50	0.75	NS	0.75	Cb+Ta 10XC Min. to 1.0 Max.
ER2209	5.9	0.03	0.5-2.0	0.90	0.03	0.03	7.5-9.5	21.5-23.5	2.5-3.5	NS	0.75	N:0.08-0.20

Table-A3.1 (Contd…)
WELD METAL CHEMICAL COMPOSITION

Electrode/ Consumable	SFA No.	Weight, %										Other Elements % [a]
		C	Mn	Si	P	S	Ni	Cr	Mo	V	Cu	
ERNiCr-3	5.14	0.10	2.5-3.5	0.50	0.03	0.015	67.0 min	18.0-22.0	NS	NS	0.50	Fe: 3.0; Cb+Ta: 2.0-3.0; Ti: 0.75; Other: 0.5
ERNiCrFe-7A	5.14	0.04	1.0	0.50	0.02	0.015	Rem.	28.0-31.5	0.50		0.30	Fe: 7.0-11-0; Cb+Ta: 0.5-1.0; Ti: 1.0; Other: 0.5; Co: 0.12; Al: 1.10
YT 304H	--	Proprietary GTAW rod for Super 304H										
THERMANIT 304H Cu	--											
TGS2CW	--	Proprietary GTAW rod for T23										
YT-HCM2S												
2CrWV-TIG	--											
9CRWV TIG	--	Proprietary GTAW rod for Gr.92										
THERMANIT MTS 616	--											

TABLE – A3.1 (Contd…)
WELD METAL CHEMICAL COMPOSITION

Notes:

a) Other elements listed without specified values shall be reported, if intentionally added. The total of these latter unspecifiedelements and all other elements not intentionally added shall not exceed 0.50%.

b) The maximum weight percent of copper in the rod or electrode due to any coating plus the residual copper content in the steel shall be 0.50.

c) The maximum weight percent of copper in the rod or electrode due to any coating plus the residual copper content in the steel shall comply with the stated value.

d) Nickel plus incident Cobalt.

e) Copper plus incident Silver.

f) "Rem" stands for remainder.

g) Manufacturer's certification to have met the requirements of ASME Sec. II Part C is acceptable in cases where the chemical analysis are not reflected.

h) Single values are maximum.

i) NS – Not Specified

TABLE-A3.2
MECHANICAL PROPERTY REQUIREMENTFOR ALL-WELD METAL

Electrode	SFA No.	Tensile Strength Ksi / MPa	Yield Strength at 0.2% of Proof Stress, Ksi/ MPa	Elongation In 2 inch (50.8 mm) %
E6010	5.1	60 / 430	48 / 330	22
E6013	5.1	60 /430	48 / 330	17
E7018	5.1	70 / 490	58 / 400	22
E7018-1[a]	5.1	540	58 / 400	22
E7018-A1	5.5	70 / 490	57 / 390	22
E8018-G[b]	5.5	570	450	19
E8018-B2	5.5	80 /550	67 / 460	19
E9018-B3	5.5	90 /620	77 / 530	17
E9015-B91	5.5	90 /620	77 / 530	17
E9015-B92	5.5	90/620	77/530	17
E9018-B23	5.5	90/620	77/530	17
E308	5.4	80 / 550	-	35
E308L	5.4	75 / 520	-	35
E309	5.4	80 / 550	-	30
E309L	5.4	75 / 520	-	30
E347	5.4	75 / 520	-	30
E316	5.4	75/520	--	30
E2209	5.4	100/690	--	22
ENiCrFe-3	5.11	80/550	--	30
ENiCrFe-7	5.11	80/550	--	30
ENi-CI	5.15	40-65 / 276-448	38-60 / 268-414	3-6
ENiFe-CI	5.15	58-84 / 400 -579	43-63 / 294 -434	6-18

a. These electrodes shall meet the lower temperature impact requirement of average minimum. (27 Joules at – 45° C) and other properties at 620±20°C for 300 minutes.

b. These electrodes shall meet the impact requirement of average minimum (20 Joules at + 25° C) and other properties at 550±10°C for 60 minutes.

Table- A3.2 (Contd...)

MECHANICAL PROPERTY REQUIREMENT FOR ALL-WELD METAL

Electrode	SFA No.	Tensile Strength Ksi / MPa	Yield Strength at 0.2% of Proof Stress, Ksi / MPa	Elongation In 2 inch (50.8 mm) %
ER70S-6	5.18	70/480	58/400	22
ER70S-A1	5.28	75/515	58/400	19
ER80S-B2	5.28	80 / 550	68 / 470	19
ER90S-B3	5.28	90 / 620	78 / 540	17
ER80S-D2	5.28	80 / 550	68 / 470	17
ER90S-B9	5.28	90 / 620	60 / 410	16
ER308	5.9	These values are not required in the test certificate		
ER308L	5.9			
ER309	5.9			
ER309L	5.9			
ER347	5.9			
ER316	5.9			
ER2209-16	5.9			
ERNiCr-3	5.14	80/550	--	
ERNiCrFe-7A	5.14	85/590	--	

NOTE:

a) Single values are minimum.

b) Manufacturer's certification to have met the requirements of ASME-Section II Part C is acceptable in cases where the mechanical properties are not reflected.

c) 1Ksi is approximately equal to 6.89 MPa.

Section A3.2- Receipt Inspection of Welding Electrodes / Filler Wires

1.0 All electrodes/filler wires received at site stores shall be segregated for type and size of electrode.

2.0 Ensure that electrode packets received are free from physical damage.

3.0 Where electrodes are damaged, the same shall be removed from use.

4.0 Only electrodes identified in the “list of approved vendors of welding electrodes” shall be accepted.

5.0 Where filler metals are supplied by manufacturing unit, inspect for damages, if any.

6.0 Ensure availability of relevant test certificates. Refer tables of chemical compositions and mechanical properties for acceptance.

7.0 Endorse acceptance/rejection on the test certificate.

Section A3.3- Storage & Identification of WeldingElectrodes/Filler Wires

1.0 SCOPE:

1.1 This procedure is applicable for storage of welding electrodes/filler wires used at sites.

2.0 PROCEDURE:

2.1 Only materials accepted (based on receipt inspection) shall be taken into account for storage.

2.2 STORAGE FACILITY:

2.2.1 The storage facility shall be identified.

2.2.2 Access shall be made available to authorized personnel.

2.2.3 The storage area shall be clean and dry.

2.2.4 Steel racks may be used for storage. Avoid usage of wooden racks for.storing inside the storage room.

2.2.5 Maintain the temperature of the storage facility above the ambient temperature. This can be achieved by the use of appropriate heating arrangements.

2.3 The electrodes/filler wire shall be segregated and identified for

a. Type of electrode e.g. E7018.
b. Size of electrode e.g. Dia. 3.15 mm.

2.4 Identification of filler wires:

2.4.1 On receipt of GTAW filler wires, check AWS No. or brand name embossed and retain the same identification throughout.

Section A3.4-Drying and Holding of Welding Electrodes

1.0 SCOPE:

1.1 This section details activities regarding drying and holding of welding electrodes used at sites.

2.0 PROCEDURE:

2.1 While handling, avoid contact of oil, grease with electrodes. Do not use oily or wet gloves.

2.2 It is recommended that not more than two days' requirements electrodes are dried.

3.0 GTAW Filler Wires:

3.1 These wires do not require any drying.

4.0 Covered Electrodes:

4.1 Drying and holding :

4.1.1 Identify drying oven and holding oven.

4.1.2 They shall preferably have a temperature control facility upto 400°C for drying oven and 200°C for holding oven.

4.1.3 A calibrated thermometer shall be provided for monitoring temperature.

4.2 On opening a packet of electrodes, segregate and place them in the drying oven. Mix-up of electrodes shall be avoided.

4.2.1 After loading, raise the drying oven temperature to the desired range as per table in 4.2.5.

4.2.2 Note the time when the temperature reaches the desired range. Maintain this temperature for the duration required as per Table in 4.2.5.

4.2.3 On completion of drying, the electrodes shall be transferred to holding oven immediately and maintained at minimum temperature of 150°C till issue.

4.2.4 The electrode shall not be subjected to more than three cycles of drying.

4.2.5 Maintaina register containing following details:

Sl. No.	Date	AWS number/Specification	Batch No./Size	Dia.	Qty.	Drying temperature Start time	Drying Temperature end time	Remarks

Drying and Holding Parameters

AWS Classification	Drying (*)		Minimum Holding Temperature °C (@)
	Temperature °C	Time (Hours)	
E7018	250 - 300	2	150
E7018-1	250 - 300	2	150
E7018-A1	250 - 300	2	150
E8018-G	250 - 300	2	150
E8018-B2	250 - 300	2	150
E9018-B3	250 - 300	2	150
E9018-B23	250 - 300	2	150
E9015-B91	250 - 300	2	150
E9015-B92	250 - 300	2	150
E308, E309, E310 E316& E347	250 - 300	1	150
ENiCrFe-3	250 - 300	2	150
ENiCrFe-7	250 - 300	2	150

Note: (*) - Guideline has been given however, supplier's recommendations shall be followed.

(@) - Maintain the temperature in the oven till issue.

4.2.4 After issue, maintain the electrodes in a portable oven at a minimum temperature of 65°C till use. This is not applicable for E6013 (Rutile) electrodes, however the following instruction shall be followed for E6013 electrodes:

(1) Rutile electrodes require some moisture in the coating and they would not require drying. If they become damp, re-drying at around 120 to 150°C for 1 hour will be sufficient.

(2) These electrodes with potassium silicate binder can be used on both DCEP/DCEN polarities and on AC. E6013 electrodes generally have better arc striking and stability characteristics with an easily detachable slag.

4.3 Unused, returned electrodes shall be segregated and reused only after repeating drying and holding cycles.

Section A3.5- Selection and Issue of Welding Electrodes / Filler Wires

1.0 SCOPE:

1.1. This procedure details methods for selection and issue of welding electrodes/filler wires for site operations.

2.0 PROCEDURE:

2.1 Selection:

2.1.1 The type of filler wire/electrode for welding shall be based on the details given in the contract documents like Field Welding Schedule, drawings, Welding Procedure Specifications as supplied by the concernedmanufacturing units.

2.1.2 Where not specified by the manufacturing units, selection shall be based on the tables enclosed (Table A3.3 to Table A3.7. as applicable).

2.1.3 Where electrodes/ filler wires are not covered in the documents mentioned in 2.1.1 and 2.1.2, refer to the concernedmanufacturing units.

2.2 Issue:

2.2.1 Issue of welding electrodes / filler wires shall be based on authorised welding electrodes issue voucher.

2.2.2 It is recommended to restrict quantity issued to not more than 4 hours' requirements.

2.2.3 Re-dried low hydrogen electrodes shall be carried to the work spot in a portable oven.

2.2.4 Maintain the temperature in the portable oven at the work spot above 65°C.

2.2.5 Unused electrodes shall be segregated and reused only after repeating drying and holding cycles.

Table- A3.3
SELECTION OF GTAW FILLER WIRE, SMAW ELECTRODE FOR BUTT WELDS IN TUBES, PIPES AND HEADERS

Material	Welding Process	P1 Gr 1/ P1 Gr 2	P3 Gr 1	P4 Gr 1	P5A Gr 1	P15 E Gr 1	T23	T92/P92	P8	P8 SA 213 UNS S 30432	DIN14MoV6 3 or equivalent
P1 Gr 1	GTAW	ER 70S-A1									
P1 Gr 2	SMAW	E7018-1 Note 1									
P3 Gr 1	GTAW	ER 70S-A1	ER 70S-A1								
	SMAW	E7018-1	E7018-A1								
P4 Gr 1	GTAW	ER 70S-A1	ER 70S-A1	ER 80S-B2							
	SMAW	E7018-1	E7018-A1	E8018-B2							
P5A Gr 1	GTAW	ER 70S-A1	ER 70S-A1	ER 80S-B2	ER 90S-B3	ER 90S-B3	ER90S-B3				
	SMAW	E7018-1	E7018-A1	E8018-B2	E9018-B3	E9018-B3	E9018-B3				
P15 E Gr.1 Gr.91	GTAW					ER90S-B9	TGS2CW/ 2CrWVTIG/ YT-SCM2S	ER90S-B9			
	SMAW					E9015-91	E9018-B23	E9015-B91			
T23	GTAW						TGS2CW/ 2CrWVTIG/YT-SCM2S	TGS2CW/ 2CrWVTIG/ YT-SCM2S			
	SMAW						E9018-B23	E9018-B23			

Table- A3.3 (Contd…)

Material	Welding Process	P1 Gr 1 P1 Gr 2	P3 Gr 1	P4 Gr 1	P5A Gr 1	P15 E Gr 1	T23	T92/P92	P8	P8 SA 213 UNS S 30432	DIN14MoV63 or equivalent
P15 E Gr.1 Gr.92	GTAW							9CrWV-TIG/ Themanit-MTS616			
	SMAW							E9015-B92			
P8	GTAW			ERNiCr3	ERNiCr3	ERNiCr3	ERNiCr3	ERNiCrFe7A	ER347		
	SMAW			ENiCrFe3	ENiCrFe3	ENiCrFe3	ENiCrFe3	ENiCrFe7	E347		
P8 SA 213 UNS S30432	GTAW									YT304H/ THERMANIT 304H Cu	
DIN14MoV63 or equivalent	GTAW				ER 90S-B3						ER90S-B3
	SMAW				E9018-B3						E9018-B3

Note-1: E7018-A1 for P1 Gr2 + P1 Gr2 when PWHT is involved.

Table- A3.4
SELECTION OF ELECTRODES FOR WELDING ATTACHMENTS TO TUBES

Tube Material	Attachment Material			
	P1 Group 1	**P4 Group 1**	**P5A Group 1**	**P8**
P1 Group 1 P1 Group 2	E 7018	E 7018	E 7018	E 309
P3	E 7018-A1	E 7018-A1	E 7018-A1	E 309
P4 Group 1	E 8018-B2	E 8018-B2	E 8018-B2	E 309
P5A Group 1	E 9018-B3	E 9018-B3	E 9018-B3	E 309
P8 including SA 213 UNS S30432		E 309	E 309	E 347
P15E Gr.1 (Gr. 91/92)			E9018-B3	ENiCrFe-3
SA213T23			E9018-B3	ENiCrFe-3

Table- A3.5
SELECTION OF ELECTRODES, PREHEAT, PWHT
FOR ATTACHMENT TO ATTACHMENT WELDS
(Seal Bands, High Crown Bars, End Bars, End Bar Lifting Lugs and Collector Plates etc.)

Material (Note 2)	Welding Requirements	P1	P3	P4	P5 A	P8 Group 1	P8 Group 2	P 15E / 1
P1	Electrode Preheat PWHT	E7018 Nil Nil	-	E 7018 150°C 650 – 670°C	-	-	-	-
P3	Electrode Preheat PWHT	E7018 150°C (Note 1) For Thickness>16mm: 620-650°C	E7018-A1 150°C For Thickness>16mm: 620-650°C	-	-	-	-	-
P4	Electrode Preheat PWHT	E7018 150°C (Note 1) For Thickness>13mm: 650-670°C	E7018-A1 150°C For Thickness>13mm: 650-670°	E8018-B2 150°C (Note 1) For Thickness>13mm: 650-670°C	-	-	-	-
P5 A	Electrode Preheat PWHT	-	-	E8018-B2 150°C (Note 1) For Thickness>13: 680-710°C	E9018-B3 150°C (Note 1) For Thickness>13:680-710°C	-	-	-
P8	Electrode Preheat PWHT	E309 Nil Nil	-	E309 Nil Nil	E309 Nil Nil	E347 Nil Nil	E309 Nil Nil	-
P 15E/ 1	Electrode Preheat PWHT	-	-	-	E9018-B3 220°C 730-760 °C	ENi Cr Fe3 220°C (only on P15E side) 730-760 °C	ENi Cr Fe3 220°C (only on P15E side) 730-760 °C	E9015-B91 220°C 740-770 °C

Note – 1 : Preheat is not required for P3/P4up to 16 mm& for P5 A up to 13 mm, if PWHT is carried out.
Note - 2: For load carrying members, PWHT is required irrespective of thickness.

Table- A3.6
SELECTION OF ELECTRODES FOR WELDING NOZZLE ATTACHMENTS, HAND HOLE PLATE, RG PLUG ETC. TO HEADERS, PIPES

Header, Pipe Material	Attachment Material					
	P1	**P3**	**P4**	**P5 A**	**P15 E/1**	**P8**
P1	E7018-1	E7018-1	E7018-1	-	-	ENiCrFe3
P4	E7018-1	E7018-A1	E8018-B2	E8018-B2	-	-
P5 A	-	-	E8018-B2	E9018-B3	E9018-B3	ENiCrFe3
P15 E/1	-	-	-	E9018-B3	E9015-B91	ENiCrFe3
DIN 14MoV63 or equivalent	-	-	-	E9018-B3	-	ENiCrFe3

Table – A3.7
SELECTION OF ELECTRODES FOR NON-PRESSURE PARTS (INCLUDING STRUCTURES) (NOTE 1)

Material	SMAW Electrodes	SAW Wires	CO_2 Wires
P1 + P1 (IS2062 E250)	For butt welds ≤ 6 mm: E 6013 (only for Ducts) > 6 mm: E 7018 For fillets ≤8 mm : E 6013 >8 mm: E 7018	EL 8 EM 12 K EL 8 EM 12 K	E 71 T - 1
Corten Steel + P1	E 6013 or E 7018	EM 12 K	
Corten Steel + Corten Steel	E 8018 – B2	EB 2	E 81 T 1 – B2
IS2062 E350+E350/ E250	E7018-1	EM 12 K	NA
IS2062 E450+E450	E8018-G	EG	NA
SA 204 Gr.A	E7018-A1	NA	NA

Note 1: E 6013 Electrodes can be used for all non-load carrying welds of all thickness of IS 2062 plates up to 20 mm thickness and 8 mm fillets

TABLE- A3.8
A NUMBERS
CLASSIFICATION OF FERROUS WELD METAL ANALYSIS FOR PROCEDURE QUALIFICATION

A. No.	Types of Weld Deposit	Analysis, % (Note 1)					
		C	Cr	Mo	Ni	Mn	Si
1	Mild steel	0.20	–	–	–	1.60	1.00
2	Carbon-Molybdenum	0.15	0.50	0.40-0.65	–	1.60	1.00
3	Chrome (0.4% to 2%)-Molybdenum	0.15	0.40-2.00	0.40-0.65	–	1.60	1.00
4	Chrome (2% to 6%)-Molybdenum	0.15	2.00-6.00	0.40-1.50	–	1.60	2.00
5	Chrome (6% to 10.5%)-Molybdenum	0.15	6.00-10.50	0.40-1.50	–	1.20	2.00
6	Chrome-Martensitic	0.15	11.00-15.00	0.70	–	2.00	1.00
7	Chrome-Ferritic	0.15	11.00-30.00	1.00	–	1.00	3.00
8	Chromium-Nickel	0.15	14.50-30.00	4.00	7.50-15.00	2.50	1.00
9	Chromium-Nickel	0.30	19.00-30.00	6.00	15.00-37.00	2.50	1.00
10	Nickel to 4%	0.15	–	0.55	0.80-4.00	1.70	1.00
11	Manganese-Molybdenum	0.17	–	0.25-0.75	0.85	1.25-2.25	1.00
12	Nickel-Chrome-Molybdenum	0.15	1.50	0.25-0.80	1.25-2.80	0.75-2.25	1.00

Note 1: Single values shown above are maximum.

Table A3.9
F NUMBERS GROUPING OF ELECTRODES AND WELDING RODS FOR QUALIFICATION

	ASME Specification No.	AWS Classification No.
1	SFA-5.1	EXX20
1	SFA-5.1	EXX22
1	SFA-5.1	EXX24
1	SFA-5.1	EXX27
1	SFA-5.1	EXX28
1	SFA-5.4	EXXX(X)-26
1	SFA-5.5	EXX20-X
1	SFA-5.5	EXX27-X
2	SFA-5.1	EXX12
2	SFA-5.1	EXX13
2	SFA-5.1	EXX14
2	SFA-5.1	EXX19
2	SFA-5.5	E(X)XX13-X
3	SFA-5.1	EXX10
3	SFA-5.1	EXX11
3	SFA-5.5	E(X)XX10-X
3	SFA-5.5	E(X)XX11-X
4	SFA-5.1	EXX15
4	SFA-5.1	EXX16
4	SFA-5.1	EXX18
4	SFA-5.1	EXX18M
4	SFA-5.1	EXX48
4	SFA-5.4 other than austenitic and duplex	EXXX(X)-15
4	SFA-5.4 other than austenitic and duplex	EXXX(X)-16
4	SFA-5.4 other than austenitic and duplex	EXXX(X)-17
4	SFA-5.5	E(X)XX15-X
4	SFA-5.5	E(X)XX16-X
4	SFA-5.5	E(X)XX18-X
4	SFA-5.5	E(X)XX18M
4	SFA-5.5	E(X)XX18M1

Table- A3.9 (Contd…)
F NUMBERS GROUPING OF ELECTRODES AND WELDING RODS FOR QUALIFICATION

F.No.	ASME Specification No.	AWS Classification No.
5	SFA-5.4 austenitic and duplex	EXXX(X)-15
5	SFA-5.4 austenitic and duplex	EXXX(X)-16
5	SFA-5.4 austenitic and duplex	EXXX(X)-17
6	SFA-5.2	All classifications
6	SFA-5.9	All classifications
6	SFA-5.17	All classifications
6	SFA-5.18	All classifications
6	SFA-5.20	All classifications
6	SFA-5.22	All classifications
6	SFA-5.23	All classifications
6	SFA-5.25	All classifications
6	SFA-5.26	All classifications
6	SFA-5.28	All classifications
6	SFA-5.29	All classifications
6	SFA-5.30	INMs-X
6	SFA-5.30	IN5XX
6	SFA-5.30	IN3XX(X)
Aluminium and Aluminium-Base Alloys		
21	SFA-5.3	E1100
21	SFA-5.3	E3003
21	SFA-5.10	ER1100
21	SFA-5.10	R1100
21	SFA-5.10	ER1188
21	SFA-5.10	R1188
22	SFA-5.10	ER5183
22	SFA-5.10	R5183
22	SFA-5.10	ER5356
22	SFA-5.10	R5356
22	SFA-5.10	ER5554
22	SFA-5.10	R5554
22	SFA-5.10	ER5556

TABLE- A3.9 (Contd…)
F NUMBERS GROUPING OF ELECTRODES AND WELDING RODS FOR QUALIFICATION

F.No.	ASME Specification No.	AWS Classification No.
22	SFA-5.10	R5556
22	SFA-5.10	ER5654
22	SFA-5.10	R5654
23	SFA-5.3	E4043
23	SFA-5.10	ER4009
23	SFA-5.10	R4009
23	SFA-5.10	ER4010
23	SFA-5.10	R4010
23	SFA-5.10	R4011
23	SFA-5.10	ER4043
23	SFA-5.10	R4043
23	SFA-5.10	ER4047
23	SFA-5.10	R4047
23	SFA-5.10	ER4145
23	SFA-5.10	R4145
23	SFA-5.10	ER4643
23	SFA-5.10	R4643
24	SFA-5.10	R206.0
24	SFA-5.10	R-C355.0
24	SFA-5.10	R-A356.0
24	SFA-5.10	R357.0
24	SFA-5.10	R-A357.0
25	SFA-5.10	ER2319
25	SFA-5.10	R2319
Copper And Copper Alloys		
31	SFA-5.6	ECu
31	SFA-5.7	ERCu
32	SFA-5.6	ECuSi
32	SFA-5.7	ERCuSi-A

TABLE- A3.9 (Contd...)
F NUMBERS
GROUPING OF ELECTRODES AND WELDING RODS FOR QUALIFICATION

F.No.	ASME Specification No.	AWS Classification No.
33	SFA-5.6	ECuSn-A
33	SFA-5.6	ECuSn-C
33	SFA-5.7	ERCuSn-A
34	SFA-5.6	ECuNi
34	SFA-5.7	ERCuNi
34	SFA-5.30	IN67
35	SFA-5.8	RBCuZn-A
35	SFA-5.8	RBCuZn-B
35	SFA-5.8	RBCuZn-C
35	SFA-5.8	RBCuZn-D
36	SFA-5.6	ECuAl-A2
36	SFA-5.6	ECuAl-B
36	SFA-5.7	ERCuAl-A1
36	SFA-5.7	ERCuAl-A2
36	SFA-5.7	ERCuAl-A3
37	SFA-5.6	ECuNiAl
37	SFA-5.6	ECuMnNiAl
37	SFA-5.7	ERCuNiAl
37	SFA-5.7	ERCuMnNiAl
Nickel And Nickel Alloys		
41	SFA-5.11	ENi-1
41	SFA -5.11	ENiCrFe-3 & ENiCrFe-7A
41	SFA-5.14	ERNi-1
41	SFA-5.14	ERNiCr-3 & ENiCrFe-7A
41	SFA-5.30	IN61
42	SFA-5.11	ENiCu-7
42	SFA-5.14	ERNiCu-7
42	SFA-5.14	ERNiCu-8
42	SFA-5.30-7	IN60

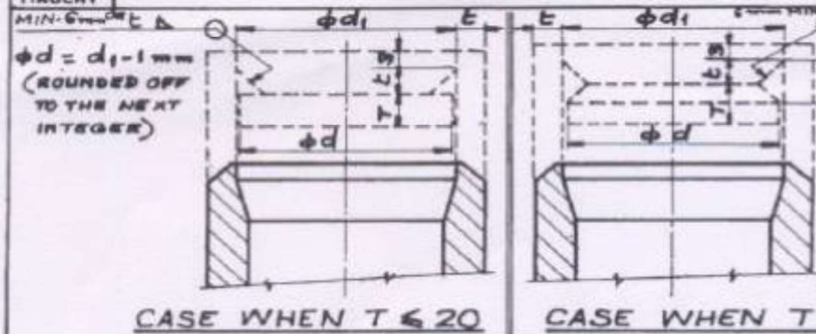
TABLE- A3.9 (Contd...)
F NUMBERSGROUPING OF ELECTRODES AND WELDING RODS FOR QUALIFICATION

F.No.	ASME Specification No.	AWS Classification No.
45	SFA5.11	ENiCrMo-11
45	SFA5.14	ERNiCrMo-1
45	SFA5.14	ERNiCrMo-8
45	SFA5.14	ERNiCrMo-9
45	SFA5.14	ERNiCrMo-11
45	SFA5.14	ERNiFeCr-1
Hard-Facing Weld Metal Overlay		
71	SFA-5.13	E Co Cr – A & All classifications
72	SFA-5.21	ER Co Cr – A & All classifications

SELECTION CHART FOR DUMMY END COVERS FOR HYDRAULIC TEST

THICKNESS 'T' = 0.5 $d_1\sqrt{P/f}$ (ISO-REC-R 831/1968) f = 1900 kg/cm²
ROUNDED OFF TO THE NEXT NEAREST RATIONALISED PLATE SIZE.

TIRUCHY



THICKNESS T mm	MATERIAL
6 to 20	BM-C20
21 to 63	BM-C16
ABOVE 63	ASTM-A36

THICKNESS OF DUMMY END COVERS FOR HYDRAULIC TEST (T)

TEST PRESSURE 'P' IN kg/cm² / φ OF TUBE/PIPE 'd' in mm	30	45	60	75	90	105	120	135	150	165	180	210	240	270	300	350
(MIN) 15	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
25	5	5	5	5	5	5	5	5	5	5	5	5	6	6	6	8
30	5	5	5	5	5	5	5	5	5	6	6	6	8	8	8	8
35	5	5	5	5	5	5	6	6	6	6	8	8	8	8	8	10
40	5	5	5	5	6	6	6	8	8	8	8	8	8	10	10	10
45	5	5	5	6	6	6	8	8	8	8	8	10	10	10	10	12
50	5	5	6	6	8	8	8	8	8	10	10	10	10	12	12	12
55	5	6	6	8	8	8	8	10	10	10	10	10	12	12	12	14
60	5	6	8	8	8	8	10	10	10	10	10	12	12	14	14	14
65	5	6	8	8	8	10	10	10	10	12	12	12	14	14	14	16
70	6	8	8	8	10	10	10	12	12	12	12	14	14	14	16	16
75	6	8	8	10	10	10	12	12	12	12	14	14	16	16	16	20
80	6	8	8	10	10	12	12	12	12	14	14	14	16	16	20	20
85	8	8	10	10	10	12	12	14	14	14	14	16	16	20	20	20
90	8	8	10	10	12	12	14	14	14	14	16	16	20	20	20	20
95	8	10	10	12	12	12	14	14	16	16	16	20	20	20	20	25
100	8	10	10	12	12	14	14	16	16	16	20	20	20	20	25	25
125	10	12	12	14	16	16	20	20	20	20	20	25	25	25	32	32
150	12	14	16	16	20	20	20	25	25	25	25	32	32	32	32	36
175	12	16	20	20	20	25	25	25	32	32	32	32	32	36	36	40
200	14	20	20	25	25	25	32	32	32	32	32	36	40	40	56	56
250	20	20	25	32	32	32	36	36	36	40	40	56	56	56	56	56
300	20	25	32	32	36	36	40	56	56	56	56	56	56	63	63	65
350	25	32	32	36	40	56	56	56	56	56	56	63	63	70	75	80
400	32	32	40	56	56	56	56	56	63	63	63	70	75	80	85	90
450	32	36	56	56	56	56	63	63	65	70	70	80	85	90	95	100
500	36	40	56	56	56	63	65	70	75	75	80	85	90	95	100	110

MICROFILMED ON
ROLL 00037 FRAME 528

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CHECKED BY

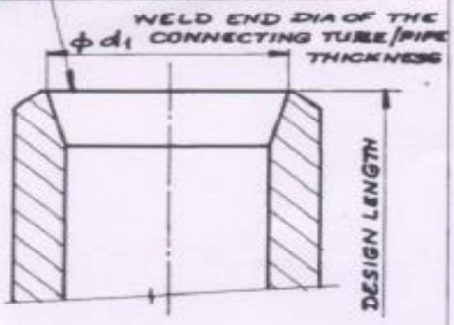
40-B-006-2897

TIRUCHY

NIPPLES - FREE END DETAILS.

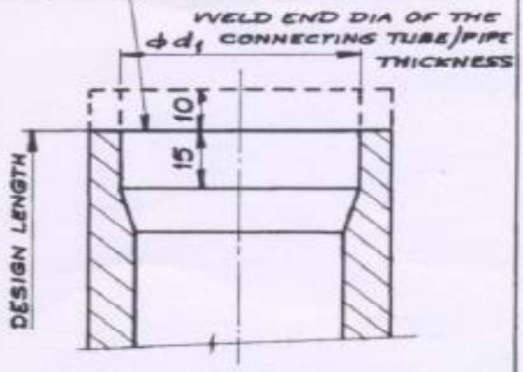
(FOR HEADERS ONLY.)

INDICATE STYLE NO 'D' - d_1 TO BPS NO 710004-74 (LAT. REV.)



STRAIGHT NIPPLES WHICH DO NOT REQUIRE ANY ALLO-WANCE. (NO SHOP HYD. TEST.)

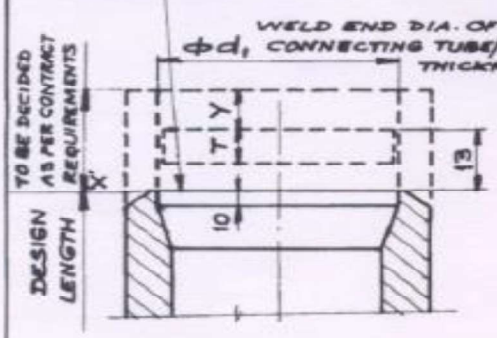
INDICATE STYLE NO 'C' - d_1 TO BPS NO 710004-74 (LAT. REV.)



STRAIGHT & BENT NIPPLES WHICH REQUIRE 10 mm ALLO-WANCE. (NO SHOP HYD. TEST.)

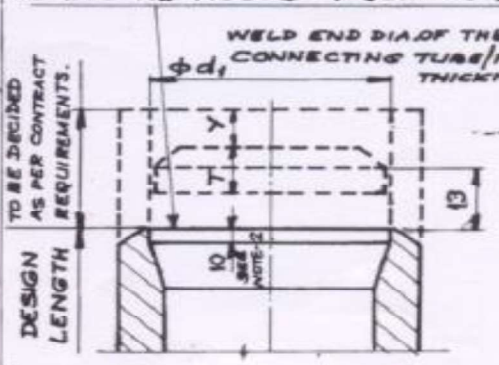
CASE WHEN $T \leq 20$

INDICATE STYLE NO 'C' - d_1 TO BPS NO 710004-74 (LAT. REV.)



CASE WHEN $T > 20$

INDICATE STYLE NO 'C' - d_1 TO BPS NO 710004-74 (LAT. REV.)



STRAIGHT & BENT NIPPLES THAT ARE HYD. TESTED AT SHOPS. (WHETHER THEY REQUIRE ANY ALLOWANCE OR NOT)

NOTE: 1. FOR VALUES OF T & Y FOR DIFFERENT SIZES OF NIPPLES AT VARIOUS TEST PRESSURES REFER DRG. NO 40-B-006-2897.

2. IN CASE THE THICKNESS REQUIRED FOR THE DUMMY END COVER IS MORE THAN 25 mm THE INSIDE HEIGHT OF MACHINING (WHICH IS NOW 10 mm) WILL BE INCREASED ACCORDINGLY.

PREPARED BY	CHECKED BY.

40-B-006-2899

CHAPTER A4 - PROCEDURE FOR WELDER QUALIFICATION

SECTION A4.1-PROCEDURE FOR WELDER QUALIFICATION FOR NON-IBR APPLICATIONS

1.0 SCOPE:

1.1 This chapter details the procedure for qualification of welder and performance monitoring.

2.0 CONTENTS:

SECTION A4.2-QUALIFICATION OF WELDER

1.0 BASE METAL:

1.1 For selection refer Tables provided in Chapter II (Base Materials) of this manual.

2.0 TEST COUPON:

2.1 Depending on the range to be qualified, choose the appropriate test coupon from Table – A6.1

2.2 For plate butt welds, details of edge preparation shall be as per Figure-A6.9.

2.3 For pipe butt welds, details of edge preparation shall be as per Figure-A6.10.

2.4 For structural tack welds, refer Figure-A6.1.

3.0 REQUIREMENT OF TESTS:

3.1 For Structural Tack Welders:

3.1.1 Break Test as per Figure-A6.2.

3.2 For Plate and Pipe Butt welders:

3.2.1 100 % Radiographic examination of test welds shall be carried out. Procedure and acceptance criteria shall be as per NDE Manual (BHEL:PS:NDEM – Latest)

4.0 ESSENTIAL VARIABLES :

4.1 Changes to the following variables require requalification.

4.1.1 **Process:** Example: Change from GTAW to SMAW or vice versa.

4.1.2 **Joint:** A change from one type of bevel to another. Example: 'V' bevel to 'U' bevel.

4.1.3 **Base Metal :**A change in thickness or pipe diameter beyond the limits as prescribed in Table- A6.1

4.1.4 **Filler Metal:**A change from one F number to another F-number, except as specified in Table-A6.1.

4.1.5 **Positions:**This procedure envisages qualification of welders to perform in all positions. Deviation to this is not recommended.

4.1.6 **Gas:**This procedure envisages test to pre-prescribed gas as for production welds. Deviation to this is not recommended.

4.1.7 **Electrical Characteristics:**

a) AC to DC and vice versa.

b) In DC, DCEN (Electrode Negative) to DCEP (Electrode Positive) and vice versa.

4.1.8 **Technique:** This procedure envisages only use of uphill progression technique.

Acceptance Criteria:

Structural Tack Welding:

- No cracks.
- No lack of fusion.
- Undercut not exceeding 1 mm.
- Not more than 1 porosity (max. diameter of porosity 2 mm).

Plate/Pipe Welding:

Visual Inspection:

a) No cracks.

b) No lack of fusion or incomplete penetration.

c) Not more than 1 porosity in a length of 100 mm of length of weld (max. porosity diameter 2mm).

5.0 VALIDITY:

5.1 When a welder meets the requirements of this procedure, the validity will be for a maximum of 2 years from the date of test, limited to validity specified by statutory authority, as applicable.The validity may be extended by one year each time, based on satisfactory performance, with sufficient back up records.

6.0 REQUALIFICATION :

6.1 Requalification is required for the following :

a) Where there is a specific reason to doubt the skill of the welder.

b) Due to non-engagement of the welder for a continuous period of 6 months.

7.0 RECORDS:

The welding in charge at site shall maintain the following records:

a) Record of Welder Performance qualification Test (as per Annexure V).

b) Register of qualified welders (employer-wise) containing the following details:

1) Name of welder.
2) Age.
3) Tested for pipe / tube / plate / tack.
4) Performance Test No.
5) Validity.
6) Welder Code.
7) Remarks.

The above register shall be updated for deletions also.Copies of welder identity card (including details as in 7 b and relevant variables qualified) and pertinent radiography reports.

8.0 ENCLOSURES :

1. Table –A6.1: Welder Qualification Requirements.
2. Record of Welder Performance Qualification Test.
3. Figure-A6.1: Structural Tack Weld Specimen.
4. Figure-A6.2: Break Test.
5. Figure-A6.3:Weld Positions.
6. Figure- A6.4 - 6G position
7. Figure- A6.5 - Flat position
8. Figure- A6.6 - Vertical position
9. Figure- A6.7 - Horizontal position
10. Figure- A6.8 - Overhead position
11. Figure-A6.9: Plate Butt Weld Specimen.
12. Figure-A6.10: Pipe Butt Weld Specimen

ANNEXURE - V: RECORD OF WELDER PERFORMANCE QUALIFICATION TEST

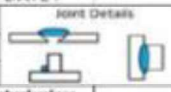
WELDER/TACK WELDER QUALIFICATION TEST RECORD -NON IBR					
Site :			Test Record No. :		Affix welder photo
Contractor Name :			DATE :		
NAME Sri.			Joint Details 		
ID NO :					
WPS No. :		Rev :			
Variables			Recorded Actual values used in Qualification		Qualification Range
Process / Type					
Electrode (Single or Multiple)					
Current / Polarity					
Position					
Weld Progression					
Backing					
Material / Specification			to		
Thickness : (Plate)					
Groove					
Fillet					
Thickness : (Pipe / Tube)					
Groove					
Fillet					
Diameter : (Pipe)					
Groove					
Fillet					
Filler Rod / Electrode					
SFA No					
AWS Class					
F.No					
Gas / Flux Type :					
Pre-heat temp :		Inter-pass Temp :		Post-heat Temp :	
VISUAL INSPECTION					
ACCEPTABLE :	YES	or	NO	DATE :	
Guided Bend Test Results					
Type	Result		Type		Result
Fillet Test Results					
Apperance				Fillet Size	
Fracture Test Root Penetration				Macroetch	
Inspected by				Test Number	
Organization				Date	
RADIOGRAPHIC TEST RESULTS					
Report No/Date		Result		Report No/Date	Result
Reviewed by				Reviewer Level :	
NDT Company Name :				Date	
We certify that the statement in this record is correct and that the test weld were prepared, welded and tested in accordance with requirements.					
This is valid upto					
Contractor :			Signature :		Date :
BHEL :			Signature :		Date :
Customer :			Signature :		Date :

TABLE – A6.1
WELDER QUALIFICATION REQUIREMENTS (FOR NON-IBR APPLICATIONS)

Sl. No.	Test For	Base[6] Metal Note 1	Test Coupon Dimension OD, t	Electrode[6] to be used Note 2, 4	Weld Positions	Reference Figure	Range Qualified Dia. & T	Position Qualified	Electrode Qualified Note 2, 4
1	Structural tack	P1 Gr 1	t=10mm or 12mm	(E6013) F2 (E7018) F4	3F&4F 3F&4F	Fig. A6.1 A6.2 & A6.3	T-Unlimited T-Unlimited	All All	F2, F1 F4 & Below
2	Plate Welder (Structural)	- do -	t≥25mm t<25mm	F4 F4	3G & 4G 3G & 4G	Fig.A6.7 & A6.8	T≥3.0 mm* T>3.0 mm*≤2t	All All	F4 & Below F4 & Below
3	Plate Welder (Other than structural)	- do -	t≥13mm t<13mm	F4 F4	2G, 3G & 4G 2G, 3G & 4G	Fig.A6.6 , A6.7 & A6.8	T-Unlimited OD≥600mm T≤2t OD≥600mm	All All	F4 & Below F4 & Below
4	Pipe/Tube Welder	- do -	OD<25mm OD≥25mm &≤73mm OD>73mm t<13mm t≥13mm	F4 F4 F4 F4 F4	6G 6G 6G 6G 6G	Fig.A6.4	Test piece Dia.& above 25mm & above 73mm & above T≤2t T-Unlimited	All All All All All	F4 & Below F4 & Below F4 & Below F4 & Below F4 & Below

* Also qualifies for welding fillet welds on material of unlimited thickness.

TABLE – A6.1 (contd...)

NOTES:

1. For P grouping refer Chapter II.
2. For F grouping refer Chapter III.
3. Base material limitation:
   a. Where test coupons belong to P1 thro' P15E, welder is qualified for base materials P1 thro' P15E.(ASME Sec IX QW 423, Alternate base material for welder qualification)

      It means, if a welder is qualified with carbon steel material, he is also qualified for alloy steel and vice versa.
   b. Use appropriate F group electrodes.
4. Qualification in one F number, qualifies for that F-number only, except as stated below in A, B, C & D.
   A. Qualification in F4 qualifies for F4 and below.
   B. Qualification in F5 qualifies for F5 only.
   C. Qualification in any of F41 thro' F45 qualifies for F41 thro' F45.
   D. For non-ferrous materials, the base materials shall be typical of production material and appropriate filler materials shall be selected. Qualification is limited to the base material, process and filler F group. Diameter and thickness limitations apply as per Table –A6.1

   OD = outer diameter, t = thickness of test coupon; T = thickness qualified.
5. Where qualification is for GTAW followed by SMAW, the welder is also qualified up-to 6 mm thickness by GTAW process.
6. Base material indicated is carbon steel; for other base materials, corresponding electrodes are to be chosen. Also for GTAW process, the corresponding filler wire should be chosen.

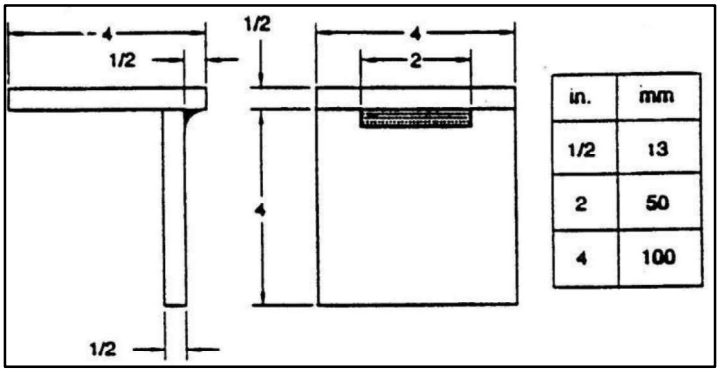


Figure A6.1 – Structural Tack Weld Specimen

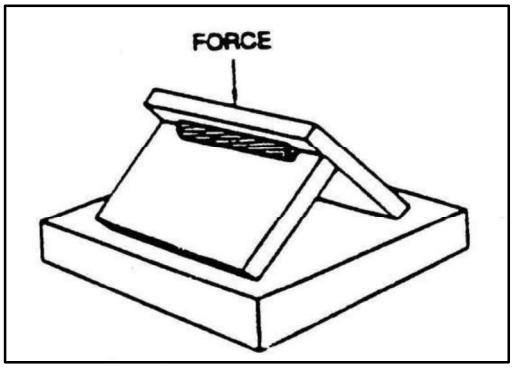


Figure A6.2 – Break Test

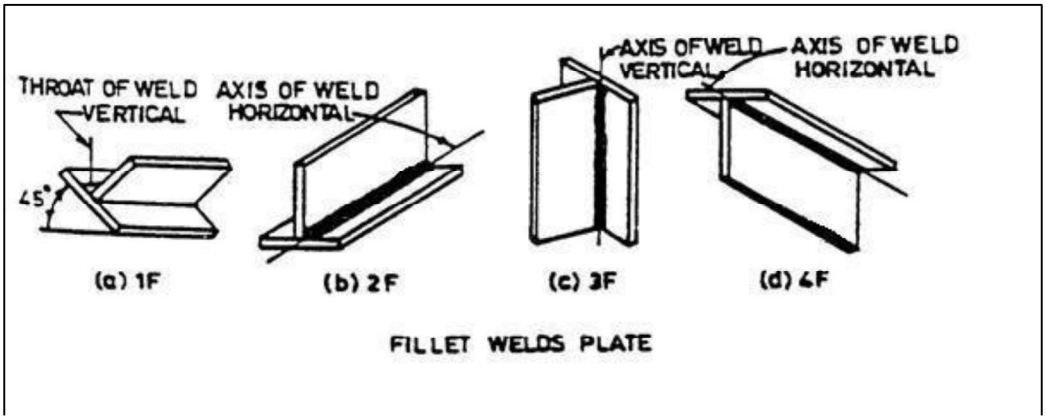


Figure A6.3 - WeldPositions

SECTION A4.3-PROCEDURE FOR WELDER QUALIFICATION FOR IBR APPLICATIONS

1.0 SCOPE

1.1 These requirements shall apply to testing of welders/welding operators engaged in the manufacture and welding connected with sitefabrication, erection and repair of boilers and piping of ferrous material under the purview of IBR.

2.0 DEFINITION

Welder: one who performs manual or semiautomatic welding.

3.0 ENGAGING OF CERTIFIED WELDERS

All welders engaged on welding of boilers or piping under fabrication, erection and repair at site shall possess a valid certificate as required byIBR, as per Form XIII issued by the Competent Authority under IBR.

4.0 QUALIFICATION TEST AND ISSUE OF CERTIFICATE

Every welder shall be duly tested and qualified at site to the satisfaction of BHEL/Customer.Every welded test piece for the examination of welders/welding operator shall be stamped by BHEL with an identification mark on either side of the weld. After satisfactory completion of the tests, BHEL shall issue a Certificate/ID Card to each Qualified Welder as per the Format given in Figure no.A6.9.

4.1 Each welder shall havebasic knowledge on the following:

i. Weld edge preparation
ii. Working of welding equipment.
iii. Properties of material to be welded – cold and hot working, thermal conductivity, fusion point, oxidation (for welders engaged in alloy steel welding).
iv. Electro-technical principles viz. kinds of current, striking arc voltage, welding arc voltage, etc.
v. Weld defects, their causes and prevention.
vi. Electrodes for different types of materials, welds and joints in different positions.

4.2 MATERIAL FOR TESTS – The material of plates, tubes, pipes and electrodes used for these tests shall conform to the requirements given below:

4.2.1 TEST WELDS FOR QUALIFICATION

(a) PLATE WELDING –

i. One weld joint of two pieces of boiler quality plates with double ‘V’ ordouble ‘U’ grooves over a minimum length of 300 mm shall be made in the following positions (size of plates to be welded being not less than 229 mm x 381 mm x 16 mm each):

(1) Flat position (figure A6.5) - Plate in a horizontal plane with the weld metal deposited from above.

(2) Horizontal Position (figure A6.6) – Plate in a vertical plane with the axis of the weld horizontal.

(3) Vertical Position (figure A6.7)- Plate in a vertical plane with the axis of the weld vertical

(4) Overhead Position (figure A6.8) – Plate in a horizontal plane with the weld metal deposited from underneath.

Qualification in Horizontal position shall automatically qualify Flat position. Qualification in Vertical position shall automatically qualify Flat and Horizontal positions. Also, qualification in Overhead position shall automatically qualify Flat, Horizontal and Vertical positions.

(b) For Pipe Welding –6G-Position:

Tube/Pipe with its axis inclined at 45 Deg. to horizontal. Welding shall be done without rotating the Tube/ pipe. Refer FigureA6.4.

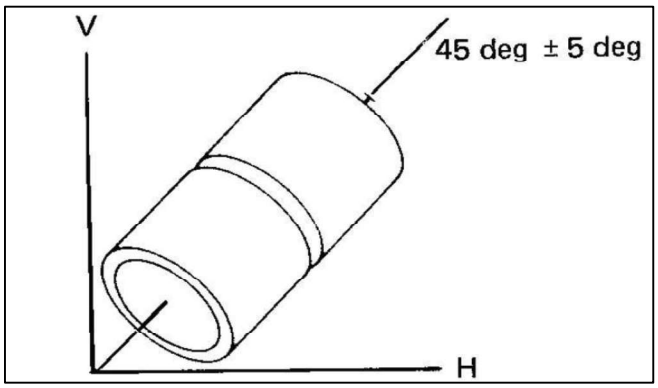


Figure A6.46G-Position

5.0 VALIDITY OF CERTIFICATE

a) Certificate issued to a welder shall remain valid for a period of twenty-four months from the date of issue, provided that the welder has, subsequent to the test, been continuously (gap not more than six months) employed on the class and type of work for which he is qualified.

b) The certificate may be extended, after the validity period, for another twenty-four months after conducting the re-qualification tests in-line with the initial Qualification tests.

c) In case of unsatisfactory performance of the Certified Welder as observed by the site engineer, the welder shall be re-qualified as per the requirements prior to engaging in subsequent welding works.

d) A welder qualified for a type and process of higher grade of steel can be allowed to weld the lower grade of steel.

e) A welder qualified on groove weld shall automatically qualify for fillet and socket welds.

6.0 EXAMINATION OF TEST SPECIMENS FOR QUALIFICATION TESTS

(a) The test specimens shall be visually examined as per Cl 6.0 of Chapter A7 of this Manual.

(b) After visual examination, the test specimen shall be subjected to radiographic examination as per the requirements specified in NDE Manual (BHEL:PS:NDEM-Latest).

7.0 MAINTENANCE OF RECORDS

Records of Qualified welders shall be maintained by the site engineer till the closure of the project. At the time of project closure, these records shall be handed over to the customer, if required by the Contract.

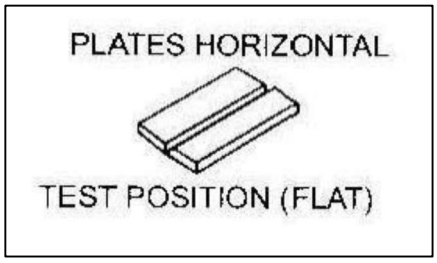


Figure A6.5Flat position

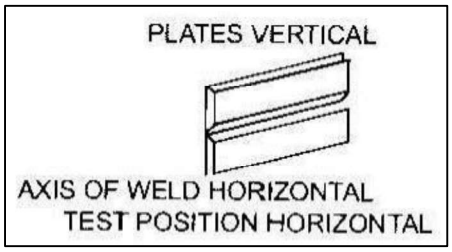


Figure A6.6Horizontal Position

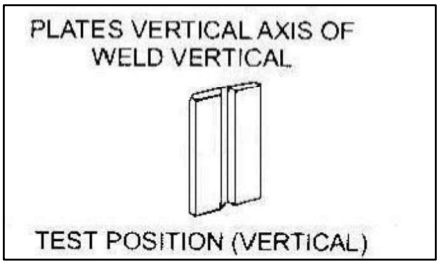


Figure A6.7Vertical Position

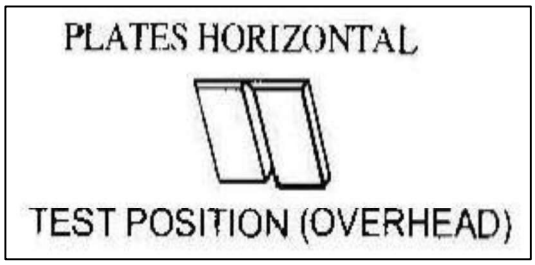


Figure A6.8Overhead Position

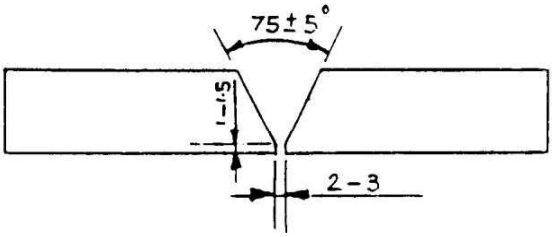
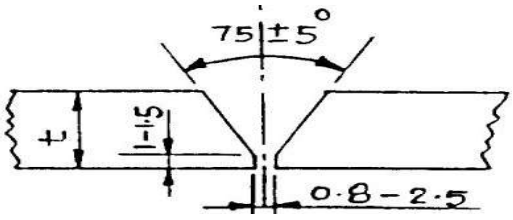
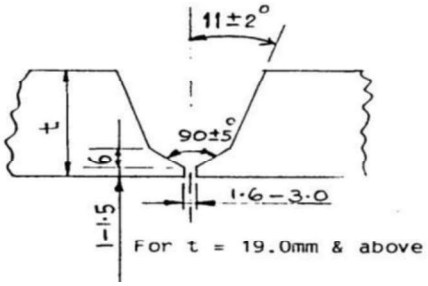


Figure A6.9- Plate butt weld specimen





(A) for T upto 19 mm **(B) For T = 19.0mm &Above**

Figure – A6.10 – Pipe Butt Weld Specimen

WELDER PERFORMANCE QUALIFICATION (WPQ)- For IBR

Affix the Welder Recent Photo

Performance Test No. : _____ **Date :** _____

Welder's Name : _____ ID No. : _____

Contractor : _____

Test Description

Identification of WPS followed _____ Type : _____

Test Coupon(TC) /Production Weld (PW): _____ Welding process(es) used : _____

Specification of base metal (s) _____ Thickness : _____

Testing Conditions and Qualification Limits

Welding Variables	Actual Values	Range Qualified
Backing (metal, weld metal, double welded, flux)		
Pipe Diameter		
Base metal P-No or Code case to P.No or Code case		
Filler metal or Electrode SFA No		
Filler metal or Electrode Classification		
Filler metal or Electrode F.Number		
Deposit thickness for each process		
Position Qualified		
Vertical progression (Uphill or downhill)		
Inert gas backing for GTAW		
Current type / polarity		

RESULTS

Guided Bend Test :

Type	Result	Type	Result	Type	Result
N.A	N.A	N.A	N.A	N.A	N.A
N.A	N.A	N.A	N.A	N.A	N.A

Visual examination results ACCEPTABLE

Radiographic test results _____ Lab.Name _____

Fillet Weld - Fracture test _____ Length & %age of defects _____

Macro examination _____ Fillet size _____

Concavity/convexity _____

Welding test conducted by _____

Welding test witnessed by _____

We certify that the statements in this record are correct and that the test coupons were prepared, welded and tested in accordance with the requirements.

This is valid up to _____

CONTRACTOR	BHEL
Name :	
Signature :	
Date :	
Engineer	**Erection Engineer**

Figure A6.11: BHEL issued Welder Qualification Certificate

SECTION A4.4-WELDER PERFORMANCE MONITORING

1.0 PURPOSE:

1.1 This procedure deals with monitoring the performance of welders engaged at sites. This procedure is applicable where radiography is performed.

2.0 PROCEDURE:

2.1 The welder performance shall be monitored on a calendar month basis.

2.2 Extent of radiography shall be representative of weekly outputs of the welder.

2.3 Quantum of radiography shall be as per contractual requirements.

2.4 Evaluation of welds radiographed shall be as per NDE manual or other documents as specifically applicable.

2.5 **Welder performance evaluation:**

2.5.1 **For welds having diameter≤ 88.9 mm:**

2.5.1.1 The percentage of defects shall be calculated as a percentage of number of unaccepted welds to those radiographed.

2.5.1.2 Upto and including 5% defects: Performance is satisfactory else unsatisfactory.

2.5.2 **For welds having diameter>88.9 mm and plate welds:**

2.5.2.1 The percentage of defects shall be calculated as a percentage of length of defects to the length radiographed.

2.5.2.2 Upto and including 2.5% defects: performance is satisfactory else unsatisfactory.

2.6 When a welder gives unsatisfactory performance for a continuous period of 3 months, he shall be re-qualified.

2.6..1 Requalification of welder shall be called for when there is a specific reason to question his ability to make acceptable welds. This shall override requirements of clause 2.6.

2.7 Welds produced during any month shall be radiographed and evaluated latest by 10th of the succeeding month.

2.7..1 Under circumstances when clause 2.7 is not satisfied for any particular welder, he may be disengaged from the job till such time his performance is evaluated for the month in study.

2.7..2 Site in-charge may waive the restriction imposed in 2.7.1reviewing the situations for non-compliance with Cl.2.7 and may allow engagement of the welder in question for a period not exceeding one successive month to the month in study.

3.0 RECORDS:

3.1 Welding in-charge shall prepare and maintain Welder Performance Records, welder-wise as per the Annexure VI.

ANNEXURE VI: WELDERS PERFORMANCE MONITORING RECORD

WELDERS PERFORMANCE MONITORING RECORD - MONTH/YEAR :						
	Dia ≤ 88.9 mm (Note -1)			Dia > 88.9mm (Note-2)		
Welder Code	No of joints RT taken	No of defective joints	%age of defects	Length Radiographed	Length of defects	%age of defects

Note : 1. Upto and including 5% defects., performance is satisfactory else unsatisfactory.
2. Upto and including 2.5% defects, peformance is satisfactory else unsatisfactory.

CHAPTER – A5
INSPECTION OF WELDING

1.0 SCOPE:

1.1 This procedure provides details for performing visual inspection of weld fit-ups, welding in progress and completed welds.

2.0 REFERENCE:

2.1 Contract drawings.

2.2 Field Welding Schedule (supplied by Units) or equivalent.

2.3 Welding Procedure Specification, where supplied.

2.4 Indian Boiler Regulations (for boilers erected in India)

3.0 GENERAL REQUIREMENTS:

3.1 Ensure that the components to be welded are in accordance with the contract drawings, Welding Schedule and other relevant documents.

3.2 The condition of welded surfaces to be inspected shall be clean and dry.

3.3 There shall be sufficient lighting to allow proper interpretation of visual inspection.

4.0 WELD FIT-UP INSPECTION:

4.1 The surface to be welded shall be smooth and free from deep notches, irregularities, scale, rust, oil, grease and other foreign materials.

4.2 Positive Material Identification (PMI) shall be carried out for all alloy steel and stainless steel materials for the parent metal before fit-up and for weld after welding.However, in case of tubes random PMI check shall be done on the parent metal and on 10% of the welds made by each welder per day. The procedure recommended by the PMI equipment manufacturer shall be followed for testing.

4.3 Piping, tubing and headers to be joined shall be aligned within allowable tolerances on diameters, wall thicknesses and out-of-roundness as below:

Maximum permissible misalignment at bore

Bore (mm)	Max. Misalignment (mm)	
	For GTAW	For SMAW
Up to 100	1.0	1.0
Over 100 to 300	1.6	1.6
Over 300	1.6	2.4

4.4 While fit up, components to be welded shall not show any appreciable off-set or misalignment when viewed from positions apart.

4.5 The root opening of components to be joined shall be adequate to provide acceptable penetration.

4.6 On fillet welds, the parts to be joined shall be brought as close to contact as practical, although in most instances a small opening between the parts is desirable.

4.7 Weld area shall be protected from drafts and wind, to maintain inert gas shield.

5.0 CHECKS DURING WELDING OPERATION:

5.1 Ensure the required minimum preheat temperature is maintained during welding. Preheating shall be done using resistance heating or induction heating or LPG burners. Preheating by cutting/ heating torches is not permitted.

5.2 Ensure correct electrode / filler metal is used for welding.

5.3 Tack welds shall be examined by the welder before they are incorporated in the final weld.

5.4 Ensure proper drying / holding of electrodes prior to use.

5.5 Ensure inter pass temperature mentioned in WPS is not exceeded during welding.

5.6 Ensure proper cleaning of weld between beads.

6.0 CHECKS ON THE COMPLETED WELD:

6.1 There shall be no visible cracks, pin-holes or incomplete fusion.

6.2 The weld surface must be sufficiently free of coarse ripples, grooves, overlaps, abrupt ridges and valleys, visible slag inclusions, porosity and adjacent starts and stops.

6.3 Undercuts shall not exceed 0.8 mm (0.4 mm for tubes) or 10% of wall thickness whichever is less.

6.4 Where inside surface is readily accessible, the same shall be inspected for excess penetration and root concavity. The permissible limits are given below:

- Root concavity: max of 2.5 mm or 20% of thickness at weld, whichever is lesser, provided adequate reinforcement is present.
- Excess penetration: up to and including 3.2 mm.

6.5 For plate butt welds, the weld reinforcement shall not exceed 3.2 mm.

6.6 For circumferential joints in piping and tubing the maximum weld reinforcements permitted are given below :

Maximum Permissible Reinforcements (ASME Sec I –PW 35)

Thickness of base metal in mm	Reinforcement in mm
Up to 3.0	2.5
Over 3 to 5	3.0
Over 5 to 13	4.0
Over 13 to 25	5.0
Over 25 to 50	6.0
Over 50	Max of 6.0 or 1/8 of weld width

6.7 There shall be no overlaps.The faces of fillet welds are not excessively convex or concave and the weld legs are of proper length.

6.8 In case of weld joints in pressure parts and joints like ceiling girder, the weld joint shall be suitably identified.

CHAPTER – A6
SAFE PRACTICES IN WELDING

(This is included for information purposes only)

1.0 This covers many of the basic elements of safety general to arc welding processes. It includes many, but not all, of the safety aspects related to structural welding. The hazards that may be encountered and the practices that will minimize personal injury and property damage are reviewed here.

2.0 **Electrical Hazards**

2.1 Electric shock can kill. However, it can be avoided. Live electrical parts should not be touched. Read and understand the manufacturer's instructions and recommended safe practices. Faulty installation, improper grounding, and incorrect operation and maintenance of electrical equipment are all sources of danger.

2.2 **All electrical equipment and the work-pieces should be grounded.** A separate connection is required to ground the work-piece. The work lead should not be mistaken for a ground connection.

2.3 To prevent shock, the work area, equipment, and clothing should be kept dry at all times. Dry gloves and rubber soled shoes should be worn. The welder should stand on a dry board or insulated platform.

2.4 Cables and connections should be kept in good condition. Worn, damaged or bare cables should not be used. In case of electric shock, the power should be turned off immediately. If the rescuer must resort to pulling the victim from the live contact, non-conducting materials should be used. A physician should be called and CPR continued until breathing has been restored, or until a physician has arrived.

3.0 Fumes and Gases

3.1 Many welding, cutting, and allied processes produce fumes and gases which may be harmful to one's health. Fumes and solid particles originate from welding consumables, the base metal, and any coating present on the base metal. Gases are produced during the welding process or may be produced by the effects of process radiation on the surrounding environment. Everyone associated with the welding operation should the possible effects of over-exposure to fumes and gases range from irritation of eyes, skin, and respiratory system to more severe complications. Effects may occur immediately or at some later time. Fumes can cause symptoms such as nausea, headaches, dizziness, and metal fumes fever. Sufficient ventilation, exhaust at the arc,

or both, should be used to keep fumes and gases from breathing zones and the general work area.

4.0 Noise

4.1 Excessive noise is a known health hazard. Exposure to excessive noise can cause a loss of hearing. This loss of hearing can be either full or partial, and temporary or permanent. Excessive noise adversely affects hearing capability. In addition, there is evidence that excessive noise affects other bodily functions and behaviour. Personal protective devices such as ear muffs or ear plugs may be employed. Generally, these devices are only accepted when engineering controls are not fully effective.

5.0 Burn Protection

5.1 Molten metal, sparks, slag, and hot work surfaces are produced by welding, cutting and allied process. These can cause burns if precautionary measures are not used.

5.2 Workers should wear protective clothing made of fire resistance material. Pant cuffs or clothing with open pockets or other places on clothing that can catch and retain molten metal or sparks should not be worn. High top shoes or leather leggings and fire resistant gloves should be worn. Pant legs should be worn over the outside of high top boots. Helmets or hand shields that provide protection for the face, neck, and ears, should be worn, as well as head covering to protect. Clothing should be kept free of grease and oil. Combustible materials should not be carried in pockets. If any combustible substance is spilled on clothing it should be replaced with fire resistance clothing before working with open arc or flame.

5.3 Appropriate eye protection should be used at all times. Goggles or equivalent also should be worn to give added eye protection.

Insulated gloves should be worn at all times when in contact with hot items or handling electrical equipment.

6.0 Fire Prevention

6.1 Molten metal, sparks, slag, and hot work surfaces are produced by welding, cutting, and allied processes. These can cause fire or explosion if precautionary measures are not used.

6.2 Explosions have occurred where welding or cutting has been performed in spaces containing flammable gases, vapours, liquid, or dust. All combustible material should be removed from the work area. Where possible, move the work to a location well

away from combustible materials. If neither action is possible, combustibles should be protected with a cover or fire resistant material. All combustible materials should be removed or safely protected within a radius of 35 ft. (11m) around the work area.

6.3 Welding or cutting should not be done in atmospheres containing dangerously reactive or flammable gases, vapours, liquid, or dust. Heat should not be applied to a container that has held an unknown substance or a combustible material whose contents when heated can produce flammable or explosive vapours. Adequate ventilation should be provided in work areas to prevent accumulation of flammable gases, vapours or dusts. Containers should be cleaned and purged before applying heat.

7.0 Radiation

7.1 Welding, cutting and allied operations may produce radiant energy (radiation) harmful to health. Everyone should acquaint themselves with the effects of this radiant energy.

7.2 Radiant energy may be ionizing (such as X-rays) or non-ionizing (such as ultraviolet, visible light, or infrared). Radiation can produce a variety of effects such as skin burns and eye damage, if excessive exposure occurs.

7.3 Some processes such as resistance welding and cold pressure welding ordinarily produce negligible quantities of radiant energy. However, most arc welding and cutting processes (except submerged arc when used properly), laser welding and torch welding, cutting, brazing, or soldering can produce quantities of non-ionizing radiation such that precautionary measures are necessary.

1. Welding arcs should not be viewed except through welding filter plates.
2. Transparent welding curtains are not intended as welding filter plates, but rather, are intended to protect passersby from incidental exposure.
3. Exposed skin should be protected with adequate gloves and clothing as specified.
4. The casual passersby to welding operations should be protected by the use of screens, curtains, or adequate distance from aisles, walkways, etc.
5. Safety glasses with ultraviolet protective side shields have been shown to provide some beneficial protection from ultraviolet radiation produced by welding arcs.

CHAPTER – B1
ERECTION WELDING PRACTICES FOR SA335 P91/P92, SA182 F91/F92 & SA217 C12A MATERIALS

1.0 SCOPE:

1.1. This document details out the practices to be adopted during erection of SA335 P91/P92,SA182 F91/F92 and SA 217 C12A materials.

2.0 MATERIAL:

2.1 Pipe materials shall be identified as follows:-

1) Colour codes given by the MUs.
2) Hard Stamping: Specification, Heat No, Size.
3) Paint / Stencil: WO DU, as per the relevant drawing & document.

2.2 When any defect like crack, lamination, and deposit noticed during visual examination the same shall be confirmed by Liquid Penetrant Inspection. If confirmed, it shall be referred to unit.

3.0 ERECTION:

3.1 Edge Preparation and fit up:

3.1.1 Cutting of P91/P92/F91/F92 material shall be done by band saw / hacksaw / machining / grinding only.Edge preparation (EP) shall be done by grinding/machining. During machining /grinding, care shall be taken to avoid excessive pressure to prevent heating up of the pipe edges.

3.1.2 All Edge Preparations done at site shall be subjected to Liquid Penetrant Inspection (LPI). Weld build-up on Edge Preparation is prohibited.

3.1.3 The weld fit-up shall be carried out properly to ensure proper alignment and root gap. Neither tack welds nor bridge piece shall be used to secure alignment. Partial root weldof minimum 25mm length by GTAW at minimum 4 locations and fit-up by a clamping arrangement is recommended. Use of site manufactured clamps for fit up is acceptable.The necessary purging and preheat shall be done as per clause 3.3 and 5.0 respectively. Welding shall be done employing IBR qualified welders only.

3.1.4 The fit-up shall be as per the drawing. Root gap shall be 2 to 2.5mm and root mismatchshall be within 1.6mm. Suitable reference punch marks shall be made on both the pipes (at least on three axis).

a) At 200 mm from the EP for UT.
b) At 1000 mm from the EP for identifying weld during PWHT.

3.2. Fixing of thermocouple (TC) and heating elements during preheating and PWHT:

3.2.1 Heat Treatment Manual (AA/CQ/GL/011/ PART II-HTM-Latest),Chapter 1, Clause no. 3.1.1, 3.1.5, 3.2.1, 3.2.2&3.2.6shall be referred for guidelines for fixing of thermocouples and heating elements on the jobs

3.3 Arrangement for purging:

3.3.1 Argon gas conforming to Gr 2 of IS 5760 (latest) shall be used for purging the root side of weld. The purging dam (blank) shall be fixed on either side of the weld bevel prior to pre-heating. The dam shall be fixed inside the pipe and it shall be located away from the heating zone. Purging shall be done for root welding(GTAW) followed by two filler passes of SMAW in case of butt welds. Purging is not required in the case of nozzle and attachment welds, when they are not full penetration joints.

3.3.2 The flow rate which shall be maintained during purging is 10 to 26 litres/minute. Purging shall be started from inside of pipe when root temperature reaches 220°C. Continuous and adequate Argon Gas shall be provided to ensure complete purging in the root area. The minimum pre-flushing time for purging before start of welding shall be 5 minutes, irrespective of the pipe size.

3.3.3 Wherever possible, solid purging gas chambers shall be used which shall be removed after welding. If not possible, only water-soluble paper is to be used. Plastic foils that are not water-soluble are NOT acceptable.

3.3.4 **Using Aluminium dam arrangement**:

In order to retain the Argon gas at the inside of the pipe near root area of the weld joint, the purging dams made of Aluminium (or other suitable material like mild steel) and permanent gaskets may be provided during the weld fit-up work similar to one as indicated in the Figure B2.1.The Aluminium discs shall be firmly secured with a thin wire rope. After completion of the root welding followed by two filler passes, the disc shall be pulled outwards softly.

CAUTION: ENSURE REMOVAL OF PURGE DAM ARRANGEMENT AFTER WELDING

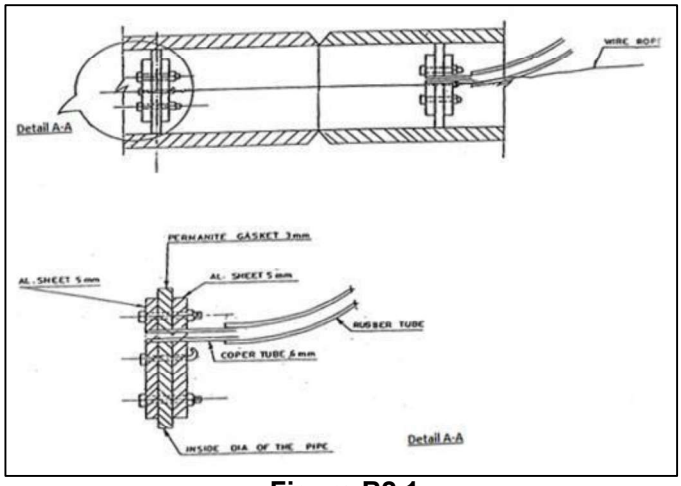


Figure B2.1

3.3.5 **Using water soluble paper:**

The dams can be made of water-soluble paper/water soluble tissue paper for creating the purging chamber. The advantage in such dam arrangement is that dissolving in water can flush thedams. The following are different methods used.

The Purge damming process illustrated as below:

3.3.5.1. For small diameter pipes, simply stuff water soluble paper/water soluble tissue paper into each section to be joined(Refer Figure B2.2).

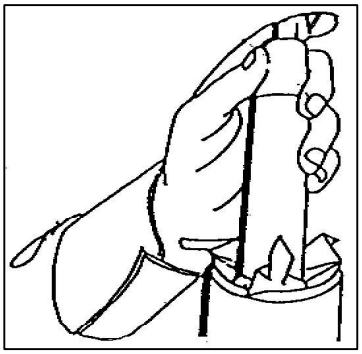


Figure B2.2

3.3.5.2. For larger pipes, cut out a circular aluminium foil disc slight larger than the diameter and shape it to the inside pipe circumference. (A small hole may be punched in the paper to ensure complete evacuation of air when purging)(ReferFigureB2.3).

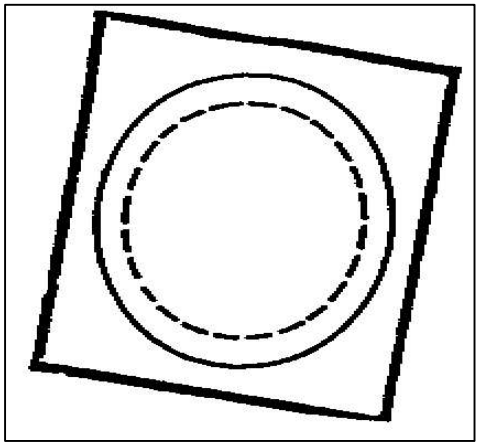


Figure B2.3

3.3.5.3. Position the disc within the pipe and tape in place with water soluble paper. Repeat procedure for other section. Insert the backing gas into the joint with a needle valve and make root pass in the usual manner (Refer Figure B2.4).

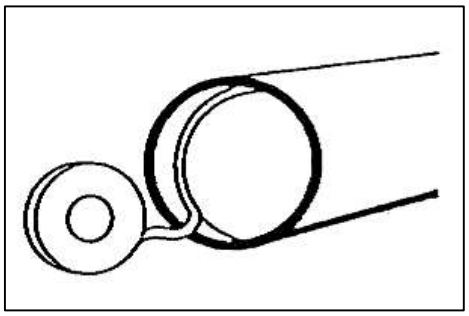


Figure B2.4

3.3.5.4. For pipes larger than 508 mm diameter, simply splice two sheets of water soluble paper together with water soluble tape as per Figure B2.5 and repeat procedure as shown in Figure B2.3 and B2.4 above.

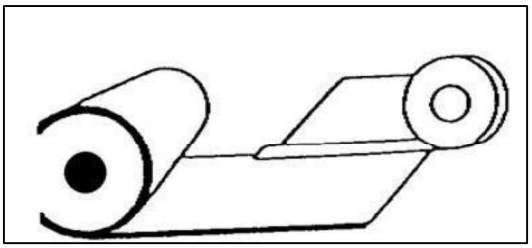


Figure B2.5

4.0 WELDING / WELDERS QUALIFICATION:

Welders Qualified as per IBR and qualified at site with Gr.91/Gr.92 material only shall be engaged. Welders log book shall be maintained and welders performance shall be monitored by site engineer. The applicable WPS as per FWS shall be followed for welder qualification and welding.

5.0 PREHEATING:

Heat Treatment Manual (AA/CQ/GL/011/ PART II-HTM-Latest),Chapter 1, Clause 3.1 shall be referred for guidelines for preheating.

6.0 WELDING:

6.1 Root Welding shall be done using GTAW process (as per WPS) five minutes after the start of argon purging. Filler wire shall be cleaned and free from rust or oil. Argon Purging shall be continued till minimum two filler passes of SMAW.

6.2 The inter-pass temperature shall not exceed 350°C. After completion of welding bring down the temp to 80–100°C and hold it at this temperature for one hour minimum. The PWHT shall commence after completing one hour of holding.

7.0 STORAGE OF WELDING CONSUMABLES:

Refer Chapter A3, Section A-3.4of this Manual for guidelines which shall be followed for receipt, storage, drying & holding and issue of welding consumables.

CAUTION:No LPI / Wet MPI/UT shall be carried out on weld before PWHT

8.0 POST WELD HEAT TREATMENT:

8.1 Heat Treatment Manual (AA/CQ/GL/011/ PART II-HTM– Latest), Chapter 1, Clause no. 3.2 shall be referred for guidelines on PWHT. In addition, the below requirements and precautions shall also be followed:

8.2 Welding and PWHT shall be monitored every one hour by site authorized personnel.

8.3 Preventive measures during power failure and non-functioning of equipment: No interruption is allowed during welding and PWHT. Hence all the equipment for the purpose of power supply, welding, heating etc., shall have alternative arrangements.(Diesel generator for providing power to the welding and heating equipment, standby welding and heating equipment, reserve thermocouple connections, gas burner arrangement for maintaining temperature etc.). Following preventive measures shall be adopted until normal power supply or backup power supply through diesel generator is restored.

8.3.1 **Interruption during start of preheating**:

In case of any power failure/interruption during preheating, the weld fit-up shall be insulated and brought to room temperature. After the electric supply resumes the joint shall bepreheated as per Clause No: 5.0.

8.3.2 **Interruption during GTAW / SMAW**:

Maintain a preheat temperature of 220°C minimum using LPG gas burners till the welding is restarted. In case, preheat temperature is not maintained, an inter-stage stress relieving shall be carried out followed by visual inspection to ensure that no surface cracks are present in the weld, prior to restart of the welding.

8.3.3 **Interruption during cooling cycle**: After SMAW welding completion and cooling to holding temperature at 80 to 100°C, care shall be taken to avoid faster cooling rate by providing adequate insulation. The required temperatureof 80 – 100°C shall be maintained by gas burner arrangements till power resumes / start of PWHT (within 8 hours).

8.3.4 **Interruption during post weld heat treatment**;Heat treatment Manual (AA/CQ/GL/011/ PART II-HTM– Latest), Chapter 1, clause no. 3.2.5 shall be referred for guidelines to be followed for interruption during PWHT.

8.3.5 In all the above cases (8.3.1 to 8.3.4), the temperaturemeasurement on the weld joint shall be recorded using calibrated gauges/instrumentsat regular Intervals of 15 minutes in the log book by SiteEngineer.

8.4 Caution:

The PWHT temperature recorded in the chart shall not deviate from the specified values since any deviations to the specified soaking temperature Range, will adversely affect the mechanical properties of the weldment and may lead to rejection of the weldment. The weld Joints should be kept dry and no water/liquid is allowed to come in contact with the weld or preheated portion of pipe under any circumstances, till PWHT is completed.

9.0 CALIBRATION:

All equipment like recorder, thermocouple, compensating cable, oven thermostat etc. shall have valid calibration carried at BHEL approved laboratories. The calibration reports shall be reviewed and accepted by welding In-charge at site prior to use.

10.0 NONDESTRUCTIVE EXAMINATION (ReferNDE ManualAA/CQ/GL/011/ Part III-NDEM latest):

10.1 All NDE shall be done after PWHT only.Prior to testing all welds shall be smoothly ground.All welds (fillet & butt) shall be subjected to MPI (MPI shall be done by YOKE type only). In addition to MPI, butt-welds and all full penetration welds shall be examined by UT.

UT procedure shall be as per BHE: NDT: PB: UT21 with additional requirementsas in (a) through (e):

a) The calibration blocks used shall be of the same product form and material specification or equivalent P-Number grouping as one of the materials being examined. P-Nos. 1, 3, 4, 5A through 5C, and 15A through 15F materials are considered equivalent for this purpose.

b) The UT equipment shall be calibrated prior to use and should be of 'digital type' capable of storing calibration data as well as ultrasonic test results as per procedure numberBHE:NDT:PB:UT-21.

c) All recordable indications shall be stored in memory of – either the digital flaw detector or a PC for review at a later period.

d) The equipment calibration data for specific weld as well as the hard copy of 'Static echo-trace pattern' – showing the flaw-echo amplitude with respect to DAC, flaw depth, projection surface distance (probe position) and beam-path shall be attached to UT test report. This hard-copy of echo-trace with equipment calibration data shall form part of test documentation.

e) The examination as well as evaluation shall be performed by a qualified Level II personnel, and a test report shall be issued. Any defect noticed during NDT shall be marked with marker.

11.0 REPAIR OF WELD JOINTS:

11.1 Weld repair at root:

If any surface defect is revealed at the time of visual inspection during root welding, the following steps shall be followed:

1. Maintain the temperature at 80-100°C for 1 hour.
2. Perform inter-stage PWHT.
3. Remove the defect by grinding.
4. After complete removal of defect, preheat the weld area to 220°C minimum and re weld with GTAW before starting SMAW, if required.

11.2 Weld repair on completion:

11.2.1 Any defect observed on the weld shall be brought to the notice of Site engineer. Any repair on weld shall be carried out with their approval only.

11.2.2 If any defects are noticed on the fully completed weld while performing UT after completion of PWHT, the depth of the defect shall be locatedfrom the weld outside surface. The defect area shall be marked and repaired as below:

a) The weld shall be removed by grinding (gouging not permitted) such that the area for repair welding shall be free from sharp corners and provided with sufficient slope towards the weldface sides.

b) Surface examination (MPI/LPI) on the ground area shall be performed to ensure complete defect removal before re-welding. Repair welding shall be carried as per the applicable WPS as for original welding.

12.0 HARDNESS SURVEY:

Hardness shall be measured using portable hardness tester.The equipment used for the hardness measurement shall be calibrated as recommended by the equipment manufacturer.

The surface shall be cleaned and prepared as per hardness test instrument manufacturer's recommendation prior to hardness survey.Hardness survey shall be done on each joint at three locations along the circumference. At each location three readings shall be taken on weld and parent metal .The readings on the parent metal shall be taken within 15mm from the edge of the weld.All the hardness values shall be recorded.

The hardness of the weld metal and the base metal in the soak band (heating band), excluding welding heat-affected zone shall be between 160HB & 300HB for Gr.91 and Gr.92 joints. The hardness measurements shall be recorded in the format as given in Annexure IX.Joints having hardness above 300HB shall be re-heat treated

and hardness shall be checked again. If hardness is still more, the case shall be referred to concerned MUs/ECs.In case Hardness falls below 160HB also, the case shall be referred to the concerned MUs/ECs.

Cautionary note: To achieve meaningful and consistent hardness results, below recommendations should be followed:

- The accuracy of the instrument shall be verified prior to use.
- The surface to be tested shall be reasonably flat and free of scale and oxides, grease, paint, etc.
- Prior to hardness test, the de-carburized surface layer with a thickness up to 0.8mm shall be removed by grinding/buffing, without encroaching the specified minimum wall thickness of the pipe/tube.

ANNEXURE IX – HARDNESS MEASUREMENT

BHARAT HEAVY ELECTRICALS LTD

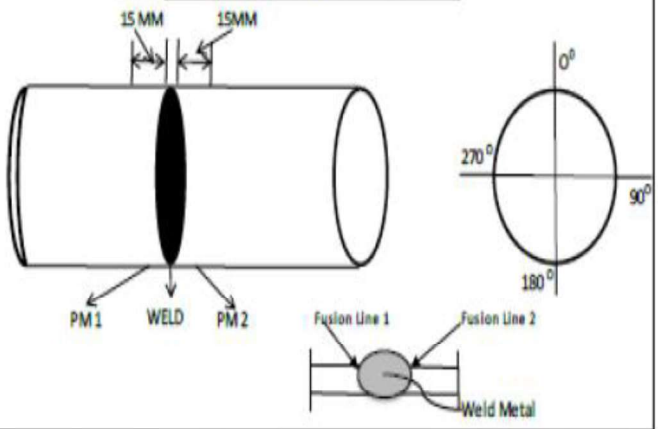
T91/T92/P91/P92/F91/F92/C12A HARDNESS TESTING PROTOCOL

PROJECT NAME :	UNIT No. :	Customer Name :
Report No.:	Date :	Contractor :
Description :	Specn :	Stage of test : After PWHT
Calibration Block No.:	Equipment details:	
PGMA :	Model No :	
JOINT NO. :		

Location	PM 1	WELD	PM 2
Readings	AVERAGE OF 3 READINGS	AVERAGE OF 3 READINGS	AVERAGE OF 3 READINGS
12 O'Clock/ 0^0			
3 O' Clock/ 90^0			
6 O'Clock/ 180^0			
9 O'Clock/ 270^0			

PM: PARENT MATERIAL (15 MM FROM THE WELD FUSION LINE). ALL AVERAGE READINGS SHOULD BE LESS THAN THE PERMISSIBLE HARDNESS VALUE.

HARDNESS TEST LOCATIONS SKETCH



Gap between successive reading shall be 1mm in the same spot

RECOMMENDATION / RESULT : ACCEPTED / NOT ACCEPTED / RE-PWHT

	AGENCY	NAME	SIGNATURE & DATE
INSPECTED BY	CONTRACTOR		
CHECKED BY	BHEL		
WITNESSED BY	CUSTOMER		

13.0 COMBINATION WELDING:

For other combination of materials with Gr.91/Gr.92, the applicableWPS for the same shall beobtained fromconcerned MUs/ECs.

14.0 DEMAGNETIZATION:

Refer NDE Manual BHEL:PS:NDM:latest Chapter 1.10

15.0 TRAINING:

15.1 The personnel engaged in P91 piping fabrication shall be trained in the following areas.

a. Method and care to be taken during fit-up.
b. Argon gas root purging arrangement.
c. Fixing of thermocouple and wires.
d. Arrangements for Pre/Post heating requirements and methods.
e. Adjustment of heating pads/cables at the time of controlling the temperature within specified tolerance limits during welding or PWHT in case of induction heating.
f. Good knowledge of the WPS requirements.
g. Handling of P91 welding consumables and re-drying conditions.
h. Special precautions to be taken during the power/equipment failure.
i. Weld joints of dissimilar thickness / material specification.
j. Weld defect control and weld repair systems.

15.2 **Specific training for welders:**

a. The qualified welders who will be engaged in P91 welding shall be given training on pipe joints simulated with P91 welding and heating cycle conditions.
b. The acquaintance on welding positions, as applicable shall be given using P91 pipes and P91 welding consumables.
c. Welding techniques and instructions on Dos and DON'Ts of P91 welding.
d. Welders only who are qualified on P91 welding alone shall be engaged.
e. Whenever new welders have to be engaged they shall undergo all the training as above and shall be qualified with P91 material only.

16.0 CONTROL ON WELDERS:

The welder during welding at site follow the following procedures.The welder shall interact with the HT operator (Induction equipment operator) to ensure that preheat and inter-pass temperature during welding are maintained as per requirements.The

welder shall not mix the welding electrodes with that of the other welder. At the end of the shift, the unused electrodes shall be returned to the stores.

17.0 PERSONNEL / CONTRACTORS ENGAGED FOR HEATING CYCLES (HT OPERATOR):

17.1 The Personnel / Contractor shall have adequate heat treat experience on P91 or similar material.

17.2 HT operator shall be aware of the following:

a. The equipment used and its working principle and operation.

b. The procedures to be followed in using heating equipment.

c. Procedure to be followed in case of power failure or equipment non-functioning so that heating cycle is not disrupted.

d. Calibration of equipment.

e. Method of fixing thermocouples and compensating cables leading to HT recorder.

f. Fixing of heating pads or elements on the pipe joints and also in maintaining the temperature within the specified limits.

18.0 NDE PERSONNEL QUALIFICATIONS:

All NDE personnel performing NDT like UT & MPI/LPI shall be qualified in accordance with BHEL Procedure meeting the requirements of recommended practice SNT–TC-IA.MPI & LPI shall be carried out by level I qualified personnel and shall be evaluated by level II qualified personnel. However UT examination and evaluation shall be done by level II qualified personnel.

19.0 LEVEL OF SUPERVISION

Site In charge shall be responsible for the completion of all activities from weld fit-up tofinal clearance of weld joints after satisfactory NDE and acceptance by BHEL/Customer/IBR.

20.0 DO'S AND DON'T'S DURING P 9 1 /P 92 /F9 1 /F92 /C1 2 A WELDING.HEAT TREATMENT AND NDE AT CONSTRUCTION SITE:

20.1 **DO ' S:**

a. Cutting by Band saw/Hack saw/Machining.

b. Pipes Edge Preparation by machining. Machining shall be done without excessive pressure to prevent heating up of pipe

c. Grinding may be done on exceptional cases after approval and taking adequate care to prevent overheating.

d. Thermocouple wire (hot/Cold junctions) shall be welded with capacitor discharge portable spot-welding equipment.

e. Reserve Thermocouples shall be madeavailable,in case of failure of connected thermocouple elements.

f. Ensure adequate Argon Gas for complete purging of air inside the pipe before starting GTAW root welding.

g. Ensure Preheating at 220 °C minimum before GTAW root welding.

h. Start preheating only after clearance from Welding engineer / Quality assurance engineer for weld fit-up and alignment of the joint as well as fixing of Thermocouple connections (for Induction heating)

i. Do visual inspection onroot weld maintaining weld preheating temp.

j. Continue Argon purging until the GTAW root welding followed by minimum two filler passes of SMAW, is completed.

k. Perform partial root welding to facilitate fit-up if necessary.

l. Ensure proper use of TIG wires as identified by color coding or suitable hard punching.

m. Keep the GTAW wires in absolutely clean condition and free from oil, rust, etc.

n. Dry the SMAW electrodes before use.

o. Ensure the inter-pass temperature is less than 350°C.

p. Hold at 80-100°C fora period ofMinimum 1 hour before the start of PWHT.

q. Record entire heating cycle on Chart through recorders.

r. Exercise control during grinding of weld and adjoining base metal while removing surface/sub-surface defects or during preparation for NDE.

s. Ensure no contact with moisture during preheat, welding, post heat and PWHT of Weld Joints.

t. Ensure removal of argon purging arrangements after welding.

u. Use short Arc only. The maximum weaving shall be limited to 1.5 times the Dia. of the electrode.

20.2 <u>DO N' T' s</u>:

a. Avoid Oxy-Acetylene flame cutting.

b. Avoid Weld-build up to correct the weld end-d1 or to set right the lip of the weld bevel.

c. Avoid Arc strike on materials at the time of weld fit up or during welding.

d. Do not Tack weld the Thermocouple wires with Manual Arc/TIG welding.

e. NO GTAW root welding without thorough purging of root area.

f. Do not use Oxy-acetylene flame heating for any heating requirements.

g. Do not use Thermal chalks on the weld groove.

h. Do not stop argon purging till completion of GTAW root welding and two layers of SMAW.

i. No Tack welding or Bridge piece welding is permitted.

j. Do not use unidentifiedTIG wires or electrodes.

k. Do not exceed the maximum interpass temperature indicated in WPS

l. Do not allow moisture, rain, water, cold wind, cold draft etc. to come in contact with the weld zone or heating zone during the entire cycle from preheat to PWHT.

m. Do not exceed the limits of PWHT soaking temperature.

n. Do not Interrupt the Welding/heating cycle except for unavoidable power failures

o. Do not use un-calibrated equipment for temperature measurement during heating, welding, post weld, heat treating etc.

21.0 DOCUMENTATION:

The documentation shall be as per the approved Quality Plan.

CHAPTER – B2
ERECTION WELDING PRACTICES FOR SA 213 T91/T92 MATERIALS

1.0 SCOPE:

1.1 This document details out the practices to be adopted during welding of SA213 T91/T92 material.

2.0 MATERIAL:

2.1 Tube materials shall be identified as follows:-

a) Colour codes given by the Manufacturing Units (MU).

b) Paint / Stencil: WO DU, as per the relevant drawing & document.

2.2 When any defect like crack, lamination, and deposit noticed during visual examination, the same shall be confirmed by Liquid Penetrant Inspection. If confirmed, it shall be referred to unit.

3.0 ERECTION:

3.1 **Edge preparation and Fit up:**

3.1.1 Cutting of T91/T92 material shall be done by band saw/hacksaw/machining/ grinding only. Edge preparation (EP) shall be done by grinding/machining. During machining/ grinding, care should be taken to avoid excessive pressure to prevent heating of the tube edges.

3.1.2 The weld fit-up shall be carried out to ensure proper alignment and root gap. Neither tack welds nor bridge pieces shall be used to secure alignment. Use site fabricated clamps for fit up. Ensure that coil load does not come on stubs/header. Coil load shall be transferred to the crown plate/ end bar assembly. The necessary purging and preheat shall be done as per clause 3.3 and 5.0 respectively.

3.2 **Fixing of thermocouple (TC) and heating elements during preheating and PWHT**

3.2.1 Heat Treatment Manual (AA/CQ/GL/011/ PART II-HTM-Latest), Chapter 1, Clause no. 3.1.1, 3.1.5, 3.2.1, 3.2.2, 3.2.6 & 3.2.7 shall be referred for guidelines for fixing of thermocouples and heating elements on the jobs.

3.3 **Arrangement for purging**:

3.3.1 Argon gas with requisite quality shall be used for purging the root side of weld. The purging dam (water soluble paper) shall be fixed on header nipple side of the weld bevel prior to fit-up and pre-heating. Purging is to be done from cross over tube downstream end. (Refer Figure B3.2 and B3.3). Ensure that atmospheric air is completely purged out through the root gap before starting welding and welding can be continued with Argon backing. The flow rate which shall be maintained for purging is 6 to 8 litres per minute.

3.3.2 When root temperature reaches 220°C, start purging through cross over tube downstream end for 5 minutes. Then the root gap is to be covered by insulating material. Continuous and adequate argon gas shall be provided to ensure complete

purging in the root area. Only water-soluble paper is to be used. Plastic foils that are not water-soluble are NOT acceptable.

3.3.3 Usage of water soluble paper:

3.3.3.1 The dams can be made of water-soluble paper /water soluble tissue paper for creating the purging chamber. The advantage in such dam arrangement is that the dissolving paper dam gets flushed during hydraulic test. The following is the method to be used:

3.3.3.2 Stuff the water-soluble paper/ water soluble tissue paper into the Header Nipples at a distance of 60mm(approximately) from the weld end as per attached Figure B3.1

4.0 WELDING/WELDERS QUALIFICATION:

4.1 Welders Qualified as per IBR and qualified at site with Gr.91/Gr.92 material only shall be engaged. Welders log book shall be maintained and welders performance shall be monitored by site engineer. The applicable WPS as per FWS shall be followed for welder qualification and welding.

5.0 PREHEATING (Bunching of tubes can be followed):

5.1 Heat Treatment Manual (AA/CQ/GL/011/ PART II-HTM-Latest), Chapter 1, Clause 3.1 shall be referred for guidelines for preheating.

6.0 WELDING:

6.1 Welding shall be done as per the WPS. Filler wire shall be clean and free from rust or oil. Argon Purging shall be continued till completion of welding in case of full GTAW and for minimum two filler passes of SMAW in case of GTAW + SMAW.

7.0 POST WELD HEAT TREATMENT (PWHT) – RESISTANCE HEATING METHOD(Bunching of tubes can be followed):

7.1 Heat Treatment Manual (AA/CQ/GL/011/ PART II-HTM– Latest), Chapter 1, Clause no. 3.2.12 shall be referred for guidelines on PWHT.

8.0 HARDNESS SURVEY:

8.1 100% hardness survey shall be conducted on welds and parent material in first five coils. Based on satisfactory results, the hardness survey can be reduced to 10% covering each heat treatment cycles as per FWS requirement. The equipment recommended to measure the hardness is EQUOTIP or equivalent. Portable equipment used in the hardness measurement shall be calibrated.

8.2 The surface shall be cleaned and prepared as per hardness test instrument manufacture's recommendation prior to hardness survey. Hardness survey of weld and parent metal (both tubes) shall be carried out. The hardness shall be between 160HB & 300HB. The hardness measurements shall be recorded in the format as given in Annexure IX. Joints having hardness above 300HB shall be re-heat treated and hardness shall be checked again. If hardness is still more, the case shall be

referred to concerned MUs. In case Hardness falls below 160HB also, the case shall be referred to the concerned MUs.

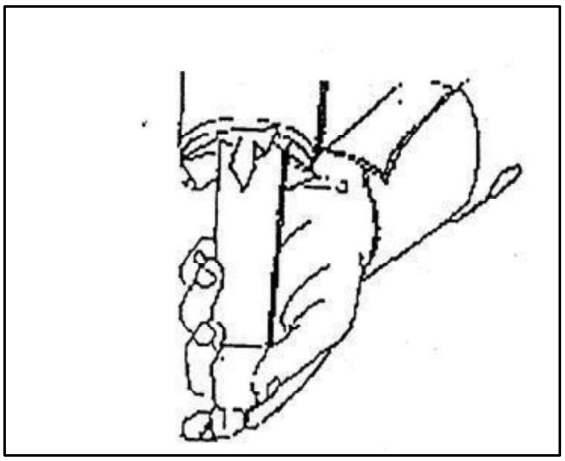


Figure B3.1: Insertion of Water Soluble Tissue paper

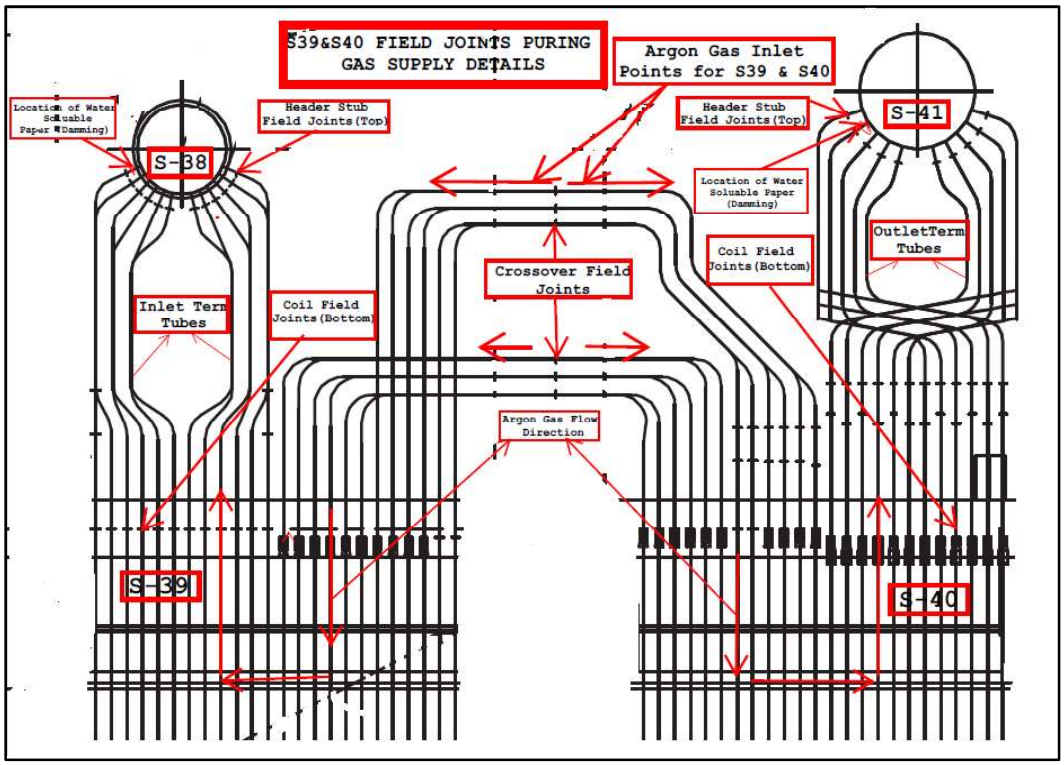


Figure B2.2: Purging Arrangement for SH Header Field Joints

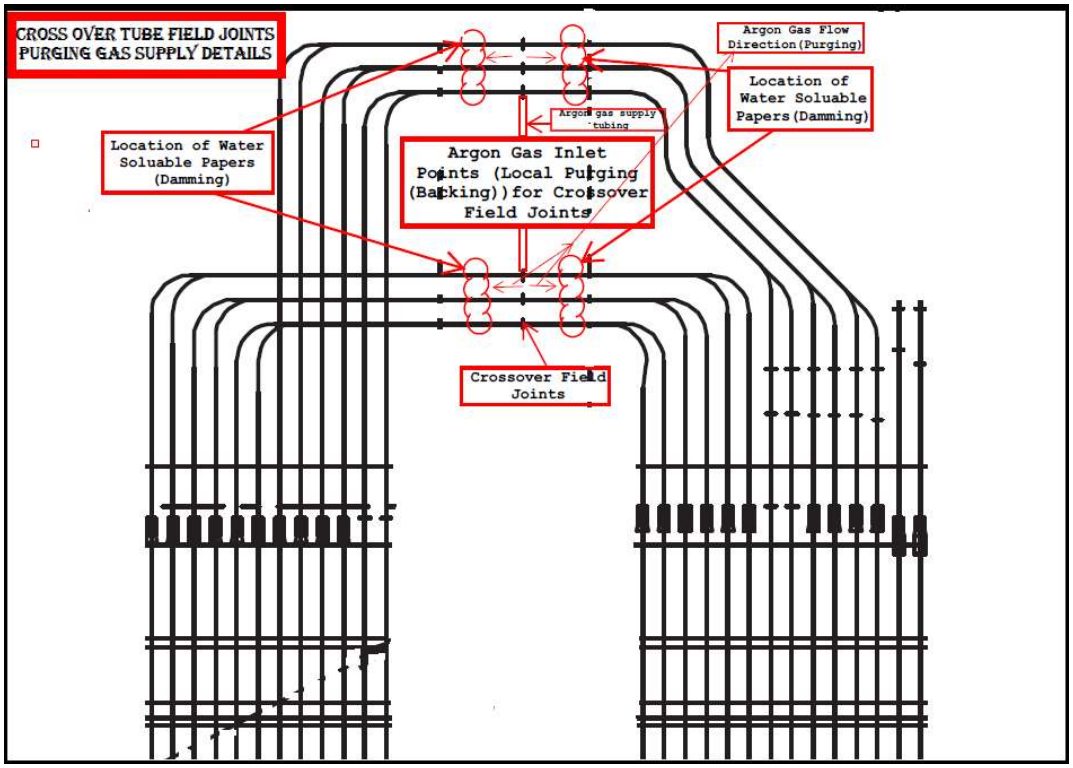


Figure B2.3: Purging Arrangement for Cross Over Tube Field Joints

CHAPTER –B3
ERECTION WELDING PRACTICES FOR SA213 T23 MATERIAL

1.0 SCOPE:

1.1 This procedure is applicable for the welding of T23 tubes at sites.

2.0 Ensure the availability of the following items/characteristics before preparing the joint for welding:

a) LPG gas (for heating in case of interruption in preheating)
b) Grinding machine
c) Mini cutter
d) Conical grinder
e) Proper illumination
f) Thermal chalk or pyrometer
g) Torch light
h) Portable Oven
i) Hacksaw and chisel

3.0 PROCEDURE:

The following procedure shall be followed for T23 Welding at Site:

3.1 Clean the edges of the tube, both OD & ID by buffing upto 30 mm from the edge of the tube.

3.2 Create a purging dam on both tubes at about 200 to 250 mm away from the joint beforefit-up.

3.3 Fit-up the tubes for butt joint with a root gap of 2 to 2.5 mm and ensure a land of 1 to 1.5 mm.

3.4 Set up Argon purging for the tube to tube butt joint.

3.5 Carryout preheating by wrapping heating pads/coils uniformly for a width of 200 mm on both sides of the joint. Each tube should be provided with a thermocouple (K type) at a distance of 75 mm from the joint.(Refer FigureB4.1, B4.2 &B4.3)

3.6 Preheat the joint to a minimum of 200°C and ensure the same with a thermal chalk or a pyrometer before the start of welding.

3.7 Ensure drying of SMAW electrodes at 250 to 300°C for 2 hours and keep them at a temperature of 150°C in a Holding oven after drying.

3.8 The electrodes shall be maintained dry at 65 to 100 °C in a portable oven after issue from the holding oven till use.

3.9 Perform welding as per applicable WPS using IBR qualified welders.

3.10 Ensure the welding of root and second pass by TIG welding process and further layers by SMAW process. Alternatively, the entire joint may be welded by TIG process using the applicable WPS.

3.11 Maintain the Interpass temperature at 350°C max. Ensure the same using thermal chalk or pyrometer after each pass of welding.

3.12 Conduct post heating on the completed weld at 250 to 280°C for a minimum of 1 hour immediately after completion of welding and then allow the joint to cool in air to ambient temperature.(Refer Figure B4. 4)

3.13 Perform RT to ensure that the joints are defect free.

3.14 If RT reveals any unacceptable defect, cut the joint and put a spool piece in place for a minimum length of 200 mm. Repeat the procedure from step 3.1 to 3.13.

3.15 Perform PWHT on the weldment within 7 days after post heating.

3.16 Use only calibrated PWHT accessories (thermocouples, temperature recorder, etc.).

3.17 Use only ceramic resistance pads with low voltage heating arrangement for PWHT.

3.18 Ensure the PWHT arrangement to meet the following conditions;

3.19 When heat treating butt welds, the width of the circumferential heating band on either side of the weld must be at least 3 times the width of the widest part of the weld groove but not less than twice the thickness of the thicker part welded. The width of the insulation band shall be at least twice the total width of the heating band.

3.20 Ensure wrapping of heating pads, location of thermocouples before covering with insulation.(referFigure B4.5& B4.6)

3.21 PWHT shall be carried out with 1 thermocouple per joint.

3.22 PWHT time and temperature shall be as per applicable WPS.

3.23 Measure hardness on the joint and ensure it to be within 160 to 260 HB. If hardness exceeds 260 HB, PWHT shall be repeated and hardness checked. The total no. of PWHT cycles shall not exceed 3 times for a joint.

3.24 In case the hardness measures above 260HB even after 3 PWHT cycles, cut the joint and put a spool piece in place for a minimum length of 200 mm. Repeat the procedure from step 3.1 to 3.23. In case the hardness measures below 160HB, it shall be referred to the MUs.

4.0 DOCUMENTATION:

Record the details of welding carried out in correlation to welders, heat treatment and NDE reports.

Figure B3.1: Preheating by Resistance coil winding

Figure B3.2: K - Type Thermocouple

Figure B3.3: Preheating arrangement with thermocouples in place

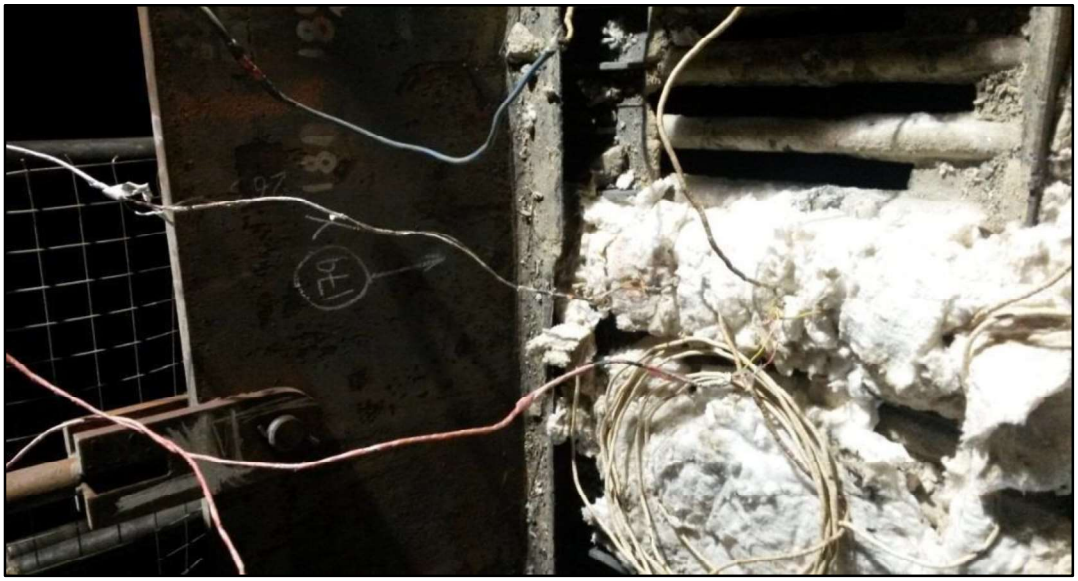


Figure B3.4: Post heating arrangement

Figure B3.5: Heating pads in place for PWHT

Figure B3.6: PWHT in progress

GUIDE LINES FOR HEAT TREATMENT

IMPORTANT NOTE

THIS GUIDELINES FOR HEAT TREATMENT PROVIDES BROAD BASED GUIDELINES FOR CARRYING OUT HEAT TREATMENT WORKS AT SITES. HOWEVER, SITES SHALL ENSURE ADHERENCE TO THE PRIMARY DOCUMENTS LIKE CONTRACT DRAWINGS, FIELD WELDING SCHEDULES, WELDING PROCEDURE SPECIFICATIONS, PLANT / CORPORATE STANDARDS, STATUTORY DOCUMENTS, CONTRACTUAL OBLIGATIONS, AS APPILCABLE AND SPECIAL INSTRUCTIONS, IF ANY, ISSUED BY RESPECTIVE MANUFACTURING UNITS SPECIFIC TO THE PROJECTS.

Table of Contents

CHAPTER-1
HEAT TREATMENT PROCEDURE - BOILER AND AUXILIARIES

1.0 SCOPE:

1.1 This procedure provides information, method and control for Pre-Heat, Post Heat and Post Weld Heat Treatment (PWHT) of welds of boiler and piping components at sites.

2.0 DOCUMENTS:

2.1 The following documents are referred in preparation of this procedure:

- ASME Sec I & Sec IX
- ASME B31.1
- Indian Boiler Regulations
- AWS D1.1
- BHEL Welding Manual (AA/CQ/GL/011/ Part I-WM – Latest)

2.2 The following are to be referred as Primary Documents:

- Contract drawings
- Field Welding Schedule or equivalent
- Plant / Corporate standards, wherever supplied
- Welding procedure specification
- Contractual obligations, if any

2.2.1 Where parameter for Pre-Heat, Post Heat and PWHT are not available in the primary documents, reference may be made to this procedure.

2.2.2 Where such parameters are not contained either in the primary documents or in this procedure, reference may be made to Manufacturing Units.

3.0 PROCEDURE:

3.1 **Preheating & Post heating**:

3.1.1 Prior to start of preheating, ensure that surfaces are clean and free from grease, oil and dirt. Preheating temperature shall be maintained as per applicable WPS. Preheating shall be checked and recorded, using thermal chalks/ crayons or pyrometers in case of tubes other than T91/T92/T23. For all other components including T91/T92/T23 tube joints, the preheat temperature shall be ensured by using a calibrated chart recorder and two calibrated thermocouples fixed at 0° and 180° positions on both sides of the joint. Preheating shall be checked at a distance of 1.5 times the part thickness or 75mm (whichever is greater) from weld end. The thermocouple shall be fixed using the capacitor discharge welding machine. The preheating arrangements shall be inspected and approved by site engineer.

3.1.1.1 Bunching of tubes for Preheating:

Where a bunch of closely placed tube welds (e.g. Super Heater / Reheater Coils) requires to be preheated, the same may be grouped together as if they form a single component. The maximum number of tubes bunched together in such cases shall be limited to 12. Each joint

within the bunch shall have at least one thermocouple fixed near the joint for preheat monitoring.

3.1.2 When parts of two different thicknesses are welded together, the preheating requirements of the thicker part shall govern.

3.1.3 When parts of two different P numbers are joined together, the material requiring higher preheat shall govern (please refer Tables A2.1 to A2.7 of Welding Manual, AA/CQ/GL/011/ PART I-WM – Latest, for P numbers).

3.1.4 In case of any power interruption during welding, the joint shall be wrapped with dry thermal insulating blankets to ensure slow and uniform cooling. **Requirement of uninterrupted power supply shall be ensured for materials like Gr.91, 92 & 23 and BS EN 10025**

3.1.5 Preheating & Post Heating Methods:

3.1.5.1 Preheating & Post heating shall be applied by any of the methods given below:

a) Electrical resistance heating
b) Induction heating
c) LPG burners

3.1.5.2 Preheating/post heating using cutting/ heating torches with oxy-acetylene flame is not permitted.

3.1.6 In addition, the following requirements shall also be followed:

3.1.6.1 Alternate burner arrangements shall be made for preheating/post heating during power failure to maintain the required temperature.

3.1.6.2 Two additional spare thermocouples shall be fixed for emergency use.

3.1.6.3 Preheating/Post heating shall be done locally BY heating a circumferential band covering the parent material away from the weld groove by induction or electrical resistance heating. The heating element (Coil/Finger/Ceramic Pad) placed on the heating band shall be closely packed without any gaps between the element. The area shall be free of grease, oil etc. prior to preheating/post heating.

3.2 Post Weld Heat Treatment (PWHT):

3.2.1 PWHT shall be done by locally heating a circumferential band covering the entire weld and adjacent area of base metal, by induction or electrical resistance heating. The heating element (coil/ finger element/ pad) placed on the heating band shall be closely packed without any gaps between the elements. The area shall be free of grease, oil etc. prior to PWHT.

3.2.1.1 Unless otherwise specified in the FWS/WPS, the PWHT parameters shall be as per the Tables 1.1, 1.2, 1.3, 1.4.

3.2.2 **Heating and Insulation band for PWHT:**

3.2.2.1 When heat treating butt joints, width of the circumferential heating band on either side of the weld must be at least 3 times the width of the widest part of the weld groove; but not less than twice the thickness of the thicker part being welded. When heat treating nozzles and attachment welds, the width of the heating band beyond the welding to be heat treated on either side of weld shall be at least 3 times the base material thickness. The heating band shall extend axially around the entire vessel. Width of the insulation band on either side shall be at least twice the width of the heating band.

3.2.2.2 In case of fin welded panels where circumferential winding of the coil is not possible heating elements shall be placed on both sides of the panels

3.2.3 Post weld heat treatment temperature cycle shall be measured and monitored by use of thermocouples with calibrated recorders.

3.2.4 Where the soaking temperature is found to be lesser than specified, the PWHT cycle shall be repeated.

3.2.5 In case of interruption during PWHT, the following actions shall be taken depending on the stage during which interruption has occurred.

1) During heating cycle

Repeat the whole operation from beginning.

2) During soaking

Heat treat subsequently for balance soaking. If the balance soaking time required is less than 15 minutes, soaking time shall be maintained for 15 minutes minimum.

3) During cooling (above 300 °C).

If the Rate of Cooling (ROC) during interruption meets the specified rate, cool subsequently at the required rate. Otherwise, reheat to the soaking temperature, hold for 15 minutes and then cool at the specified rate.

3.2.6 **Fixing of thermocouple (TC) during preheating, post heating and PWHT:**

3.2.6.1 Thermocouples shall be fixed on the job using capacitor discharge welding method. Thermocouple leads shall be attached within 6 mm of each other. A Welding Procedure Specification shall be prepared, describing the low-energy capacitor discharge equipment, the combination of materials to be joined, and the technique of application. No preheating is required. Also Qualification of the welding procedure is not required. The energy output of the welding process shall be limited to 125 W-sec. After temporary attachments are removed, the areas shall be examined by LPI.

Following are the equipment / facilities for heating cycles.

(1) Thermo couples: Ni-Cr / Ni-Al of 0.5 mm gauge size (K-Type).

(2) Temperature Recorders: 6 Points / 12 Points/ 24 Points.

3.2.6.2 Following are guidelines regarding number and placement of thermocouples:

- Minimum of two thermocouples shall be placed for each joint, 180° apart.
- Thermocouples shall be located at a distance of approximately 1.5 times the parent metal thickness from the weld centre.
- Additionally, one point of the temperature recorder shall be used for recording ambient temperature.
- For placement of thermocouples on P91/P92/F91/F92/C12A Figure 1.1 shall be referred for preheating and Figure 1.2 shall be referred for PWHT.

3.2.6.3 Thermocouple leads shall be suitably insulated to protect the ends from direct radiation from heating elements.

3.2.6.4 The temperature variation between any two thermocouples shall be within 50°C for temperature above 300°C during heating and cooling.

3.2.7 **Bunching of tubes for PWHT:**

3.2.7.1 Where a bunch of closely placed tube welds (e.g. Super Heater / Reheater Coils) require to be Post weld heat treated, the same may be grouped together as if they form a single component. The maximum number of tubes bunched together in such cases shall be limited to 12. Each joint within the bunch shall have at least one thermocouple fixed near the joint for PWHT temperature monitoring.

3.2.8 **Soaking Time:**

3.2.8.1 Unless otherwise specified in the FWS/WPS, the soaking time shall be calculated as 2.5 minutes per mm of thickness with 30 minutes minimum for tube welds and 60 minutes minimum for other welds. For P1 material, the soaking time shall be calculated as 2.5 minutes per mm of thickness upto 50mm with an additional 15 minutes for every 25mm thickness above 50mm.

3.2.8.2 The following guidelines shall be used to determine the thickness and subsequent selection of the soaking time of PWHT:

(a) For full penetration butt welds, the nominal thickness is the thinner of the parts being joined.

(b) For full penetration corner welds, the nominal thickness is the depth of the weld.

(c) For partial penetration groove and material repair welds, the nominal thickness is the depth of the weld. The total depth of partial or full penetration groove welds made from both sides shall be taken as the sum of the depth of both sides at a given location.

(d) For fillet welds, the nominal thickness is the weld throat. When a fillet weld is used in conjunction with a groove weld, the nominal thickness is the total of groove depth and fillet throat thickness.

3.2.8.3 Soaking time is to be reckoned from the time temperature of the joint crosses the recommended lower temperature of the cycle, to the time it comes down below the same recommended lower temperature of the cycle.

3.2.9 **Heating and Cooling Rates:**

3.2.9.1 Wherever not specified, the heating rate above 300°C and cooling rate after soaking upto 300°C shall be as follows: This is applicable for all materials except Gr.91/Gr.92 materials for which Cl. 3.2.11.3 shall be referred.

Thickness of Material	**Maximum Heating Rate Above 300°C**	**Maximum Cooling Rate Upto 300°C**
≤ 25 mm	220°C/hour	220°C/hour
> 25 ≤ 50 mm	110°C/hour	110°C/hour
> 50 ≤ 75 mm	75°C/hour	75°C/hour
> 75mm	55°C/hour	55°C/hour

3.2.10 **PWHT Job Card:**

3.2.10.1 Prior to start of PWHT operations, a job card shall be prepared including details of weld reference, soaking time, soaking temperature, maximum rates of heating and cooling, temperature recorder details and date of PWHT as per Annexure I of this manual except Gr.91/Gr.92/Gr.23 materials. For P91/P92/F91/F92/C12A/T91/T92/T23 materials Annexures II, III, IV in Chapter A1 of Welding Manual - AA/CQ/GL/011/ PART I-WM – Latest, as applicable, shall be referred.

3.2.10.2 Obtain the clearance for post weld heat treatment cycle from the site engineer.

3.2.10.3 On completion of PWHT, the actual parameters shall be recorded on the job card.

3.2.10.4 A chart number shall be given to each chart and attached to the job card.

3.2.11 **Heat Treatment of P91/P92/F91/F92/C12A welds:**

3.2.11.1 A minimum of four thermocouples shall be placed such that at least two are on the weld and the other two on the base material on either side of the weld within the heating band, 180° apart, at a distance of 50mm (approximately) from the center of the weld joint as per Figure 1.2. Two standby thermocouples shall also be provided on the weld (to be used in case of any failure of the thermocouple).

3.2.11.2 The PWHT temperature shall be 740-770°C and the soaking time shall be 2.5 minutes per mm of weld thickness, subject to a minimum of one hour. All records shall be reviewed by site Engineer prior to PWHT clearance. Heating shall be done by Induction heating only. However for thickness upto 32 mm, Resistance heating may also be used.

3.2.11.3 The rate of heating / cooling (above 300 ° C):-

Thickness up to 50 mm - 110°C / hour (max)

Thickness 50 to 75mm - 75°C / hour (max)

Thickness above 75mm - 55°C / hour (max)

3.2.11.4 Welding and PWHT shall be monitored every one hour by site engineer. Job card for PWHT shall be maintained as per Annexure II, Chapter A1 of Welding Manual - AA/CQ/GL/011/ PART I-WM – Latest.

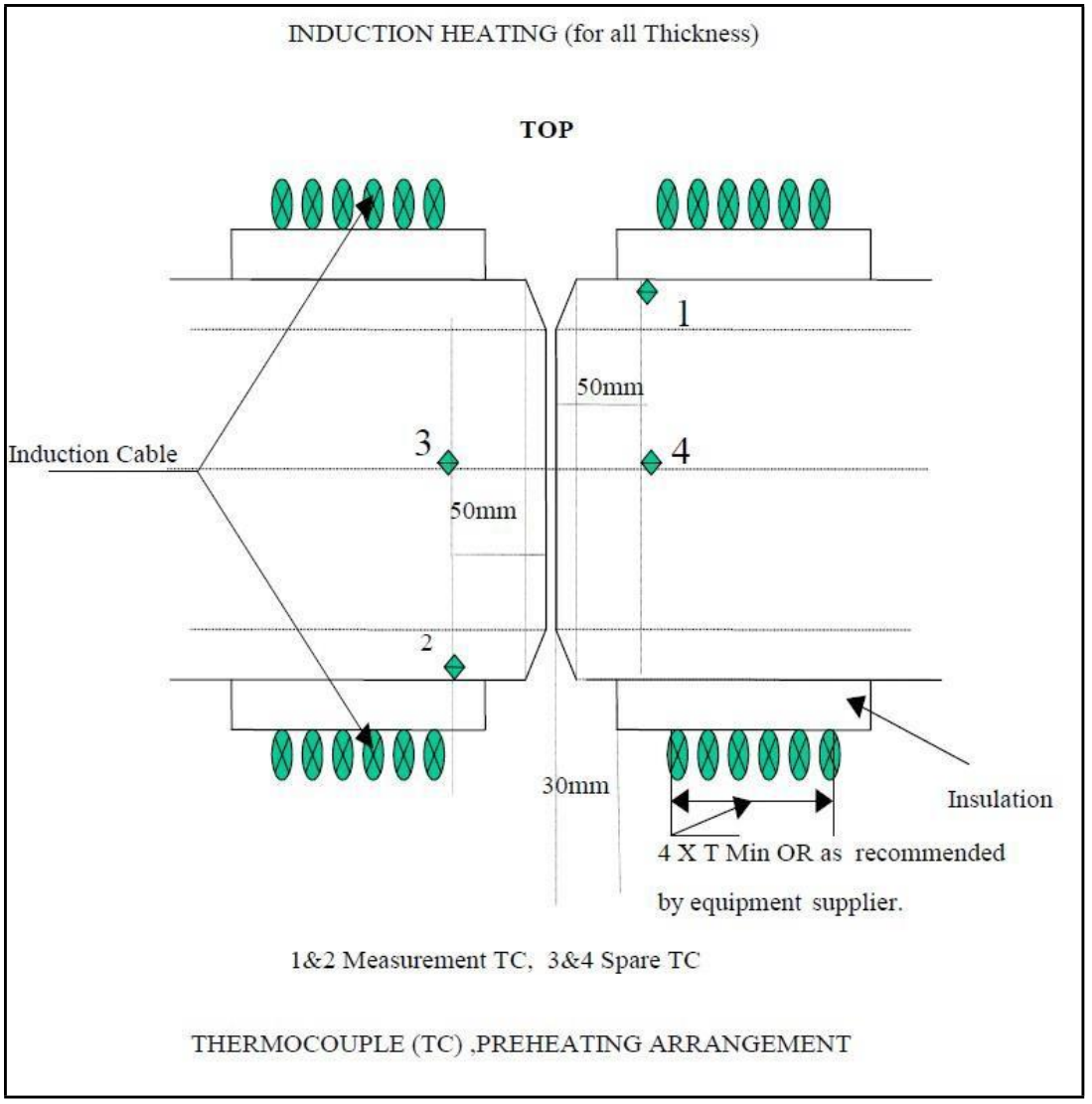


Figure 1.1: Placement of Thermocouples on P91/P92/F91/F92/C12A materials for Preheating

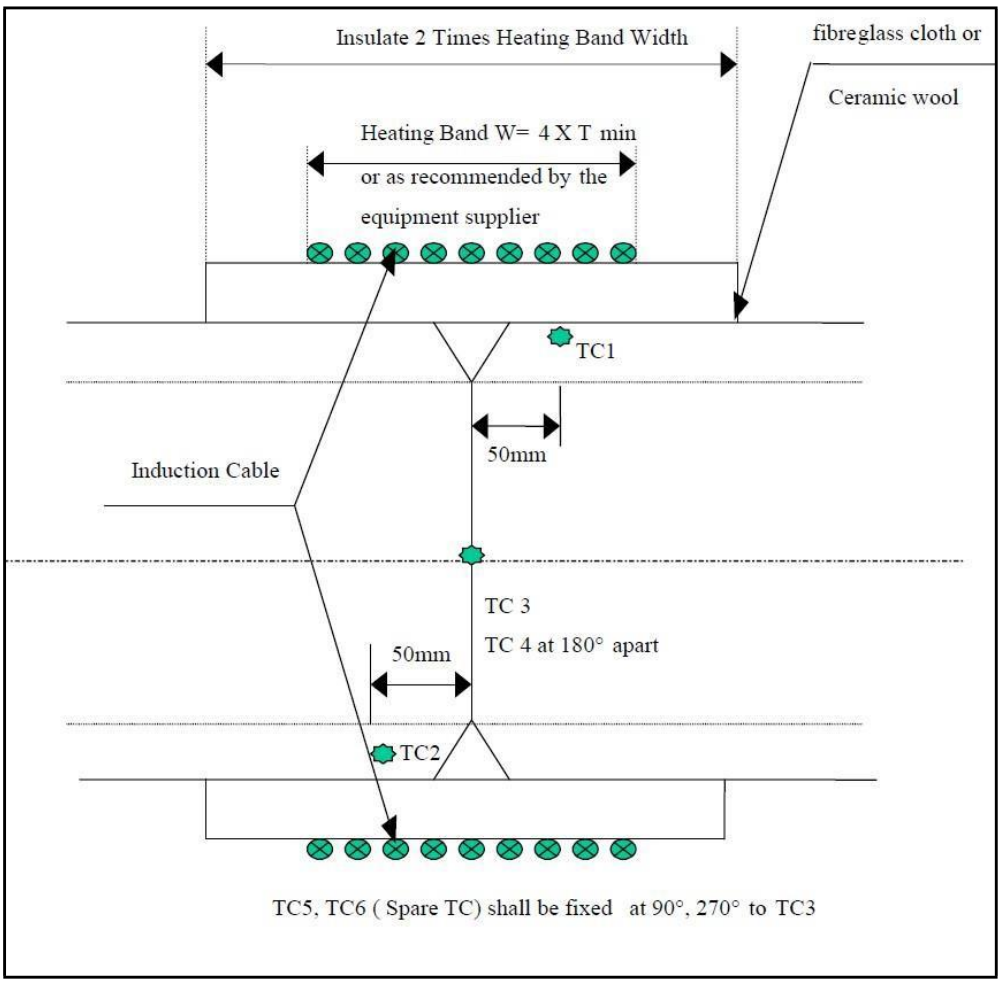


Figure 1.2: Placement of Thermocouples on P91/P92/F91/F92/C12A materials for PWHT

3.2.12 **Heat Treatment of T91/T92/T23 welds:**

3.2.12.1 Heat treatment controls of T91/T92 welds shall be as detailed in Cl. 3.2.1 to Cl.3.2.10 of this Manual.

3.2.12.2 Figure 1.2 & 1.3 of this manual shall be referred for Resistance heating coil arrangement for Preheating and PWHT of T91/T92 tube assembly.

3.2.12.3 The PWHT temperature shall be 730-760°C and the soaking time shall be 2.5 minutes per mm of weld thickness, subject to a minimum of 30minutes. All records shall be reviewed by site Engineer prior to PWHT clearance.

3.2.12.4 The rate of heating / cooling (above 300 ° C) for T91/T92 welds shall not exceed 140°C/hour.

3.2.12.5 Heat treatment controls of T23 welds shall be as detailed in Chapter B4 of Welding Manual - AA/CQ/GL/011/ PART I-WM – Latest.

3.3 **Heat Treatment of Components /Systems other than Boiler and Piping:**

3.3.1 Preheating, post heating and PWHT methodologies and parameters shall be as recommended by the concerned equipment suppliers.

3.4 **Heat Treatment Operator Requirements:**

The operator for the Heat Treatment shall be a qualified technician and shall be conversant in the operation & maintenance of heat treatment machines & process. He shall be trained by the concerned Site Engineer in order to operate and maintain the equipment and carry out the process properly.

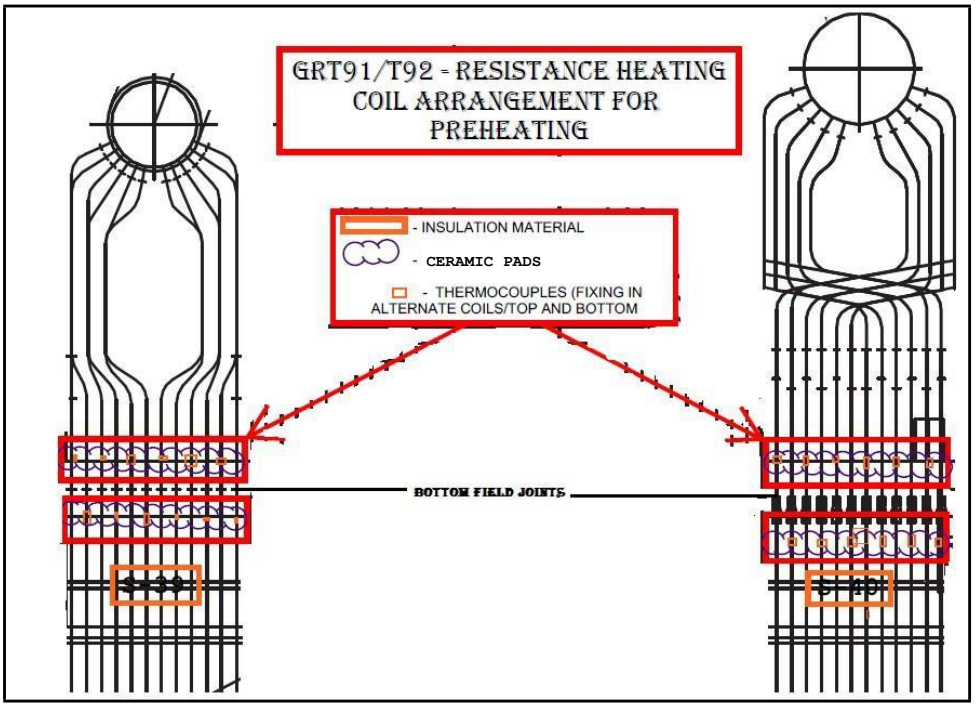


Figure 1.3: Resistance heating Coil arrangement for Preheating of T91/T92 tube assembly

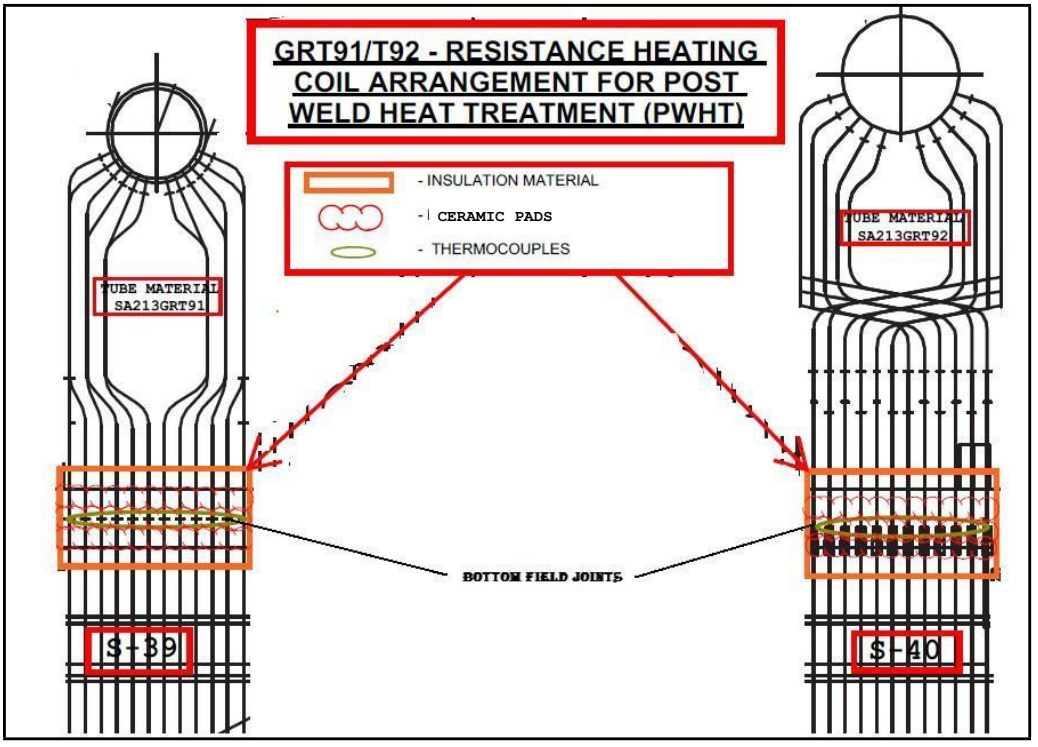


Figure 1.4: Resistance heating Coil arrangement for PWHT of T91/T92 tube assembly

3.5 **List of Tables:**

- Table-1.1: Weld preheat and PWHT for tubes and pipes outside diameter ≤ 102 mm.
- Table-1.2: Weld preheat and PWHT for Boiler Header welds.
- Table-1.3: Weld preheat and PWHT for pipes outside diameter > 102 mm.
- Table-1.4: Pre-heat and PWHT for Non-Pressure Parts including Structural.

4.0 RECORDS:

Relevant records like Job card and HT Charts shall be maintained by the Site Engineer till the closure of the project. The records may be handed over to the customer at the time of project closure if required by the contract

ANNEXURE I: PWHT JOB CARD

POST WELD HEAT TREATMENT (PWHT) JOB CARD

Project: _____

Card No. : _____ Date : Unit

No. : _____ Package :

Description: Temp. Recorder Details :

Weld Reference : _____ 1. Make : _____

Material Spec. : _____ 2. Type : _____

Size: Dia. mm _____ 3. Sl. No. _____

Thick (t) mm _____ 4. Chart speed: _____ mm / hour

NDE Cleared on : _____ 5. Calibration Due on : _____

Report No. : _____

Thermocouple Locations :

Minimum 2

Distance of TC from the weld centre =

Heating Band =

Insulation Band =

Date of PWHT Chart No. : _____

Start Time : _____ End Time :

	Required	Actual		
Rate of Heating (Max) °C/h				
Soaking Temperature °C				
Soaking Time (Minutes)				
Rate of cooling (Max)° C				

Ambient temperature recorded on the PWHT Chart: _____

TABLE – 1.1
WELD PRE HEAT AND PWHT FOR TUBES & PIPES
OUTSIDE DIAMETER ≤ 102 mm
(Applicable for Butt Welds and Socket Welds)

P. No. of Material	Thickness (mm)	Preheat (°C)	PWHT (°C)
P1 Gr 1	≤ 19	Nil	Nil
P1 Gr 2 (C ≤0.25%)	≤ 19	Nil	Nil
P1 Gr 2 (C > 0.25%)	≤ 9	Nil	Nil
	> 9	Nil	595-625
P3 Gr 1	≤ 13	Nil	Nil
P3 Gr 2	> 13	100 (Note 1)	620 - 650
P4 Gr 1	≤ 13	150	Nil
	> 13	150	650 - 670
P5 A Gr 1	≤ 8	150	Nil
	> 8	150	680 -710
P15 E Gr 1 (Gr. 91 & Gr.92)	All	220	730 - 760
SA 213 T23	All	220	730 - 760
P8	All	Nil	Nil

Note 1: Pre-heating is necessary for t >16mm.

TABLE – 1.2
WELD PREHEAT AND PWHT FOR BOILER HEADER WELDS
(Applicable For Welding of Header to Header Joints)

P. No. of Header Material	Thickness (mm)	Preheat °C	Post Heating °C	PWHT °C
P1Gr 1	$t \leq 19$	Nil	Nil	Nil
	$19 < t \leq 25$	Nil	Nil	595 - 625
	$25 < t \leq 75$	100	Nil	595 - 625
	$t > 75$	150	Nil	595 - 625
P1Gr 2	$t \leq 19$	Nil	Nil	620 – 635
	$t > 19$	150	150 for 2 hours	620 – 635
P4 Gr 1	All	150	Nil	650 - 670
P5 A	All	150	250 for 2 hours	680 - 710
P15E Gr1 (Gr 91 & Gr 92)	All	220	Nil	740 - 770
P15 E Gr1 + P5 A	All	220	Nil	730-760
T23	All	220	250 for 1 hour	730 - 760

TABLE – 1.3
WELD PREHEAT AND PWHT FOR PIPES
OUTSIDE DIAMETER >102 MM

P No. of Material	Thickness (mm)	Butt Welds		Stub and Attachment welds				Post heat °C
		Preheat °C	PWHT °C	Throat ≤ 19 mm		Throat > 19 mm		
				Preheat °C	PWHT °C	Preheat °C	PWHT °C	
P1 Gr 1	≤ 19	Nil	Nil	Nil	Nil	Nil	595 - 625	Nil
	>19≤25	Nil	595 - 625	Nil	595 - 625	Nil	595 - 625	Nil
	>25≤75	150	595 - 625	150	595 - 625	150	595 - 625	Nil
	>75	150	595 - 625	150	595- 625	150	595 - 625	Nil
P1 Gr 2	≤9	Nil	Nil	Nil	Nil	Nil	595 - 625	Nil
	>9≤19	Nil	595 - 625	Nil	595 - 625	Nil	595 - 625	Nil
	>19	150	595 - 625	150	595 - 625	150	595 - 625	150 for 2 hrs
P4 Gr 1	All	150	640-670	150	640- 670	150	640- 670	Nil
P5 A	All	150	680 - 710	150	680- 710	150	680- 710	250 for 2 hrs
P15 E Gr1	All	220	740-770	220	740- 770	220	740- 770	NA
P15 E Gr1 + P5 A	All	220	730-760	220	730- 760	220	730- 760	NA

For butt welds of different P group combinations, PWHT temperature may be as follows:

P1 + P3 -	620 to 650°C
P1 + P4 -	640 to 670°C
P4 + P5A-	680 to 710°C

(For other P Group combinations, refer to Manufacturing unit)

TABLE – 1.4

PREHEAT AND PWHT FOR NON PRESSURE PARTS INCLUDING STRUCTURALS

P. No. of Material / Material Specification	Gas Cutting		Welding		
	Thickness (mm)	Preheat °C	Thickness (mm)	Preheat (°C)	PWHT (°C)
P1 / IS 2062 E250 BR, E350 BR,E350C	> 50	Nil 100	> 63	Nil 100 150	595-625 1.0 All butt welds > 50 mm thick 2.0 For Ceiling girders if thickness > 50 mm 3.0 No HT required for web to flange fillet welds.
BS EN 10025 Gr 420 N (Ceiling Girder)	All	220	All	220	620 – 650
P3 Gr 1 and Gr 2	T>25	150	All	150	620-650 a) All butt welds in tension member b) All butt welds of fabricated components > 16mm thick and fillet welds with throat thickness > 13 mm
P4 Gr 1	All	150	All	150	650-680 a) All butt welds in tension member b) All butt welds of fabricated components > 16mm thick and fillet welds with throat thickness > 13 mm
P5A Gr 1	All	150	All	150	680-710 All welds (Note 2)
P15E Gr.1	Not permitted	Not permitted	All	220	740-770

NOTE:

1. All gas cut edges shall be ground for a width of 3mm to remove the HAZ.
2. All welds of P5A material shall be post heated at 250°C for 2 hours immediately after welding.

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GENERAL GUIDELINES FOR INSULATION WORKS

This booklet is given as a general guideline to this tenderers about insulation works, However instructions given in the drawings & other schedule issued during execution of the work shall be final and binding of the contractor.

Bharat Heavy Electricals Limited
(A Govt. Of India Undertaking)
Power Sector Southern Region
690, Anna Salai , Nandanam,
Chennai – 600 035

GENERAL NOTES ON
ERECTION OF INSULATION

1. It is important that the sheet metal covering is done, by a experienced and competent tinsmith.

2. Person, who is doing the actual job, can alter the following said methods of fixing the sheet metal, as and when necessary, only after consulting the BHEL Erection Engineer.

3. Fixing pin of corresponding thickness of insulation shall be welded by **STUD WELDING** process.

4. Circumferential and axial overlapping of outer casing should be 50 mm unless specified otherwise.

5. **FOR HORIZONTAL AND INCLINED DUCT AND PIPE**:

   1) All overlapping in axial direction should be at the bottom of the duct and pipe. Provision of beading and Sealing compound is not required.

   2) For circumferential overlapping of inclined duct and pipe, provision of beading and Sealing compound is not required.

   3) For circumferential overlapping of horizontal pipe and duct, provide beading. Apply Sealing compound if necessary.

5A. **FOR VERTICAL DUCT AND PIPE:**

   1) For overlapping in the axial direction provide beading. Apply Sealing compound if necessary.

   2) For circumferential overlapping provision of beading and Sealing compound is not required.

6. The joints of wool mattresses should be staggered in both circumferential and axial direction. The Wire netting at the joints of Wool mattresses are to be sewn together by G.I. sewing wire dia 0.71 mm.

7. In case more than one layer of Wool mattress is to be applied for pipe insulation the inner layer should be tied by two turns of G.I binding wire dia 1.22 mm at a pitch of 240 mm, and the outer layer should be tied by two turns of G.I. binding wire dia 1.22 mm at a pitch of 160 mm. The ends of the wire should be twisted and pressed in to the insulation.

8. All the overlapping of outer casing should be made such that no rain water enters into the insulation through the joints.

9. Incase of insulation fixing pin welding to tubes, equal circumferential pitch is to be maintained. Use a minimum number of 4 pins, at 90 degree radial spacing.

10. The inner side of the Aluminum / G.I sheet of outer casing should be painted with two coats of anticorrosive Paint (IS:158). Retainer – Type A must be coated with Aluminum paint to avoid bi-metal corrosion or Neoprene strip must be provided between Retainer – Type A and Casing support.

    The above mentioned paints are not in BHEL scope of supply

11. Self tapping screws should be fixed over the circumferential overlapping. The axial joints should be on the Casing supports and outer casing should be fixed to Casing supports with Self tapping screws at a pitch of 150 mm approximately.

12. The outer casing should be wound tightly around the insulation and then fixed with Self tapping screws when there is not any Fixing pin for insulation.

13. Loose wool can be taken from the Wool mattresses wherever required.

14. Clean the surface to be insulated of rust, dust, grease, loose scale, oil, moisture, etc.

15. Care shall be taken that flexible insulation is not unduly compressed.

16. After insulating the equipment with Calcium silicate / Mineral wool mattress, all voids in the joints shall be filled with Moldable insulation / loose mineral wool respectively.

17. Each day application of insulation should be weather proofed overnight by either with the final protective casing or with some temporary weatherproof covering so that it does not get drenched in rain.

18. The indicated thickness of insulation is the minimum requirement which should be provided. Any alteration in the thickness of insulation should be done only after getting the prior approval from the Design Engineer.

19. The layers of Wool mattresses are to be taken as indicated below:

	LAYER IN mm				
THICKNESS IN mm	1st	2nd	3rd	4th	5th
250	50	50	50	50	50
230	50	60	60	60	
210	50	50	50	60	
200	50	50	50	50	
190	40	50	50	50	
180	60	60	60		

160	50	50	60
150	50	50	50
140	40	50	50
120	60	60	
100	50	50	
80	40	40	

20. Where junctions between two or three bodies or different dia, occur and different insulation thickness is specified the greater thickness shall be continued for a length equal to one dia of the smaller body then smoothly tapered to the required smaller thickness over a length equal to two dia of the smaller body. When there is a differential thermal expansion between these bodies, they should be insulated individually.

21. The required fixing components and outer casing sheets have been released under PG_32. The insulation materials have been released under PG-33.

22. **STORAGE INSTRUCTIONS**:

22a) Mineral wool mattress:

These materials should be stored under fully covered sheds. Stocking must be done over planks and must be out of contact with ground. Height of stacking should not exceed 3 Meters.

Once drenched in water these materials loose all the desired properties and become unsuitable for use. Drying the material does not restore the desired properties.

22b) Outer casing sheets:

Outer surfaces are meant for improving the appearances also scratch marks, dents, etc, spoil the appearance.

23. Typical insulation arrangement drawings are indicated below.

1)	Tees	4-00-235-08546
2)	Elbows	4-00-235-08547
3)	Flanges	4-00-235-08548
4)	Expansion joint for pipe	4-00-235-08549
5)	Expansion piece for duct	3-00-235-06258 & 3-00-235-06259
6)	Manhole door for duct	3-00-235-06260

INSULATION OF DRUM END

MATERIAL:

1) FLAT 50 X 6
2) FIXING PIN INSLN DIA – 6
3) RETAINER TYPE – A
4) G.L. BINDING WIRE DIA – 1.22 / 0.914
5) WOOL MATTRESS
6) OUTER CASING
7) SELF TAPPING SCREW – M4 X 13
8) G.L. SEWING WIRE DIA – 0.71 / 0.914

APPLICATION:

Install Flat 50 x 6 circumferential bands to fit snugly around the drum.

Flat 50 x 6 lattice bar 8 numbers should be radially placed over the dished end and contouring the same and it is to be welded over circumferential bands.

Weld the Fixing pins to the lattice bars circumferential bands.

Fix the Wool mattress.

Position the Retainer and tack weld to the Pin.

Tie with Binding wire across the Pins.

Fix the outer casing strips by Self tapping screws.

INSULATION OF PIPES AND BUNCH OF TUBES

MATERIAL:

1) WOOL MATTRESS
2) G.L. SEWING WIRE DIA-0.71 / 0.914
3) G.L. BINDING WIRE DIA – 1.22 / 0.914
4) OUTER CASING
5) SELF TAPPING SCREW – M4 x 13

APPLICATION:

Fix the insulation over the bunch of tubes / pipes.

Tie the insulation with G.I. binding wire circumferentially.

Fix the outer casing sheet with self-tapping screws.

INSULATION OF VERTICAL PIPES
(WELDING OF FIXING PINS NOT PERMITTED ON PIPES)

MATERIALS:

1) FIXING PIN INSLN DIA – 6
2) RETAINER TYPE – A
3) CASING SUPPORT – 850MM
4) OUTER CASING
5) WOOL MATTRESS
6) SELF TAPPING SCREW – M4X13
7) CLAMP
8) SUPPORTING SHEET
9) FLAT 50 x 6
10) PACKING CLOTH – 3 MM TK
11) HEX HD BOLT M8X40
12) HEX NUT M8
13) PNCHD WASHER A9
14) GI BINDING WIRE DIA – 1.22 /0.914
15) GI SEWING WIRE DIA – 0.71 / 0.914
16) SHEET 3.15x30x3000

APPLICATION:

At every three meters provide the Clamps over the pipe with bolt but and washer by using packing cloth in between the pipe and clamp. Fix the sheet 3.15x30x3000 over the pipe and weld to the clamps. Weld the fixing pin over the sheet. Consult the Welding engineer before welding.

Weld the Flat to the Clamps.

Weld the Supporting sheets to the Flats.

Fix the insulation.

Position the Retainer Type – A and tack weld to the Pins.

Tie the insulation to the pipe with GI biding wire circumferentially.

Fix the casing support to the Retainer by using two numbers of Self tapping screws, fixed diagonally for each Retainer.

Fix the outer casing sheet with self tapping screws.

INSULATION OF VALVE

MATERIAL:

1) SM CLAMP FOR DETACHABLE INSULATION TYPE – A (To be used up to 200 mm overall dia)

1)a SM CLAMP FOR DETACHABLE INSULATION TYPE – B (To be used above 200 mm overall dia)

2) WOOL MATTRESS

3) OUTER CASING

4) SELF TAPPING SCRES – M4 x 13

5) G.I SEWING WIRE DIA – 0.71

6) SNAP HD RIVET 3 x 8

7) CHS SCREW M4 x 20

8) HEX NUT M4

APPLICATION:

The sheeting shall be made in two halves and the Sheet metal clamp mounted.

Wool mattress thickness according to adjacent pipe lines shall be pressed in to two halves.

The two halves shall be fitted over the valve to be insulated and locked by Sheet metal clamp.

Self tapping screws shall be used for clamping the two edges of the outer sheet casing when the length of the valve is more.

After assembling the Clamp put a bit of GI Binding wire as a pin through 1.6 mm hole provided.

INSULATION OF DUCT / FLAT SURFACE

MATERIALS:

1) FIXING PIN INSLN DIA – 6
2) WOOL MATTRESS
3) OUTER CASING
4) RETAINER TYPE – A
5) GI BINDING WIRE DA – 1.22 / 0.914
6) CASING SUPPORT – 650 MM
7) SELF TAPPING SCREW M4 x 13
8) GI SEWING WIRE DIA – 0.71 / 0.914

APPLICATION:

Weld the Fixing pin over the Duct / Flat surface.

Fix the insulation.

Position the Retainer Type – A and tack weld to the Fixing pins.

The GI Binding wire dia 1.22 shall be wound across the Fixing pins diagonally underneath the Retainer Type – A.

Fix the Casing support – 650 long to the Retainer Type – A by using two numbers of Self tapping screws, fixed diagonally for.

Retainer Type – A.

Fix the outer casing by using Self tapping screws.

DUCT STIFFENERS

When the stiffeners protrudes through the insulation and are exposed to atmosphere, provide an additional 40 mm insulation over the stiffener.

DUCT DAMPER & GATE

Insulation thickness shall be s per the adjacent duct insulation. The stuffing boxes should not be insulated. A clear gap of 50 mm (minimum) should be maintained all around the stuffing boxes.

AIR HEATERS

DO NOT insulate over the axial seal, adjuster seal access covers and basket removal doors insulation should be applied in a manner to permit a free circulation of ambient air around the bearing.

INSULATION OF DUCT
(CLEARING STIFFENERS)

MATERIALS:

1) FIXING PIN INSLN DIA – 6
2) RETAINER TYPE – A
3) RETAINER TYPE – C
4) CASING SUPPORT – 650 MM
5) GI BINDING WIRE DIA – 1.22/0.914
6) GI SEWING WIRE DIA – 0.71 / 0.914
7) OUTER CASING
8) SELF TAPPING SCREW M4X13
9) WOOL MATTRESS
10) WELD MESH
11) CORNER SUPPORT
12) ANGLE 40X40X5 – 100

APPLICATION:

Weld the Fixing pin over the Duct.

Position the Retainer Type – C so that it will be in the same plane as that of the top surface of the stiffener.

Tack weld the Retainer – Type – C to the Fixing pin.

For the top plate of the horizontal duct, spread the Weld mesh over the Retainer Type – C.

This serves as the additional support where people walk over the insulation.

Weld the Corner support to the bottom corners of the duct.

Weld the Angle to the corner support.

This arrangement will help to achieve a sharp corner for the insulation and outr casing.

Fix the insulation.

Position the Retainer Type – A and tack weld to the Fixing pin.

The Biding wire shall be wound across the pins diagonally underneath the Retainer Type – A.

Fix the Casing support - 650 mm long to the Retainer by using 2 numbers of Self tapping screws, fixed diagonally for each Retainer.

Fix the outer casing by using Self tapping screws.

PROCEDURE FOR CURING OF CASTABLE REFRECTORY

CURING OF REFRACTORY WORK

Curing of refractory means retaining the moisture for a minimum period in order to ensure the proper hydration of the binder. Curing of exposed castable surfaces should start after the surface has become firm. This can be tested when a finger rubbed across the surface comes away clean or when the surface feels warm to the touch. Moisture loss for the first 24 hours, after the material has been installed shall be retarded. Initial set occurs within one or two hours.

Castables should be cured for 24 hours. Moist conditions can be maintained by protection with damp sacking or plastic sheet which should not come into immediate contact with the refractory or alternatively by dry coating the castable with an impervious organic based sealing compound. In some instances, satisfactory results can be obtained by sparkling water over the surface. It should be watered for a period of 20 to 24 hours after 4 to 5 hours of construction. The rate of water applicable should be carefully controlled to prevent washing of the fines and to prevent collection of pools in low spots. Shield the surface from direct sunlight at least for about 48 hours. 8 hours after casting and pouring, remove the wooden frames which have no load bearing function in order to permit watering of the lateral parts of the structures. In case of steel frames apply water without stripping them. On completion of the curing period the application of moisture should be stopped. The exposed castable should be allowed to air dry for 24 hours. Naturally air drying of castable after curing will actually cause slight increase in strength. The castable can be all dried indefinitely without adverse effect. Optimum results cane be obtained with a drying period of 48 hours.

Before lighting the boiler for drying the setting the following shall be attended.

1. All dirt and foreign objects sticking to tube surface are to be removed to ensure a thoroughly clean surface.

2. Expansion joints are to be cleaned and inspected for the proper functioning of expansion during operation.

3. Test sample of castable refractory is to be taken from entry door regions to determine the moisture content in the laboratory.

   Sample of castable are to be taken for the determination of moisture content before and after drying. When the moisture content drops below 0.58 the castable is considered to be dry and the boiler is ready for commissioning. All result of measurement should be duly recorded.

CARE OF THE REFRACTORY WORK

The refractory work is subjected to considerable thermal stresses during boiler operation. Sudden application of heat or cooling introduces severe stresses and endangers the refractory work. Even when the boiler is operated in the recommended regime possibilities of damage occurring to the refractories (due to severed reasons such as bad workmanship, poor quality, slag deposition, corrosive atmosphere etc) must be kept in mind. The following simple rules to be observed.

(i) Avoid sudden cooling of the furnace after a shut down. A cooling rate of 20º to 30º per hour for the refractory lining in the initial period is recommended. This means that FD fans must be stopped after a shut down of the boiler. Ventilation of the furnace by natural draft is permissible only after six hours of shut down. Forced cooling can be started only after 16 hours.

(ii) Avoid quick heating of the furnace. Boiler starting diagram is usually a reliable guide.

(iii) Thoroughly examine the refractory work during shot downs for cracks, chipping off spelling etc. During operation also this can be checked periodically by visual examination through observation holes.

Whenever defects are notice arrange for their quick alimentation, by shutting down the boiler at the earliest depending on the scarceness of the defect.

(iv) Abnormal heating of outside metal sheet covering of the boiler and hot spots are usually a good indication of damaged refractory and insulation in this area. The leakage of flue gas will spoil the property of good mattresses within a short time.

(v) Deep the access door, observation doors, etc. properly shut. They are entry points for cold air and this cold air can damage the refractory work by localized cooling.

(vi) Sufficient quantity of water is to be added to the castable refractory for mixing before application as per supplier’s recommendations.

METHOD OF APPLICATION AND CURING OF POURABLE INSULATION

(i) Typical application are for insulating behind buckstays and areas such as roofs having multiplicity of hangers, rods and other penetrations.

(ii) The application of pourable insulation cab be pumping and gunning.

(iii) Density of the pourable insulation installed and cured is around 600 to 650 Kgs/ M

(iv) Pourable insulation is a hydraulic setting insulation additive or air entrainment agents shall not be used.

(v) (a) Empty the entire bag at a time and mi the while material so that segregated particles get mixed.

(b) The pourable insulation should be thoroughly mixed with coal clean water to develop casing and pump consistencies.

© The correct quantity of water shall be placed in the mixer before adding the dry pourable insulation normally about 70 to 100 by weight. However this has to be confirmed from the supplier while purchasing this material.

(d) Mixing time shall not to be less than the minutes or more than five minutes.

(e) Dried out material shall not be remixed.

(f) Pourable insulation once mixed must be in place within half an hour.

(vi) (a) All areas where pourable insulation will be placed must be fee of scale, rust, dust or other loose materials.

(b) All porous forms used such as wood etc shall be oiled before pouring.

© All absorbent surface such as insulation brick, concrete, shall be wet down thoroughly to prevent water absorption.

(d) Waiting of wall insulation used as forms at buckstay levels is not required.

(vii) (a) The surface of pourable insulation once in place will become firm in approximately two hours. The surfaces should be kept damp with an occasional light spray or covering with a cloth that is kept damp for the entire 24 hours curing period.

(b) For mixing and spraying the water should be clean and cold.

© Application of moisture after 24 hours should be stopped forms etc should be removed and the materials allowed to air dry for 24 hours.

(viii) The shuttering scaffolding moulds should be removed after about 36 hours of casing.

APPLICATION OF INSULATION FOR BOILER PIPING, PIPING AND EQUIPMENTS / VESSELS AND ACCESSORIES.

Bonded mattress having standard thickness to 25, 10, 50, 60, 75 mm confirming IS 8103 having a density of 150 kg/cubic meter and light bonded mattress having a density of 150 kg/cubic meter and light bounded mattress having standard thickness of 25. 40, 50, 60, 75 mm conforming to IS 9842 having a density of 144 kg/cubic meter and pipe section in the standard thickness of 25, 40, 50, 60, 75 mm confirming IS 9842 having density of 144 kg/cubic meter will be 100 kg/cubic Mtr.

The application of insulation will be done as per general notes/ drawings enclosed. The application commissioning shall be as per latest editions of IS 7413 code of practice for application and finishing of thermal insulation materials between 40º C to 700º C of Bs 5970 code for practice for thermal insulation of pipe work and equipment (in the temperature range – 100º C to + 870º C).

Inspection before application, during the application and after the application of insulation will be carried out by BHEL Field Quality Engineer as per BHEL Field Quality Plan. Every layer of insulation shall be got approved by BHEL Engineer / FQA Engineer.

Prior to applying insulation the surfaces to be insulated shall be made clean and dry and free from dirt and grease. Where cladding is attached to carbons steel or low alloy steels the steel shall be first prime painted with zinc chromate and then painted with Aluminum paintings. Wherever required to provide aluminum foil as protective covering for bolts and other fittings shall be arranged by contactor. The prints wherever required for preservation coating shall be supplied by contractor.

For insulation of piping with performed pipe sections the came shall be applied over pipe and finally be held in position with 15 mm wide aluminum band at greater than 300 mm spacing for mineral wool insulation.

For insulation of piping with mattresses having backing GI wire netting, the required lengths and shapes are to be cut from the blankets and wrapped on the piping and held in position with proper support by fastening the binding to be done circumferential at not greater than 300 mm spacing.

Performed insulation on vertical or near vertical piping must be supported in position by means of metal ring at interval not greater than 960 mm.

The support attachment may be welded or clamped to the pipe, subject to the approval of BHEL Site Engineer Necessary fabrication of support rings to be done as per site requirement.

Piping bends shall be insulated to the same specification as adjacent straight piping and should form a smooth external surface. Where performed material is used it should be cut loster-back fashion and wired or strapped into position.
Pipe insulation shall be cut to fit nearly around hangers and supports. On horizontal lines which are supported directly on pipe racks the insulation and weather proofing shall be sufficiently cut away at the support to accommodate pipe movement.

Protrusions through insulations which themselves do not required insulations such as pipe clamps supports of small pipings instrument take offs etc shall be covered to the same thickness as the adjacent insulation expect for hanger rods.

At outdoor location the hanger rod protraction shall be shielded with metal flashing to deflect rain and protect the insulation from moisture while permitting the movement of the hanger rod.

Arrangement of securing the metal finish even the insulation shall ensure that direct metal contact between the insulated surface and outer meter cladding is avoided. 4mm thick asbestos board packing shall be used at interface to thermally isolate the metal covering from supporting arrangement. All cladding joints shall be vapours tight and shall be able to accommodate thermal movements. Paste type self setting vapours sealing compound shall be used.

Metal cladding on piping shall be screwed with self tapping screws. These joints should be arranged approximately 30º below horizontal centre line so as to shed water on any horizontal pipe line. The screws shall be flat or round head types of 12mm size and overlapping of 50 mm on both longitudinal and circumferential joints. The screws shall be provided at not greater than 150 mm spacing.

Insulation expansion joints shall be provided in all pipelines to allow movements and expansion of the pipe. The recommended intervals of expansion joints are.

Pipe Temperature	Spacing of Insulation Expansion joints
Below 200°C	5.5 M
201° - 300°C	3.5 M
301°C - 400°C	3.0 M
Above 400°C	2.0 M

All joints in the insulation shall be staggered. For multiple layer of insulation the different layers shall be applied so that the butt joints of one layer do not coincide with those of the other layers. At the joint of each layer of insulation loose insulation shall be packed firmly.

Equipments Insulation Application Procedure

For equipment and shells a matrix of insulation support shall be developed by:-

(a) Welding the insulation support lugs on a frame work prepared with 20 mm x 3 mm size MS Straps where direct welding of lugs to he sheet is not permitted.

(b) Welding the directly on shell after written permission by Site Engineer. The material of the support shall be similar to the material of the shell in this case.

The support shell be pitched at 300 mm for vertical and underside surfaces and 500 mm for oppressed surfaces. A support shall be located above each vessel flange at a sufficient distance above the flange bolts to allow for easy removal. The top and bottoms supports shall be slotted suitably for attachments of straps and wires.

The support lugs shall be 6 mm

Insulation with back up GI wire noting, shall be cut to fit the equipments and shall be wrapped on the equipment and held in position with proper support and tie wires. All joints between course shall be staggered and tightly butter and adjacent edges laced together with lacing wire.

Insulation shall be fastened in place with MS Straps of 20 x 3 mm, on approx., 300 mm centers where contour of equipment permits. Straps shall be tightened with a banding machine and champed with seals.

Insulation on top of horizontal heads shall be cut to fit the curvature of the head and shall be secured in place with the help of radial straps fixed in between circumferential rings. Insulation on bottom heads shall be wired to nuts welded to head. Insulation shall also be strapped to bottoms insulation support. For outdoor equipments insulation shall be arranged to be weather proof.

Metal jacketing shell be applied directly over the met insulation and neatly fitted to place. All gaps shall be arranged so as to shed water. Suitable flashing and weather proofing shell be provided at all nozzles, manholes and other projections to prevent the entrance of water.

VALVES & FLANGES INSULATION APPLICATION

The insulation on all valves and flanged joints shall be enclosed in a removable jacketing so that it may be removed without disturbing the concerned equipment or piping. The thickness of insulation shall be same as that of the pipe line in which these valves and fittings are located.

The layout of wool mattresses to be adopted to obtain the specified insulation thickness are as per be on unless otherwise specified:

Thickness of Insulation (mm)	Layer			
	I	II	III	IV
25	25			
40	40	-	-	-
50	50	-	-	-
60	60	-	-	-
65	40	25	-	-
75	75	-	-	-
80	40	40	-	-
100	50	50	-	-
110	60	50	-	-
125	75	50	-	-
135	75	60	-	-
150	75	75	-	-
155	75	40	40	-
160	75	60	25	-
165	75	50	40	-

The material density of boned mineral wool used for pipe having outside diameter more than 355.6 mm is 150 kg/cubic mater 13 8183.

The material density of bonded mineral wool used for pipe having outside diameter less than or equal to 355.6 mm is 144 kg/cubic meter IS 9842.

Cladding material used is galvanised steel sheet as per IS 277 GRADE 375.

Cladding material gauge for pipe outside diameter less than or equal to 300 mm is 24 SWG.

Cladding material gauge for pipe outside diameter greater than 300 is 22 SWG.

For piping up to including 355.6 mm OD, first layer shall be pipe sections and subsequent layer shall be bonded. Wherever pipe sections are not supplied the first layer has to be wrapped using bonded wool material for piping 355.6 mm OD, bonded mattress shall be used or all the layers.

Description of type of insulation and the method of Application for Boiler Feed Pumps

1. **Type of insulation**

The pumps should be insulated with 125 mm thick flexible wire backed mineral wool mattress of 150 kg/ density.

2. **Method of Application**

The above insulation is to be applied to 2.0 mm thick flats aluminum sheeting (18 SWG) and secured by 19 mm vide aluminum retaining dips and 1/8 inch diameter aluminum pop rivets, all to be secured by 2 inch long X No.8 spacing to a 40 mm wide x 3 mm thick angle iron frame work of all welded construction bound by 40 mm PVC tape.

SECTION - A

THERMAL INSULATION FOR PIPING AND EQUIPMENTS

1.0 INTRODUCTION

In a thermal power station or process plant, thermal insulation or heat lagging of piping and equipment's carrying hot fluids is essential for hest economy and protection of operating personnel. Any pip which is at a temperature higher than it s surroundings will loose heat and the amount of heat lost will depend upon the temperature of the fluid and the thermal conductivity of the piping material/covering.

The heat lost through bare pipe increases with

a) Increase in the temperature of fluid conveyed
b) Decrease in ambient temperature and
c) Increase in wind velocity of the surroundings.

The heat so lost hast potential for work and rapidly increasing cost of fuel in the recent past has promoted to find all possible means to conserve energy. Providing proper and adequate insulation on to the piping and equipments controls heat transfer and maintains the required services temperature.

2.0 METHOD OF APPLICATION

The method of application is highly skilled job. Badly fitted/laid insulation can lead to greater hear loss, higher cold surface temperature than that estimated and frequent maintenance. Following are the important points to be considered in the application of the insulation.

2.1 Before applying insulation, it should be ensured that all instrument tappings, clamps, lugs and other connections on the surface to be insulate d have been properly installed as per relevant drawings.

2.2 All surfaces to be insulated shall be cleaned of all foreign materials such as dirt, grease, loose scale, moisture etc.

2.3 Welding of lugs, attachments, clips etc. on the surface to be insulated for supporting insulation shall not be carried out without the permission of the authorized person.

2.4 All flanged joints shall be insulated only after final tightening and testing.

2.5 The insulation shall be applied to all surfaces when they are at ambient temperature.

2.6 Where more than one layer of insulation is involved, mattresses should have staggered joints (at 60 deg) and they must be held in close contact with face of

pipes/fittings by means of binding wires / Aluminum bands / seals. Circumferential joints of multilayer insulation should also be staggered by at least 150 mm.
(Refer Drg. No. PE-4-999-169-01).

2.7 For the first layer of insulation and in case of multi layer of insulation, mattresses with hexagonal wire netting will be facing on outer side.

2.8 Insulation mattresses shall be held in place by fastening over with binding wire. Care should be taken to see that the flexible insulation mattresses are not unduly compressed. The ends of binding wire shall be lightly twisted together, bent over and pressed into the insulation. For mattresses, binding wire shall be used at intervals of 300mm.

In the addition Aluminium bands shall also be provided at 300 mm intervals for diameters greater than 500mm. (Refer Drg No. PE-4-99-169-01.)

2.9 Where junctions between bodies of different diameters occur and difference in insulation thickness is specified, the greater thickness is to be continued for a length equal to one diameter of the smaller body and then smoothly tapered to the required smaller thickness over a length equal to two diameters of the small body.

2.10 The indicated thickness of insulation are minimum requirement which should be maintained. Any change in the thickness of the insulation should be done only after prior approval of the design engineer.

2.11 The day-to-day insulation work should be covered with suitable protective materials to prevent the rain water entry, if same is expected.

2.12 The insulation shall be cut to fit the piping O.D / equipment and shall be wrapped on the piping / equipments and held in position with proper support and wires. All the joints should be properly staggered and tightly butted and adjacent edges laced (Refer Drg No. PE-4-999/169/01)

2.13 The insulation of valves and flange joints shall be enclosed in a removable jacketing so that it may be removed without disturbing the concerned equipment or piping. The thickness of insulating shall be same as that of the pip line in which these valves and fittings are located. (Refer Drg No. PE-4-999-169-07.)

2.14 Steam / Air / Gas leakages in and around the pipes to be insulated with be attended before applying insulation.

2.15 In order to provide support to Aluminium cladding, support rings made out of 20 x 3 mm M.S. flats shall be fixed at equal intervals of approximately 850 mm spacing and at every circumferential joints. These rings shall be fixed with ‘L’

type lugs and shall be fabricated from 20 x 3 mm M.S flats. To reduce that conductivity through these lugs 20 mm x 3 mm size Ceramic mill board shall be used between rings and lugs (Refer Drg No. PE-4-999-169-04 and PE-4-999-169-13).

2.16 Spacing between supporting rings for vertical piping shall be 3 mtrs. Support rings are to be provided only when the vertical height exceeds 3 mtrs.
(Refer Drg No. PE-4-999-169-03-and PE-4-999-169-05).

2.17 For vertical pipes since support rings is provided ate every 3 mtrs interval, only two spacer rings shall be provided in between support rings.

2.18 Spacer rings shall be provided at both ends of elbows/bends, valves and flanges pipe having dia more than 89mm.

2.19 Wherever the end of hanger clamp assembly protrudes out of the insulation at the bottom suitable box structure are to be provided. Pipe hangers and supports should be covered in such a way that the moisture cannot penetrate into the insulation.

2.20 It is very important that sheet metal cladding should be done by a well experienced and competent fabricator. Person doing the job can alter the method of fixing of cladding sheet after consulting the concerned design engineer.

2.21 The longitudinal joint in the outer cladding sheet should always be at the lower half of the circumference for horizontal piping so that no rain water enters the insulation through the joints. (Refer Drg No. PE-4-999-169-01).

2.22 The joints of outer cladding should be staggered axially.

2.23 Inside surface of all Aluminium sheet will have two coats of Bituminous paint applied uniformly.

2.24 Aluminium sheets covering on outdoor horizontal pipes will be provided with 3 mm drain hole at the bottom center line at 6 mtr intervals.

2.25 The cladding sheet shall provides directly over the insulation/finishing cement (1F APPLICABLE). Suitable flashing and weather proofing shall be provided at all nozzles, manholes and other projections to prevent the entrance of water.

2.26 Loose wool can be taken from wool mattresses. Wherever gaps and voids have to be filled.

2.27 Sealing compound to be applied on Aluminum cladding sheet joints.

2.28 Support rings/spacer rings shall be provided if the insulation thickness > 40mm and pipe diameter > 89mm.

2.29 Equipment's name plates shall not be insulated.

2.30 Clips made out of sheet be riveted inside the box for insulation of valves and flanges to hold the insulation in box. (Refer Drg No. PE-4-999-169-06).

2.31 The insulation local to the inspection points of the critical piping shall be removable.

3.00 For Thermal Insulation Material Specification related to the project refer Annexure – 1.

IMPORTANT POINTS TO BE TAKEN CARE DURING APPLICATION

I) Binding wires for all layers of insulation will be at distance of 300mm.

ii) In addition Aluminum bands/seals also to be provided at distance of 300 mm for sizes above 500mm.

iii) Aluminum bands/seals to be provided over aluminum sheets at distance of 500mm.

iv) Ceramic mill boards to be used between all 'L' type lugs and the support rings.

v) Inside surface of Aluminum sheets to have 2 coats of bituminous paint applied uniformly.

vi) Gaps to be properly filled with loose wool taken from mattresses.

vii) End of hanger clamp assembly protruding out of insulation at the bottom should be suitably boxed with Aluminum sheets.

viii) Valves to be insulated properly in box structure as given in enclosed drawings.

ix) Multilayer longitudinal and circumferential joints should be staggered.

ANNEXURE – 1

1.0 **Thermal insulating materials shall be per the details given below:-**

1.1 **Lightly Bonded Mineral (Rock) wool Mattresses** of density 150 Kg / Cub. Mt with S.S. wire netting will be applied for the first layer of insulation where hot face temperature greater than 400 degree centigrade. For subsequent layers matters of density 150 Kg / Cub. Mtr with G.S. wire netting will be applied.

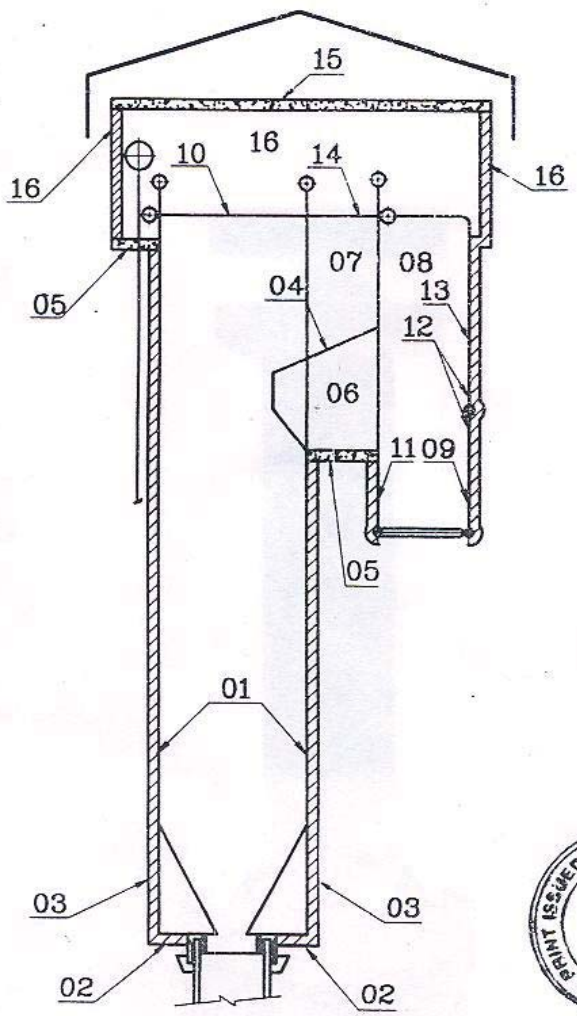
1.2 **Lightly Bonded Mineral (Rock) wool Mattresses** of density 100 Kg/Cub. Mt with G.S. wire netting will be applied for all layers of insulation for host face temperature less than and equal to 400 degree centigrade.

2.0 **Binding and lacing wires:** For insulation matters shall be of stainless steel for all insulation interface temperatures.

3.0 **Aluminum cladding sheet** shall be provided over the Mattresses ad per details given below.

18 SWG (1.22 mm thk.)	For pipes with dia over insulation above 450 MM.
20 SWG (0.91 mm thk.)	For pipes with dia over insulation above 150 MM and less than equal to 450MM.
22 SEG (0.71 mm thk.)	For pipes with dia over insulation less than equal to 150mm.

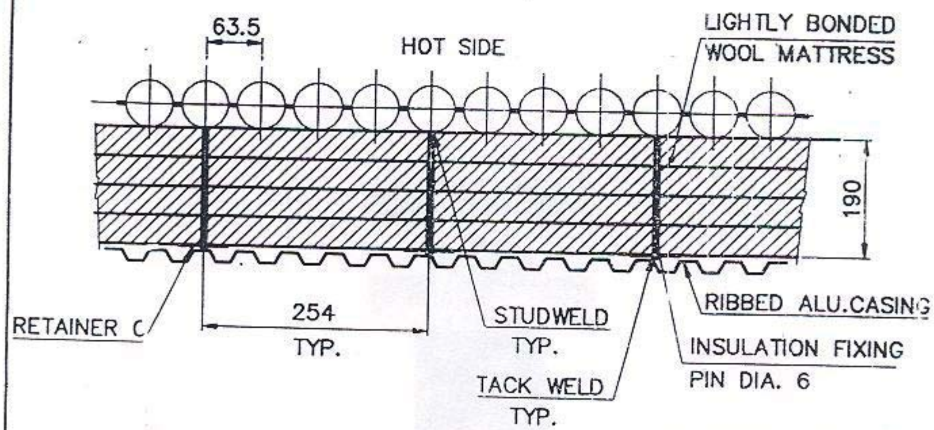
SECTION – B



INSULATION	DRN	C.S		DRG.NO. 4-00-215-08551	REV.NO. 00
	CHD	C.G.S			
	APPD	C.G.S			

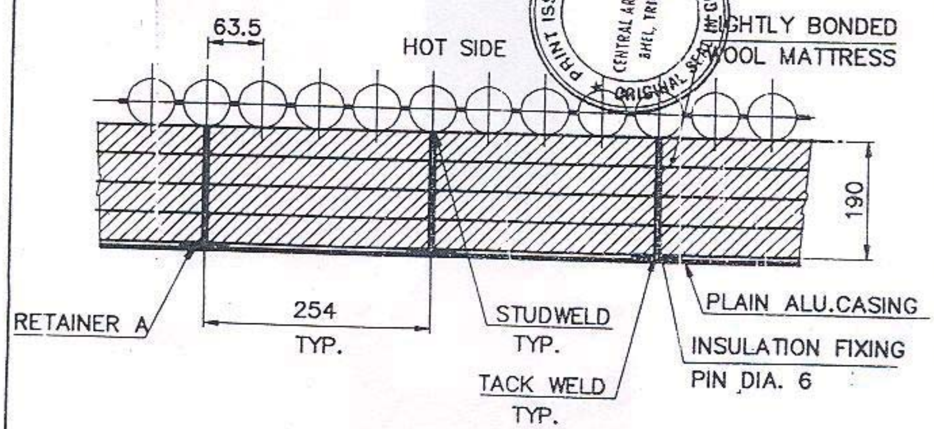
CTS001384-0

DETAIL 01



WT./SQ.M ≃ 32 KGS

DETAIL 02

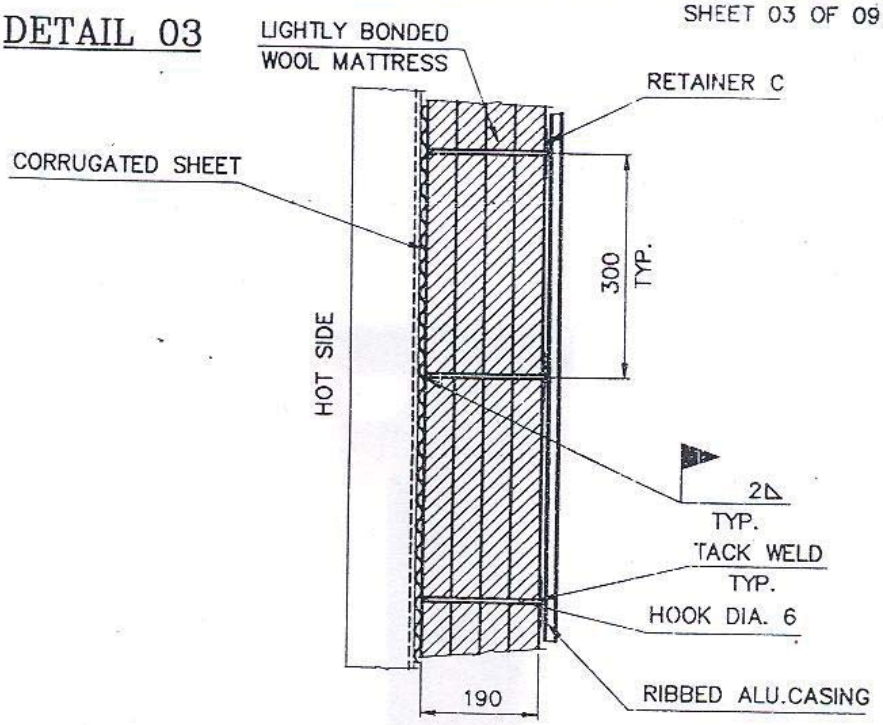


WT./SQ.M. ≃ 29 KGS

			DRG.NO.	REV.NO.
INSULATION	DRN	C.S	4-00-215-08552	00
	CHD	C.G.S		
	APPD	C.G.S		

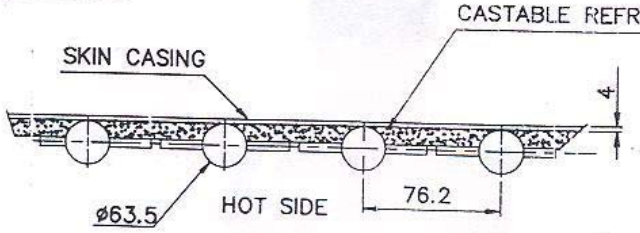
CTS001384-0

DETAIL 03



WT./SQ.M. ≃ 45 KGS

DETAIL 04

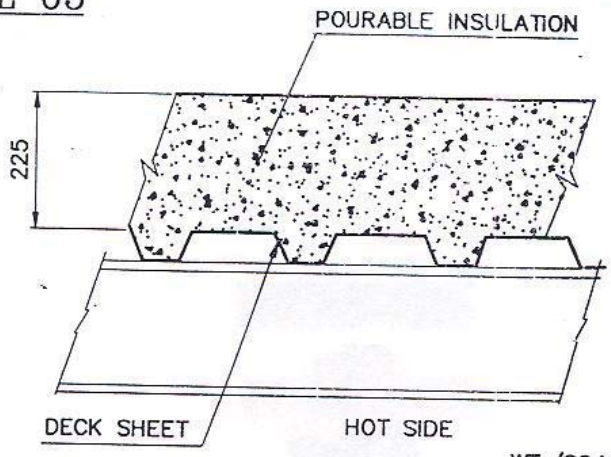


WT./SQ.M. ≃ 72 KGS

INSULATION	DRN	C.S ,		DRG.NO. 4–00–215–08553	REV.NO. 00
	CHD	C.G.S			
	APPD	C.G.S			

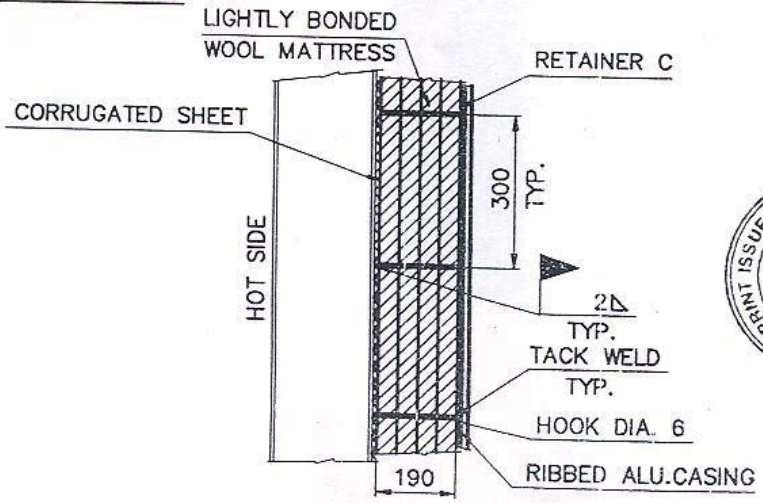
CTS001384-0

DETAIL 05



WT./SQ.M ≃ 193 KGS

DETAIL 06

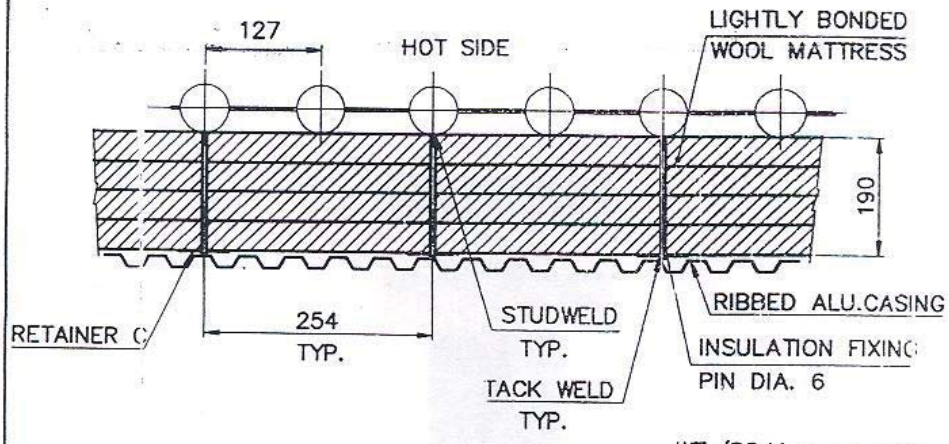


WT./SQ.M ≃ 45 KGS

INSULATION	DRN	C.S		DRG.NO. 4-00-215-08554	REV.NO. 00
	CHD	C.G.S			
	APPD	C.G.S			

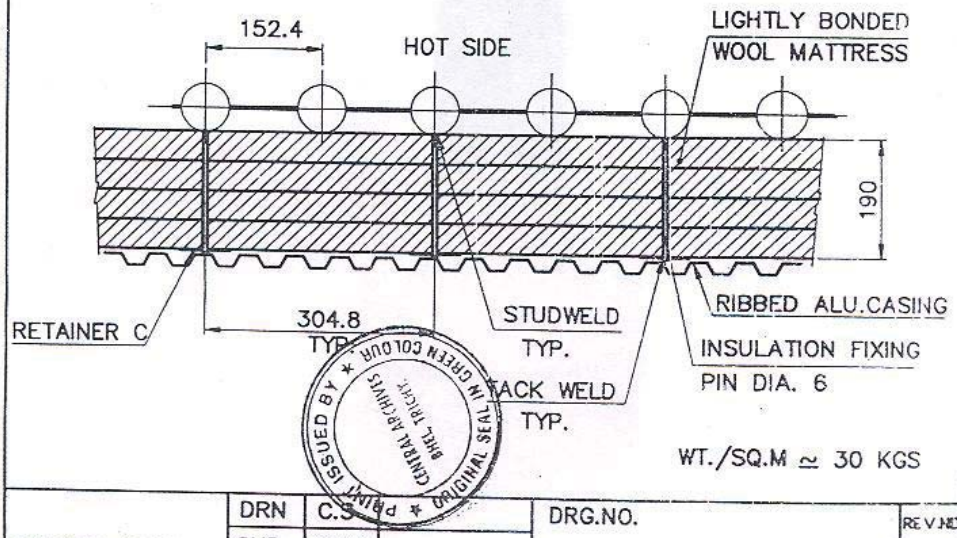
CTS001384-0

DETAIL 07



WT./SQ.M ≃ 32 KGS

DETAIL 08

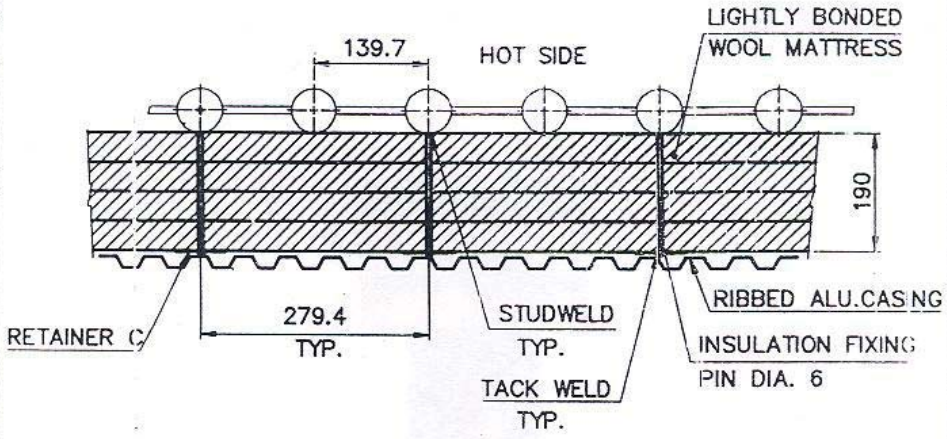


WT./SQ.M ≃ 30 KGS

INSULATION	DRN	C.S		DRG.NO. 4-00-215-08555	REV.NO. 00
	CHD	C.G.S			
	APPD	C.G.S			

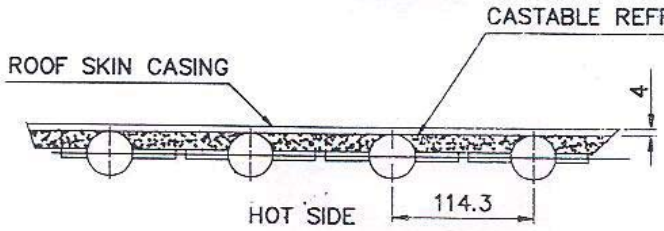
CTS001384-0

DETAIL 09



WT./SQ.M ≃ 30 KGS

DETAIL 10

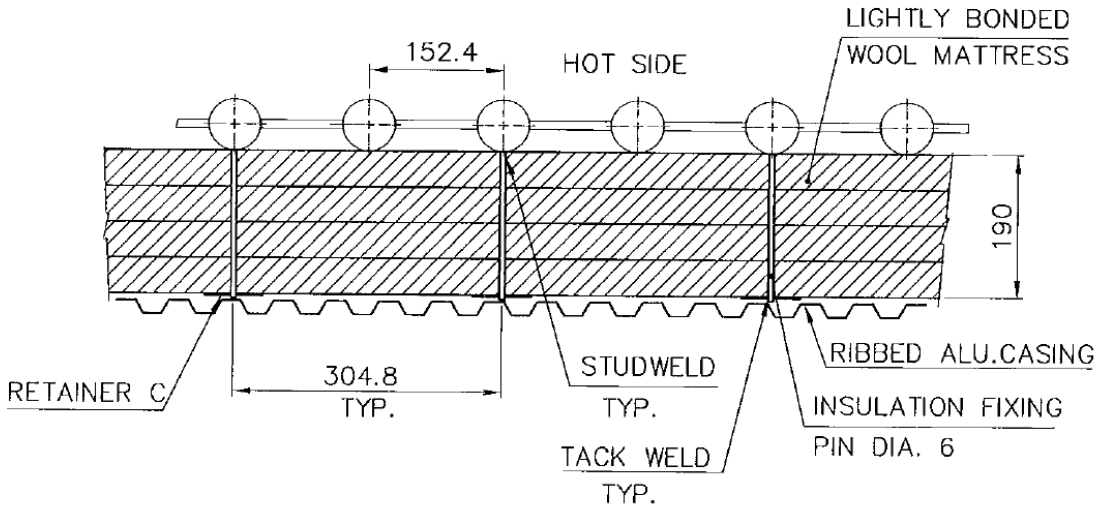


WT./SQ.M. ≃ 75 KGS

INSULATION	DRN	C.S		DRG.NO.	REV.NO.
	CHD	C.G.S		4–00–215–08556	00
	APPD	C.G.S			

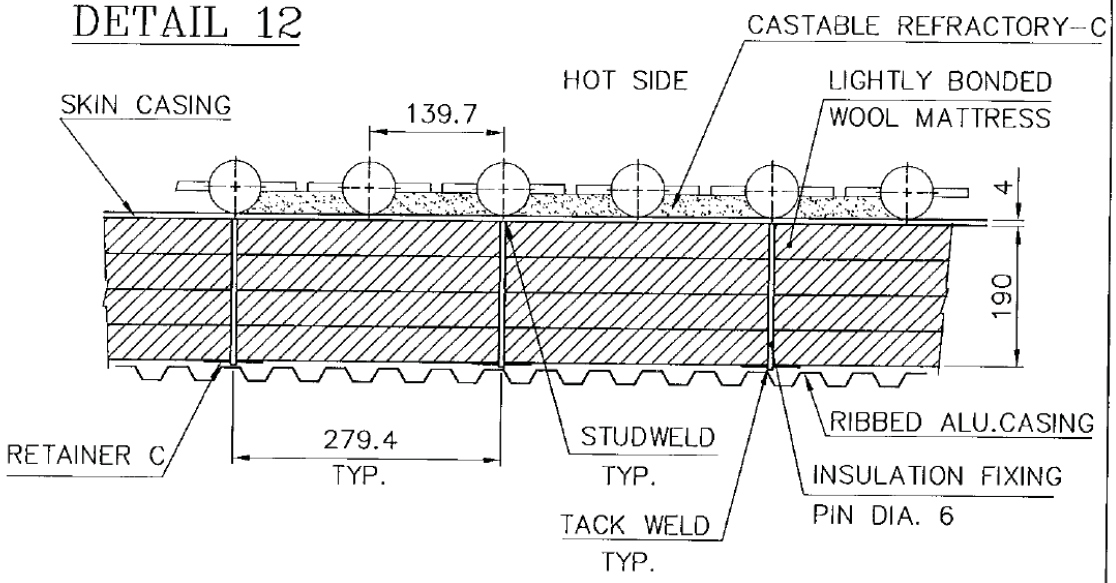
CTS001384-0

DETAIL 11



WT./SQ.M ≃ 30 KGS

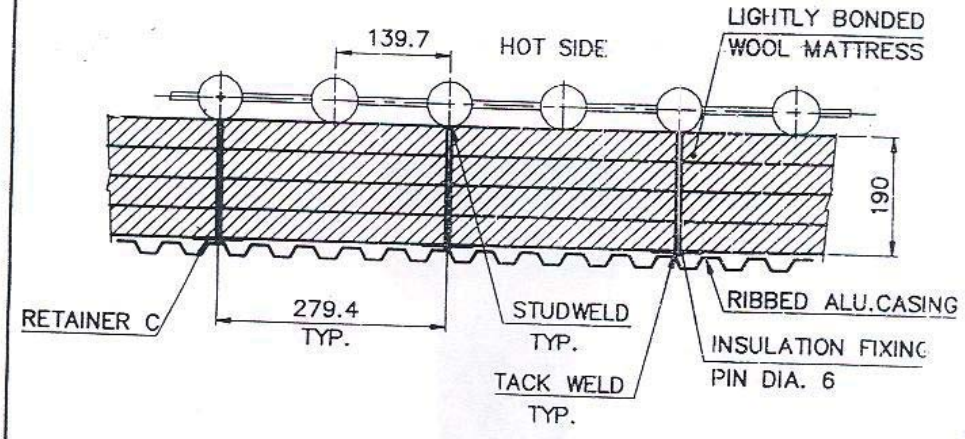
DETAIL 12



WT./SQ.M ≃ 85 KGS

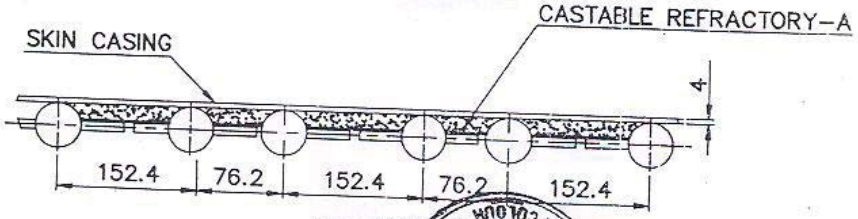
INSULATION	DRN	C.S		DRG.NO. 4-00-215-08557	REV.NO. 00
	CHD	C.G.S			
	APPD	C.G.S			

DETAIL 13



WT./SQ.M ≃ 30 KGS

DETAIL 14



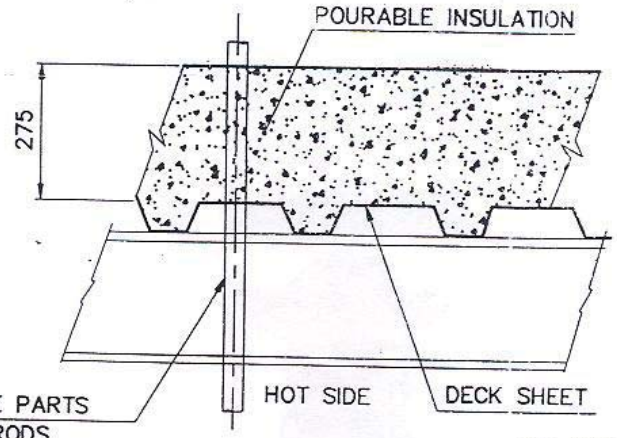
WT./SQ.M. ≃ 75 KGS

PRINT ISSUED BY ★ GREEN COLOUR ★ ORIGINAL SEAL IN THIS ARCHIVES

INSULATION	DRN	C.S		DRG.	REV.NO.
	CHD	C.G.S		4–00–215–08558	00
	APPD	C.G.S			

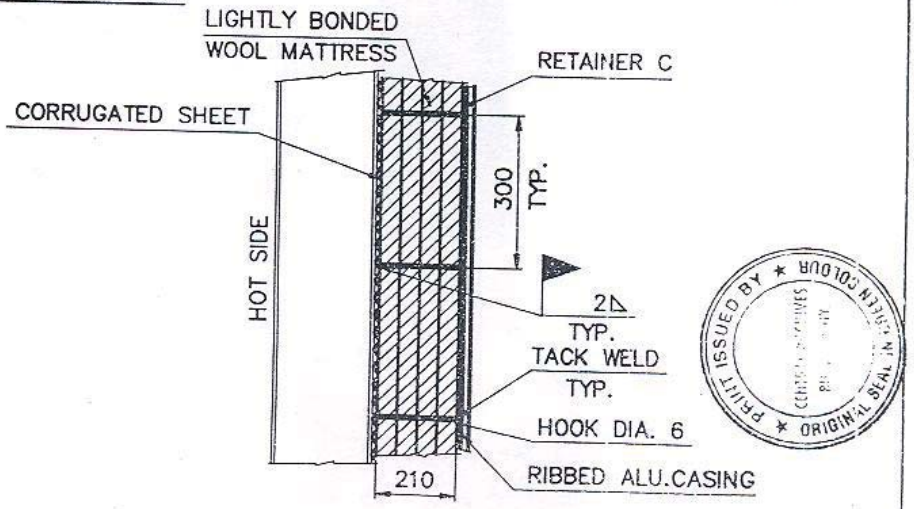
CTS001384-0

DETAIL 15



WT./SQ.M ≃ 233 KGS

DETAIL 16



WT./SQ.M ≃ 46 KGS

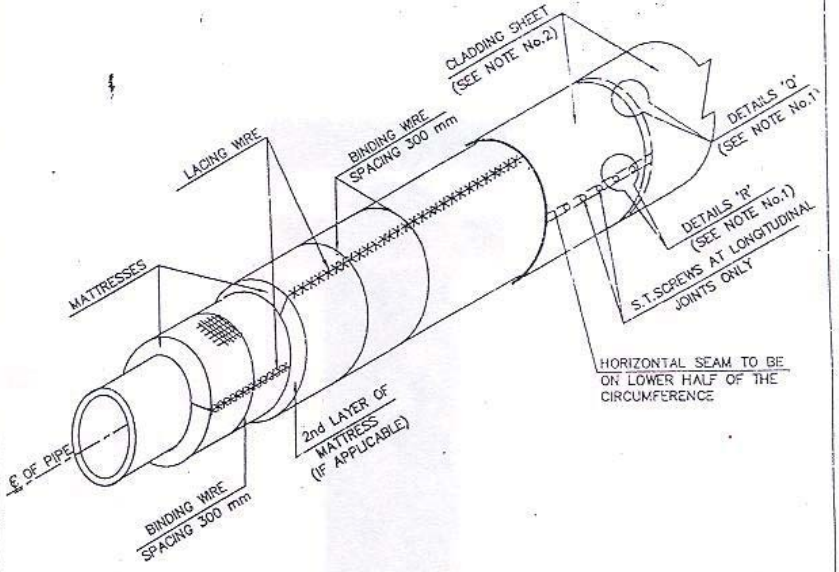
INSULATION	DRN	C.S		DRG.NO. 4-00-215-08559	REV.NO. 00
	CHD	C.G.S			
	APPD	C.G.S			

CTS001284-0

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM)

REV.	DATE	ALTERED / CHECKED	REV.	DATE	ALTERED / CHECKED

JOB NO. STANDARD



NOTES:—

1. FOR DETAILS 'Q' AND 'R' REFER DRG No. PE-4-999-169-12
2. FOR SHEET SUPPORT REFER DRG No. PE-4-999-169-04
3. FOR GENERAL INFORMATION ON APPLICATION OF INSULATION REFER DOCUMENT "INSTRUCTIONS FOR APPLICATION OF THERMAL INSULATION FOR PIPING AND EQUIPMENTS".
4. IN ADDITION TO BINDING WIRE ALUMINIUM BANDS TO BE PROVIDED FOR DIAMETERS > 500 MM.

MATERIALS REQUIRED:—

1. MATTRESSES
2. BANDS AND SEALS
3. CLADDING SHEET
4. S.T.SCREWS
5. SEALING COMPOUND
6. LACING WIRE
7. BINDING WIRE

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECTS ENGINEERING MANAGEMENT
NEW DELHI

DEPT.	CODE	SCALE	WEIGHT (KG.)	REF. TO ASSY. DRG	ITEM
MP	M	N.T.S.	—	—	—

TITLE:
INSULATION APPLICATION
(HORIZONTAL PIPES WITH MATTRESSES)

	NAME	SIGN	DATE
DRN	S.C.S.		
DESN	S.C.S.		9.6.97
CHD	D.B.S.		9.6.97
APPD	S.K.J.		11.6.97

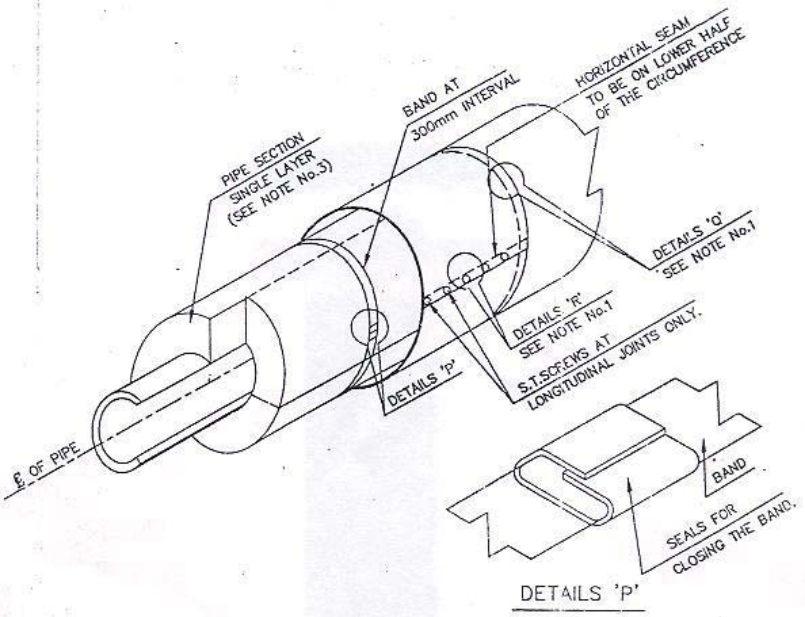
CARD CODE	DRAWING NO.	
—	PE-4-999-169-01	
	SHEET 1 OF 1	REV. 00

D1 A4

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM)

REV.	DATE	ALTERED / CHECKED	REV.	DATE	ALTERED / CHECKED

JOB NO. STANDARD



DETAILS 'P'

NOTES:–

1. FOR DETAILS 'Q' AND 'R' REFER DRG. No. PE–4–999–169–12
2. FOR CLADDING SHEET SUPPORT REFER DRG. No. PE–4–999–169–04
3. 2nd & 3rd LAYER IF ANY SHALL BE OF MATTRESSES.
4. FOR GENERAL INFORMATION ON APPLICATION OF INSULATION REFER DOCUMENT "INSTRUCTIONS FOR APPLICATION OF THERMAL INSULATION FOR PIPING AND EQUIPMENTS"

MATERIALS REQUIRED:–

1. PIPE SECTIONS
2. BANDS AND SEAL
3. CLADDING SHEET
4. S.T. SCREWS
5. SEALING COMPOUND

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POWER SECTOR
PROJECTS ENGINEERING MANAGEMENT
NEW DELHI

DEPT.	CODE	SCALE	WEIGHT (KG.)	REF. TO ASSY. DRG	ITEM
MPL	M	N.T.S.	—	—	—

TITLE:–
INSULATION APPLICATION
(HORIZONTAL PIPES WITH PIPE SECTION)

	NAME	SIGN	DATE
DRN	S.C.S.		6.6.97
DESN	S.C.S.		9.6.95
CHD	D.B.S.		9.6.95
APPD	S.K.J.		11.6.95

CARD CODE —

DRAWING NO. PE–4–999–169–02

SHEET 1 OF 1 REV. 00

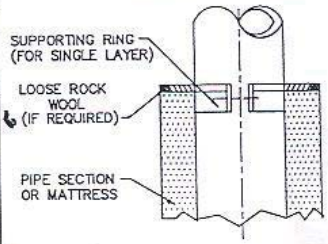
D2

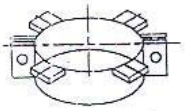
A4

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM)

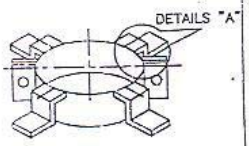
REV.	DATE	ALTERED / CHECKED	REV.	DATE	ALTERED / CHECKED

JOB NO. STANDARD

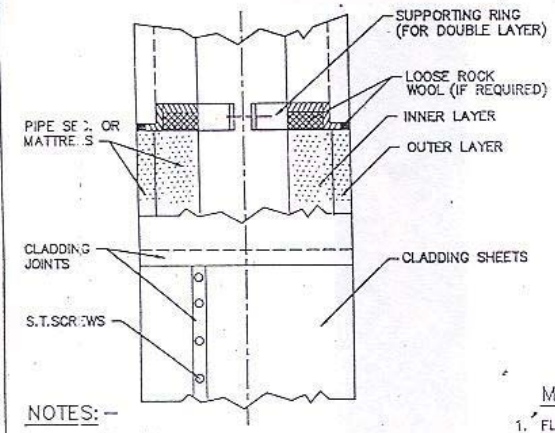


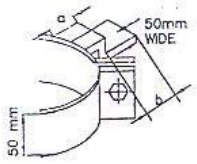


SUPPORT RING
(FOR SINGLE LAYER)



SUPPORT RING
(FOR DOUBLE LAYER)





DETAIL 'A'

NOTES:-

1. LENGTH 'a' & 'b' TO BE 12 TO 50mm LESS THAN SPECIFIED INSULATION THICKNESS.
2. SUPPORT RING TO BE FABRICATED OUT OF MS FLATS/STRAPS.
3. SUPPORT RING REQUIRED FOR PIPE 80 Nb & LARGER IF INSULATION THICKNESS LARGER THAN 30mm.
4. SUPPORT RINGS REQUIRED FOR MATTRESS ONLY.
5. FOR GENERAL INFORMATION ON APPLICATION OF INSULATION REFER DOCUMENT "INSTRUCTIONS FOR APPLICATION OF THERMAL INSULATION FOR PIPING AND EQUIPMENTS"

MATERIALS REQUIRED:-

1. FLATS/STRAPS
2. MATTRESSES/PIPE SECTIONS
3. CLADDING SHEET
4. NUTS AND BOLTS
5. SELF TAPPING SCREWS
6. SEALING COMPOUND
7. SUPPORT RINGS (FOR MATTRESSES ONLY)

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECTS ENGINEERING MANAGEMENT
NEW DELHI

DEPT.	CODE	SCALE	WEIGHT (KG.)	REF. TO ASSY. DRG	ITEM
MPL	M	N.T.S.	—	—	—

TITLE:-
INSULATION APPLICATION
(VERTICAL PIPING)

	NAME	SIGN	DATE
DRN	S.C.S.		9.6.97
DESN	S.C.S.		9.6.97
CHD	D.B.S.		9.6.97
APPD	S.K.J.		9.6.97

CARD CODE	DRAWING NO.	REV.
—	PE-4-999-169-03	00

SHEET 1 OF 1

1-4

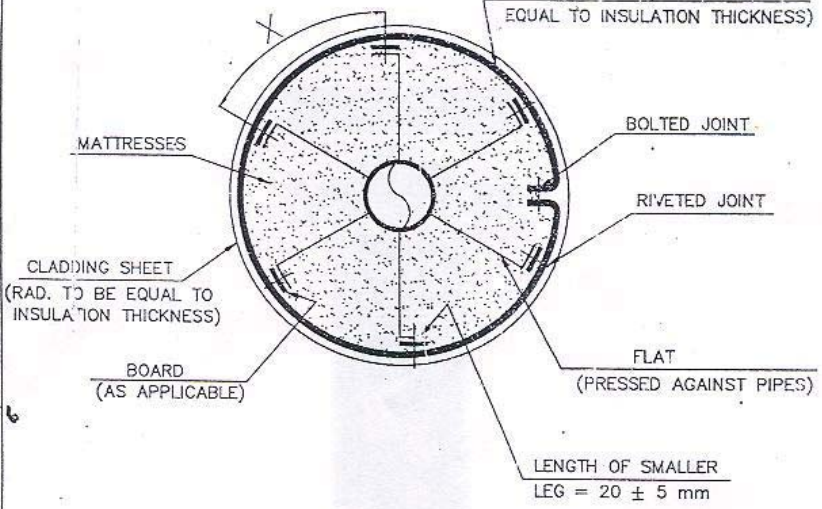
DB

A4

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM)

REV.	DATE	ALTERED / CHECKED	REV.	DATE	ALTERED / CHECKED

JOB NO. STANDARD



X = 150 mm TO 200 mm SO THAT NUMBER OF WEBS IS EVEN NUMBER

MATERIAL REQUIRED:–

1. FLATS
2. RIVETS
3. BOLTS AND NUTS
4. BOARD

NOTE:–

1. FOR GENERAL INFORMATION ON APPLICATION OF INSULATION REFER DOCUMENT "INSTRUCTIONS FOR APPLICATION OF THERMAL INSULATION FOR PIPING AND EQUIPMENTS".

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECTS ENGINEERING MANAGEMENT
NEW DELHI

DEPT.	CODE	SCALE	WEIGHT (KG)	REF. TO ASSY. DRG	ITEM
MPL	M	N.T.S.	—	—	—

TITLE:– INSULATION APPLICATION (CLADDING SHEET, SUPPORT RING FOR HOR. PIPE O.D>114.3mm & HOR. EQUIPMENTS)

	NAME	SIGN	DATE
DRN	S.C.S.		
DES'N	S.C.S.		9.6.92
CHD	D.B.S.		9.6.92
APP'D	S.K.J.		11.6.92

CARD CODE —

DRAWING NO. PE-4-999-169-04

SHEET 1 OF 1 REV. 00

AL-11

D4

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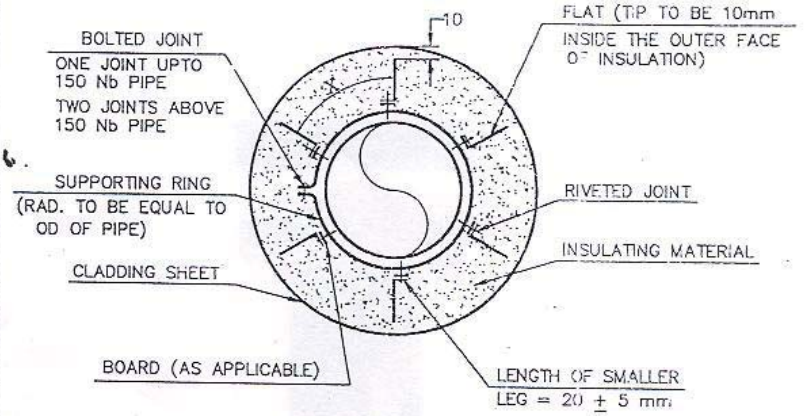
FIRST ANGLE PROJECTION ALL DIMENSIONS ARE IN MM

REV.	DATE	ALTERED / CHECKED	REV.	DATE	ALTERED / CHECKED

JOB NO. STANDARD



X = 150 mm TO 200 mm SO THAT NUMBER OF WEBS IS EVEN NUMBER

MATERIAL REQUIRED:–

1. FLATS
2. RIVETS
3. BOLTS AND NUTS
4. BOARD

NOTES:–

1. INSULATION DETAILS ON VERTICAL PIPING SHALL BE SAME AS PER FOR HORIZONTAL PIPES.
2. SPACING BETWEEN SUPPORTING RINGS SHALL BE 3 Mtrs.
3. FOR INSULATION OF END OF VERTICAL EQUIPMENTS REFER DRG. No. PE–4–999–169–09.
4. FOR GENERAL INFORMATION ON APPLICATION OF INSULATION REFER DOCUMENT "INSTRUCTIONS FOR APPLICATION OF THERMAL INSULATION FOR PIPING AND EQUIPMENTS.
5. FLATS/RINGS OF REQUIRED LENGTH/DIA SHALL BE MADE BY ERECTING AGENCY AT SITE FROM MS FLATS/STRAPS.

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECTS ENGINEERING MANAGEMENT
NEW DELHI

DEPT.	CODE	SCALE	WEIGHT (KGS)	REF. TO ASSY. DRG	ITEM
M-L	M	N.T.S.			

TITLE:– INSULATION APPLICATION (INSULATION SUPPORT RING FOR VERTICAL PIPING & VERTICAL EQUIPMENTS)

	NAME	SIGN	DATE
DRN	S.C.S.		9.6.92
DESN	S.C.S.		9.6.92
CHD	D.B.S.		9.6.92
APPD	S.K.J		11.6.92

CARD CODE

DRAWING NO. PE–4–999–169–05

SHEET 1 OF 1 REV. 00

AL–222

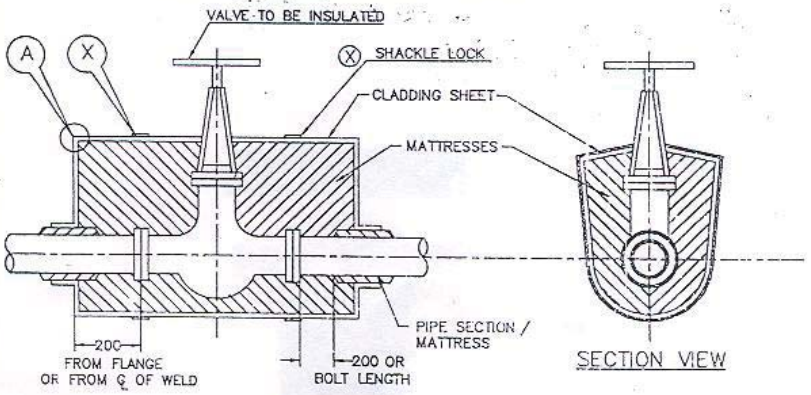
DE

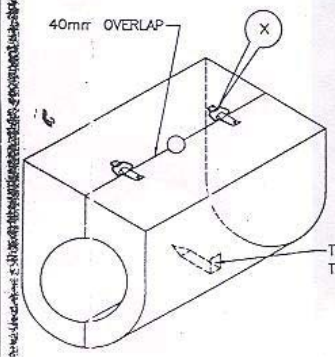
A4

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM)

REV.	DATE	ALTERED / CHECKED	REV.	DATE	ALTERED / CHECKED

JOB NO. STANDARD





ASSEMBLED VALVE BOX

MATERIALS REQUIRED:–

1. MATTRESSES
2. CLIPS OF SHACKLE LOCKS FABRICATED OUT OF CLADDING SHEET
3. CLADDING SHEET
4. RIVETS
5. SHACKLE LOCKS CONNECTING BUCKLES. (REF. DRG. PE-4-999-169-10)
6. SELF TAPPING SCREWS
7. SEALING COMPOUND.

NOTE:–

1. FOR DETAIL A & X REFER DRG No. PE-4-999-169-10
2. FOR GENERAL INFORMATION ON APPLICATION OF INSULATION REFER DOCUMENT "INSTRUCTIONS FOR APPLICATION OF THERMAL INSULATION FOR PIPING AND EQUIPMENTS".

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECTS ENGINEERING MANAGEMENT
NEW DELHI

DEPT.	CODE	SCALE	WEIGHT (KG.)	REF. TO ASSY. DRG	ITEM
MPL	M	N.T.S.	—	—	—

TITLE:–
INSULATION APPLICATION
(VALVES)

	NAME	SIGN	DATE
DRN	S.C.S.		5.6.97
DESN	S.C.S.		5.6.97
CHD	D.B.S.		6.6.97
APPD	S.K.J.		11.6.97

CARD CODE —

DRAWING NO. PE-4-999-169-06

SHEET 1 OF 1 REV. 00

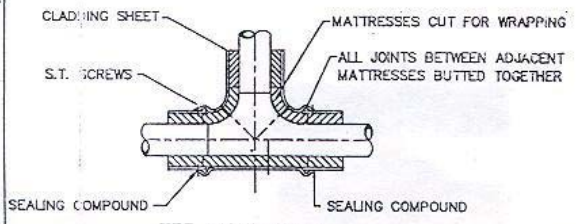
DG

A4

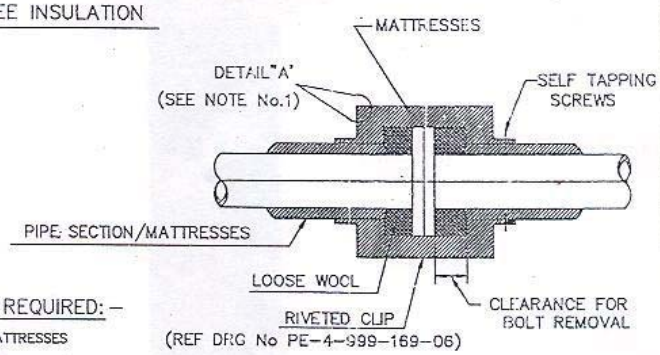
FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM)

REV.	DATE	ALTERED / CHECKED	REV.	DATE	ALTERED / CHECKED
6					

JOB NO. STANDARD



TEE INSULATION



(REF DRG No PE-4-999-169-06)

FLANGE JOINT INSULATION

MATERIALS REQUIRED:-

1. PIPE SECTION/MATTRESSES
2. STITCHING WIRE .
3. CLADDING SHEET
4. BINDING WIRE
5. SELF TAPPING SCREWS
6. SEALING COMPOUND

NOTE:-

1. FOR DETAIL "A" REFER DRG No. PE-4-999-169-10
2. FOR GENERAL INFORMATION ON APPLICATION OF INSULATION REFER DOCUMENT "INSTRUCTIONS FOR APPLICATION OF THERMAL INSULATION FOR PIPING AND EQUIPMENTS.

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECTS ENGINEERING MANAGEMENT
NEW DELHI

DEPT.	CODE	SCALE	WEIGHT (KG.)	REF. TO ASSY. DRG	ITEM
MPL	M	N.T.S.	—	—	—

TITLE:-
INSULATION APPLICATION
(TEES AND FLANGE JOINTS)

	NAME	SIGN	DATE
DRN	S.C.S.		9.6.97
DESN	S.C.S.		9.6.97
CHD	D.B.S.		9.6.97
APPD	S.K.J.		9.6.97

CARD CODE —
DRAWING NO. PE-4-999-169-07
SHEET 1 OF 1
REV. 00

L-6

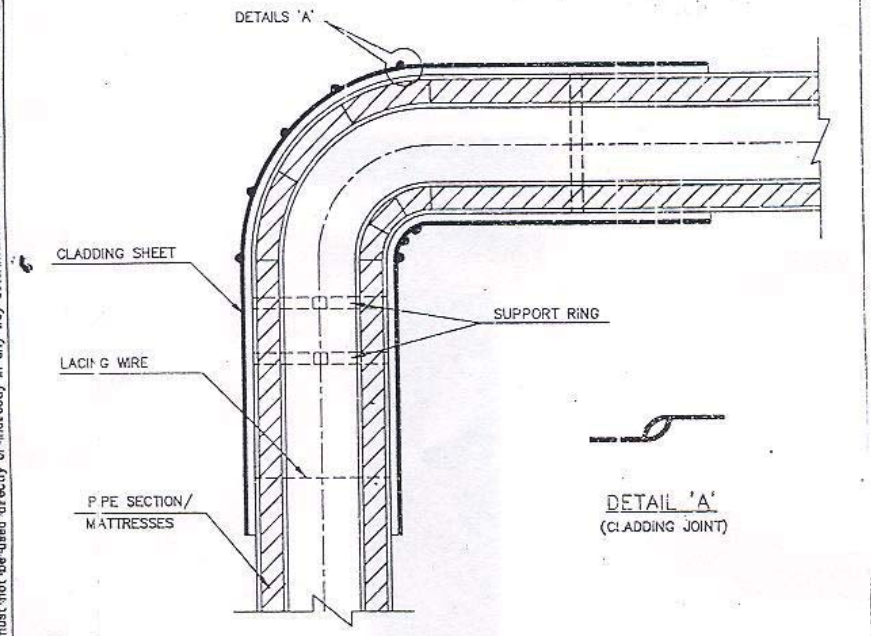
DF

A4

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM)

REV.	DATE	ALTERED / CHECKED	REV.	DATE	ALTERED / CHECKED

JOB NO. STANDARD



MATERIALS REQUIRED:-

1. MATTRESSES
2. PIPE SECTION (IF APPLICABLE)
3. LACING WIRE
4. CLADDING SHEET
5. BINDING WIRE
6. SELF TAPPING SCREWS
7. SEALING COMPOUND

NOTES:-

1. TWO SELF TAPPING SCREWS TO BE USED FOR EACH SHEET SEGMENT AT INNER SIDE OF BEND.
2. FOR GENERAL INFORMATION ON APPLICATION OF INSULATION REFER DOCUMENT "INSTRUCTIONS FOR APPLICATION OF THERMAL INSULATION FOR PIPING AND EQUIPMENTS.

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECTS ENGINEERING MANAGEMENT
NEW DELHI

DEPT.	CODE	SCALE	WEIGHT (KG.)	REF. TO ASSY. DRG	ITEM
MPL	M	N.T.S.	—	—	—

TITLE:-
INSULATION APPLICATION
(ELBOWS & BENDS SIZE EXCEEDING 150mm)

	NAME	SIGN	DATE
DRN	S.C.S.		9.6.97
DESN	S.C.S.		9.6.97
CHD	D.B.S.		9.6.97
APPD	S.K.J.		11.6.97

CARD CODE —

DRAWING NO. PE-4-999-169-08

SHEET 1 OF 1 REV. 00

D8

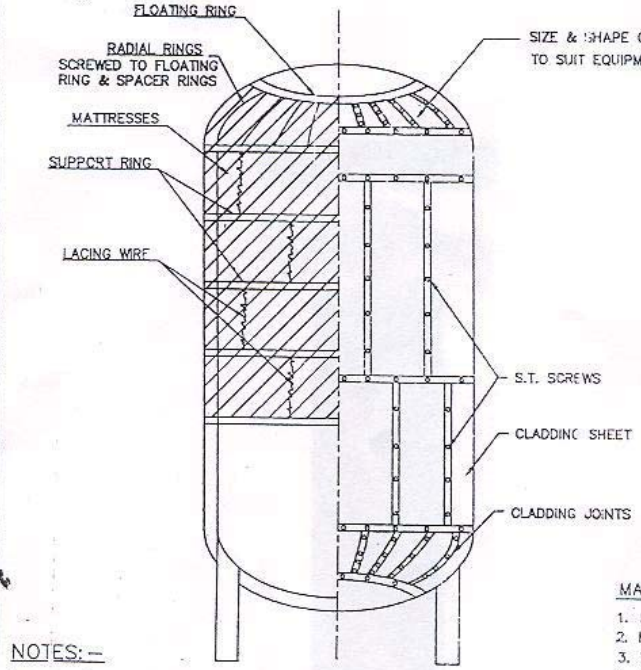
A4

L-7

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM)

REV.	DATE	ALTERED / CHECKED	REV.	DATE	ALTERED / CHECKED

JOB NO. STANDARD



MATERIALS REQUIRED:–

1. FLATS
2. MATTRESSES
3. BINDING WIRE
4. LACING WIRE
5. CLADDING SHEET
6. GLASS FABRIC/BOARDS (AS APPLICABLE)
7. RIVETS
8. SELF TAPPING SCREWS
9. SEALING COMPOUND
10. STRAPS/BANDS

NOTES:–

1. STRAPS/BANDS CUT FROM SHEET, WITH SEAL SHALL BE USED OVER FINAL LAYER AT 300mm INTERVALS.
2. INSULATION OF HOR. EQPTS. SHALL BE AS FOR HOR. PIPES. REFER DRG No. PE–4–999–169–01 & PE–4–999–169–02
3. FOR CLADDING SHEET SUPPORT REF. DRG. No. PE–4–999–169–04.
4. FOR INSULATION SUPPORT REF. DRG. No. PE–4–999–169–05.
5. INSULATION OF ENDS OF HOR. EQPTS. SHALL BE SIMILAR TO THIS DRG.
6. WELDING TO EQUIPMENT NOT PERMITTED.
7. FOR GEN. INF. ON APPLICATION OF INSULATION REF. DOC. "INSTRUCTIONS FOR APPLICATION OF THERMAL INSULATION FOR PIPING & EQPTS".

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECTS ENGINEERING MANAGEMENT
NEW DELHI

DEPT.	CODE	SCALE	WEIGHT (KG.)	REF. TO ASSY. DRG	ITEM
MPL	M	N.T.S.	—	—	—

TITLE:–
INSULATION APPLICATION
(EQUIPMENT)

	NAME	SIGN	DATE
DRN	S.C.S.		
DESN	S.C.S.		9.6.97
CHD	D.B.S.		9.6.97
APPD	S.K.J.		11.6.97

CARD CODE	DRAWING NO.	REV.
—	PE–4–999–169–09	00

SHEET 1 OF 1

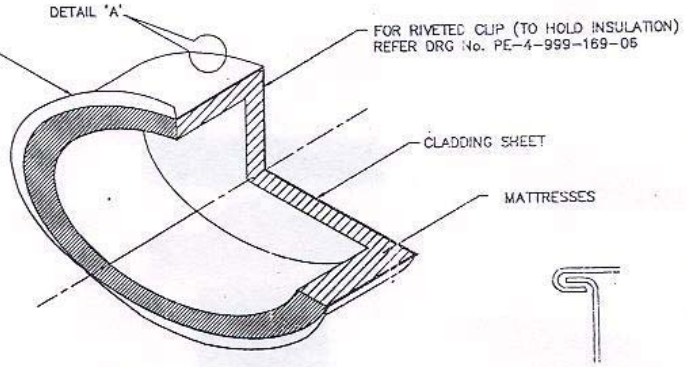
D9

A4

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM)

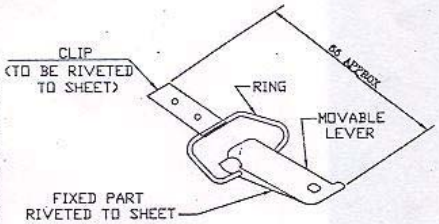
REV.	DATE	ALTERED / CHECKED	REV.	DATE	ALTERED / CHECKED

JOB NO. STANDARD



INSULATING COVER FOR MAN HOLE

DETAILS 'A'
(LOCKING OF SHEETS)



G.I. SHACKLE LOCK CONNECTING BUCKLE
DETAILS 'X'

MATERIAL REQUIRED:-
(FOR SHACKLE LOCK)

1. CLIP (MADE FROM CLADDING SHT.)
2. RIVETS

MATERIAL REQUIRED:-
(MAN HOLE)

1. MATTRESSES
2. CLADDING SHEET
3. SELF TAPPING SCREWS
4. RIVETS
5. CLIPS (TO BE MADE AT SITE)
6. SEALING COMPOUND

NOTES:-

1. FOR GENERAL INFORMATION ON APPLICATION INSULATION REFER DOCUMENT "INSTRUCTIONS FOR APPLICATION OF THERMAL INSULATION FOR PIPING AND EQUIPMENTS".

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECTS ENGINEERING MANAGEMENT
NEW DELHI

DEPT.	CODE	SCALE	WEIGHT (KG.)	REF. TO ASSY. DRG	ITEM
MPL	M	N.T.S.	—	—	—

TITLE:-
INSULATION APPLICATION
(FABRICATED HEAT INSULATING COVER FOR MAN-HOLE)

	NAME	SIGN	DATE
DRN	S.C.S.		9.6.97
DESN	S.C.S.		9.6.97
CHD	D.B.S.		11.6.97
APPD	S.K.J.		

CARD CODE	DRAWING NO.	REV.
—	PE-4-999-169-10	00

SHEET 1 OF 1

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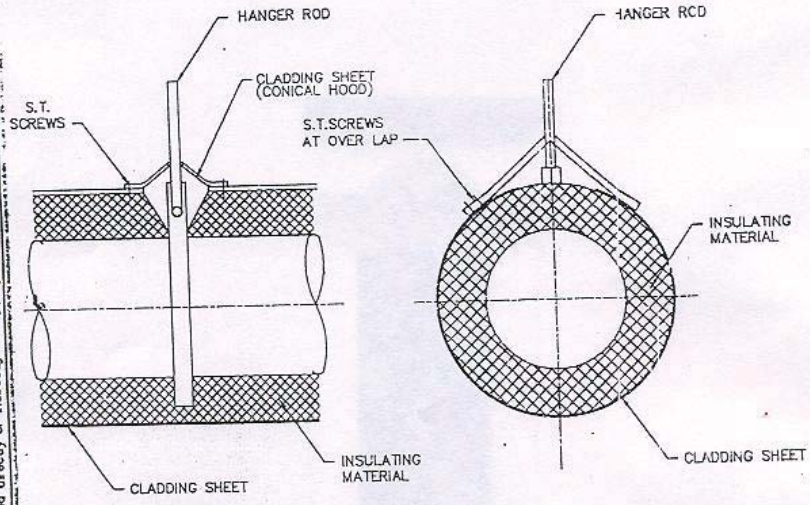
A4

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM)

REV.	DATE	ALTERED	REV.	DATE	ALTERED
01	10.5.13	CHECKED			CHECKED

NOTE 2 ADDED.

JOB NO. STANDARD



MATERIALS REQUIRED:-

1. MATTRESSES/PIPE SECTIONS
2. CLADDING SHEET
3. SELF TAPPING SCREWS
4. SEALING COMPOUND

NOTES:-

1. FOR GENERAL INFORMATION ON APPLICATION OF INSULATION REFER DOCUMENT "INSTRUCTIONS FOR APPLICATION OF THERMAL INSULATION FOR PIPING AND EQUIPMENTS".
2. WHEREVER THE END OF CLAMP PROTRUDES OUT OF INSULATION AT THE BOTTOM, SUITABLE BOX STRUCTURE TO BE PROVIDED (MADE OF ALUMINIUM).

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECTS ENGINEERING MANAGEMENT
NEW DELHI

DEPT.	CODE	SCALE	WEIGHT (KG.)	REF. TO ASSY. DRG	ITEM
MPL	M	N.T.S.	—	—	—

	NAME	SIGN	DATE
DRN	S.C.S.		5.6.13
DESN	S.C.S.		6.6.13
CHD	D.B.S.		10.6.13
APPD	S.K.J.		

TITLE:- INSULATION APPLICATION (METAL FLASHING ON HANGER ROD PROTRUSION)

CARD CODE —

DRAWING NO. PE-4-999-169-11

SHEET 1 OF 1 REV. 00

L-10

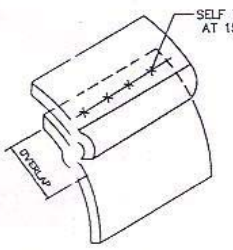
D11

14

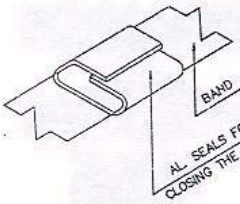
FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM)

REV.	DATE	ALTERED / CHECKED	REV.	DATE	ALTERED / CHECKED

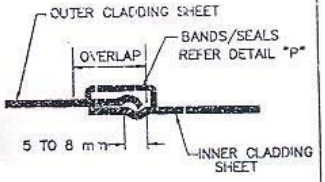
JOB NO. STANDARD



**DETAIL 'R'
(LONGITUDINAL JOINT)



DETAIL 'P'



*DETAIL 'Q'
(CIRCUMFERENCIAL JOINT)

**

1. JOINTS TO BE MADE AT 45° FROM BOTTOM
2. JOINTS TO BE ON LOWER HALF OF THE CURCUMFERENCE FOR HORIZONTAL PIPES AND EQUIPMENTS.
3. SEALING COMPOUND WILL BE USED ON ALL LONGITUDINAL JOINTS.

*

1. TELESCOPIC SLIDING JOINTS SHALL HAVE 5 TO 8mm SPACING.
2. THE OVERLAPING OF TELESCOPIC JOINTS SHALL BE AS BELOW:--

CIRCUMFERENCE OF SHEET(mm)	LONGITUDINAL OVERLAP(mm)
< 400	30
401 - 500	40
> 500	50

3. TELESCOPIC JOINT SHALL BE PLAIN.

NOTE:-

1. ALL JOINTS NEAR OIL PIPING TO HAVE SEALING COMPOUND.
2. FOR GENERAL INFORMATION ON APPLICATION OF INSULATION REFER DOCUMENT "INSTRUCTIONS FOR APPLICATION OF THERMAL INSULATION FOR PIPING AND EQUIPMENTS".

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECTS ENGINEERING MANAGEMENT
NEW DELHI

DEPT.	CODE	SCALE	WEIGHT (KG.)	REF. TO ASSY. DRG	ITEM
MPL	M	N.T.S.	—	—	—

TITLE:- INSULATION APPLICATION (DETAILS OF "P", "Q" AND "R")

	NAME	SIGN	DATE
DRN	S.C.S.		9.6.97
DESN	S.C.S.		9.6.97
CHD	D.B.S.		9.6.97
APPD	S.K.J.		11.6.97

CARD CODE —

DRAWING NO. PE-4-999-169-12

SHEET 1 OF 1 REV. 00

L-11

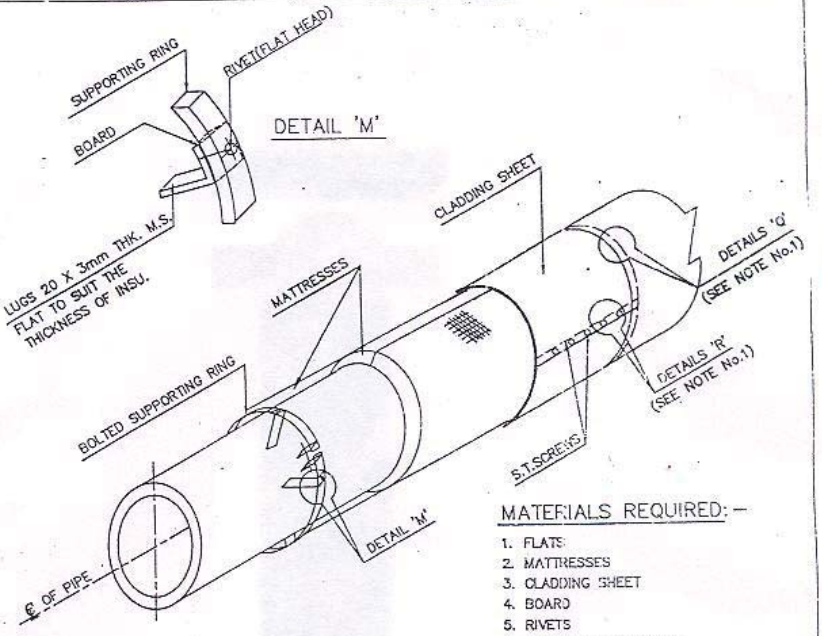
D12

A4

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM)

REV.	DATE	ALTERED / CHECKED	REV.	DATE	ALTERED / CHECKED

JOB NO. STANDARD



MATERIALS REQUIRED:–

1. FLATS
2. MATTRESSES
3. CLADDING SHEET
4. BOARD
5. RIVETS
6. SELF TAPPING SCREWS
7. SEALING COMPOUND
8. BOLTS & NUTS.

DETAILS OF LUGS:

PIPE Nb(mm)	No. OF LUGS
1. 33 – 150	4
2. 200 – 300	6
3. 350 – 450	8
4. 500 – 600	10

NOTES:–

1. FOR DETAILS 'Q' AND 'R' REFER DRG No. PE–4–999–169–12
2. FOR GENERAL INFORMATION ON APPLICATION OF INSULATION REFER DOCUMENT "INSTRUCTIONS FOR APPLICATION OF THERMAL INSULATION FOR PIPING & EQUIPMENTS".

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECTS ENGINEERING MANAGEMENT
NEW DELHI

DEPT.	CODE	SCALE	WEIGHT (KG.)	REF. TO ASSY. DRG	ITEM
MPL	M	N.T.S.	—	—	—

TITLE:–
INSULATION APPLICATION
(SUPPORT RING FOR PIPE O.D.>168.3mm)

	NAME	SIGN	DATE
DRN	S.C.S.		7.6.12
DESN	S.C.S.		9.6.12
CHD	D.B.S.		
APPD	S.K.J.		

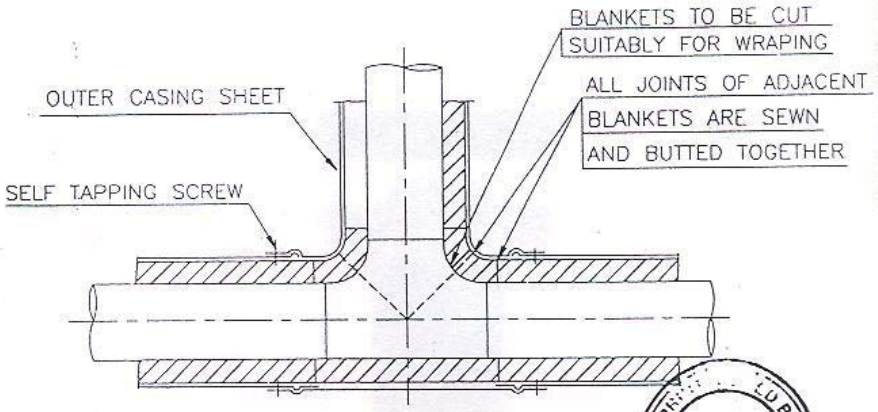
CARD CODE —

DRAWING NO. PE-4-999-169-13

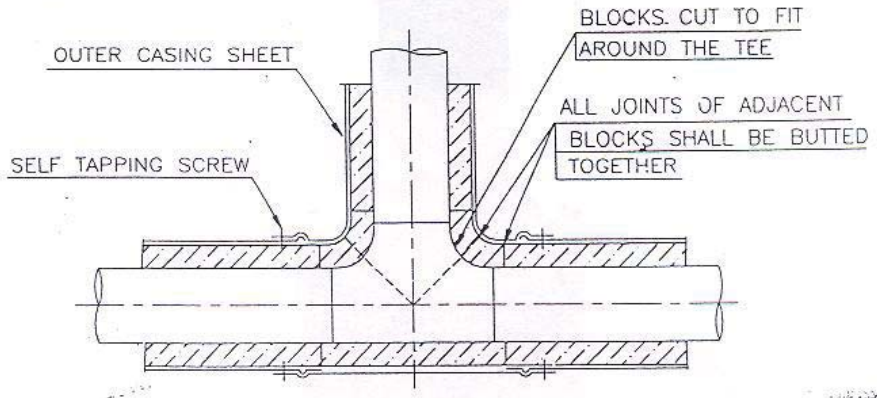
SHEET 1 OF 1 REV. 00

D13

TEE INSULATION



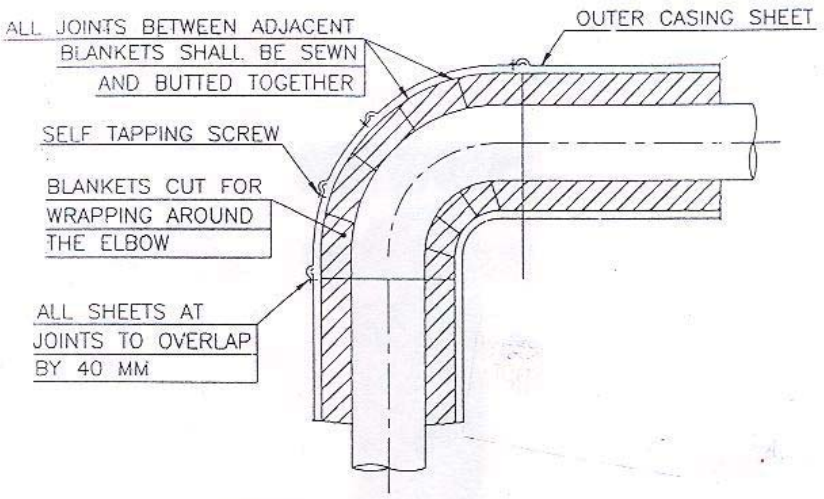
TEE INSULATION
(WITH WOOL MATTRESS)



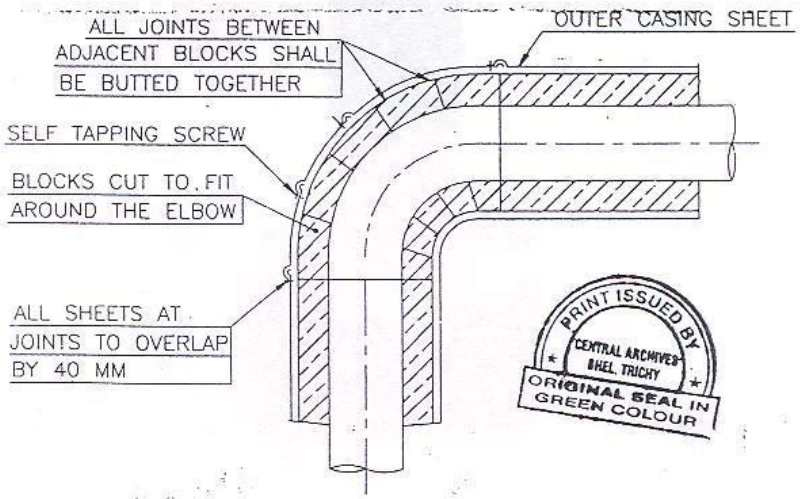
TEE INSULATION
(WITH CALCIUM SILICATE),

INSULATION	PREPARED	A.R.JOTHIGURUNATHAN	SIGNATURE	DATE 04.12.03	DRAWING NO : 4-00-235-08546	REV.
	CHECKED	K.KALIRAJAN				
	APPROVED	C.GUNASEKARAN				

ELBOW INSULATION



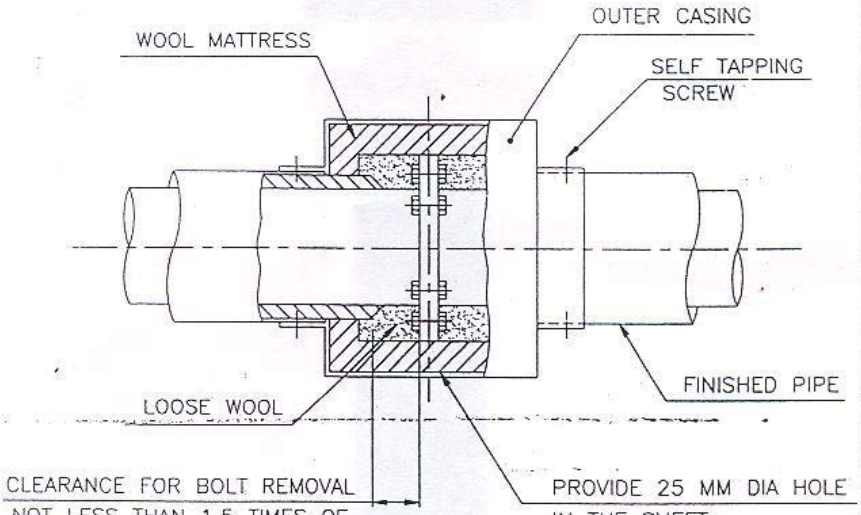
WITH WOOL MATTRESS



WITH CALCIUM SILICATE

INSULATION	PREPARED	A.R.JOTHIGURUNATHAN	SIGNATURE	DATE 04.12.03	DRAWING NO : 4-00-235-08547	REV
	CHECKED	K.KALIRAJAN				
	APPROVED	C.GUNASEKARAN				

FLANGE INSULATION

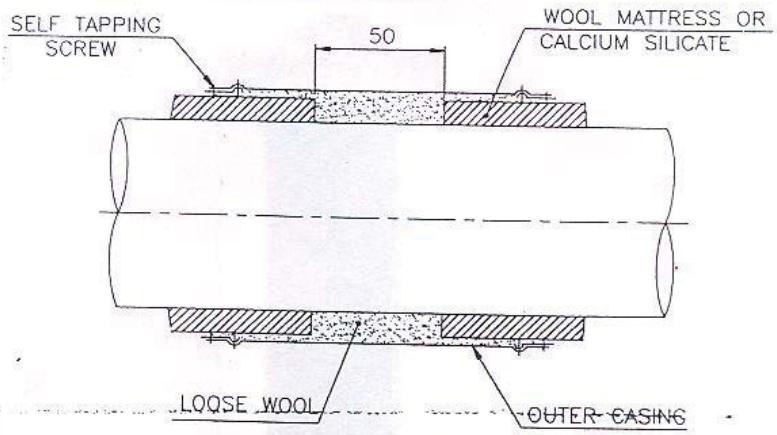


NOTE:—

1. WHEREEVER THE FLANGES ARE ENVISAGED FOR DISMANTLING, THIS TYPICAL ARRANGEMENT IS TO BE FOLLOWED.

INSULATION	PREPARED	A.R.JOTHI GURUNATHAN	SIGNATURE	DATE 04.12.03	DRAWING NO : 4-00-235-08548	REV
	CHECKED	K.KALIRAJAN				
	APPROVED	C.GUNASEKARAN				

EXPANSION JOINT FOR PIPES

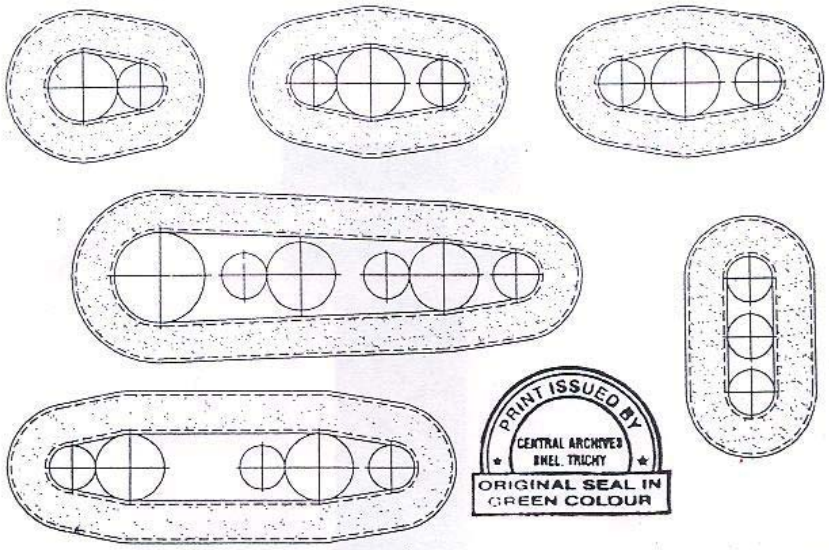


NOTE:-

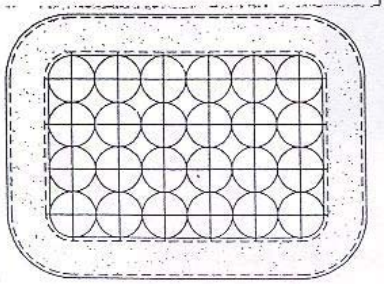
1. THIS ARRANGEMENT IS APPLICABLE FOR BOTH HORIZONTAL AND VERTICAL PIPE LINES,AT EVERY 5 METRES.
2. WHEN THE OPERATING TEMPERATURE IS BELOW 230°C,EXPANSION JOINTS ARE NOT REQUIRED.
3. FOR PIPES,WHERE THE FLOW IS ONLY INTERMITTANT,EXPANSION JOINTS ARE NOT REQUIRED.

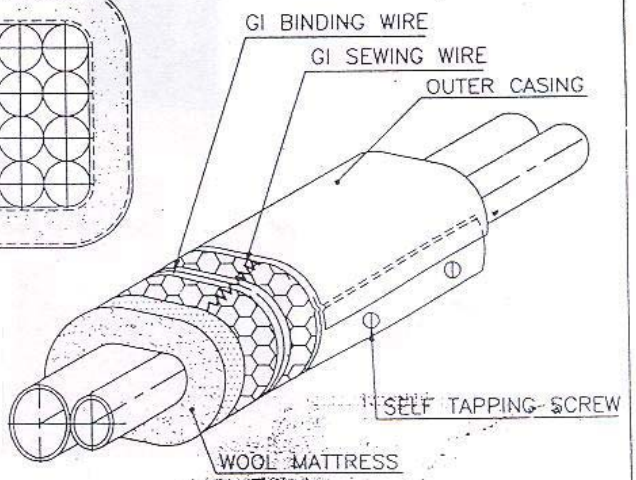
INSULATION	PREPARED	A.R.JOTHI GURUNATHAN	SIGNATURE	DATE 04.12.03	DRAWING NO : 4-00-235-08549
	CHECKED	K.KALIRAJAN			REV
	APPROVED	C.GUNASEKARAN			

BUNCH INSULATION



FOR NOTES REFER DRG 4-00-235-08541

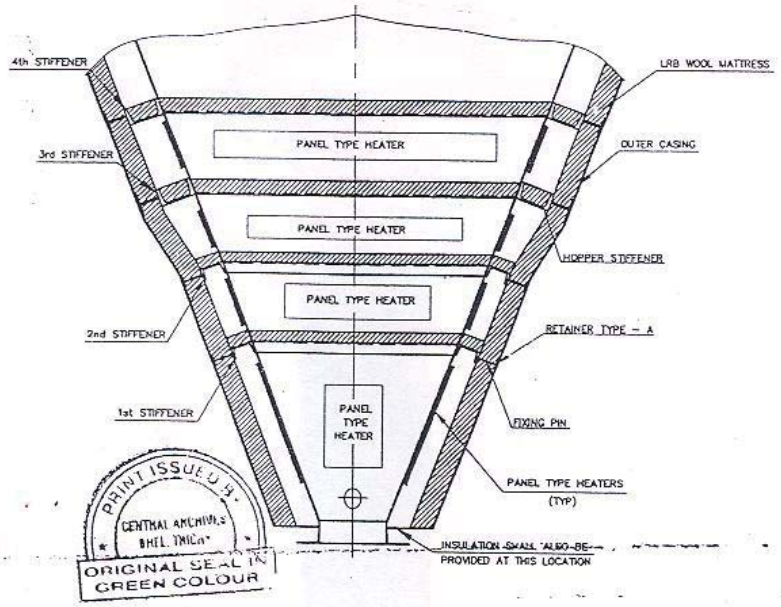




INSULATION	PREPARED	A.R.JOTHIGURUNATHAN	SIGNATURE	DATE 04.12.03	DRAWING NO : 4-00-235-08550	REV
	CHECKED	K.KALIRAJAN				
	APPROVED	C.GUNASEKARAN				

REV	DATE	ALTERED : A.R.J
01	01.10.05	CHD & APPD : C.G.S
DRAWING ALTERED		

FOR TOLERANCES OF UNTOLERANCED DIMENSIONS DURING MANUFACTURE REFER PLANT STD. NO TP 023 0299



NOTE:

01. THE INSULATION SHOWN IS FOR TYPICAL PANEL HEATER HOPPERRS.THIS IS TO BE FOLLOWED WHERE EVER PANEL TYPE HEATERS ARE ENMSAGED.

02. INSULATION FIXING PINS AND RETAINERS SHOULD NOT FOUL WITH THE PANEL HEATERS .

03. FOR OTHER INSULATION DETAILS, REFER DRG. 1-00-235-06654.

		NAME	SIGNATURE	DATE
Bharat Heavy Electricals Ltd	DRN	A.R.J		20.09.05
UNIT: HIGH PRESSURE BOILER PLANT TIRUCHIRAPALLI - 620014.	CHD	C.G.S		22.09.05
355-056	APPD	C.G.S		22.09.05

DEPT	ALL DIMENSIONS ARE IN MM	PROJECTION	SCALE	WEIGHT (Kg)	REF TO ASSY / OLD DWG
L&I					
CODE 123					

TITLE	DRAWING NO	REV
HOPPER INSULATION DETAIL FOR PANEL TYPE HEATERS	4-00-235-08702	01

SCR system (Selective Catalytic Reduction)

1 Introduction

SCR is designed to reduce NO_x level to meet Emission norms. The SCR process converts the NO_x contained in the flue gas into nitrogen (N_2) and water (H_2O) with the use of ammonia (NH_3) as the reduction agent. The basic reactions are the following:

$4NO + 4NH_3 + O_2 \rightarrow 4N_2 + 6H_2O$ -------- [1]

$2NO_2 + 4NH_3 + O_2 \rightarrow 3N_2 + 6H_2O$ -------- [2]

2 Description

In SCR system, catalysts are required to achieve sufficient reaction rate to achieve the desire NO_x removal efficiency. The NO_x reduction efficiency of the catalyst increases with maintaining optimum temperature at catalyst inlet. Flue gas duct tapped off between LTRH & Economizer banks from second pass of boiler (i.e. Economizer bypass duct) for connection to SCR reactor inlet duct. With this arrangement, optimum flue gas temperature at SCR inlet will be maintained. Before the flue gas enters the SCR catalyst, ammonia is added and mixed in such a way that a near homogeneous distribution of ammonia and NO_X in the flue gas is achieved. Effective flue gas and ammonia mixing, is essential to high removal efficiency and low ammonia slip over the life of the catalyst. Reagent is injected into the flue gas through nozzles mounted on the Ammonia Injection system which is located at SCR inlet duct. Ammonia injection system consists of flow meter block and vent valve and modulating valve to control ammonia injection rate. The injection causes mixing of the reagent and flue gas. The heat of the boiler provides the energy for the reaction in the reactor. Within the appropriate temperature range and after a series of reactions, the reagent radicals come into contact with the NO_x and form it to N_2 and H_2O. The Reacted flue gas then passes out of the reactor.

Anhydrous Ammonia storage & handling facilities is provided to store Anhydrous Ammonia which is transported to the site in Ammonia truck in liquid form. The Anhydrous Ammonia will be unloaded in the storage tank through unloading compressor/Pumps.

Anhydrous Ammonia storage tanks is provided to store the reagent. An-hydrous Ammonia Transfer pump along with Interconnecting supply piping is provided to transfer the reagent from the storage facility to the Ammonia Dilution Air Skid (ADAS).

3 Salient components

SCR shall consist of the following salient components

a. SCR reactor

The SCR reactor is a high dust, hot side arrangement located downstream of the economizer and upstream of the two air preheaters. Flue gas will flow vertically down through the catalyst layers. There will be two SCR reactor with two outlets located directly above the two air preheaters. Adequate clearance between catalyst layers will be provided to facilitate loading and unloading of modules as well as internal reactor inspections. Multiple layers of catalyst is provided. All ductwork in SCR system contains adequate vanes, baffles, and mixing devices to ensure that gas velocity, temperature and ammonia distribution requirements are met. The vanes and mixing devices are designed to promote streamlined flow. A spare layer accommodating the future addition minimum one layer is provided. The SCR system has a reactor bypass to be used during start-up, shutdown and emergency conditions.

b. Catalyst

The catalyst supplied will be plate type with a vanadium/titanium composition. Catalyst pitch will be selected to provide an optimized design of geometric surface area versus volume and differential pressure. The module framework is constructed of carbon steel material

c) Anhydrous ammonia unloading

One (1) ammonia truck unloading system is proposed. The actual truck volume depends on the specific ammonia supplier. The truck will be connected to unloading station with hoses and couplings. Ammonia is transferred from the truck by way of one (1) of two (2) 100% ammonia unloading compressors. During unloading, the vapour from the storage tank is compressed and discharged into the truck. The increased vapor in the truck forces the liquid from the truck into the storage tank. The

truck unloading skid provides a terminal point for connection of the truck to the plant's piping system to the tank. There is one line for liquid being transferred from the truck to the tank, and one line for vapor returned from the tank to the truck.

d) Anhydrous ammonia storage tank

Four (4) nos, horizontal, un-insulated storage tanks will be supplied to store ammonia. The tanks are supported on saddles at each end. The tanks are constructed as ASME Section VIII; Division I code vessels, in accordance with all state and local requirements. The tanks are provided with nozzles for connection of valves and instrumentation. The liquid fill and vapour return lines for loading of ammonia are equipped with actuated valves. Each storage tank is provided with safety valves that relieve pressure directly to the atmosphere through vent stacks, away from any platform or work area. If the storage tank must be emptied for inspection or emergency, multiple plugged drain connections are provided on the tank to facilitate draining of the tank.

e) Ammonia Vaporization and Dilution Air System

Suitable ammonia vaporization system is envisaged for vaporizing the liquid ammonia. The dilution air system includes two centrifugal dilution air fans. One fan is operational and the other is standby to provide a 100% redundant system. The different temperature, pressure and flow measurements are used to monitor and control the dilution air conditions to ensure sufficient flow to dilute the ammonia. Anhydrous ammonia is injected into the dilution air stream to mix with air. The dilution air flow transmitter monitors air flow to prevent high ammonia concentrations in the ammonia/air mixture. Sufficient residence time will allow for proper mixing of the ammonia with the dilution air before the mixture is injected into the flue gas duct. Once the ammonia is mixed with the air, the mixture is split into multiple injection streams for the reactor, which are introduced into the flue gas duct at each static Mixer. Each of the streams has flow indicators and balancing valves to adjust the injection flows to each mixer.

e) Ammonia Injection System

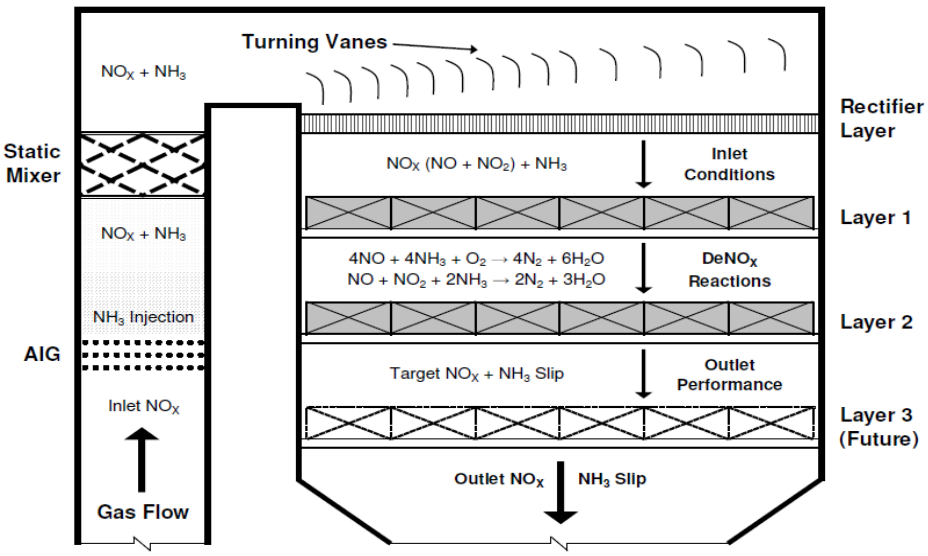
Ammonia Injection system will be supplied providing safe and effective operation to achieve the guaranteed ammonia supply rates over the full load range. Each injection system will be designed with multiple injection branches. The injection system will be properly supported to prevent thermal distortion and damage due to vibration induced by the flue gas flow.

f) De dusting system

Soot blowers or Sonic horn or Ash sweeper are used in keeping particulate matter entrained in the flue gas stream so as to avoid the possible formation of deposits on catalytic surfaces.

4. Typical SCR Arrangement

Typical SCR arrangement is shown below for illustration purposes



5. Safety System

SCR safety system will be comprised of Gaseous ammonia detectors to detect leaks and water sprinklers to absorb the leakage.

6. Statutory Requirements During Execution

Following approvals permits/ certificates to be obtained by EPC contractor for the entire plant including SCR & Anhydrous ammonia system

1. Safety certificate & approvals of the proposed plant as per factories act from Directorate of industrial safety &health (DISH)
2. Ammonia Storage& handling – as per explosives act from PESO, chief controller of explosives, Pollution control board ,DISH
3. Safety system for commissioning of the electrical system as per indian electricity rules from Chief electrical Inspectorate to Government

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SECTION-IX

TECHNICAL SPECIFICATION
FOR
FABRICATION OF STRUCTURAL STEELWORK

CONTENT

VOLUME : VII-C

SECTION-IX

TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEELWORK

1.0.0 SCOPE

This specification covers supply, fabrication, testing, painting and delivery to site of structural steelwork including supply of all consumable stores and bolts, nuts, washers, electrodes and other materials required for fabrication and field connections of all structural steelwork in general covered under the scope of the contract. However, for any special structures such as rail & road bridges, steel chimney, tanks, transmission towers, furnace structures, etc., the relevant Indian Standard or IRC specification and Codes of Practices shall be given due consideration over & above this specification.

2.0.0 GENERAL

2.1.0 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified elsewhere in the contract, shall include, but not be limited to the following :

a) Preparation of complete detailed fabrication drawings and erection marking drawings required for all the structures covered under the scope of the contract based on approved design drawings marked 'Released for construction'.

b) To submit revised design with calculations and detailed fabrication drawings in case any substitution of the designed sections are to be made.

c) To submit design calculations for joints and connections developed by the contractor along with detailed fabrication drawings.

d) Prepare and submit monthly materials reconciliation statement showing effective utilization of raw steel materials supplied from EPC contractor's store for time to time assessment of scrape generation.

e) Furnish shop painting of all fabricated steelwork as per requirements of this Specification.

f) Suitably mark, bundle and pack for transport all fabricated materials.

g) Prepare and furnish detailed Bill of Materials, Drawing Office Despatch lists, Bolt List and any other list of bought out items required in connection with the fabrication and erection of the structural steelwork.

h) Insure, load and transport all fabricated steelwork field connection materials to site.

2.2.0 **Work by others**

No work under this specification will be provided for by any agency other than the contractor, unless specifically mentioned otherwise elsewhere in the contract.

2.3.0 **Codes and standards**

All work under this specification shall, unless otherwise specified in the contract, conform to the requirements of the latest revision and/or replacements of the following or any other relevant Indian Standard specifications and codes of practice. In case any particular aspect of the work is not specifically covered by any Indian Standard Specification, any other standard practice, as may be specified by the Engineer shall be followed :

IS : 800 - Code of practice for general construction in steel.

IS : 801 - Code of practice for use of cold formed light gauge steel structural members in general building construction.

IS : 806 - Code of practice for use of steel tubes in general building construction.

IS : 808 - Dimensions for rolled steel beams, channels and angle sections.

IS : 812 - Glossary of terms relating to welding & cutting of metals.

IS : 813 - Scheme of symbols for welding.

IS : 814 - Covered electrodes for metal arc welding of carbon and carbon manganese steel.

IS : 815	-	Classification coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel.
IS : 816	-	Code of practice for use of metal arc welding for general construction in mild steel.
IS : 817	-	Code of practice for training & testing metal arc welders.
IS : 818	-	Code of practice for safety and health requirements in electric and gas welding and cutting operations.
IS : 819	-	Code of practice for resistance spot welding for light assemblies in mild steel.
IS : 822	-	Code of practice for inspection of welds.
IS : 919 (Part - 1&2)	-	Recommendations for limits and fits for engineering.
IS : 1161	-	Steel Tubes for structural purposes.
IS : 1182	-	Recommended practice for Radiographic Examination of fushion welded butt joints in steel plates.
IS : 1200 (Part - 8)	-	Method of measurement of steel work and iron work
IS : 1239 (Part - 1&2)	-	Mild steel tubes, tubulars & other wrought steel fittings
IS : 1363 (Part - 1 to 3)	-	Hexagon head bolts, screws & nuts of product grade C
IS : 1364 (Part - 1 to 5)	-	Hexagon head bolts, screws and nuts of product grade A & B
IS : 1365	-	Slotted counter sunk head screws (dia. 1.6 to 20 mm)
IS : 1367 (Part - 1 to 18)	-	Technical supply conditions for threaded steel fasteners.
IS : 1608	-	Method for tensile testing of steel products.
IS : 1730	-	Dimensions for steel plate, sheet and strip for structural and general engineering purposes.

IS : 1852	-	Rolling and cutting tolerances for hot-rolled steel product.
IS : 1977	-	Structural steel (Ordinary quality)
IS : 2016	-	Plain washer
IS : 2062	-	Steel for general structural purposes.
IS : 2629	-	Recommended practice for hot-dip galvanising of iron and steel.
IS : 2633	-	Method for testing uniformity of coating on zinc coated articles.
IS : 3644	-	Code of practice for ultrasonic pulse echo testing by contact and immersion method.
IS : 3757	-	High Strength Structural Bolt
IS : 4000	-	High strength bolts in steel structure
IS : 4759	-	Specifications for hot-dip zinc coatings on structural steel and other allied products.
IS : 4923	-	Hollow steel sections for structural use.
IS : 5334	-	Code of practice for magnetic particle flaw detection of weld.
IS : 5369	-	General requirements for plain washers and lock washer.
IS : 6005	-	Code of practice for phosphating of iron and steel.
IS : 6649	-	Specification for hardened and tempered washers for high strength structural bolts and nuts.
IS : 6623	-	Specification for high strength structural nuts.
IS:7215	-	Tolerances for fabrication of steel structures.
IS : 7280	-	Bare wire electrode for submerged arc welding
IS : 8500	-	Structural steel micro alloyed (medium & high strength quality).

IS : 8629 (Part - I to III)	-	Code of practice for protection of iron steel & structures from atmospheric corrosion.
IS : 9595	-	Recommendation for metal arc welding of carbon manganese steels.

PAINTING

IS : 117	-	Specification for ready mixed paint, brushing, finishing, exterior, semi-gloss, for general purposes.
IS : 128	-	Specification for ready mixed paint, brushing, finishing, semi-gloss for general purposes, black.
IS : 1477 (Part - I & II)	-	Code of practice for painting of ferrous metal in building
IS : 2074	-	Ready mixed paint, air-drying red-oxide zinc chrome priming.
IS : 2339	-	Specification for aluminium paints for general purposes in dual container.
IS : 2932	-	Specification for enamel, synthetic exterior type - I.
IS : 2933	-	Specification for enamel, synthetic exterior type - II.

2.4.0 **Conformity with Designs**

Except where the standard connection details are furnished, the contractor shall design all connections, supply and fabricate all steelwork and furnish all connection materials in accordance with the approved drawings and/or as instructed by the Engineer Keeping in view the maximum utilization of the available sizes and sections of steel materials. The methods of painting, marking, packing and delivery of all fabricated materials shall be in accordance with the provisions of the contract and/or as approved by the Engineer. Provision of all relevant Indian Standard Specifications and Codes of Practice shall be followed unless otherwise specified in the contract.

2.5.0 **Materials to be used**

2.5.1 **General**

All steel materials shall be free from all imperfections, mill scales, slag intrusions, laminations, pittings, rusts etc. that may impair their strength, durability and appearance. All materials shall be of tested quality only unless otherwise permitted by the Engineer and/or Consultant.

If desired by the Engineer, Test Certificates of materials supplied by the contractor in respect of each consignment shall be submitted in triplicate. Whenever the materials are required to be used from unidentified stocks, if permitted by the Engineer, a random sample shall be tested at an approved laboratory from each lot of 50 tonnes or less of any particular section.

The arc welding electrodes shall conform to the relevant Indian Standard Codes of Practice and Specifications and shall be of heavily coated type and the thickness of the coating shall be uniform and concentric. With each container of electrodes, the manufacturer shall furnish instructions giving recommended voltage and amperage (Polarity in case of D.C. supply) for which the electrodes are suitable.

2.5.2 **Steel**

All steel materials to be used in construction within the purview of this specification shall comply with any of the following Indian Standard Specifications as may be applicable :

IS : 801 - Cold formed light gauge steel structural member.

IS : 806 - Steel tubes in general building construction.

IS : 1161 - Steel tubes for structural purpose.

IS : 1977 - Structural steel (Ordinary quality) St-42-0

IS : 2062 - Steel for general structural purpose

IS : 8500 - Structural steel-microalloyed (Ordinary & high strength quality)

In case of imported steel materials being used, these shall conform to specifications equivalent to any of the above as may be applicable.

2.5.3 **Electrodes**

All electrodes to be used under the Contract shall comply with any of the following Indian Standard Specifications as may be applicable :

IS : 814 - Covered electrodes for metal arc welding structural steel

IS : 815 - Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel.

IS : 7280 - Base wire electrode for submerged arc welding.

2.5.4 **Bolts and Nuts**

All bolts and nuts shall conform to the requirements of Indian Standard Specification IS:1367 - Technical Supply Conditions for Threaded Fasteners.

Materials for Bolts and nuts under the purview of this contract shall comply with any of the following Indian Standard Specifications as may be applicable.

a) Mild Steel : All mild steel for bolts and nuts when tested in accordance with the following Indian Standard Specification shall have a tensile strength of not less than 44 Kg/mm2 and a minimum elongation of 23 per cent on a gauge length of 5.6 ÖA, where 'A' is the cross sectional area of the test specimen :

IS : 1367 - Technical supply conditions for threaded fasteners.

IS : 1608 - Method for tensile testing of steel other than sheet, strip, wire and tube.

b) High Tensile Steel : The material used for the manufacture of high tensile steel bolts and nuts shall have the mechanical properties appropriate to the particular class of steel as set out in IS:1367 or as approved by the Engineer.

2.5.5 **Washers**

Washers shall be made of steel conforming to any of the following Indian Standard Specifications as may be applicable under the provisions of the Contract :

IS : 1977 - Structural steel (Ordinary Quality) St-42-0

IS : 2062 - Steel for general structural purpose

IS : 8500 - Structural steel - microalloyed (medium & high strength quality)

IS : 6623 - High Strength Structural Nuts

IS : 6649 - Hardened and tampered washers for high strength structural bolts & nuts.

2.5.6 **Paints**

Paints to be used for shop coat of fabricated steel under the purview of this contract shall conform to the Indian Standard Specification IS:2074 - Ready mixed Paint, Air Drying, Red Oxide - Zinc Chromate Priming.

In highly corrosive environment other type of primer such as epoxy rasin based zinc rich primer ~~(such as blast steel EZ1 of Shalimer Paints Ltd., or equivalent)~~ may be necessary.

2.6.0 **Storage of Material**

2.6.1 **General**

All materials shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for the work. Any material which has deteriorated or has been damaged shall be removed from the contractor's yard immediately, failing which, the Engineer shall be at liberty to get the material removed and the cost incurred thereof shall be realised from the Contractor. The Contractor shall maintain upto date accounts in respect of receipt, use and balance of all sizes and sections of steel and other materials. In case the fabrication is carried out in contractor's fabrication shop outside the plant site where other fabrication works are also carried out, all materials meant for use in this contract shall be stacked separately with easily identifiable marks.

2.6.2 **Steel**

The steel to be used in fabrication and the resulting cut- pieces shall be stored in separate stacks off the ground section-wise and length-wise so that they can be easily inspected, measured and accounted for at any time. If required by the Engineer, the materials may have to be stored under cover and suitably painted for protection against weather.

2.6.3 **Electrodes**

The electrodes for electric are welding shall be stored in properly designed racks, separating different types of electrodes in distinctly marked compartments. The electrodes shall be kept in a dry and warm condition if necessary by resorting to heating.

2.6.4 **Bolts, Nuts and Washers**

Bolts, nuts and washers and other fastening materials shall be stored on racks off the ground with a coating of suitable protective oil. These shall be stored in separate gunny bags or compartments according to diameter, length and quality.

2.6.5 **Paints**

Paints shall be stored under cover in air tight containers. Paints supplied in sealed containers shall be used up as soon as possible once the container is opened.

2.7.0 **Quality Control**

The Contractor shall establish and maintain quality control procedures for different items of work and materials to the extent he deems necessary to ensure that all work is performed in accordance with this specification. In addition to the Contractor's quality control procedures, materials and workmanship at all times shall be subjected to inspection by the Engineer or Engineer's representative. As far as possible, all inspection by the Engineer or Engineer's representative shall be made at the Contractor's fabrication shop whether located at Site or elsewhere. The Contractor shall co-operate with the Engineer or Engineer's representative in permitting access for inspection to all places where work is being done and in providing free of cost all necessary help in respect of tools and plants, instrument, labour and materials required to carry out the inspection. The inspection shall be so scheduled as to provide the minimum interruption to the work of the Contractor.

Materials or workmanship not in reasonable conformance with the provisions of this Specification may be rejected at any time during the progress of the work.

The quality control procedure shall cover but not be limited to the following items of work :

a)	Steel	:	Quality, manufacturer's test certificates, test reports of representative samples of materials from unidentified stocks if permitted to be used.
b)	Bolts, Nuts & Washers	:	Manufacturer's certificate, dimension checks, material testing.
c)	Electrodes	:	Manufacturer's certificate, thickness and quality of flux coating.
d)	Welders	:	Qualifying Tests

e) Welding sets : Performance Tests

f) Welds : Inspection, X-ray, Ultrasonic tests

g) Paints : Manufacturer's certificate, physical Inspection reports

h) Galvanizing : Tests in accordance with IS : 2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS : 4759 - Specification for Hot-Dip Zinc coatings on Structural Steel and other allied products.

2.8.0 **Standard Dimensions, Forms and Weights**

The dimensions, forms, weights and tolerances of all rolled shapes bolts, nuts, studs, washers etc. and other members used in the fabrication of any structure shall, wherever applicable, conform to the requirements of the latest relevant Indian Standards, wherever they exist, or, in the absence of Indian Standards, to other equivalent standards.

2.9.0 **Shop Drawings**

The contractor shall within thirty (30) days after the award of the Contract submit to the Engineer the Schedule of Fabrication and delivery of structural steelwork for approval. He shall, within forty-five (45) days after the award of the contract start to submit progressively for approval, the shop drawings based on the approved Design Drawings and, before proceeding with the fabrication work, shall get the said shop drawings approved in accordance with the contract.

The sequence of submission of shop drawings for approval shall match with the approved fabrication and delivery schedule. The approval for the shop drawings will be accorded only towards the general conformity with the design requirements as well as specification and will ensure the correctness of general arrangement for centre line dimensions and levels, Section sizes, and adequacy of connections including splice joints as to the no. of bolts, weld length, size of gusset/end plates. The correctness of all other details like cutting lengths, matching of holes, notch dimensions, match markings, bill of materials, bolt list etc. will be entirely the contractor's responsibility. The approval of the drawing however shall not relieve the contractor of his sole responsibility in carrying out the work correctly and fulfilling the complete requirements of contract documents.

The shop drawings shall include but not be limited to the following :

a) Assembly drawings giving exact sizes of the sections to be used and identification marks of the various sections.

b) Dimensional drawings of base plates, foundation bolt location etc.

c) Details of all connections with supporting calculations.

d) Comparison sheets to show that the proposed alternative section, if any, are as strong as the original sections shown on the Design Drawings.

e) Complete Bill of Materials and detailed drawings of all sections as also their billing weights.

f) Any other drawings or calculations that may be required for the clarification of the works or substituted parts thereof.

The shop drawings shall give all the necessary information for the fabrication, erection and painting of the steelwork in accordance with the provisions of this Specification. Shop drawings shall be made in accordance with the best modern practice and with due regard to sequence, speed and economy in fabrication and erection. Shop drawings shall give complete information necessary for fabrication of various components of the steelwork, including the location, type, size and extent of welds. These shall also clearly distinguish between shop and field bolts and welds and specify the class of bolts and nuts. The drawings shall be drawn to a scale large enough to convey all the necessary information adequately. Notes on the shop drawings shall indicate those joints or groups of joints in which it is particularly important that the welding sequence and technique of welding shall be carefully controlled to minimize the locked -up stresses and distortion. Welding symbols used shall be in accordance with the requirements of the Indian Standard Specification --IS:813 - Scheme of symbols for Welding, and shall be consistent throughout. Weld lengths called for on the drawings shall mean the net effective length.

The Contractor shall be responsible for and shall pay for any alterations of the work due to any discrepancies, errors or omissions on the drawings or other particulars supplied by him, whether such drawings or other particulars have been duly approved or not in accordance with the Contract.

3.0.0 WORKMANSHIP

3.1.0 Fabrication

3.1.1 General

All workmanship shall be equal to the best practice in modern structural shops, and shall conform to the provisions of the Indian Standard IS:800 - Code of Practice for use of Structural Steel in General Building Construction and other relevant Indian Standards or equivalent.

3.1.2 **Straightening Material**

Rolled materials before being laid off or worked, must be clean, free from sharp kinks, bends or twists and straight within the tolerances allowed by the Indian Standard Specification IS:1852 - Specification for rolling and cutting tolerance for hot-rolled steel products. If straightening is necessary, it may be done by mechanical means or by the application of a limited amount of localized heat. The temperature of heated areas, as measured by approved methods, shall not exceed 600 Deg. C.

3.1.3 **Cutting**

Cutting shall be effected by shearing, cropping or sawing. Use of a mechanically controlled gas cutting torch may be permitted for mild steel only. Gas cutting of high tensile steel may also be permitted provided special care is taken to leave sufficient metal to be removed by machining, so that all metal that has been hardened by flame is removed. Gas cutting without a mechanically controlled torch may be permitted if special care is taken and done under expert hand, subject to the approval of the Engineer.

To determine the effective size of members cut by gas, 3 mm shall be deducted from each cut edge. Gas cut edges, which will be subjected to substantial stress or which are to have weld metal deposited on them, shall be reasonably free from gouges. Occasional notches or gauges not more than 4 mm deep will be permitted. Gouges greater than 4 mm, that remain from cutting, shall be removed by grinding. All re-entrant corners shall be shaped notch-free to a radius of at least 12 mm. Shearing, cropping and gas cutting shall be clean, reasonably square and free from any distortion.

3.1.4 **Planning of Edges**

Planning or finishing of sheared or cropped edges of plates or shapes or of edges gas-cut with a mechanically controlled torch shall not be required, unless specifically required by design and called for on the drawings, included in a stipulation for edge preparation for welding or as may be required after the inspection of the cut surface. Surface cut with hand-flame shall generally be ground, unless specifically instructed otherwise by the Engineer.

3.1.5 **Clearances**

The erection clearance for cleated ends of members connecting steel to steel shall preferably be not greater than 2 mm at each end. The erection clearance at ends of beams without web cleats shall be not more than 3 mm at each end, but where, for practical reasons, greater clearance is necessary, suitably designed cleatings shall be provided.

3.2.0 **Bolted Construction**

3.2.1 **Holes**

Holes through more than one thickness of material for members, such as compound stanchions and girder flanges, shall be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, if the thickness of the material is not greater than the nominal diameter of bolt plus 3 mm subject to a maximum thickness of 16 mm provided that the holes are punched 3 mm less in diameter than the required size and reamed after assembly to the full diameter.

Holes for rivets or black bolts shall be not more than 1.5 mm or 2.0 mm (depending on whether the diameter of the bolt is less or more than or equal to 25 mm) larger in diameter than the nominal diameter of the black bolt passing through them.

Holes for turned and fitted bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to a tolerance grade of H8 as specified in IS:919. Parts to be connected shall be firmly held together by tacking welds or clamps and the holes drilled through all the thicknesses in one operation and subsequently reamed to size. Holes not drilled through all thickness in one operation shall be drilled to a smaller size and reamed out after assembly.

Holes for bolts shall not be formed by gas cutting process.

3.2.2 **Assembly**

Drifting to enlarge unmatching holes shall not generally be permitted. In case drifting is permitted to a slight extent during assembly, it shall not distort the metal or enlarge the holes. Holes that must be enlarged to admit the bolts shall be reamed. Poor matching of holes shall be cause for rejection. The component parts shall be so assembled that they are neither twisted not otherwise damaged, and shall be so prepared that the specified cambers, if any, are maintained.

Bolted construction shall be permitted only in case of field connections if called for on the Drawings and is subjected to the limitation of particular connections as may be specified. In special cases, however, shop bolt connections may be allowed if directed by the Engineer.

Washers shall be tapered or otherwise suitably shaped, where necessary, to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project out through the nut at least one thread. In all cases the bolt shall be provided with a washer of sufficient thickness under the nut to avoid any threaded portion of the bolt being within the thickness of the parts bolted together. In addition to the normal washer, one spring washer or lock-nut shall be provided for each bolt for connections subjected to vibrating forces or otherwise as may be specified on the Drawings.

3.3.0 **Welded Construction**

3.3.1 **General**

Welding shall be in accordance with relevant Indian Standards and as supplemented in the Specification Welding shall be done by experienced and good welders who have been qualified by tests in accordance with IS:817.

3.3.2 **Preparation of Material**

Surface to be welded shall be free from loose scale, slag, rust, grease, paint and any other foreign material except that mill scale which withstands vigorous wire brushing may remain. Joint surfaces shall be free from fins and tears. Preparation of edges by gas-cutting shall, wherever practicable, be done by a mechanically guided torch.

3.3.3 **Assembling**

Parts to be fillet welded shall be brought in as close contact as practicable and in no event shall be separated by more than 4 mm. If the separation is 1.5 mm or greater, the size of the fillet welds shall be increased by the amount of the separation. The fit of joints at contact surfaces which are not completely sealed by welds, shall be close enough to exclude water after painting. Abutting parts to be butt-welded shall be carefully aligned. Misalignments greater than 3 mm shall be corrected and in making the correction the parts shall not be drawn into a sharper slope than two degrees (2 Deg.).

The work shall be positioned for flat welding whenever practicable.

3.3.4 **Welding Sequence**

In assembling and joining parts of a structure or of built-up members, the procedure and sequence of welding shall be such as will avoid needless distortion and minimize shrinkage stresses. Where it is impossible to avoid high residual stresses in the closing welds of a rigid assembly, such closing welds shall be made in compression elements.

In the fabrication of cover-plated beams and built-up members, all shop splices in each component part shall be made before such component part is welded to other parts of the member. Long girders or girder sections may be made by shop splicing not more than three sub-sections, each made in accordance with this paragraph.

When required by the Engineer, welded assemblies shall be stress relieved by heat treating in accordance with the provisions of the relevant Indian Standard or any other Standard approved by the Engineer.

3.3.5 **Welding Technique**

All complete penetration groove welds made by manual welding, except when produced with the aid of backing material not more than 8 mm thick with root opening not less than one-half the thickness of the thinner part joined, shall have the root of the initial layer gouged out on the back side before welding is started from that side, and shall be so welded as to secure sound metal and complete fusion throughout the entire cross- section. Groove welds made with the use of the backing of the same material as the base metal shall have the weld metal thoroughly fused with the backing material. Backing strips need not be removed. If required, they may be removed by gouging or gas cutting after welding is completed, provided no injury is done to the base metal and weld metal and the weld metal surface is left flush or slightly convex with full throat thickness.

Groove welds shall be terminated at the ends of a joint in a manner that will ensure their soundness. Where possible, this should be done by use of extension bars or run-off plates. Extension bars or run-off plates need not be removed upon completion of the weld unless otherwise specified elsewhere in the Contract.

To get the best and consistent quality of welding, automatic submerged arc process shall be preferred. The technique of welding employed, the appearance and quality of welds made, and the methods of correcting defective work shall all conform to the relevant Indian Standards.

3.3.6 **Temperature**

No welding shall normally be done on parent material at a temperature below (-) 5 Deg.C. However, if welding is to be undertaken at low temperature, adequate precautions as recommended in relevant Indian Standard shall be taken. When the parent material is less than 40 mm thick and the temperature is between (-) 5 Deg. C and 0 Deg. C, the surface around the joint to a distance of 100 mm or 4 times the thickness of the material, whichever is greater, shall be preheated till it is handwarm. When the parent material is more than 40 mm thick, the temperature of the area mentioned above shall be in no case be less than 20 Deg. C. All requirements regarding preheating of the parent material shall be in accordance with the relevant Indian Standard.

3.3.7 **Peening**

Where required, intermediate layers of multiple-layer welds may be peened with light blows from a power hammer, using a round-nose tool. Peening shall be done after the weld has cooled to a temperature warm to the hand. Care shall be exercised to prevent scaling or flaking of weld and base metal from over peening.

3.3.8 **Equipment**

These shall be capable of producing proper current so that the operator may produce satisfactory welds. The welding machine shall be of a type and capacity as recommended by the manufacturers of electrodes or as may be approved by the engineer.

3.4.0 **Finish**

Column splices and butt joints of compression members depending on contact for stress transmission shall be accurately machined and close-butted over the whole section with a clearance not exceeding 0.2 mm locally at any place. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc., after welding together, should be accurately machined so that the parts connected butt over the entire surfaces of contact. Care should be taken that those connecting angles or channels are fixed with such accuracy that they are not reduced in thickness by machining by more than 2.0 mm.

3.5.0 **Slab bases and caps**

Bases and caps fabricated out of steel slabs, except when cut from material with true surface, shall be accurately machined over the bearing surface and shall be in effective contact with the end of the stanchion. A bearing face which is to be grouted direct to a foundation need not be machined if such face is true and parallel to the upper face.

To facilitate grouting, holes shall be provided, where necessary, in stanchion bases for the escape of air.

3.6.0 **Lacing bars**

The ends of lacing bars shall be neat and free from burrs.

3.7.0 **Separators**

Rolled section or built-up steel separators or diaphragms shall be required for all double beams except where encased in concrete, in which case, pipe separators shall be used.

3.8.0 **Bearing Plates**

Provision shall be made for all necessary steel bearing plates to take up reaction of beams and columns and the required stiffeners and gussets whether or not specified in Drawings.

3.9.0 **Architectural Clearances**

Bearing plates and stiffener connections shall not be permitted to encroach on the designed architectural clearances.

3.10.0 **Shop Connections**

a) All shop connections shall be welded as specified on the Drawings.

b) Certain connections, specified to be shop connections, may be changed to field connections if desired by the Engineer for convenience of erection and the Contractor will have to make the desired changes at no extra cost to the Owner.

3.11.0 **Castings**

Steel castings shall be annealed

3.12.0 **Shop Erection**

The steelwork shall be temporarily shop-erected complete or as directed by the Engineer so that accuracy of fit may be checked before despatch. The parts shall be shop-erected with a sufficient number of parallel drifts to bring and keep the parts in place. In case of parts drilled or punched using steel jigs to make all similar parts interchangeable, the steelwork shall be shop erected in such a way as will facilitate the check of interchangeability.

3.13.0 **Shop Painting**

3.13.1 **General**

Unless otherwise specified, steelwork which will be concealed by interior building finish need not be painted; steelwork to be encased in concrete shall not be painted. Unless specifically exempted, all other steelwork shall be given one coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned, in accordance with the following paragraph, by brush, spray, roller coating, flow- coating or dipping as may be approved by the Engineer.

After inspection and approval and before leaving the shop, all steelwork specified to be painted shall be cleaned by hand- wire brushing or by other mechanical cleaning methods to remove loose mill scale, loose rust, weld slag or flux deposit, dirt and other foreign matter. Oil and grease deposits shall be removed by solvent. Steelwork specified to have no shop paint shall, after fabrication, be cleaned of oil or grease by solvent cleaners and be cleaned of dirt and other foreign material by through sweeping with a fibre brush.

After completion of the pre-cleaning, the metal surface shall be immediately painted with red oxide zinc chromate primer conforming to IS : 2074.

In highly corrosive environment, all steelwork shall be given a coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned by sand blasting to SA 2/1/2 grade minimum. The shop paint shall be epoxy rasin based zinc rich primer ~~such as Blast Steel EZ1 of Shalimer Paint Limited or equivalent.~~

3.13.2 **Inaccessible Parts**

Surfaces not in contact, but inaccessible after assembly, shall receive two coats of shop paint, positively of different colours to prove application of two coats before assembly. This does not apply to the interior of sealed hollow sections.

3.13.3 **Contact Surfaces**

Contact surface shall be cleaned in accordance with Sub-clause 3.13.1 before assembly.

3.13.4 **Finished Surfaces**

Machine finished surfaces shall be protected against corrosion by a rust inhibiting coating that can be easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.

3.13.5 **Surfaces adjacent to field welds**

Unless otherwise provided for, surfaces within 50 mm of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.

3.14.0 **Galvanizing**

3.14.1 **General**

Structural steelwork for switchyard or other structures as may be specified in the Contract shall be hot dip galvanized in accordance with the American Society for Testing and Materials Specification ASTM-A 123 or IS : 2629 - Recommended practice for Hot-Dip Galvanising of Iron and steel. Where the steel structures are required to be galvanized the field connection materials like bolts, nuts and washers shall also be galvanized.

3.14.2 **Surface Preparation**

All members to be galvanized shall be cleaned, by the process of pickling of rust, loose scale, dirt, oil, grease, slag and spatter of welded areas and other foreign substances prior to galvanizing. Pickling shall be carried out by immersing the steel in an acid bath containing either sulphuric or hydrochloric acid at a suitable concentration and temperature. The concentration of the acid and the temperature of the bath can be varied, provided that the pickling time is adjusted accordingly.

The pickling process shall be completed by thoroughly rinsing with water, which should preferably be warm, so as to remove the residual acid.

3.14.3 **Procedure**

Galvanizing shall be carried out by hot dip process in a proper and uniformly heated bath. It shall meet all the requirements when tested in accordance with IS:2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS:4759 - Specification for Hot-dip zinc coatings on Structural Steel & other allied products.

After finishing the threads of bolts, galvanizing shall be applied over the entire surface uniformly. The threads of bolts shall not be machined after galvanizing and shall not be clogged with zinc. The threads of nuts may be tapped after galvanizing but care shall be taken to use oil in the threads of nuts during erection.

The surface preparation for galvanizing and the process of galvanizing itself, shall not adversely affect the mechanical properties of the materials to be galvanized. Where members are of such lengths as to prevent complete dipping in one operation, great care shall be taken to prevent warping.
Materials on which galvanizing has been damaged shall be acid stripped and re-galvanized unless otherwise directed, but if any member becomes

damaged after having been dipped twice, it shall be rejected. Special care shall be taken not to injure the skin on galvanized surfaces during transport and handling. Damages, if occur, shall be made good in accordance with the provisions of this Specification or as directed by the Engineer.

4.0.0. INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY

4.1.0 Inspection

Unless specified otherwise, inspection to all work shall be made by the Engineer or Engineer's representative at the place of manufacture prior to delivery. The Engineer or his representative shall have free access at all reasonable times to those parts of the manufacturer's works which are concerned with the fabrication of the steelwork under this Contract and he shall be afforded all reasonable facilities for satisfying himself that the fabrication is being done in accordance with the provisions of this Specification.

The Contractor shall provide free of charge, such labour, materials, electricity, fuel, water, stores, tools and plant, apparatus and instruments as may be required by the Engineer to carry out inspection and/or tests in accordance with the Contract.

The Contractor shall guarantee compliance with the provisions of this Specification.

4.2.0 Testing and Acceptance Criteria

4.2.1 General

The Contractor shall carry out sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost, unless otherwise specified in the Contract. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.

4.2.2 Steel

All steel supplied by the Contractor shall conform to the relevant Indian Standards. Except otherwise mentioned in the Contract, only tested quality steel having mill test reports shall be used. In case unidentified steel materials are permitted to be used by the Engineer, random samples of materials will be taken from each unidentified lot of 50 M.T. or less of any particular section for tests to conform to relevant Indian Standards. Cost of all tests shall be borne by the Contractor.
All material shall be free from all imperfections, mill scales, slag intrusions, laminations, pittings, rusts etc. that may impair their strength, durability and appearance.

4.2.3 **Testing Criteria for checking Lamination in raw steel plates**

All raw steel plate of thickness more than 20 mm supplied by the contractor shall be checked against lamination before procurement & prior to commencement of fabrication work in the following ways as directed by the Engineer :

a) Ultrasonic testing along the edge of specified points of the plates shall be carried out to delete lamination in the plates, if any.

b) If the results of the tests in (a) are not satisfactory, the whole area of the plates shall be checked by ultrasonic testing at specified nodal points formed at equidistant grid locations. The spacing of the grids shall be determined from tests in (a) or as directed by the Engineer.

If the results of the above tests are not satisfactory, the plates shall not be taken up for fabrication work. Even after fabrication at shop, if the Engineer requires any ultrasonic testing to detect lamination of plates, the same shall be carried out by the Contractor. If the plates in the fabricated item is found to be laminated, the component will be rejected.

4.2.4 **Welding**

All electrodes shall be procured from reliable manufacturers with test certificates. The correct grade and size of electrode which has not deteriorated in storage shall be used. The inspection and testing of welding shall be performed in accordance with the provisions of the relevant Indian Standards or other equivalents. For every 50 tonnes of welded fabrication, the Engineer may ask for at least 1 (one) test-destructive or non-destructive including X-ray, ultrasonic test or similar, the cost of which shall be borne by the Contractor. In the event of further tests as may be desired by the Engineer, the cost of such test shall be borne by the Contractor if the results are found to be unsatisfactory; and if the test shows no defect, the cost shall be borne by the Owner. In cases of the test results showing deficiency, the Engineer shall have option to reject or instruct any remedial measures to be taken free of charge to the Owner.

4.2.5 **Bolts, nuts and washers**

All bolts, nuts and washers shall be procured from reputed manufacturer approved by the Engineer and shall conform to the relevant Indian Standards. If desired by the Engineer, representative samples of these materials may have to be tested in an approved laboratory and in accordance with the procedures described in relevant Indian Standards. Cost of all such testing shall have to be borne by the Contractor.

4.2.6 **Shop painting**

All paints and primers shall be of standard quality and procured from approved manufacturers and shall conform to the provisions of the relevant Indian Standards.

4.2.7 **Galvanizing**

All galvanizing shall be uniform and of standard quality when tested in accordance with IS:2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS:4759 - specification for Hot-Dip Zinc Coatings on Structural Steel & other allied products.

4.3.0 **Tolerance**

The tolerances on the dimensions of individual rolled steel components shall be as specified in IS:1852 - specification for rolling and Cutting Tolerances for Hot-rolled Steel Products. The tolerances on straightness, length etc. of various fabricated components (such as beams and girders, columns, crane gantry girder etc.) of the steel structures other than steel railway & road bridges, structures subjected to dynamic loading (like wind, seismic etc.) and thin walled construction (like box girders) shall be as specified in IS:7215 - Tolerances for Fabrication of Steel Structures.

4.4.0 **Acceptance**

Should any structure or part of a structure be found not to comply with any of the provisions of this Specification, the same shall be liable to rejection. No structure or part of the structure, once rejected, shall be offered again for test, except in cases where the Engineer considers the defects rectifiable. The Engineer may, at his discretion, check the test results obtained at the Contractor's works by independent tests at an approved laboratory and should the items, so tested, be found to be unsatisfactory, the costs shall be borne by the contractor, and if satisfactory, the costs shall be borne by the Owner.

When all tests to be performed in the Contractor's shop under the terms of this contract have been successfully carried out, the steelwork will be accepted forthwith and the Engineer will issue an acceptance certificate, upon receipt of which, the items will be shop painted, packed and despatched. No item to be delivered unless an acceptance certificate for the same has been issued. The satisfactory completion of these tests or the issue of the certificates shall not bind the Owner to accept the work, should it, on further tests before or after erection, be found not in compliance with the Contract.

4.5.0 **Delivery of Materials**

4.5.1 **General**

The Contractor will deliver the fabricated structural steel materials to site with all necessary field connection materials in such sequence as will permit the most efficient and economical performance of the erection work. the Owner may prescribe or control the sequence of delivery of materials, at his own discretion.

4.5.2 **Marking**

Each separate piece of fabricated steelwork shall be distinctly marked on all surfaces before delivery in accordance with the markings shown on approved erection drawings and shall bear such other marks as will further facilitate identification and erection.

4.5.3 **Packing and Shipping**

All projecting plates or edges and all ends of members of joints shall be stiffened, all straight members and plates, shall be bundled, all screwed ends and machined surfaces shall be suitably packed and all bolts, nuts, washers, and small loose parts shall be packed separately in order to prevent damage or distortion during shipping.

Shipping shall be strictly in accordance with the sequence stipulated in the agreed programme. Payment may be held up for items sent in advance of the sequence till they could be erected. The Contractor shall include and provide for in his rates, the freight and other charges for despatching the materials to the worksite and also for securely protecting and packing the materials to avoid loss or damage during transport by rail, road or water. All packings shall allow for easy removal and checking at site. Special precautions shall be taken against rusting, corrosion, breakage or damage otherwise of the materials. All parts shall be adequately braced to prevent damage in transit.

Each bundle, bale or package delivered under this contract shall be marked on as many sides as possible and such distinct marking (all previous irrelevant markings being carefully obliterated) shall show the following : -

a) Name and address of the consignee

b) Name and address of the consignor

c) Gross weight of the package in tonnes and its dimensions

d) Identification marks and/or number of the package

e) Custom registration number, if required

All markings shall be carried out with such materials as would ensure quick drying and indelibility.

Each component or part or piece of material when shipped, shall be indelibly marked and/or tagged with reference to assembly drawings and corresponding piece numbers.

Each packing case shall contain in duplicate in English a packing list pasted on to the inside of the cover in a water- proof envelope, quoting especially -

a) Name of the Contractor

b) Number and date of the Contract

c) Name of the office placing the contract

d) Nomenclature of stores

e) A schedule of parts or pieces, giving the parts or piece number with reference to assembly drawings and the quantity of each.

The shipping dimensions of each package shall not exceed the maximum dimensions permissible for transport over the Indian Railways/Roads.

After delivery of the materials at site, all packing materials shall automatically become the property of the Owner without any extra payment.

Notwithstanding anything stated here in before, any loss or damage resulting from inadequate packing shall be made good by the Contractor at no additional cost to the Owner. When facilities exist, all shipments shall be covered by approved Insurance Policy for transit at the cost of the Contractor.

The contractor shall ship the complete materials or part on board a vessel belonging to an agency approved by the Owner or on rail and/or road transport as directed. The Contractor shall take all reasonable steps to ensure correct appraisal of freight rates, weights and volumes and in no case will the Owner be liable to pay any warehouse, wharfage, demurrage and other charges.

If, however, the Owner has to make payment of any of the above mentioned charges, the amount paid will be deducted from the progressive bills of the Contractor.

Necessary advise regarding the shipment with relevant details shall reach the Engineer at least a week in advance.

5.0.0. INFORMATION TO BE SUBMITTED

5.1.0 With Tender

The following information are required to be submitted with the Tender :

a) **Progress Schedule**

The Contractor shall quote in his Tender a detailed schedule of progress of work and total time of completion, itemizing the time required for each of the following aspects of work.

i) Preparation and approval of shop drawings

ii) Procurement of materials

iii) Fabrication and shipping of all anchor bolts

iv) Fabrication and shipping of main steelwork

v) Fabrication and shipping of steelwork for bunkers. Tanks and/ or silos as applicable.

vi) Fabrication and shipping of all other remaining steel work including miscellaneous steelwork

vii) Final date of completion of all shipments

Time required for completion being one of the main criteria for selecting the successful bidder, it is desired that the bidder quotes the minimum time required by him for completing the work.

b) **Shop**

Location of the Tenderer's fabrication workshop giving details of equipment, manpower, the total capacity and the capacity that will be available exclusively for this contract shall be submitted.

c) **Matching Steel**

A rough indication of the quantities and details of matching steel sections required to start the work shall be furnished.

5.2.0 After Award

After award of the Contract the successful Tenderer is to submit the following :

a) Complete fabrication drawings, material lists, cutting lists, bolt lists, field welding schedules based on the design drawings furnished to him in accordance with the approved schedule.

b) Monthly Progress Report with necessary photographs in six (6) copies to reach the Engineer on or before the 7th day of each month, giving the up-to-date status of preparation of detailed shop drawings, bill of materials, procurement of materials, actual fabrication done, shipping and all other relevant information.

c) Detailed monthly material reconciliation statements relevant to the work done and reported in the Progress Report, giving the stock at hand of raw steel, work in progress, finished materials and scrap.

d) Results of any test as and when conducted and as required by the Engineer.

e) Manufacturer's mill test report in respect of steel materials, bolts, nuts and electrodes as may be applicable.

6.0.0 RATES

6.1.0 General

In general, even though it may not be specifically mentioned in the Schedule of Items, the rates for items mentioned in the Schedule of Items shall include cost of all materials consumed in the work or incidental to it, hire charges of tools and plants, cost of labour, insurance, all transport charges including taking delivery of raw steel from Contractor's Site Stores and transporting the same to the Contractor's fabricating workshop and delivery of finished fabricated materials ~~back~~ to sites, all taxes, royalties,, making approaches, security and safety arrangements, power, fuel, lubricant, preparation of all fabrication drawings, material lists, cutting lists, bolt lists, field welding schedule, services, supervision, overheads, profits etc. complete in all respects unless certain items specifically excluded by the terms and conditions of the Contract and as mentioned in the following sub-clauses.

6.2.0 Fabrication

The rates quoted for fabrication of various categories of steelwork shall specifically include taking delivery and transport of raw steel from the stockyard as mentioned in the Contract upto the Contractor's fabricating shop and one shop coat of approved metal protection paint but exclude any transport of the fabricated materials. The rates for fabrication shall also include supply of all electrodes required for shop and field work including 10% extra for field work.

6.3.0 ~~Transport~~

The rate quoted for transport shall include all C.I.F. from the Contractor's fabricating shop upto the Site and loading of the fabricated materials on railway wagons or trucks at the fabricating shop but shall generally exclude unloading at site(which is generally included in the rate for erection). But, in case the terms & conditions of the contract so desire, the cost of unloading of the fabricated material at site shall also be included in the quoted rates for transport.

6.4.0 **Bolts, nuts and washers**

The rates quoted for the supply of bolts, nuts and washers shall include the total cost of delivery of the materials at site or to the Owner's Site stores as directed by the Engineer.

7.0.0 **METHOD OF MEASUREMENT**

7.1.0 **Fabrication**

Measurement shall be in tonnes and based on the unit weights as per relevant Indian Standards and on the following considerations : -

a) All members, except plate works paid under rates for bunkers, tanks, etc., will be measured square.

b) All plate works paid under rates for bunkers, tanks, etc. as applicable will be measured as actual.

c) No deduction will be made for bolt and/or holes and/or holes upto 25 Sq.Cm.

d) Unless otherwise specified no allowance shall be made for weld metals in case of welded steel structure.

7.2.0 **Supply of bolts, nuts and Washers**

The supply of bolts, nuts and washers will be measured on standard unit weight basis or actuals whichever is less.

7.3.0 **Transport**

The measurement for transport of fabricated steelwork will be for the net weight of the fabricated materials as measured under Sub-clause 7.1.0 excluding the weight of all packing and supporting materials necessary for transport.

8.0.0 **PAYMENT**

Unless mentioned otherwise in the tender / contract document, for fabricated materials delivered to Site, the Contractor shall be entitled to 90% of the value of the materials supplied and the balance 10% shall be paid only after the final erection, and aligning of the fabricated materials. In addition, the Security Money as stipulated in the Contract, shall be deducted from each payment.

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SECTION-X

TECHNICAL SPECIFICATION
FOR
ERECTION OF STRUCTURAL STEEL WORK

CONTENT

VOLUME : VII-C

SECTION-X

TECHNICAL SPECIFICATION FOR ERECTION OF STRUCTURAL STEEL WORK

1.0.0 SCOPE

This specification covers the erection of structural steelwork including receiving and taking delivery of fabricated structural steel materials arriving at Site, and/or from Contractor's Site Stores or store Yard, installing the same in position, painting and grouting the stanchion bases all complete as per Drawings, this Specification and other provision of the Contract.

2.0.0 GENERAL

2.1.0 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified in the Contract, shall include but not be limited to the following :

a) The Contractor shall provide all construction and transport equipment, tools, tackle, consumables, materials, labour and supervision required for the erection of the structural steelwork.

b) Receiving, unloading, checking and moving to storage yard at Site including prompt attendance to all insurance matters as necessary for all fabricated steel materials arriving at Site. The Contractor shall pay all demurrage and/or wharfage charges etc. on account of default on his part.

c) Transportation of all fabricated structural steel materials from Site storage yard, handling, rigging, assembling, bolting, welding and satisfactory installation of all fabricated structural steel materials in proper location according to approved erection drawings and/or as directed by the Engineer. If necessary suitable temporary approach roads to be built for transportation of fabricated steel structures.

d) Checking center lines, levels of all foundation blocks including checking line, level, position and plumb of all bolts and pockets. any defect observed in the foundation shall be brought to the notice of the Engineer. The Contractor shall fully satisfy himself regarding the correctness of the foundations before installing the fabricated steel structures on the foundation blocks.

e) Aligning, plumbing, leveling, bolting, welding and securely fixing the fabricated steel structures in accordance with the Drawings or as directed by the Engineer.

f) Painting of the erected steel structures if required by the Contract.

g) All minor modifications of the fabricated steel structures as directed by the Engineer including but not limited to the following:-

i) Removal of bends, kinks, twists etc. for parts damaged during transport and handling.

ii) Cutting, chipping, filling, grinding etc. if required for preparation and finishing of site connections.

iii) Reaming of holes for use of higher size bolt if required.

iv) Welding of connections in place of bolting for which holes are either not drilled at all or wrongly drilled during fabrication. Welding in place of bolting will be permitted only at the discretion of the Engineer.

v) Refabrication of parts damaged beyond repair during transport and handling or Refabrication of parts which are incorrectly fabricated.

vi) Fabrication of parts omitted during fabrication by error, or subsequently found necessary.

vii) Drilling of holes which are either not drilled at all or are drilled in incorrect location during fabrication.

viii) Carry out tests in accordance with this Specification if directed.

2.2.0 **Work by others**

No work under this Specification will be provided for by any agency other than the Contractor unless specifically mentioned elsewhere in the Contract.

2.3.0 **Codes and Standards**

All work under this Specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specification and codes of Practice of equivalent :

IS-800	:	Code of Practice for general construction in steel
IS-456	:	Code of Practice for plain or reinforced concrete
IS-7205	:	Safety Code for erection of Structural Steel work
IS-12843	:	Tolerance for erection of Steel Structures

2.4.0 **Conformity with designs**

The Contractor will erect the entire fabricated steel structure, align all the members, complete all field connections and grout the foundations all as per the provisions of this specification and the design criteria detailed in the approved erection drawings and/or other stated document. All work shall conform to the provisions of the relevant Indian Standard Specifications and/or the instructions of

the engineer. The testing and acceptance of the erected structures shall be in accordance with the provisions of this Specification and /or the instructions of the Engineer.

2.5.0 **Material**

2.5.1 **General**

All fabricated steel structures and connection materials shall be supplied by the Contractor for fabrication work. The Contractor for erection work will take delivery of all the materials from the Contractor's Stores or storage yard at Site. The Contractor may also have to take delivery directly from railway wagons or trucks at Site as per terms & condition of the contract, in which case he shall have to unload the materials and perform all formalities like checking of materials and attend to insurance matters in accordance with Sub-Clause 2.1.0 and as specified herein before.

While taking delivery, the Contractor will check the quantity, quality and the sizes of the materials and verify the adequacy of the same in accordance with the Drawings and Specifications. In case the Contractor finds any material inadequate, he shall inform the Engineer immediately prior to taking delivery of the same. No claim whatsoever, in respect of bad quality, shortages or difference in size will be entertained once the delivery is taken and the Contractor shall make good any such deficiency, if detected later, either by repair or with fresh material as may be directed by the Engineer at the Contractor's Own cost.

Excepting all field connection materials like bolts, nuts, washers and electrodes, which will be supplied by the fabrication Contractor to the extent of 10% in excess of the estimated requirements as per Drawings, all other consumables like oxygen and acetylene gas, paints, fuels, lubricants, oil, grease, cement, sand, aggregates and any other material that may be required for the execution of the works in accordance with the contract will be supplied by the contractor for erection work and will be deemed to have been included in this rates.

2.5.2 **Materials to conform to Indian Standards**

All materials required to be supplied by the Contractor under this Contract shall conform to the relevant Indian Standard Specifications.

2.6.0 **Storage of materials**

2.6.1 **General**

All material shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for use in the works. Any material which has been deteriorated or damaged beyond repairs and has become unfit for use shall be removed immediately from the site, failing which, the Engineer shall be at liberty to get the materials removed by agency and the cost incurred thereof shall be realised from the Contractor's dues.

2.6.2 **Yard**

The Contractor will have to establish a suitable yard in an approved location at site for storing the fabricated steel structures and other materials which will be delivered to him by the Owner according to the Contract. The yard shall have proper facilities like, drainage, lighting, suitable access for large cranes, trailers and other heavy equipments. The yard shall be fenced all around with security arrangement and shall be of sufficiently large area to permit systematic storage of the fabricated steel structures without overcrowding and with suitable access for cranes, trailers and other equipment for use in erection work in proper sequence in accordance with the approved programme of work.

The Tenderer should visit the site prior to submission of his Tender to acquaint himself with the availability of land and the development necessary by way of filling, drainage, access roads, fences, sheds etc. all of which shall be carried out by the Contractor at his own cost as directed by the Engineer.

2.6.3 **Covered Store**

All field connection materials, paints, cement etc. shall be stored on well designed racks and platforms off the ground in a properly covered store building to be built at the cost of the Contractor.

2.7.0 **Quality control**

The contractor shall establish and maintain quality control procedures for different items of work and materials as may be directed by the Engineer to assure compliance with the provisions of the Contract and shall submit the records of the same to the Engineer. The quality control operation shall include but not be limited to the following items of work :

a) Erection : Lines, levels, grades, plumbs, joint characteristics including tightness of bolts.

b) Grouting : Cleaning and roughness of foundation, quality of materials used for grouting, admixtures, consistency and strength of grout.

c) Painting : Preparation of surface for painting, quality of primers and paints, thinners, application and uniformity of coats.

2.8.0 **Taking Delivery**

The erection Contractor shall take delivery of fabricated structural steel and necessary connection materials supplied by the fabrication Contractor from railhead, trucks and/or the Owner's stores at site as may be necessary and as per terms & conditions of the contract or as directed by the Engineer. He shall check, unload, transport the materials to his stores for proper storing at his own cost. The erection Contractor shall submit claims to insurance or other authorities and pursue the same in case of loss or damage during transit and handling and all loss thereof shall be borne by him.

The erection contractor shall also take all precautions against damage of the materials in his custody after taking delivery and till the same are erected in place and accepted. The Contractor shall salvage, collect and deliver all the packing materials to the Owner free of charge.

3.0.0 **WORKMANSHIP**

3.1.0 **Erection**

3.1.1 **Plant and equipment**

The suitability and adequacy of all erection tools and plant and equipment proposed to be used shall be efficient, dependable, in good working condition and shall have the approval of the Engineer.

3.1.2 **Method and sequence of erection**

The method and sequence of erection shall have the prior approval of the Engineer. The Erection shall arrange for most economical method and sequence available to him consistent with the Drawings and Specifications and such information as may be furnished to him prior to the execution of the Contract.

3.1.3 **Temporary bracing**

Unless adequate bracing is included as a part of the permanent framing, the erector during erection shall install, free of cost to the Owner, temporary guys and bracings where needed to secure the framing against loads such as wind or seismic forces comparable in intensity to that for which the structure has been designed, acting upon exposed framing as well as loads due to erection equipment and erection operations.

If additional temporary guys are required to resist wind or seismic forces acting upon components of the finished structure installed by others during the course of the erection of the steel framing, arrangement for their installation by the erector shall be made free of cost to the Owner.

The responsibility of the Contractor in respect of temporary bracings and guys shall cease when the structural steel is once located, plumbed, levelled, aligned and grouted within the tolerances permitted under the specification and guyed and braced to the satisfaction of the Engineer.

The temporary guys, braces, false work and cribbing shall be removed immediately upon completion of the steel erection and shall return to the Owner's store in good condition if the materials are supplied by the Owner otherwise permission shall be given to Contractor to take out the materials from the project site. The Owner may remove and return the materials in good condition to the Contractor without any charge if they have been left in place under other agreed arrangement.

3.1.4 **Temporary floors for buildings**

It shall be the responsibility of the Contractor to provide free of cost planking and to cover such floors during the work in progress as may be required by any Act of Parliament and/or by-laws of state, Municipal or other local authorities.

3.1.5 **Setting out**

Positioning and leveling of all steelwork, plumbing of stanchions and placing of every part of the structure with accuracy shall be in accordance with the approved Drawings and to the satisfaction of the Engineer. Concrete foundations, where required, shall be made by other agencies. Anchor bolts and other anchor steel shall be embedded by other agencies. The Contractor

shall check the positions and levels of the anchor bolts, etc. before concreting and get them properly secured against disturbance during pouring operations. He shall remain responsible for correct positioning. For heavy columns, etc. the Contractor shall set proper screed bars if desired by the Engineer, to maintain proper level. No extra payment shall be made for this.

Each tier of column shall be plumbed and maintained in a true vertical position subject to the limits of tolerance allowable under this Specification.

No permanent field connections by bolting or welding shall be carried out until proper alignment and plumbing has been attained.

3.1.6 **Field bolting**

All relevant portions in respect of bolted construction of the Specification for Fabrication of Structural Steelwork applicable to the Project shall also be applicable for field bolting in addition to the following :

Bolts shall be inserted in such a way so that they may remain in position under gravity even before fixing the nut. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible materials. When assembled, all joint surfaces, including those adjacent to the washers shall be free of scales except tight mill scales. They shall be free of dirt, loose scales, burns, and other defects that would prevent solid seating of the parts. Contact surfaces within friction-type joints shall be free of oil, paint, lacquer, or galvanizing.

All high tensile bolts shall be tightened to provide, when all fasteners in the joint are tight, the required minimum bolt tension by any of the following methods.

a) **Turn-of-nut method**

When the turn-of-nut method is used to provide the bolt tension, there shall first be enough bolts brought to a "snug tight" condition to ensure that the parts of the joint are brought into good contact with each other. "snug tight" is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified in Table-1 with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation there shall be no rotation of the part not turned by the wrench.

TABLE - I

Bolts length not exceeding 8 x dia. or 200 mm	Bolt length exceeding 8xdia. or 200 mm	Remarks
1/2 turn	2/3 turn	Nut rotation is relative to bolt regardless of the element (nut or bolt) being turned. Tolerance on rotation - 30 over or under.

Bolts may be installed without hardened washers when tightening is done by the turn-of-nut method. However, normal washers shall be used.

Bolts tightened by the turn-of-nut method may have the outer face of the nut match-marked with the protruding bolt point before final tightening, thus affording the inspector visual means of noting the actual nut rotation. Such marks can be made by the wrench operator by suitable means after the bolts have been brought up snug tight.

b) **Torque Wrench tightening**

When torque wrenches are used to provide the bolt tensions, the bolts shall be tightened to the torques specified in TABLE - II. Nuts shall be in tightening motion when torque is measured. When using torque wrenches to install several bolts in a single joint, the wrench shall be returned to touch up bolts previously tightened, which may have been loosened by the tightening of subsequent bolts, until all are tightened to the required tension.

TABLE - II

Nominal Bolt Diameter (mm)	Torque to be applied (Kg.M) for bolt class 8.8 of IS : 1367
20	59.94
22	81.63
24	103.73

NOTE :

The above torque values are approximate for providing tensions of 14.7 MT for 20 mm dia., 18.2 MT for 22 mm dia; and 21.2 MT for 24 mm dia. bolts under moderately lubricated condition. The torque wrench shall be calibrated at least once daily to find out the actual torque required to produce the above required tension in the bolt by placing it in a tension indicating device. These torques shall be applied for tightening the bolts on that day with the particular torque wrench.

In either of the above two methods, if required, for bolt entering and wrench operation clearances, tightening may be done by turning the bolt while the nut is prevented from rotating.

Impact wrenches if used shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately ten seconds.

Holes for turned bolts to be inserted in the field shall be reamed in the field. All drilling and reaming for turned bolts shall be done only after the parts to be connected are assembled. Tolerances applicable in the fit of the bolts shall be in accordance with relevant Indian Standard Specifications. All other requirements regarding assembly and bolt tightening shall be in accordance with this sub clause.

3.1.7 **Field Welding**

All field assembly and welding shall be carried out in accordance with the requirements of the specification for fabrication work applicable to the project, excepting such provisions therein which manifestly apply to shop conditions only. Where the fabricated structural steel members have been delivered painted, the paint shall be removed before field welding for a distance of at least 50 mm on either side of the joints.

3.1.8 **Holes, cutting and fitting**

No cutting of sections, flanges, webs, cleats, bolts, welds etc. shall be done unless specifically approved and / or instructed by the Engineer.

The erector shall not cut, drill or otherwise alter the work of other trades, or his own work to accommodate other trades, unless such work is clearly specified in the Contract or directed by the Engineer. Wherever such work is specified the Contractor shall obtain complete information as to size, location and number of alterations prior to carrying out any work. The Contractor shall not be entitled for any payment on account of any such work.

3.2.0 **Drifting**

Correction of minor misfits and reasonable amount of reaming and cutting of excess stock from rivets will be considered as permissible. For this, light drifting may be used to draw holes together and drills shall be used to enlarge holes as necessary to make connections. Reaming, that weakens the member or makes it impossible to fill the holes properly or to adjust accurately after reaming shall not be allowed.

Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins and reamers shall immediately be called to the attention of the Engineer and approval of the method of correction obtained. The use of gas cutting torches at erection site is prohibited.

3.3.0 **Grouting of stanchion bases and bearings of beams and girders on stone, brick or concrete (Plain or reinforced)**

Grouting shall be carried out with Ordinary Cement grout as described below :

The mix shall be one (1) part cement and one (1) part sand and just enough water to make it workable. The positions to be grouted shall be cleaned thoroughly with compressed air jet and wetted with water and any accumulated water shall be removed. These shall be placed under expert supervision, taking care to avoid air-locks. Edges shall be finished properly. If the thickness of grout is 25 mm or more, two (2) parts of 6 mm down graded stone chips may be added to the above noted cement-sand grout mix, if required, by the Engineer or shown on the drawings.

Admixtures like aluminium powder, "ironite" or equivalent may be required to be added to the grout to enhance certain desirable properties of the grout.

Alternatively, the grouting may be done with non-shrink high strength free flow cementious grout (ready mixed) like Conbextra-GP-1 or "Sika grout - 214", or "Anchor NSG" or approved equivalent.

No grouting shall be carried out until a sufficient number of bottom lengths of stanchions have been properly lined, leveled and plumbed and sufficient floor beams are tied in position.

Whatever method of grouting is employed, the operation shall not be carried out until the steelwork has been finally leveled and plumbed, the stanchion bases being supported meanwhile by steel wedges, and immediately before grouting, the space under steel shall be thoroughly cleaned.

3.4.0 **Painting after erection**

Field painting, if required to be done by the erection Contractor, shall only be done after the structure is erected, leveled, plumbed, aligned and grouted in its final position, tested and accepted by the Engineer. However, touch up paintings, making good any damaged shop painting and completing any unfinished portion of the shop coat shall be carried out by the erection Contractor free of cost to the Owner. The materials and specification for such painting in the field shall be in accordance with the requirements of the specification for fabrication of structural steelwork applicable for the project.

Painting shall not be done in rainy or foggy weather or when humidity is such as to cause condensation on the surfaces to be painted. Before painting of steel, which is delivered unpainted, is commenced, all surfaces to be painted shall be dried and thoroughly cleaned from all loose scale and rust.

All field bolts, welds and abrasions to the shop coat shall be spot painted with the same paint used for the shop coat. Where specified, surfaces which will be in contact after site assembling shall receive a coat of paint (in addition to the shop coat, if any) and shall be brought together while the paint is still wet.

Surface which will be inaccessible after field assembly shall receive the full specified protective treatment before assembly. Bolts and fabricated steel members which are galvanized or otherwise treated and steel members to be encased in concrete shall not be painted.

The specification for paint and workmanship shall be in accordance with the requirements of the specification for fabrication of structural steelwork applicable to the project. The number of coats and the shades to be used shall be as specified or as directed by the Engineer.

3.5.0 **Stainless Steel Plate Lining in Bunker Hopper**

The hopper portion of the coal bunkers shall be lined with stainless steel plates of 4 mm thickness. The stainless steel shall be of AISI 304 quality. The work includes supply, fabrication, welding and fixing of stainless steel lining plate to bunker M.S. plate as per drawing & specification.

The stainless steel liner shall be fixed to the tanker hopper MS shall be plug welding using special electrodes (such as, Inox-CW coding AWS-310-16, ISMBOS-311 or Inox-D2 coding AWSE-309-16, ISMB 04-311 manufactured by Advani Oerlikon Ltd. or equivalent). Such plug welding shall be done by drilling 21.5 mm dia. holes at 300 mm centre to centre both ways as per drawings. The plug welding shall be ground flush with the lining plate.

3.6.0 **Final cleaning up**

Upon completion of erection and before final acceptance of the work by the Engineer, the Contractor shall remove free of cost all false work, rubbish and all Temporary Works resulting in connection with the performance of his work.

3.7.0 **Safety Measures during Erection**

The safety measures to workmen and supervisors during all types of erection work (e.g., use of lifting appliances, slingning, welding, gas cutting, etc.) should be taken as per IS : 7205. When any statutory provisions exist, the same shall be complied with in addition to the provisions contained in the above code.

4.0.0 **TESTING AND ACCEPTANCE CRITERIA**

4.1.0 **General**

Loading tests shall be carried out on erected structures, if required by the Engineer, to check adequacy of fabrication and/or erection. Any structure or a part thereof found to be unsuitable for acceptance as a result of the test shall have to be dismantled and replaced with suitable member as per the Contract of either fabrication or erection of steelwork whoever is responsible for it and no payment towards the cost of the dismantled portion and any connected work shall be made to the Contractor, unless it is proved that the deficiency is due to reasons beyond the Contractor's scope. On the basis of the tests, the Engineer will decide whether the fabricator or the erector is responsible for the unacceptable member or structure and his decision will be final. In case it is established that the unacceptability of the member or structure is due to design deficiency, the cost of replacement and/or modifications will be borne by the Owner. In course of dismantling, if any damage is done to any other parts of the structure or to any fixtures, the same shall be made good free of cost by the Contractor responsible,

to the satisfaction of the Engineer. The cost of the tests specified hereinafter shall be borne by the Owner. Any extra claim due to loss of time, idle labour, etc. arising out of these testing operations shall not be entertained, however, only reasonable and appropriate time extensions will be allowed.

The structure or structural member under consideration shall be loaded with its actual dead load for as long a time as possible before testing and the tests shall be conducted as indicated in the following Sub-clauses 4.1.1, 4.1.2 and 4.1.3. The method of testing and application of loading shall be as approved by the Engineer.

4.1.1 **Stiffness Test**

In this test, the structure or member shall be subjected, in addition to its actual dead load, to a test load equal to 1.5 times the specified superimposed load, and this loading shall be maintained for 24 hours. The maximum deflection attained during the test shall be within the permissible limit. If, after removal of the test load, the member or structure does not show a recovery of at least 80 per cent of the maximum strain or deflection shown during 24 hours under load, the test shall be repeated. The structure or member shall be considered to have sufficient stiffness, provided that the recovery after this second test is not less than 90 per cent of the maximum increase in strain or deflection recorded during the second test.

4.1.2 **Strength Test**

The structure or structural member under consideration shall be subjected, in addition to its actual dead load, to a test load equal to the sum of the dead load and twice the specified superimposed load, and this load shall be maintained for 24 hours.

In the case of wind load, a load corresponding to twice the specified wind load shall be applied and maintained for 24 hours, either with or without the vertical test load for more severe condition in the member under consideration or the structure as a whole. Complete tests under both conditions may be necessary to verify the strength of the structure. The structure shall be deemed to have adequate strength if, during the test, no part fails and if on removal of the test load, the structure shows a recovery of at least 20 per cent of the maximum deflection or strain recorded during the 24 hours under load.

4.1.3 **Structure of same design**

Where several structures are built to the same design and it is considered unnecessary to test all of them, one structure, as a prototype, shall be fully tested, as described in previous Sub-clauses, but in addition, during the first application of the test load, particular note shall be taken of the strain or deflection when the test load 1.5 times the specified superimposed load has been maintained for 24 hours. This information is required as a basis of comparison in any check test carried out on samples of the structure.

When a structure of the same type is selected for a check test, it shall be subjected, in addition to its actual dead load, to a superimposed test load, equal to 1.5 time the specified live load, in a manner and to an extent prescribed by the Engineer. This load shall be maintained for 24 hours, during which time, the maximum deflection shall be recorded. The check test shall be considered satisfactory, provided that the maximum strain or deflection recorded in the check test does not exceed by more than 20% of the maximum strain or deflection recorded at similar load in the test on the prototype.

4.1.4 **Repair for subsequent test and use after strength tests**

An actual structure which has passed the "Strength Test" as specified in Sub-clause 4.1.2 herein before and is subsequently to be erected for use, shall be considered satisfactory for use after it has been strengthened by replacing any distorted members and has subsequently satisfied the 'Stiffness Test' as specified in Sub-clause 4.1.1. herein before.

4.2.0 **Tolerances**

Some variation is to be expected in the finished dimensions of structural steel frames. Unless otherwise specified, such variations are deemed to be within the limits of good practice when they are not in excess of the cumulative effect of detailed erection clearances, fabricating tolerances for the finished parts and the rolling tolerances for the profile dimensions permitted under the Specifications for fabrication of structural steelwork applicable to this Project and as specified below:

I. **For Buildings Containing Cranes**

Component	**Description**		**Variation Allowed**
Main columns	a)	Shifting of column axis at foundation level with respect to building line	
		i) In longitudinal direction	i) ± 3.0 mm
		ii) In lateral direction	ii) ± 3.0 mm
	b)	Deviation of both major column axis from vertical between foundation and other member connection levels :	
		i) For a column upto and including 10M height	i) ± 3.5 mm from true vertical

Component	Description		Variation Allowed
	ii)	For a column greater than 10M but less than 40M height any 10M	ii) ± 3.5 mm from true vertical for length measured between connection levels, but not more than ± 7.0 mm per 30 m length
	c)	For adjacent pairs of columns across the width of the building prior to placing of truss.	± 9 mm on true span.
	d)	For any individual column deviation of any bearing or resting level from levels shown on drawings.	± 3.0 mm
	e)	For adjacent pairs of columns either across the width of building or longitudinally level difference allowed between bearing or seating level supposed to be at the same level.	3 mm
Trusses	a)	Deviation at centre of span of upper chord member from vertical plane running through centre of bottom chord	1/1500 of the span or not greater than 10 mm which ever is the least
	b)	Lateral displacement of top chord at centre of span from vertical plane running through centre	1/250 of depth of truss or 20 mm whichever is the of supports least

Component	Description		Variation Allowed
Crane Girders & Tracks	a)	Difference in levels of crane rail measured between adjacent columns.	2.0 mm
	b)	Deviation to crane rail gauge	± 3.0 mm
	c)	Relative shifting of ends of adjacent crane rail in plan and elevation after thermit welding.	1.0 mm
	d)	Deviation of crane rail axis from centre line of web.	± 3.5 mm
Setting of Expansion gaps		At the time of setting of the expansion gaps, due regard shall be taken of the ambient temperature above or below 30°C. The coefficient of expansion or contraction shall be taken as 0.000012 per Deg.C per unit length.	

II. **For Building without Cranes**

The maximum tolerances for line and level of the steel work shall be ± 3.0 mm on any part of the structure. The structure shall not be out of plumb more than 3.5 mm on each 10M section of height and not more than 7.0 mm per 30 M section.

These tolerances shall apply to all parts of the structure unless the drawings issued for erection purposes state otherwise.

4.3.0 **Acceptance**

Structures and members which have passed the tests and conform to all requirements specified in the foregoing Sub-clause 4.1.0, 4.1.1, 4.1.2, 4.1.3 and 4.1.4 and other applicable provisions of this Specification and are within the limits of tolerances specified in Sub-clause 4.2.0 and/or otherwise approved by the Engineer shall be treated as approved and accepted for the purpose of fulfilment of the provisions of this Contract.

5.0.0 **INFORMATION TO BE SUBMITTED**

5.1.0 **Before Tender**

Along with the Tenders the Tenderers will be required to submit the following information :

5.1.1 **Tentative Programme**

The Tenderer shall submit a tentative programme based on the information available in the Tender Document and visit to Site indicating the structure-wise erection schedule proposed to be maintained by the Contractor to complete the job in time in accordance with the Contract.

5.1.2 **Constructional Plant and Equipment, Tools, Temporary Works & Manpower**

A detailed list of all Constructional Plant & Equipment like cranes, derricks, winches, welding sets, erection tools etc. along with their make, model, present condition and location available with the Tenderer which he will be able to employ on the job to maintain the progress of work in accordance with the Contract shall be submitted along with the Tender. The total number of each category of experienced personnel like fitters, welders, riggers etc. that he will be able to employ on the job shall also be indicated.

5.1.3 **Erection yard**

A site plan showing the layout and location of the erection yard proposed to be established by the Tenderer shall be attached with the Tender indicating the storage space for fabricated steel materials, site-fabrication and repair shop, covered stores, offices, locations of erection equipments and other facilities. The Engineer shall have the right to modify the arrangement and location of the proposed yard to suit site conditions and the Contractor shall comply with the same without any claim whatsoever.

5.2.0 **After award of the Contract**

After award of the contract, the Contractor shall submit the following :

5.2.1 **Detailed Programme**

The Contractor shall submit a detailed erection programme within a month of the award of the Contract for completion of the work in time in accordance with the Contract. This will show the target programme, with details of erection proposed to be carried out in each fortnight, details of major equipment required and an assessment of required strength of various categories of workers in a proforma approved by the Engineer.

5.2.2 **Fortnightly Progress Report**

The Contractor shall submit fortnightly progress reports in triplicate to the Engineer showing along with necessary photographs, 125 mm x 90 mm size, and all details of actual achievements against the target programme specified in Sub- clause 5.2.1 above. Any shortfall in the achievement in a particular fortnight must be made up within the next fortnight. Along with this report, the Contractor shall also furnish details of fabricated materials in hand at site and the strength of his workers.

6.0.0 **RATES**

Even though it may not be specifically mentioned in the Schedule of Items, the rates shall include all work to be provided by the Contractor in accordance with Sub-clause 2.1.0 of this Contract and cost of all materials and labour required to complete the work or incidental to it, hire charges of Constructional Plant and Equipment and erection tools, insurance, all necessary transport, taxes and royalties, making necessary arrangements for approaches, yard, security, safety and other facilities, power, fuel, lubricant, services, supervisions, overheads, profits etc. complete in all respects. It shall also include cost of all other work and supplies not specifically mentioned but reasonably implied as being necessary to complete the works in all respects in accordance with the Contract.

7.0.0 **METHOD OF MEASUREMENT**

7.1.0 **Erection**

All measurement shall be in tonnes and based on the theoretical unit weights as per Indian Standard and on the following considerations :

a) All members, except plate work paid under rates for bunkers, tanks, etc. shall be measured square.

b) All plate work paid at rates for bunkers, tanks, etc. shall be measured as actual.

c) No deduction shall be made for bolt and/or holes for other purposes upto 25 Sq.cm. in area.

d) Unless otherwise specified in the case of welded steel structure, no allowance shall be made for the weld metal.

e) No separate payment shall be made for field connection materials such as permanent bolts, nuts, washers, erection bolts and nuts. No extra payment shall be made for site welding.

7.2.0 **Grouting**

The measurement of grouting the stanchion and other base plates shall be on the basis of theoretical volume of the voids to be filled in Cu.M. without any deduction for the volume of embedments. Edges of the grouting shall be measured square neglecting chamfers, if any.

7.3.0 **Painting**

The finish painting, other than touch up and other painting, if required to be done within the quoted rates as per this Specification, shall be measured on the basis of the tonnage of the structure erected and painted calculated on the basis of Sub-clause 7.1.0.

8.0.0 **PAYMENT**

Unless mentioned otherwise in the Tender/Contract document for fabricated materials erected, aligned, plumbed, levelled and grouted, the Contractor shall be paid 95% (ninety-five percent) of the value of erection. the balance 5% (five percent) shall be paid after acceptance of the structure withstanding necessary tests in accordance with the Contract. Necessary deductions towards Security Money shall be made from all bills of the Contractor in accordance with the Contract.

VOLUME: II B

SECTION - D
(PART I)

SUB-SECTION – D 17

FABRICATION OF STRUCTURAL STEEL WORK

Bharat Heavy Electricals Limited
Project Engineering Management
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C 0 N T E N T

SUB-SECTION – D XVII

FABRICATION OF STRUCTURAL STEEL WORK

1.00.00 SCOPE

This specification covers supply, fabrication, testing, painting and delivery to site of structural steelwork including supply of all consumable stores and rivets, bolts, nuts, washers, electrodes and other materials required for fabrication and field connections of all structural steelwork covered under the scope of the contract.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified elsewhere in the contract, shall include, but not be limited to the following

a) Preparation of complete detailed fabrication drawings and erection marking drawings required for all the structures covered under the scope of the contract based on the approved design drawings. As decided by the Engineer, some or all of these detailed drawings will have to be submitted for approval.

b) To submit revised design with calculations and detailed fabrication drawings in case any substitution of the designed sections are to be made.

c) To submit design calculations for joints and. connections developed by the contractor along with detailed fabrication drawings.

d) Furnish all materials, labour, tools and plant and all consumables required for fabrication and supply, all necessary rivets, bolts, nuts, washers, tie rods and welding electrodes for field connections,

e) Furnish shop painting of all fabricated steelwork as per requirements of this Specification.

f) Suitably mark, bundle, and pack for transport all fabricated materials.

g) Prepare and furnish detailed Bill of Materials, Drawing Office Dispatch lists, Rivet and Bolt List and any other list of bought out items required in connection with the fabrication and erection of the structural steelwork.

h) Insure, load and transport all fabricated steelwork field connection materials to site.

i) Maintain a fully equipped workshop at site for fabrication, modification

and repairs of steelwork at site as may be required to complete the works in accordance with the Contract.

2.02.00 Work by others

No work under this specification will be provided for by any agency other than the contractor, unless specifically mentioned otherwise elsewhere in the contract.

2.03.00 Codes and standards

All work under this specification shall, unless otherwise specified in the contract, conform to the requirements of the latest revision and/or replacements of the following or any other relevant Indian Standard specifications and codes of practice. In case any particular aspect of the work is not specifically covered by any Indian Standard specification, any other standard practice, as may be specified by the Engineer shall be followed:

IS : 226 - Structural steel (Standard Quality)

IS : 800 - Code of Practice for general construction in steel.

IS : 806 - Code of practice for use of steel tubes in general building construction.

IS : 808 - Rolled steel beams, channels, and angle sections

IS : 813 - Scheme of symbols for welding

IS : 814 - Covered electrodes for metal arc welding of structural steel

IS : 815 - Classification and coding of covered electrodes for metal arc welding of structural steels.

IS : 816 - Code of practice for use of metal arc welding for general construction in mild steel

IS : 817 - Code of practice for training and testing metal arc welders

IS : 818 - Code of practice for safety and health requirements in electric and gas welding and cutting operations

IS : 822 - Code of practice for inspection of welds

IS : 919 - Recommendations for limits and fits for Engineering
IS : 961 - Structural Steel (High Tensile)

IS : 1148 - Rivet bars for structural purposes

IS : 1149 - High tensile rivet bars for structural purposes

IS : 1161 - Steel Tubes for structural purposes

IS : 1200 - Method of measurement of steelwork and ironwork (Part 8)

IS : 1239 - Mild Steel Tubes

IS : 1363 - Black hexagon bolts, nuts and lock nuts (dia. 6 to 30 mm) and black hexagon screws (dia 6 to 24 mm)

IS : 1364 - Precision and semi-precision hexagon bolts, screws, nuts and l locknuts (dia, range 6 to 39 mm)

IS : 1367 - Technical supply conditions for threaded fasteners

IS : 1442 - Covered electrodes for the metal are welding of high tensile structural steel

IS : 1608 - Method for tensile testing of steel products other than sheet strip, wire and tube

IS : 1730 - Dimensions for steel plate, sheet, and strip for structural and general engineering purposes.

IS : 1731 - Dimensions for steel flats for structural and general engineering purposes

IS : 1852 - Rolling and cutting tolerances for hot-rolled steel products

IS : 1977 - Structural steel (ordinary quality) St-42-0

IS : 2062 - Steel for General Structural Purposes

IS : 2074 - Ready mixed paint, red oxide Zinc chromate priming

IS : 2595 - Code of Practice for Radiographic Testing

IS : 2629 - Recommended practice for Hot-Dip Galvanizing of Iron and Steel

IS : 2633 - Method for testing uniformity of coating on Zinc Coated Articles

IS : 3757 - High strength structural bolts

IS : 4759 - Specifications for Hot-Dip Zinc Coatings on Structural Steel and other allied products

IS : 7205 - Safety Code for Erection of Structural Steelwork

IS : 7215 - Tolerances for fabrication of steel structures

IS : 7280 - Bare wire electrodes for submerged arc welding of structural steels.

IS : 9595 - Recommendations for metal arc welding of carbon and carbon manganese steels.

2.04.00 Conformity with Designs

The contractor shall design all connections, supply and fabricate all steelwork and furnish all connection materials in accordance with the approved drawings and/or as instructed by the Engineer keeping in view the maximum Utilization of the available sizes and sections of steel materials. The methods of painting, marking, packing and delivery of all fabricated materials shall be in accordance with the provisions of the contract and/or as approved by the Engineer. Provision of all relevant Indian Standard Specifications and Codes of Practice shall be followed unless otherwise specified in the contract.

2.05.00 Materials to be used

2.05.01 General

All steel materials required for the work will be supplied by the contractor unless otherwise specified elsewhere in the contract. The materials shall be free from all imperfections, mill scales, slag intrusions, laminations, fittings, rusts etc. that may impair their strength, durability, and appearance. All materials shall be of tested quality only unless otherwise permitted by the Engineer and/or Consultant. If desired by the Engineer, Test Certificates in respect of each consignment shall be submitted in triplicate. Whenever the materials are required to be used from unidentified stocks, if permitted by the Engineer, a random sample shall be tested at an approved laboratory from each lot of 50 tones or less of any particular section.

The arc welding electrodes shall be of approved reputed manufacture and conforming to the relevant Indian Standard Codes of Practice and Specifications and shall be of heavily coated type and the thickness of the coating shall be uniform and concentric. With each container of electrodes, the manufacturer shall furnish instructions giving recommended voltage and amperage (Polarity in case of D.C. supply) for which the electrodes are suitable.

2.05.02 Steel

All steel materials to be used in construction within the purview of this specification shall comply with any of the following Indian Standard Specifications as may be applicable:

a) IS : 2062 - Steel for general structural purposes

b) IS : 961 - Structural steel High Tensile

c) IS : 1977 - Structural steel (Ordinary quality) St-42-0

In case of imported steel materials being used, these shall conform to specifications equivalent to any of the above as may be applicable.

2.05.03 Rivet Steel

All rivet steel used in construction within the purview of this Specification shall comply with one of the following Indian Standard Specifications as may be applicable:

a) IS : 1148 - Rivet Bars for structural purpose

b) IS : 1149 - High tensile rivet bars for structural purposes. Where high tensile steel is specified for rivets, steps shall be taken to ensure that the rivets are so manufactured that they can be driven and heads formed satisfactorily without the physical properties of steel being impaired.

2.05.04 Electrodes

All electrodes to be used under the Contract shall be of approved reputed manufacture, low hydrogen electrode and shall comply with any of the following Indian Standard Specifications as may be applicable

a) IS : 814 - Covered electrodes for metal arc welding of structural steel

b) IS *:* 815 - Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel

c) IS : 1442 - Covered electrodes for the metal arc welding of high tensile structural steel

d) IS : 7280 - Bare wire electrodes for submerged arc welding of

structural steels

2.05.05 Bolts and Nuts

All bolts and nuts shall conform to the requirements of Indian Standard Specification IS: 1367 - Technical Supply Conditions for Threaded Fasteners.

Materials for Bolts and nuts under the purview of this contract shall comply with any of the following Indian Standard Specifications as may be applicable.

a) Mild Steel

All mild steel for bolts and nuts when tested in accordance with the following Indian Standard Specification shall have a tensile strength of not less than 44 Kg/mm² and a minimum elongation of 23 per cent on a gauge length of 5.6 _/A, where "A" is the cross sectional area of the test specimen

i) IS: 1367: Technical supply conditions for threaded fasteners

ii) IS: 1608: Method for tensile testing of steel products other than sheet, strip, wire and tube

b) High Tensile Steel

The material used for the manufacture of high tensile steel bolts and nuts shall have the mechanical properties appropriate to the particular class of steel as set out in IS: 1367 or as approved by the Engineer.

2.05.06 Washers

Washers shall be made of steel conforming to any of the following Indian Standard Specifications as may be applicable under the provisions of the Contract:

a) IS : 2062 - Steel for general structural purposes

b) IS : 961 - Structural Steel (High Tensile Quality)

c) IS : 1977 - Structural steel (Ordinary Quality) St-42-0

d) IS : 6649 - Hardened washers

2.05.07 Paints

Paints to be used for shop coat of fabricated steel under the purview of this

contract shall conform to the Indian Standard Specification IS: 2074 - Ready mixed Paint, Red oxide Zinc Chromate Priming.

2.06.00 Coal Bin

2.06.01 Shape of bins shall be circular, polygonal, square, or rectangular in plan. Bottom hopper portion may have be conical-cum-hyperbolic or any other profile shape as shown in the drawing. Bin shall be termed as bunkers or silos according to their shape and plane of rupture of coal.

2.06.02 For general requirements, fabrication and construction details IS: 9178 (Pt.l & 11) shall be followed as general guidance. The bins shall be fabricated and erected in segments.

2.06.03 The Coal bins shall be made of mild steel plates joined together with full strength butt weld and provided with stiffeners at regular interval. Stiffeners shall be provided on the external face and it may be welded with external face.

2.06.04 Bending of plates and rolled sections to the required shape for fabrication shall be done by plate bending machine or cold bending process Without resorting to heating, hammering, angle smithy and black smithy process.

2.06.05 Poking hole (manual or pneumatic) and striking plate shall be provided to facilitate coal flow. Poking holes shall have circular MS pipe and cover cap as detailed in the drawing.

2.07.00 New Erection Marks

2.07.01 Additional structures involving new erection marks may be required to be added at any stage of work.

2.07.02 All such new erection marks shall be detailed and included in marking schemes and fabrication carded out thereafter.

2.07.03 All such new erection marks shall be considered under item of original fabrication work. As a result of additional structures becoming necessary if the work is delayed beyond the time schedule stipulated, the Engineer shall give suitable extension of time provided he is satisfied about the reasonableness of the delay involved. However, no claim for extra payments or revision of rates due to delay shall be entertained.

2.08.00 ELECTRO FORGED STEEL GRATINGS

2.08.01 Factory made fabricated electro forged gratings unit with steel conforming to IS: 2062 shall be supplied, fabricated, transported, erected and aligned in floorings, platforms, drain and trench covers, walkways, passages, staircases with edge binding strips and anti skid nosing in treads etc.

2.08.02 All grating units shall be rectangular in pattern and electro forged. The size and the spacing of the bearing bars and cross bars shall be as detailed in fabrication drawings. The contractor shall submit the grating design for different spans and load intensities along with fabrication drawings. The depth of the grating unit shall be 40 mm, unless specified otherwise.

2.08.03 The gratings shall be made up in panel units designed to coincide with the span of the structural steel framing or openings as indicated in the design/ scope drawings. Maximum possible standardization of the grating panel sizes shall be tried and designed.

2.08.04 The grating unit shall be accurately fabricated and finished, free from wraps, twists, or any defects that would impair their strength, serviceability, and appearance.

2.08.05 Grating work shall include cut outs and clearance opening for all columns, pipes, ducts, conduits or any other installation penetrating through the grating work. Such cut outs and clearances shall be treated as specified in subsequent clauses.

2.08.06 The gratings shall be notched, trimmed and neatly finished around flanges and webs of the columns, moment connections, cap plates, and such other components of the steel structures encountered during the placement of the gratings. In all such cases, the trimming shall be done to follow the profile of the components encountered. After trimming, the binding strip shall be provided on the grating to suit the profile so obtained.

2.08.07 Opening in gratings for pipes or ducts that are 150mm in size or diameter or larger shall be provided with steel bar toe plates of not less than 5mm thickness and appropriate width, set flush with the bottom of the bearing bars.

2.08.08 Penetrations in gratings that are more than 50mm but less than 150mm in size or diameter shall be welded with plates of size shown in the detailed drawings set flush with the bottom of the grating panel.

2.08.09 Unless otherwise indicated on the drawings, grating units at all penetrations shall be made up in split section, accurately fitted and neatly finished to provide for proper assembly and erection at the job site.

2.08.10 Grating units shall be provided with all necessary clips, bolts, nuts and lock washers required for proper assembly and rigid installation and fastening to abutting units supporting structural steel framing members.

2.08.11 The gratings shall be of reputed make and manufacturer, as approved by Engineer. The unit rate quoted by him for this item shall be inclusive of transport of gratings to the project site, all taxes, duties etc. He shall also provide all facilities and access to the Engineer or his representative to carry out inspection during all stages of manufacturing of gratings.

2.08.12 Maximum deviation in linear dimension from the approved dimension shall not exceed 12mm.

2.08.13 All fabricated grating section and accessories shall be blast cleaned to near white metal surface (Sa 2½) followed by either of the following two:

(a) Two coats of red lead primer and two coats of black enamel finish paint.

(b) Hot dipped galvanization at 610 gm/sq.m.

in the shop prior to erection at site, as the approved drawing.

2.08.14 Prior to finishing all surfaces shall be cleaned, free from rust, mill scale, grease, oil, or any other foreign matter by blast cleaning. BS: 4232 shall be followed for blast cleaning.

2.08.15 Primer can be applied by spray guns or by brushes, however the finish paint shall necessarily be applied by means of spray guns. The applied coatings shall be uniform, free from voids and streaks; drilled or punched holes shall be touched up prior to erection or assembly.

2.09.00 GALVANIZATION OF GRATINGS

2.09.01 Purity of Zinc to be used-for galvanizing shall be 99.5% as per IS: 2 15

2.09.02 After the shop work is complete, the structural material shall be punched with erection mark and be hot double dip galvanized. Before galvanizing the steel section shall be thoroughly blast cleaned to near white metal surface (Sa 2½).

2.09.03 The weight of the zinc coating shall be at least 610 gm/m² - unless noted otherwise.

2.09.04 The galvanized surface shall consist of a continuous and uniformly thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be cleaned and smooth and shall be free from defects like discoloured patches, bare spots, unevenness of coating, spelter that is loosely attached to the steel, blistered surface, flaking or peeling off etc. The presence of any of

these defects noticed on visual or microscopic inspection shall render the material liable to rejection.

2.09.05 There shall be no flaking or loosening when struck squarely with a chisel faced hammer. The galvanized steel member shall withstand minimum four one minute dips in copper sulphate solution as per IS: 2633.

2.09.06 When the steel section is removed from the galvanizing kettle, excess spelter shall be removed by 'bumping'. The processes known as 'wiping' or 'scrapping' shall not be used for this purpose.

2.09.07 Defects in certain members indicating presence of impurities in the galvanizing bath in quantities larger than that permitted by the specifications or lack of quality control in any manner in the galvanizing plant, shall render the entire, production in the relevant shift liable to rejection.

2.09.08 All structural steel shall be treated with sodium dichromate or an approved equivalent solution after galvanizing; so as to prevent white storage stains.

2.09.09 If the galvanizing of any member is damaged, the Engineer shall be shown of the extent of damage, if so directed the galvanizing may have to the redone in the similar manner as stated above at no extra cost to the Owner.

2.10.00 STAINLESS STEEL HOPPERS (As per BOQ item)

2.10.01 Material

In case SS Hopper is to be fabricated & erected as per BOQ item with SS415M, following specification shall be followed.
Stainless steel hopper of grade SS 415M as manufactured by SAIL or equivalent shall be provided in the lower portion of bunker hopper. SS 4 15M having the following chemical composition shall be used.

Material	%	Remarks
Carbon	10.03%	Max.
Silicon	1.60%	Max.
Manganese	0.80% to 1.50%	
Phosphorous	0.03%	Max.
Sulpher	0.03%	Max.
Chromium	10.80% to 12.50%	

Nickel	1.50%	Max.
Titanium	0.75%	Max.
Nitrogen	0.03%	Max.

The mechanical properties shall be as follows:

Description	**Value**	**Remarks**
Hardness Rock Well B Scale	90	Max.
Tensile Strength	450 MPa	Min.
Yield Strength	300 MPa	Min.
Elongation	25%	Min.

2.10.02 Fabrication

The fabrication, erection, alignment and welding shall be carried out as per the accepted practice and in accordance with relevant I.S. and international specification as well as stipulations contained herein. Fabrication drawings shall be prepared by the contractor on the basis of the design / scope drawings furnished by Engineer. The fabrication and erection works shall be done as per the approved fabrication drawings.

2.10.03 Fabrication Drawings

a) Fabrication drawing shall give the cutting plan for each hopper plate. Such, cutting plan shall be based on the size of the Stainless Steel plate available at store. In order to reduce the wastage and ensure the maximum utilization of stainless steel plate, the cutting plan shall take in the consideration of the reverse curvature and place the various elements of hopper plate in opposite fashion to reduce the end wastage. Similarly the hopper plate element having different radii shall be placed one inside the other, to optimize the stainless steel plate use. Such optimization may also required adjustment in the size of the each element of hopper plate and also additional weld joints.

b) The bill of material of hopper plate shall indicate the inner surface area of the hopper, weight of the hopper based on the inner surface area, weight of each of the cut plate of hopper fabrication, weight of cut and scrap pieces generated. Contractor shall return to the Owner's store all unutilized (surplus) stainless steel plates and all waste and cut pieces generated. Non return of any part of the surplus/waste steel pieces to the Owner's store will call for the penal recovery at three (03) times the maximum

procurement rate for the weight of stainless steel pieces not returned to the store.

c) In case the contractor does the cutting of the stainless steel without approved cutting plan then all the wastage (i.e. the difference between the weight of stainless steel plate cuts and the actual finished weight considered for the measurement for payment) shall be subjected to the penal recovery at the rate mentioned above.

2.10.04 Cuffing

Cutting may be affected by shearing, or by using plasma. The cut edges of all plates shall be perfectly straight and uniform through out. Cutting shall be done as per the cutting plan shown in the fabrication drawing. Should the Engineer find it necessary, the edges shall be ground smooth afterwards by contractor within the unit rates quoted by him. All the edge s shall be ground smooth before they are welded.

2.10.05 Jointing

Welding shall join stainless steel. All weld joints (along the inclined plane) shall be staggered. Any common welding process can weld stainless steel viz. MIG, metal arc or plasma using the covered compatible electrodes as per IS: 5206 or by inert gas arc welding as per IS: 2811. Shielding gas shall be Argon + Hydrogen mixture or Argon + Oxygen mixture. However, Argon + Oxygen mixture shall be preferred. Carbon-di-oxide mixture shall be avoided. 308L and 315L electrodes/fillers shall be used for the welding of Stainless Steel to Stainless Steel and Stainless Steel to Mild Steel respectively. However, the welding process and the type of the electrodes to be used for welding shall be as per welding procedure, as approved by the Engineer. On the basis of the welding procedure, the Contractor shall conduct qualification test.

2.10.06 Bending

The stainless steel plates shall be subjected to cold forming and bending in order to get the desired shape and profile.

2.10.07 Welding sequence

The type of electrodes, welding sequence, preheat and interpass temperature and post weld heat treatment shall be as approved by the Engineer.

2.10.08 Acceptance Criteria of Fabricated Structures

The acceptance of the fabricated structure work shall depend upon correct dimensions and alignment, absence of distortion in the structure, satisfactory results from the inspection and testing of the welded structure joints and the

test specimens, general workmanship being good meeting the tolerance requirements given in IS: 7215.

2.11.00 BEARINGS

2.11.01 PTFE (Poly tetra fluorethylene) slide bearing

a) General

The bearings shall consist of upper and lower units. The upper unit shall include a sole plate with mirror finish stainless steel facing bonded to the bottom surface of the sole plate. The lower unit shall consist of a relevant laminated elastomers pad surfaced with PTFE. A rigid confining medium substructure bonds the PTFE to the pad. When the upper and lower units are mated the stainless steel slides on the PTFE surface with an extremely low coefficient of friction. These bearings shall be designed as per the performance requirements. The bearing shall be of reputed make and manufacturer as approved by Engineer, for required vertical loads, as per the construction drawings and for a maximum displacement of ± 50 mm.

b) Material

PTFE bearing shall be sliding against highly polished stainless steel and the coefficient of friction between them shall be less than 0.06 at 55 kg/cm². In order to prevent cold flow in the PTFE surface it shall be rigidly bonded by a special high temperature resistant adhesive to the stainless steel sub-strata. The stainless steel surface, which slides against the PTFE, is mirror polished. The stainless steel shall be bonded to the top plate by special high strength adhesive. The thickness of the stainless steel shall be between 1.0 to 1.5mm.

The resilient bearing pad shall consist of multiple layers of lightweight fabric impregnated with a high quality elastomer compound vulcanized into slabs of uniform standard thickness as per the requirement. This shall withstand vertical (compressive) load not less than 500 kg/cm² and shear loads upto 40 kg/cm².

c) Installation

The seating area for PTFE bearing shall be prepared accurately level and furnished with a thin layer of epoxy resin mortar. The bearing will be placed on this layer while it is still workable and the bearing is levelled. The bearing should not be displaced as the beam is lowered into position. When the mortar and adhesive are fully set and the beam slightly above the top of the bearing. The upper surface of the bearing shall then be coated with sufficient thickness of epoxy resin mortar so that when the beam is lowered on to the temporary supports it comes into full contact

with the mortar and some is squeezed out. The surplus shall be troweled off and after the mortar is fully set the temporary supports removed.

2.12.00 Storage of material

2.12.01 General

All materials shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged, shall be removed from the contractor's yard immediately, failing which, the Engineer shall be at liberty to get the material removed and the cost incurred thereof shall be realised from the Contractor. The Contractor shall maintain upto date accounts in respect of receipt, use, and balance of all sizes and sections of steel and other materials. In case the fabrication is carried out in contractor's fabrication shop outside the plant site where other fabrication works are also carried out, all materials meant for use in this contract shall be stacked separately with easily identifiable marks.

2.12.02 Steel

The steel to be used in fabrication and the resulting cut-pieces shall be stored in separate stacks off the ground section wise and lengthwise so that they can be easily inspected, measured, and accounted for at any time. If required by the Engineer, the materials may have to be stored under cover and suitably painted for protection against weather.

2.12.03 Electrodes

The electrodes for electric arc welding shall be stored in properly designed racks, separating different types of electrodes in distinctly marked compartments. The electrodes shall be kept in a dry and warm condition if necessary by resorting to heating.

2.12.04 Bolts, Nuts and Washers

Bolts, nuts and washers and other fastening materials shall be stored on racks off the ground with a coating of suitable protective oil. These shall be stored in separate gunny bags or compartments according to diameter, length, and quality.

2.12.05 Paints

Paints shall be stored under cover in air tight containers. Paints supplied in sealed containers shall be used up as soon as possible once the container is opened.

2.13.00 Quality Control

The Contractor shall establish and maintain quality control procedures for different items of work and materials to the extent he deems necessary to ensure that all work is performed in accordance with this specification. In addition to the Contractor's quality control procedures, materials and workmanship at all times shall be subjected to inspection by the Engineer or Engineer's representative. As far as possible, all inspection by the Engineer or Engineer's representative shall be made at the Contractor's fabrication shop whether located at Site or elsewhere. The Contractor shall co-operate with the Engineer or Engineer's representative in permitting access for inspection to all places where work is being done and in providing free of cost all necessary help in respect of tools and plants, instrument, labour and materials required to carry out the inspection. The inspection shall be so scheduled as to provide the minimum interruption to the work of the Contractor.

Materials or workmanship not in reasonable conformance with the provisions of this Specification may be rejected at any time during the progress of the work.

The quality control procedure shall cover but not be limited to the following items of work

a) Steel: Quality manufacturer's test certificates, test reports of representative samples of materials from unidentified stocks if permitted to be used.

b) Rivets, Bolts, Nuts & Washers : Manufacturer's certificate, dimension checks, material testing.

c) Electrodes : Manufacturer's certificate, thickness and quality of flux coating.

d) Welders : Qualifying Tests

e) Welding sets : Performance Tests

f) Welds : Inspection, X-ray, Ultrasonic tests

g) Paints : Manufacturer's certificate, physical inspection reports

h) Galvanizing : Tests in accordance with IS 2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS : 4759 - Specification for Hot-Dip Zinc coatings on Structural Steel and other allied products.

2.14.00 Standard dimensions, forms and weights

The dimensions, forms, weights and tolerances of all rolled shapes rivets, bolts, nuts, studs, washers etc. and other members used in the fabrication of any structure shall, wherever applicable, conform to the requirements of the latest relevant Indian Standards, wherever they exist, or, in the absence of Indian Standards, to other equivalent standards.

2.15.00 Fabrication Drawings

The contractor shall within thirty (30) days after the award of the Contract submit to the Engineer the Schedule of Fabrication and erection of structural Steelworks, for approval. Within one week after receipt of approval on design of any steel structure (part or full) based on the approved design. As decided by the Engineer, six (6) copies each of some or all of the detailed fabrication drawings will have to be submitted for approval.

The sequence of preparation of fabrication drawings shall match with the approved fabrication and erection schedule. The above-mentioned approval for fabrication drawings will be accorded only towards the general conformity with the design requirements as well as specifications. The approval of drawing however shall not relieve the contractor of his sole responsibility in carrying out the work correctly and fulfilling the complete requirements of contract documents.

The fabrication drawings shall include but not limited to the following:

a) Assembly drawings giving exact sizes of the sections to be used and identification marks of the various sections.

b) Dimensional drawings of base plates, foundation bolts location etc.

c) Comparison sheets to show that the proposed alternative section, if any, is as strong as the original sections shown on the Design Drawings.

d) Complete Bill of Materials and detailed drawings of all sections as also their billing weights.

e) Any other drawings or calculations that may be required for the clarification of the works or substituted parts thereof.

These drawings shall give all the necessary information for the fabrication, erection, and painting of the steelwork in accordance with the provisions of this Specification. Fabrication drawings shall be made in accordance with the best modern practice and with due regard to sequence, speed and economy in fabrication and erection. Fabrication drawings shall give complete information necessary for fabrication of the various components of the steelwork,

including the location, type, size, and extent of welds. These shall also clearly distinguish between shop and field rivets, bolts, and welds and specify the class of bolts and nuts. The drawings shall be drawn to a scale large enough to convey all the necessary information adequately. Notes on the fabrication drawings shall indicate those joints or groups of joints in which it is particularly important that the welding sequence and technique of welding shall be carefully controlled to minimize the locked up stresses and distortion. Welding symbols used shall be in accordance with the requirements of the Indian Standard Specification. IS: 813 - Scheme of symbols for Welding, and shall be consistent throughout. Weld lengths called for on the drawings shall mean the net effective length.

The Contractor shall be responsible for and shall carry out at his cost any alterations of the work due to any discrepancies, errors or omissions on the drawings or other particulars supplied by him, whether such drawings or other particulars have been duly approved or not in accordance with the Contract.

3.00.00 WORKMANSHIP

3.01.00 Fabrication

3.01.01 General

All workmanship shall be equal to the best practice in modern structural shops, and shall conform to the provisions of the Indian Standard IS: 800 - Code of Practice for general construction in steel and other relevant Indian Standards or equivalent.

3.01.02 Straightening Material

Rolled materials before being laid off or worked, must be clean, free from sharp kinks, bends or twists and straight within the tolerances allowed by the Indian Standard Specification on IS: 1552 - Specification for rolling and cutting tolerance for hot-rolled steel products. If straightening is necessary, it may be done by mechanical means or by the application of a limited amount of localized heat. The temperature of heated areas, as measured by approved methods, shall not exceed 600°C.

3.01.03 Cutting

Shearing, cropping, or sawing shall affect cutting. Use of a mechanically controlled gas-cutting torch may be permitted for mild steel only. Gas cutting of high tensile steel may also be permitted provided special care is taken to leave sufficient metal to be removed by machining, so that all metal that has been hardened by flame is removed. Gas cutting without a mechanically controlled torch may be permitted if special care is taken and done under expert hand, subject to the approval of the Engineer.

To determine the effective size of members cut by gas, 3 mm shall be deducted from each cut edge. Gas cut edges, which will be subjected to substantial stress or which are to have weld metal deposited on them, shall be reasonably free from gouges, occasional notches or gouges not more than 4 mm deep will be permitted. Gouges greater than 4 mm that remain from cutting shall be removed by grinding. All re-entrant corners shall be shaped notch free to a radius of at least 12 mm. Shearing, cropping and gas cutting shall be clean, reasonably square and free from any distortion.

3.01.04 Planning of edges

Planning or finishing of sheared or cropped edges of plates or shapes or of edges gas-cut with a mechanically controlled torch shall not be required, unless specifically required by design and called for on the drawings, included in a stipulation for edge preparation for welding or as may be required after the inspection of the cut surface. Surface cut with hand-flame shall generally be ground, unless specifically instructed otherwise by the Engineer.

3.01.05 Clearances

The erection clearance for cleated ends of members connecting steel to steel shall preferably be not greater than 2 mm at each end. The erection clearance at ends of beams web shall be not more than 3 mm at each end, but where for practical reasons greater clearance is necessary, suitably designed cheatings shall be provided.

3.02.00 Riveted and bolted construction

3.02.01 Holes

Holes through more than one thickness of material for members, such as compound stanchions and girder flanges, shall be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, if the thickness of the material is not greater than the nominal diameter of rivet or bolt plus 3 mm subject to a maximum thickness of 16 mm provided that the holes are punched 3 mm less in diameter than the required size and reamed after assembly to the full diameter.

Holes for rivets or black bolts shall be not more than 1.5 mm or 2.0 mm (depending on whether the diameter of the rivet or bolt is less or more than or equal to 25 mm) larger in diameter than the nominal diameter of the rivet or black bolt passing through them.

Holes for turned and fitted bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to a tolerance grade of BS as specified in IS: 919. Parts to be connected shall be firmly held together by

tacking welds or clamps and the holes drilled through all the thicknesses in one operation and subsequently reamed to size. Holes not drilled through all thickness in one operation shall be drilled to a smaller size and reamed out after assembly.

Holes for rivets or bolts shall not be formed by gas cutting process.

3.02.02 Assembly

All parts of riveted members shall be well pinned or bolted and rigidly held together while riveting. Drifting to enlarge unmatching holes shall not generally be permitted. In case drifting is permitted to a slight extent during assembly, it shall not distort the metal or enlarge the holes. Holes that must be enlarged to admit the rivets or bolts shall be reamed. Poor matching of holes shall be cause for rejection .The component parts shall be so assembled that they are neither twisted not otherwise damaged, and shall be so prepared that the specified cambers, if any, are maintained.

Rivets shall ordinarily be hot driven, in which case their finished heads shall be approximately hemispherical in shape and shall be of uniform size throughout the work for rivets of the same size full, neatly finished and concentric with he holes. Rivets shall be heated uniformly to a temperature not exceeding 1 125°C they shall not be driven after their temperature has fallen below 540°C.

Rivets shall be driven by power riveters, of either compression or manually operated type, employing pneumatic, hydraulic or electric power. Hand driven rivets shall not be allowed unless in exceptional cases specifically approved by the Engineer. After driving, rivets shall be tight, shall completely fill the holes and their heads shall be in full contact with the surface. In case of countersunk rivets, the countersinking shall be fully filled by the rivet, any proudness of the countersunk head being dressed off flush, if required.

Riveted members shall have all parts firmly drawn and held together before and during riveting and special care shall be taken in this respect for all single riveted connections. For multiple riveted connections, a service bolt shall be provided in every third or fourth hole.

All loose, burnt, or otherwise defective rivets shall be cut out and replaced and special care shall be taken to inspect all single riveted connections. Special care shall also be taken in heating and driving long rivets. The Contractor shall prove the quality of riveting by cutting some rivets chosen at random by the Engineer. No extra payment will be made to the Contractor for such cutting and replacing. Riveting work, for any particular section or group, will be considered satisfactory when at least 90% of the corresponding cut rivets is found to be sound. If the ratio is below 75%, all the rivets in the particular section or group shall be cut, removed and replaced and tested again at the

Contractor's expense. For cases between 75% and 90% the engineer shall have the option to instruct cutting and replacing any number of further rivets at the Contractor's cost as he deems necessary.

Bolted construction shall be permitted only in case of field connections if called for on the Drawings and is subjected to the limitation of particular connections as may be specified. In special cases, however, shop bolt connections may be allowed if shown on drawing or directed by the Engineer.

Washers shall be tapered or otherwise suitably shaped, where necessary, to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project trough the nut at least one thread. In all cases the bolt shall be provided with a washer of sufficient thickness under the nut to avoid any threaded portion of the bolt being within the thickness of the parts bolted together. In addition to the normal washer one spring washer or lock nut shall be provided for each bolt for connections subjected to vibrating forces or otherwise as may be specified on the Drawings.

3.03.00 Welded Construction

3.03.01 General

Welding shall be in accordance with relevant Indian Standards and as supplemented in the Specification. Welding shall be done by experienced and good welders who have been qualified by tests in accordance with IS: 817.

3.03.02 Preparation of material

Surface to be welded shall be free from loose scale, slag, rust, grease, paint, and any other foreign material except that mill scale, which withstands vigorous wire brushing, may remain. Joint surfaces shall be free from fins and tears. Preparation of edges by gas cutting shall, wherever practicable, be done by a mechanically guided torch.

3.03.03 Assembling

Parts to be fillet welded shall be brought in, as close contact as practicable and in no event shall be separated by more than 4 mm. If the separation is 1.5 mm or greater, the size of the fillet welds shall be increased by the amount of the separation. The fit of joints at contact surfaces, which are not completely sealed by, welds, shall be close enough to exclude water after painting. Abutting parts to be butt-welded shall be carefully aligned. Misalignments greater than 3 mm shall be corrected and in making the correction the parts shall not be drawn into a sharper slope than two degrees (2°).

The work shall be positioned for flat welding whenever practicable.

3.03.04 Welding Sequence

In assembling and joining parts of a structure or of built-up members, the procedure and sequence of welding shall be such as will avoid needless distortion and minimize shrinkage stresses in the closing welds of a rigid assembly, such closing welds shall be made in compression elements.

In the fabrication of cover-plated beams and built-up members, all shop splices in each component part shall be made before such component part is welded to other parts of the member. Long girders or girder sections may be made by shod splicing not more than three sub-sections, each made in accordance with this paragraph.

When required by the Engineer, welded assemblies shall be stress relieved by heat-treating in accordance with the provisions of the relevant Indian Standard or any other Standard approved by the Engineer.

3.03.05 Welding technique

All complete penetration groove welds made by manual welding, except when produced with the aid of backing material not more than 8 m thick with root opening not less than one-half the thickness of the thinner part joined, shall have the root of the initial layer gouged out on the back side before welding is started from that side, and shall be so welded as to secure sound metal and complete fusion throughout the entire cross-section. Groove welds made with the use of the backing of the same material, as the base metal shall have the weld metal thoroughly fused with the backing material. Backing strips need not be removed. If required, they may be removed by gouging or gas cutting after welding is completed, provided no injury is done to the base metal and weld metal and the weld metal surface is left flush or slightly convex with full throat thickness.

Groove welds shall be terminated at the ends of a joint in a manner that will ensure their soundness. Where possible, this should be done by use of extension bars or run-off plates. Extension bars or run-off plates need not be removed upon completion of the weld unless otherwise specified elsewhere in the contract.
To get the best and consistent quality of welding, automatic submerged arc process shall be preferred. The technique of welding employed, the appearance and quality of welds made, and the methods of correcting defective work shall all conform to the relevant Indian Standards.

3.03. 12 Temperature

No welding shall normally be done on parent material at a temperature below (-) 5°C. However, if welding is to undertaken at low temperature, adequate precautions as recommended in relevant Indian Standard shall be taken. When

the parent material is less than 40 mm thick and the temperature is between (-) 5°C and 0°C, the surface around the joint to a distance of 100 mm or 4 times the thickness of the material, whichever is greater, shall be preheated till it is hand warm. When the parent material is more than 40 mm thick, the temperature of the area mentioned above shall be in no case be less than 20°C. All requirements regarding preheating of the parent material shall be in accordance with the relevant Indian Standard.

3.03. 13 Peening

Where required, intermediate layers of multiple-layer welds may be peened with light blows from a power hammer, using a round-nose tool, peening shall be done after the weld has cooled to a temperature warm to the hand. Care shall be exercised to prevent scaling or flaking of weld and base metal from over peening.

3.03. 14 Equipment

These shall be capable of producing proper current so that the operator may produce satisfactory welds. The welding machine shall be of a type and capacity as recommended by the manufacturers of electrodes or as may be approved by the engineer.

3.04.00 Finish

Column splices and butt joints of compression members depending on contact for stress transmission shall be accurately machined and close-butted over the whole section with a clearance not exceeding 0.1 mm locally at any place. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc; after welding/riveting together, should be accurately machined so that the parts connected butt over the entire surfaces of contact. Care should be taken that those connecting angles of channels are fixed with such accuracy that they are not reduced in thickness by machining by more than 1.0 mm.

3.05.00 Slab bases and caps

Bases and caps fabricated out of steel slabs, except when cut material with true surface, shall be accurately machined over the bearing surface and shall be in effective contact with the end of the stanchion. A bearing face, which is to be grouted direct to a foundation, need not be machined if such face is true and parallel to the upper face.

To facilitate grouting, holes shall be provided, where necessary, in stanchion bases for the escape of air.

3. 12.00 Lacing bars

The ends of lacing bars shall be neat and free from burns.

3. 13.00 Separators

Rolled section or built-up steel separators or diaphragms shall be required for all double beams except where encased in concrete, in which case, pipe separators shall be used.

3.14.00 Bearing Plates

Provision shall be made for all necessary steel bearing plates to take up reaction of beams and columns and the required stiffeners and gussets whether or not specified in Drawings.

3.15.00 Floor Grating

All grating units shall be rectangular in pattern and of pressure locked assembly. The size and spacing of bearing bars and cross bars shall be as approved in detailed drawings. Alternatively diamond pattern grating if approved may be used.

The grating shall be made in panel units designed to span as indicated in structural steel framing drawing or as directed by the Engineer.

The grating units shall be finished free from warps, twists, or any other defects. Grating work shall include cutouts and clearance openings for all columns, pipes, ducts, conduits etc. The gratings shall be notched, trimmed, and neatly finished around components of the steel structures encountered. Binding strip shall be provided on the grating to suit the profile. Openings in gratings shall be provided with steel bar toe plates of not less than 5 mm thickness and 100 mm width.

Unless otherwise indicated on drawings, all penetrations of grating units shall be made up in split section, accurately fitted, and neatly finished. Grating units shall be provided with all necessary clips, bolts, lock washers etc. for proper assembly and installation on supporting steel members. Maximum deviation in linear dimension shall not exceed 12 mm.

3.10.00 Chequered Plates

Minimum thickness of chequered plate floorings, covers etc. shall be 6 mm O/P. Chequered plate shall be accurately cut to the required sizes and shapes and the cut edges properly ground. Stiffeners shall be provided wherever required from design consideration.

3.11.00 Architectural Clearances

Bearing plates and stiffener connections shall not be permitted to encroach on the designed architectural clearances.

3.11.00 Shop connections

a) All shop connections shall be otherwise riveted or welded as specified on the Drawings.

b) Heads of rivets on surfaces carrying brick walls shall be flattened to 10 mm thick projection.

c) Certain connections, specified to be shop connections, may be changed to field connections if desired by the Engineer for convenience of erection and the contractor will have to make the desired changes at no extra cost to the exchequer.

3.13.00 Castings

Steel castings shall be annealed.

3.14.00 Shop erection

The steelwork shall be temporarily shop-erected complete or as directed by the Engineer so that accuracy of fit may be checked before dispatch. The parts shall be shop-erected with a sufficient number of parallel drifts to bring and keep the parts in place. In case of parts drilled or punched using steel jigs to make all similar parts interchangeable, the steelwork shall be shop erected in such a way as will facilitate the check of interchange ability.

3.15.00 Shop painting

3.15.01 General

Unless otherwise specified, steelwork, which will be concealed by interior building finish, need not be painted; steelwork to be encased in concrete shall not be painted. Unless specifically exempted, all other steelwork shall be given one coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned, in accordance with the following paragraph, by brush, spray, roller coating, flow-coating or dipping as may be approved by the Engineer.

After inspection and approval and before leaving the shop, all steelwork specified to be painted shall be cleaned by hand-wire brushing or by other methods of loose mill scale, loose rust, weld slag or flux deposit, dirt and other foreign matter. Oil and grease deposits shall be removed by the solvent. Steelwork specified to have no shop paint shall, after fabrication, be cleaned of oil or grease by solvent cleaners and be cleaned of dirt and other foreign material by trough sweeping with a fibre brush.

3.15.02 Inaccessible parts

Surfaces not in contact, but inaccessible after assembly, shall receive two coats of shop paint, Positively of different colours to prove application of two coats before assembly. This does not apply to the interior of sealed hollow sections.

3.15.03 Contact surfaces

Contact surface shall be cleaned in accordance with sub-clause 3.13.1 before assembly.

3.15.04 Finished surfaces

Machine finished surfaces shall be protected against corrosion by a rust inhibiting coating that can be easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.

3.15.05 Surfaces adjacent to field welds

Unless otherwise provided for, surfaces within 50 of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.

3.16.00 Galvanizing

3.16.01 General

Structural steelwork for switchyard or other structures as may be specified in the contract shall be hot dip galvanized in accordance with the American Society for Testing and Materials Specification ASTM-A 123 or IS: 2629 - Recommended practice for Hot-Dip Galvanizing of Iron and steel. Where the steel structures are required to be galvanized the field connection materials like bolts, nuts and washers shall also be galvanized.

3.16.02 Surface Preparation

All members to be galvanized shall be cleaned, by the process of pickling of rust, loose scale, oil, grease, slag and spatter of welded areas and other foreign substances prior to galvanizing. Pickling shall be carried out by immersing the steel in an acid bath containing either sulphuric or hydrochloric acid at a suitable concentration and temperature. The concentration of the acid and the temperature of the bath can be varied, provided that the pickling time is adjusted accordingly.

The pickling process shall be completed by thoroughly rinsing with water, which should preferably be warm, so as to remove the residual acid.

3.16.03 Procedure

Galvanizing shall be carried out by hot dip process in a proper and uniformly heated bath. It shall meet all the requirements when tested in accordance with IS: 2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS: 4759 - Specification for Hot-dip zinc coatings on Structural Steel & other allied products.

After finishing the threads of bolts, galvanizing shall be applied over the entire surface uniformly. The threads of bolts shall not be machined after galvanizing and shall not be clogged with zinc. The threads of nuts may be tapped after galvanizing but care shall be taken to use oil in the threads of nuts during erection.

The surface preparation for galvanizing and the process of galvanizing itself, shall not adversely affect the mechanical properties of the materials to be galvanized. Where members are of such lengths as to prevent complete dipping in one operation, great care shall be taken to prevent warping.

Materials on which galvanizing has been damaged shall be acid stripped and re-galvanized unless otherwise directed, but if any member becomes damaged after leaving been dipped twice, it shall be rejected. Special care shall be taken not to injure the skin on galvanized surfaces during transport, handling, and

erection. Damages, if occur, shall be made good in accordance or as directed by the Engineer.

4.00.00 INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY

4.01.00 Inspection

Unless specified otherwise, inspection to all, work shall be made by the or Engineer's representative at the place of manufacture prior to delivery. The Engineer or his representative shall have free access at all reasonable times to those parts of the manufacturer's works which are concerned with the fabrication of the steelwork under this Contract and he shall be afforded all reasonable facilities for satisfying himself that the fabrication is being done in accordance with the provisions of this Specification.

The Contractor shall provide free of charge, such labour, materials, electricity, fuel, water, stores, tools and plant, apparatus and instruments as may be required by the Engineer to carry out inspection and/or tests in accordance with the Contract. The Contractor shall guarantee compliance with the provisions of this Specification.

4.02.00 Testing and Acceptance Criteria

4.02.01 General

The Contractor shall carry out sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own Cost. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.

4.02.02 Steel

All steel supplied by, the Contractor shall conform, to the relevant Indian Standards. Except otherwise mentioned in the contract, only tested quality steel having mill test reports shall be used. In case unidentified steel materials are permitted to be used by the Engineer, random samples of materials will be taken from each unidentified lot of 50 M.T or less of any particular section for tests to conform to relevant Indian Standards. Cost of all tests shall be born by the contractor.

All material shall be free from all imperfections, mill scales, slag intrusions, laminations, fittings, rusts etc. that may impair their strength, durability, and appearance.

4.02.02 Welding

a) The weld surface shall be cleaned with steel wire brush to remove spatter metal, slag etc. and 100% of welds shall be inspected visually for size, length of weldment and external defects. Weld gauges shall be used for checking weld sizes. The surface shall be clean with regular beads and free from slags, cracks, blow-holes etc.

b) Non-destructive examination shall be carried out to determine soundness of weldments as follows:

i) 10% at random on fillet-joints.

ii) 100% on all butt-joints.

c) Should the ND tests indicate defects like improper root penetration, extensive blowholes, slag intrusion etc., such welds shall be back gauged, joints prepared again and rewelded. All defects shall be rectified by the Contractor at no extra costs.

d) All electrodes shall be procured from approved reputed manufacturers with test certificates. The correct grade and size of electrode, which has not deteriorated in storage, shall be used. The inspection and testing of welding shall be performed in accordance with the provisions of the relevant Indian Standards or other equivalents. For every 50 tones of welded fabrication, the Engineer may ask for 1(one) test-destructive or non-destructive including X -ray, ultrasonic test or similar, the cost of which shall be borne by the Contractor.

4.02.04 Rivets, bolts, nuts and washers

All rivets, bolts, nuts, and washers shall be procured from M/s. Guest Keen William Ltd. or equivalent and shall confirm to the relevant Indian Standards. If desired by the Engineer, representative samples of these materials may have to be tested in an approved laboratory and in accordance with the procedures described in relevant Indian Standards. Cost of all such testing shall have to be borne by the Contractor. In addition to testing the rivets by hammer, 2% (two per cent) of the rivets done shall have to be cut off by chisels to ascertain the fit, quality of material and workmanship. The removal of the cut rivets and re-installing new rivets shall be done by the Contractor at his own cost.

4.02.05 Shop painting

All paints and primers shall be of standard quality and procured from approved manufacturers and shall conform to the provisions of the relevant Indian Standards.

4.02. 12 Galvanizing

All galvanizing shall be uniform and of standard quality when tested in accordance with IS: 2633 - Method for testing uniformity of coating on Zinc Coated Articles and 15: 4759 - specification for Hot-Dip Zinc Coatings on Structural Steel & other allied products.

4.03.00 Tolerance

The tolerances on the dimensions of individual rolled steel components shall be as specified in IS: 1852 - specification for rolling and Cutting Tolerances for Hot-rolled Steel Products. The tolerances on straightness, length etc. of various fabricated components (such as beams and girders, columns, crane gantry girder etc.) of the steel structures shall be as specified in IS: 721 - Tolerances for Fabrication of Steel Structures.

4.04.00 Acceptance

Should any structure or part of a structure be found not to comply with any of the provisions of this specification, the same shall be liable to rejection. No Structure or part of the structure once rejected, shall be offered again for test, except in cases where the Engineer considers the defects rectifiable. The Engineer may, at his discretion, check some of the tests at an appropriate laboratory at the contractors cost.

When all tests to be performed in the Contractor's shop under the terms of this contract have been successfully carried out, the steelwork will be accepted forthwith and the Engineer will issue acceptance certificate, upon receipt of which, the items will be shop painted, packed and dispatched. No item to be delivered unless an acceptance certificate for the same has been issued. The satisfactory completion of these tests or the issue of the certificates shall not bind the Owner to accept the work, should it, on further tests before or after erection, be found not in compliance with the Contract.

4.05.00 Delivery of materials

4.05.01 General

The Contractor will deliver the fabricated structural steel materials to site with all necessary field connection materials in such sequence as will permit the most efficient and economical performance of the erection work. The Owner may prescribe or control the sequence of delivery of materials, at his own discretion.

4.05.02 Marking

Each separate piece of fabricated steelwork shall be distinctly marked on all surfaces before delivery in accordance with the markings shown on approved erection drawings and shall bear such other marks as will further facilitate identification and erection.

4.05.03 Shipping

Shipping shall be strictly in accordance with the sequence stipulated in the agreed Programme. Contractor shall dispatch the materials to the e worksite securely protecting and packing the materials to avoid loss or damage during transport by rail, road or water. All parts shall be adequately braced to prevent damage in transit.

Each bundle, bale or package delivered under this contract shall be marked on as many sides as possible and such distinct marking (all previous irrelevant markings being carefully obliterated) shall show the following:

a) Name and address of the consignee

b) Name and address of the consignor

c) Gross weight of the package in tonnes and its dimensions

d) Identification marks and/or number of the package

e) Custom registration number, if required

All markings shall be carried out with such materials as would ensure quick drying and indelibility.

Each component or part or piece of material when shipped, shall be indelibly marked and/or tagged with reference to assembly drawings and corresponding piece numbers.

Each packing case shall contain in duplicate in English a packing list pasted on to the inside of the cover in a water-proof envelope, quoting especially -

a) Name of the Contractor

b) Number and date of the Contract

c) Name of the office placing the contract

d) Nomenclature of stores

e) A schedule of parts or pieces, giving the parts or piece number with reference to assembly drawings and the quantity of each.

The shipping dimensions of each packing shall not exceed the maximum dimensions permissible for transport over the Indian Railways/Roads.

After delivery of the materials at site, all packing materials shall automatically become the property of the Owner.

Notwithstanding anything stated hereinbefore, any loss or damage resulting from inadequate packing shall be made good by the Contractor at no additional cost to the Owner. When facilities exist, all shipments shall be covered by approved Insurance Policy for transit at the cost of the Contractor.

The contractor shall ship the complete materials or part on board a vessel belonging to an agency approved by the Owner or on rail and/or road transport as directed. The Contractor shall take all reasonable steps to ensure correct appraisal of freight rates, weights and volumes and in no case will the Owner be liable to pay any warehouse, wharfage, demurrage and other charges.

If, however, the Owner has to make payment of any of the above-mentioned charges, the amount paid will be deducted from the bills of the Contractor.

Necessary advise regarding the shipment with relevant details shall reach the Engineer at least a week in advance.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 With Tender

The following information is required to be submitted with the Tender:

a) Progress Schedule

The Contractor shall quote in his Tender a detailed schedule of progress of work and total time of completion, itemizing the time required for each of the following aspects of work.

i) Preparation and approval of fabrication drawing

ii) Procurement of Materials

iii) Fabrication and shipping of all anchor bolts

iv) Fabrication and shipping of main steelwork.

v) Fabrication and shipping of steelwork for bunkers, tanks and/or silos

as applicable.

vi) Fabrication and shipping of all other remaining steelwork including miscellaneous steelwork.

vii) Final date of completion of all shipments.

b) Shop

Location of the Tenderer's fabrication workshop giving details of equipment, manpower, the total capacity, and the capacity that will be available exclusively for this contract shall be submitted.

5.02.00 After Award

After award of the Contract the successful Tenderer is to submit the following:

a) Complete fabrication drawings, material lists, cutting lists, rive and bolt lists, field welding schedules based on the approved design drawings prepared by him in accordance with the approved schedule.

b) Monthly Progress Report with necessary photographs in six (6) copies to reach the Engineer on or before the 7th day o. each month, giving the up-to-date status of preparation of detailed shop drawings, bill of materials, procurement of materials, actual fabrication done, shipping and all other relevant information.

c) Detailed monthly material reconciliation statements relevant to the Work done and reported in the Progress Report, giving the stock at hand of raw steel, work in progress, finished materials.

d) Results of any test as and when conducted and as require by the engineer.

e) Manufacturer's mill test report in respect of steel materials, rivets, bolts, nuts, and electrodes as may be applicable.

6.00.00 RATES AND MEASUREMENT

6.01.00 Rates

6.01.01 The items of work in the Schedule of items describe the work in brief. The various items of the Schedule of items shall be read in conjunction with these specifications including amendments and additions, general conditions of contract, special conditions of contracts, and other tender documents, if any. For each item of Schedule of Items, the bidder's rates shall include the activities covered in the description of the item as well as all necessary

operations described in the Specifications.

6.01.02 The bidder's rates shall include cost of all minor details which are obviously and fairly intended and which may not have been included in the description in these documents but are essential for the satisfactory completion of the work. Rates shall also include for taking all safety measures.

6.01.03 The bidder's -rates for all items of schedule of items shall include complete cost towards plant, equipment, erection and dismantling of scaffolding, men, materials and consumables, skilled and unskilled labour, levies, taxes, royalties, duties, transport, storage, repair/rectification/maintenance until handing over, contingencies, overhead and all incidental items not specifically mentioned but reasonably implied and necessary to complete the work.

6.01.04 No claims shall be entertained, if the details shown on the `Released for Construction' drawings differ from those shown on the bid/tender drawings.

6.01.05 Rates shall be inclusive of all leads and lifts/elevation.

6.01.06 The bidder's rates for Structural Steel shall include for fabrication and erection, transportation to site, preparation checking collecting and distributing of the fabrication drawings and design calculations, erection scheme, alignment, welding, including preheating and post heating, testing of welders, inspection of welds, visual inspection, non destructive and special testing, rectification and correction of defective welding works, production test plate, inspection and testing, erection scheme, protection against damage in transit, stability of structures, etc. The rates shall also be inclusive of providing and installing temporary structures, transport of Owner issue material from store, return of surplus/waste steel materials including cut pieces/waste steel, provision of additional butt/weld joint to reduce the wastage and all other general, special, such requirements as may be required, for the successful completion of the work.

The rates for fabrication are inclusive of all tests on welds and material and no extra shall be payable for quality tests specified for fabrication of structure in shop or at site.

Separate BOQ items for test on welds like radiography or Ultrasonic, DPT, magnetic particle tests are kept for tests on material/fabrication not covered under regular fabrication item of BOQ.

6.01.07 The bidder's rates for foundation bolts assembly shall include fabrication, threading, heat treatment, erection, installation, and alignment of complete bolt assembly with nuts, locknuts, anchor plates, stiffener plates, protective tape, etc. This shall also include the cost of all materials not issued by the Owner. Material issued by Owner will be specified in GCC.

6.01.08 The bidders rates for application of inorganic primer shall include surface preparation to near white metal surface by blast cleaning, abrasives, touch up painting, suitable enclosure to avoid contamination and the necessary statutory approval from the factory inspector/pollution control board etc. regarding the method of blast cleaning and abrasives used, and getting approval of the specialized agency supplying the primer specified.

6.01.09 The bidder's rates for application of finish painting system shall include surface preparation, application of intermediate (under) coat, finish coat and final finish coat, and getting approval of the specialized agency supplying the finish paint.

6.01.10 The bidder's rates for electro-forged gratings (if specified) shall include supply, fabrication, transportation to the site, erection and alignment of factory made electro-forged gratings, all taxes, duties thereon etc. The rates shall also include preparation of grating design for different spans and load intensifies, preparation of design and fabrication drawings, edge preparation, blast cleaning followed by finish paint.

6.01.11 The bidder's rates for galvanization of factory made electro-forged gratings (if specified) shall include the application of hot dipped galvanization as finish over the fabricated gratings and the treatment to be given for prevention of white storage stains, as per the technical Aspiration.

6.01.12 The bidder’s rates for permanent mild steel bolts, nuts and washers shall include the supply and fixing of such bolts, nuts and washers in position, for various types of Structural Steel works, as per the technical specification.

6.01.13 The bidder’s rates for high strength structural bolts, nuts and washers shall include the supply and fixing of such bolts, nuts and washers in position, for various types, of Structural Steel works, as per the technical specification.

6.01.14 The bidder’s rates for dismantling, additions to, alterations in and/or modifications shall be inclusive of all operations such as lowering of material, carriage etc., as mentioned in the technical specification. Unutilised steel pieces cut/removed shall be returned to the project stores free of charge. Non-return of unublized steel pieces to the Owner's store would be considered as wastage and recovery would be affected as per the provision of contract for structural steel consumption. This shall not include the weight of temporarily dismantled/supported members, connected member.

The bidder should prepare an optimised cutting plan as per fabrication drawing to utilise the steel material upto maximum extent and minimise the wastage/scrap. Quantity of wastage/scrap of material should be limited to the percentage mentioned elsewhere in the conditions of tender/ contract specifications.

6.01.15 The bidder's rates for re-erection of erection marks after additions to, alterations in and/or modifications shall be inclusive of all operations mentioned in technical specification for the calculated weight of the rectified/modified erection mark rejected at site. This shall not include the weight of temporarily dismantled/supported members, connected member. All the operations mentioned above for restoring such members shall be carried out at no extra cost. The work of erection of any erection mark which has not been dismantled but have been modified/rectified before erection shall not be paid under this item but shall be paid under relevant item of fabrication and erection of steel work of Schedule of items for the modified weight.

6.01.16 The bidder's rates for PTFE shall include design, supply, transportation of the complete assembly with guides and dust protection cover and installation of bearings in position drilling, bolting, erecting aligning etc. along with any taxes, duties thereon etc.

6.01.17 The bidder's rates for Stainless Steel hopper (if specified) shall include fabrication and erection, transportation to site, preparation checking collecting and distributing of the fabrication drawings and design calculations, all other operations mentioned in the technical specification. The rates shall also include for erection scheme, alignment, making cutting plan, cutting, jointing, bending, rolling, grinding, drilling, bolting, assembly, edge preparation, welding including pre-heating, post-heating, testing of welders, inspection of welds, inspection and testing, protection against damage in transit, stability of structures, installation of temporary structures etc. The rates shall also be inclusive of providing and installing temporary structures, transport of Owner issue material from store, return of surplus / waste steel materials including cut pieces/waste steel, provision of additional butt / weld joint to reduce the wastage and all other general, special, such requirements as may be required, for the successful completion of the work.

6.01.18 The bidders rates for preformed flexible open ended bellow strap of neoprene (if specified) shall include supply and transportation, installation in position, drilling, bolting, aligning etc. complete along with any taxes, duties thereon etc.

6.01.19 The bidder's rates for Stainless Steel Hand Rail (if specified) shall include complete Hand Rail including, materials, fabrication, grinding & finishing, stainless steel beading, stainless steel cleats, stainless steel fasteners, neoprene gaskets, preparation of shop drawing but excluding the cost of glazing. The Owner shall supply no material for this item of work.

6.02.00 MODE OF MEASUREMENT

6.02.01 The measurement for the item of foundation bolts assembly including that of nuts; locknuts shall be based on the calculated weight of steel installed in Metric Tonne, corrected to second place of decimal. The weight of the

foundation bolt shall be calculated in the same way as that done for the item of fabrication, erection, alignment of structural steel. The weight of the nut / locknut shall be taken as per actual weight supplied by the contractor and accepted by the Engineer.

6.02.02 The measurement for the item of fabrication, erection, alignment, welding, etc. of structural steel work shall be based on the approved weight of steel nearest to a Kg, by applying the unit weight as adopted at the time of issue of structural steel on the measurements worked out as given below.

6.02.03 For ISMB, ISMC, ISA, flats, round bars, square bars and pipes, length shall be taken as per distance between planes normal to the axis of the member passing through the extreme points of the section.

6.02.04 Gussets plates in trusses, and bracings, brackets plates, stiffeners, and skew cuts if any in plates for butt welds, the area shall be assumed as the minimum circumscribed rectangle. However deduction for any notch/skew cut shall be made as mentioned in clause no-6.02.06.

6.02.05 For bunker wall plates, the minimum-circumscribing rectangle of the individual plate/pieces out of which these wall plates are assembled by butt-welding, shall be measured. Care shall be taken to ensure maximum utilization of cut-pieces generated by providing extra butt joints (for which no extra payment shall be made).

6.02.06 For all other plates, where the area of any notch/skew cut in the plate is less than 0.05 sq.m. the area of the plate shall be assumed as that of the minimum circumscribing rectangle for the purpose of measurement and calculation of area for the purpose of payment. However, if the area of any notch/skew cuts in a plate is more than 0.05 sq.m, the area of notch/skew cut shall be deducted from assumed minimum circumscribing rectangular area for the purpose of payment.

6.02.07 No deduction shall be made for the hole in the members, if the area of individual hole is less than 0.05 sq.m. The weight shall be calculated by deducting the area of holes, if area of individual hole is more than 0.05 sq.m.

6.02.08 All cut-pieces and scrap generated due to cutting of holes, skew-cuts of plates, gussets, brackets, stiffeners, etc. shall be stacked separately and handed over to the project stores without being considered for material accounting as the circumscribing rectangle has been considered for payment.

6.02.09 The splice plate shown in the fabrication drawing or approved by the Engineer shall only be measured for payment.

6.02.10 The weight of permanent bolts, washers and nuts and welds shall not be included in the weights of the members. No extra payment shall be made for

welding/bolting.

6.02.11 The bolts and nuts required for erection purpose shall not be paid for and may be taken away by the Contractor after final welding for members. Erection boltholes left after removal of erection bolts shall be suitably plugged with welds.

6.02.12 The measurement for the item of application of inorganic primer including blast cleaning of steel surfaces shall be based on the weight on which the zinc silicate primer is applied, after blast cleaning in Metric Tonne, corrected to third place of decimal. The weight shall be the weight as approved, for erection mark/element of the mark painted, for payment of the item of fabrication and erection of structural steel works.

6.02.13 The measurement for the item of application of finish primer system shall be based on the weight on which the epoxy based finish primer is applied in Metric Tonne, corrected to third place of decimal. The weight shall be the weight as approved, for erection mark/element of the mark painted, for payment of the item of fabrication and erection of structural steel works.

6.02.14 The measurement for the item of gratings shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor, and accepted by the Engineer. Nothing extra shall be payable for making cutouts, notches, openings of any profile, trimming profiles etc. in the grating units.

6.02.15 The measurement for the item of hot dipped galvanization of gratings shall be based on the actual weight in Kgs, corrected to second place of decimal of gratings galvanized by the Contractor and accepted by the Engineer.

6.02.16 The measurement for the item of permanent bolts with nuts and washers shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor and accepted by the Engineer, and as per the approved bolts and nuts schedules.

6.02.17 The measurement for the item of High Strength Structural bolts with nuts and washers shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor and accepted by the Engineer, and as per the approved bolts and nuts schedules.

6.02.18 The measurement for the item of the work of dismantling, additions, alterations, reerection etc. shall be as given below

6.02.19 For dismantling, the unmodified weight of the actually dismantled erection marks shall only be measured.

6.02.20 For the work of addition to, alteration in and / or modification of 'erection

marks' either in erected position or in the fabrication yard, measurement of weight for payment purpose shall be calculated as the arithmetic sum of weight of steel cut and removed from the erection mark, weight of steel reutilised out of such cut and removed pieces and weight of additional new steel pieces added to the erection mark.

6.02.21 For re-erection the weight of the modified erection mark shall only be measured.

6.02.22 The weight shall be measured nearest to kg. and shall be arrived in a manner similar to the measurement for the item of fabrication, erection, alignment and welding of structural steel.

6.02.23 The measurement for the item of PTFE bearings shall be based on the load carrying capacity of PTFE in MT, corrected to third place of decimal, supplied by the contractor and as accepted by the Engineer and as per the approved bearing schedule, for the total vertical load carrying capacity, for all bearings.

6.02.24 The measurement for the item of stainless steel hopper shall be based on the actual finished weight of hopper weight in Kgs, corrected to second place of decimal. The hopper weight shall be arrived by multiplying of the inner surface area of the hopper with the unit weight of the hopper plate.

6.02.25 The measurement for the item of flexible open-ended bellows straps of neoprene shall be based in running meter, corrected to second place of decimal. Bellow Straps shall be supplied as per the requirement of the approved drawings. The measurement shall be done for the inner circumference of the bunker on which neoprene has been fixed and for the length supplied by the Contractor 'and as accepted by the Engineer.

6.02.26 The measurement for the item of Stainless Steel Hand Railing shall be based on finished weight of handrail in Kgs corrected to second place of decimal. The weight shall also include the weight of Stainless Steel fasteners, Stainless Steel beading, Stainless Steel cleats etc. The weight shall be the finished weight of Hand Rail, as accepted by the Engineer.

VOLUME: II B

SECTION - D
(PART I)

SUB-SECTION – D 18

ERECTION OF STRUCTURAL STEELWORK

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

SUB-SECTION – D 18

ERECTION OF STRUCTURAL STEELWORK

1.00.00 SCOPE

This specification covers the erection of structural steelwork including receiving and taking delivery of fabricated structural steel materials arriving at site, installing the same in position, painting and grouting the stanchion bases all complete as per Drawings, this Specification and other provision of the Contract.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor, unless otherwise specified in the Contract, shall include but not be limited to the following:

a) The Contractor shall provide all construction and transport equipment, tools, tackle, consumables, materials, labour, and supervision required for erection of the structural steelwork.

b) Receiving, unloading, checking, and moving to storage yard at Site including prompt attendance to all insurance matters as necessary for all fabricated steel materials arriving at Site. The Contractor shall pay all demurrage and/or wharfage charges etc. on account of default on his part.

c) Transportation of all fabricated structural steel materials from Site storage yard, handling, rigging, assembling, riveting, bolting, welding and satisfactory installation of all fabricated structural steel materials in proper location according to approved erection drawings and/or as directed by the Engineer. If necessary suitable temporary approach roads to be built for transportation of fabricated steel structures.

d) Checking center lines, levels of all foundation blocks including checking line, level, position and plumb of all bolts and pockets. Any defect observed in the foundation shall be rectified with Engineer's approval. The Contractor shall fully satisfy himself regarding the correctness of the foundations before installing the fabricated steel structures on the foundation blocks.

e) Aligning, plumbing, leveling, riveting, bolting, welding and securely fixing the fabricated steel structures including floor gratings, chequered plates etc. in accordance with the Drawings or as directed by the Engineer.

f) Painting of the erected steel structures.

g) All minor modifications of the fabricated steel structures as directed by the

Engineer including but not limited to the following:

i) Removal of bends, kinks, twists etc. for parts damaged during transport and handling.

ii) Cutting, chipping, filling, grinding, etc. if required for preparation and finishing of site connections.

iii) Reaming of holes for use of higher size rivet or bolt if required.

iv) Refabrication of parts damaged beyond repair during transport and handling or refabrication of parts, which are incorrectly fabricated.

v) Fabrication of parts omitted during fabrication by error, or subsequently found necessary.

vi) Drilling of holes which are either not drilled at all or are drilled in incorrect location during fabrication.

vii) Carry out tests in accordance with this specification.

2.02.00 Work by Others

No work under this Specification will be provided for by any agency other than the Contractor unless specifically mentioned elsewhere in the contract.

2.03.00 Codes and Standards

All work under this Specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specification and codes of Practice of equivalent:

IS: 800 - Code of practice for general construction in steel.

IS: 456 - Code of practice for main or reinforced concrete.

2.04.00 Conformity with Designs

The Contractor will erect the entire fabricated steel structure, align all the members, complete all field connections and grout the foundations all as per the provisions of this specification and the sequence and the design criteria laid down by the Engineer. All work shall conform to the provisions of this specification and /or instructions of the engineer. The testing and acceptance of the erected structures shall be in accordance with the provisions of this Specifications and/or the instructions o the Engineer.

2.05.00 Material

2.05.01 General

All fabricated steel structures and connection materials shall be supplied by the Contractor to the site. The Contractor shall take delivery from railway wagons or trucks at site, and unload the materials and perform all formalities like checking of materials and attend to insurance matters in accordance with Sub-Clause 2.01.00 and as specified hereinbefore.

2.05.02 Materials to conform to Indian standards

All materials required to be supplied by the Contractor under this contract shall conform to the relevant Indian Standard specifications.

2.06.00 Storage of Materials

2.06.01 General

All material shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for use in the works. Any material which has been deteriorated or damaged beyond repairs and has become unfit for use shall be removed immediately from the site, failing which, the engineer shall be at liberty to get the materials removed by agency and the cost incurred thereof shall be realised from the Contractor's dues.

2.06.02 Yard

The Contractor will have to establish a suitable yard in an approved location at site for storing the fabricated steel structures and other raw steel materials such as structural sections and plates as required. The yard shall have facilities like drainage, lighting, and suitable access for large cranes, trailers, and other heavy equipments. The yard shall be fenced all around with security arrangement and shall be of sufficiently large area to permit systematic storage of the fabricated steel structures without overcrowding and with suitable access for cranes, trailers and other equipment for use in erection work in proper sequence in accordance with the approved Programme of work.

The Tenderer must visit the site prior to submission of his tender to acquaint himself with the availability of land and the development necessary by way of filling, drainage, access roads, fences, sheds etc. all of which shall be carried out by the Contractor at his own cost as directed by the Engineer.

2.06.03 Covered Store

All field connection materials, paints, cement etc. shall be stored on well

designed racks and platforms off the ground in a properly covered store building to be built at the cost of the Contractor.

2.07.00 Quality Control

The contractor shall establish and maintain quality control procedures for different items of work and materials as may be directed by the Engineer to assure compliance with the provisions of the Contract and shall submit the records of the same to the Engineer. The quality control operation shall include but not be limited to the Following items of work :

i) Erection: Lines, levels, grades, plumbs, joint characteristics including tightness of bolts.

ii) Grouting: Cleaning and roughness of foundation, quality of materials used for grouting, admixtures, consistency, and strength of grout.

iii) Painting: Preparation of surface for painting, quality of primers and paints, thinners, application and uniformity of coats.

2.08.00 Taking Delivery

The Contractor shall take delivery of fabricated structural steel and necessary connection materials from railhead/trucks as may be necessary and as directed by the Engineer. He shall check, unload; transport the materials to his stores for proper storing at his own cost. The Contractor shall submit claims to insurance or other authorities and pursue the same in case of loss or damage during transit and handling and all loss thereof shall be borne by him.

The Contractor shall also take all precautions against damage of the materials in his custody after taking delivery and till the same are erected in place and accepted. The Contractor shall salvage, collect, and deliver all the packing materials to the Owner free of charge.

3.00.00 WORKMANSHIP

3.01.00 Erection

3.01.01 Plant and Equipment

The suitability and adequacy of all erection tools and plant and equipment proposed to be used shall be thoroughly verified. They shall be efficient, dependable, in good working condition and shall have the approval of the Engineer.

3.01.02 Method and sequence of erection

The method and sequence of erection shall have the prior approval of the Engineer. The Contractor shall arrange for most economical method and sequence available to him consistent with the drawings and specifications and other relevant stipulations of the contract.

3.01.03 Temporary Bracing

Unless adequate bracing is included as a part of the permanent framing, the erector during erecrtion shall install, free of cost to the Owne, temporary guys and bracings where needed to secure the framing against loads such as wind or seismic forces comparable in intensity to that for which the structure has been designed, acting upon exposed framing as well as loads due to erection equipment and erection operations.

If additional temporary guys are required to resist wind or seismic forces acting upon components of the finished structure installed by others during the course of the erection of the steel framing, arrangement for their installation by the erector shall be made free of cost to the Owner.

The requirement of temporary bracings and guys shall cease when the structural steel is once located, plumbed, levelled, aligned, and grouted within the tolerances permitted under the specification and guyed and braced to the satisfaction of the Engineer.

The temporary guys, braces, false work, and cribbing shall not be the property of the Owner and they may be removed immediately upon completion of the steel erection.

3.01.04 Temporary Floors for Buildings

It shall be the responsibility of the Contractor to provide free of cost planking and to cover such floors during the work in progress as may be required by any Act of Parliament and/or bylaws of state, Municipal or other local authorities.

3.01.05 Setting Out

Positioning and levelling of all steelwork, plumbing of stanchions and placing of every part of the structure with accuracy shall be in accordance with the approved Drawings and to the satisfaction of the Engineer. For heavy columns, etc. the Contractor shall set proper screed bars to maintain proper level. No extra payment shall be made for this.

Each tier of column shall be plumbed and maintained in a true vertical position subject to the limits of tolerance under this Specification.
No permanent field connections by riveting, bolting or shall be carried out until proper alignment and plumbing has been attained.

3.01.06 Field Riveting

All rivets shall be heated and driven with pneumatic tools. Hand passing or "throwing" of rivets are desirable. Any other method of conveying hot rivets from the furnace to the driving point must be approved by the engineer. No-cold rivets shall be driven. All other requirements of riveting including quality and acceptance criteria shall be in accordance with the relevant portions of the Specification for Fabrication of Structural Steelwork of the Project.

3.01.07 Field Bolting

All relevant Portions in respect of bolted construction of the Specification for Fabrication of Structural Steelwork applicable to the Project shall also be applicable for field bolting in addition to the following:

Bolts shall be inserted in such a way so that they may remain in position under gravity even before fixing the nut. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible materials. When assembled, all joint surfaces, including those adjacent to the washers shall be free of scales except tight mill scales. They shall be free of dirt, loose scales, burns, and other, defects that would prevent solid seating of the parts. Contact surfaces within friction type joints shall be free of oil, paint, lacquer, or galvanizing.

All high tensile bolts shall be tightened to provide, when all fasteners in the joint are tight, the required minimum bolt tension by any of the following methods.

a) Turn-of-nut Method

When the turn-of-nut method is used to provide the bolt tension, there shall first be enough bolts brought to a "snug tight" condition to ensure that the parts of the Joint are brought into good contact with each other. 'Snug tight" is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified in Table-I with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation

there shall be no rotation of the part not turned by the wrench.

TABLE-I

Bolts length not exceeding 8 times dia or 200 mm	Bolt length exceeding 8 times dia or 200 mm	Remarks
1/2 turn	2/3 turn	Nut rotation is relative to bolt regardless of the element (nut or bolt) being turned. Tolerance on rotation-30° over or under.

Bolts may be installed without hardened washers when tightening is done by the turn -of-nut -method. However, normal washers shall be used.

Bolts tightened by the turn-of-nut method may have the outer face of the match-marked with the protruding bolt point before final tightening, thus affording the inspector visual means of noting the actual nut rotation. Such marks can be made by the wrench operator by suitable means after the bolts have been brought up snug tight.

b) Torque Wrench Tightening

When torque wrenches are used to provide the bolt tensions, the bolts shall be tightened to the torques specified in TABLE-II (See Note below the Table). Nuts shall be in tightening motion when torque is measured. When using torque wrenches to install several bolts in a single joint, the wrench shall be returned to touch up bolts previously tightened, which may have been loosened by the tightening of subsequent bolts, until all are tightened to the required tension.

TABLE-II

Nominal Bolt Diameter (mm) of IS:1367	Torque to be applied (Kg.M) for bolt class 8.8
20	59.94
22	81.63
24	103.73

Note: The above torque values are approximate for providing tensions of 14.

7 T for 20 mm dia.; and 21.2 T for 24 mm dia. bolts under moderately lubricated condition. The torque wrench shall be calibrated at least once daily to find out the actual torque required to produce the above required tension in the bolt by placing it in a tension indicating device. These torques shall be applied for tightening the bolts on that day with the particular wrench.

In either of the above two methods, if required, for bolt entering and wrench operation clearances, tightening may be done by turning the bolt while the nut is prevented from rotating.

Impact wrenches if used shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately ten seconds. Holes for turned bolts to be inserted in the field shall be reamed in the field. All drilling and reaming for turned bolts shall be done only after the parts to be connected are assembled. Tolerances applicable in the fit of the bolts shall be in accordance with relevant Indian Standard Specifications. All other requirements regarding assembly and bolt tightening shall be in accordance with this sub clause.

3.01.08 Field Welding

All field assembly and welding shall be carried out in accordance with the requirements of the specification for fabrication work applicable to the project, excepting such provisions therein which manifestly apply to shop conditions only. Where the fabricated structural steel members have been delivered painted, the paint shall be removed before field welding for a distance of at least 50 mm on either side of the joints.

3.01.09 Holes, Cutting and Fitting

No cutting of sections, flanges, webs, cleats, rivets, bolts, welds etc. shall be done unless specifically approved and /or instructed by the Engineer.

The erector shall not cut, drill, or otherwise alter the work of other trades, unless such work is clearly specified in the Contract or directed by the Engineer. Wherever such work is obtain specified the Contractor shall obtain complete information as to size, location and number of alterations prior to carrying out any work. The Contractor shall not be entitled for any payment on account of any such work.

3.02.00 Drifting

Correction of minor misfits and reasonable amount of reaming and cutting of excess stock from rivets will be considered as permissible. For this, light drifting may be used to draw holes together and drills shall be used to enlarge holes as necessary to make connections. Reaming, that weakens the member

or makes it impossible to fill the holes properly or to adjust accurately after reaming, shall not be allowed.

Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins and reamers shall immediately be called to the attention of the Engineer and approval of the method of correction obtained. The use of gas cutting torches at erection site is prohibited.

3.03.00 Grouting of stanchion bases and bearings of beams and girders on stone, brick or concrete (Plain or reinforced)

Grouting shall be carried out with Ordinary Cement grout as described below:

The mix shall be one (1) part cement and one (1) part sand and just enough water to make it workable. The positions to be grouted shall be cleaned thoroughly with compressed air jet and wetted with water and any accumulated water shall be removed. These shall be placed under expert supervision, taking care to avoid air locks. Edges shall be finished properly. If the thickness of grout is 25 mm or more, two (2) parts of 6 mm down graded stone chips may be added to the above noted cement-sand grout mix, if required, by the Engineer or shown on the drawings.

No grouting shall be carried out until a sufficient number of bottom lengths of stanchions have been properly lined, leveled, and plumbed and sufficient floor beams are tied in position.

Whatever method of grouting is employed, the operation shall not be carried out until the steelwork has been finally levelled and plumbed, the stanchion bases being supported meanwhile by steel wedges, and immediately before grouting, the space under steel shall be thoroughly cleaned.

If required by the Engineer, certain admixtures like aluminium powder, “ironite” or equivalent, may be required to be added to the grout to enhance certain desirable properties of the grout. Approved non-shrink pre-mixed grout having required flowability and compressive strength may also be used with Engineer's approval.

3.04.00 Painting after Erection

Field painting shall only be done after the structure is erected, levelled, plumbed, aligned and grouted in its final position, tested and accepted by the Engineer. Normally, final painting shall be done only after the floor slabs are concreted and masonry walls are built. However, touch up painting, making good any damaged shop painting and completing any unfinished portion of the shop coat shall be carried out by the Contractor free of cost to the Owner. The materials and specification for such painting in the field shall be in accordance with the requirements of the specification for fabrication of structural

steelwork applicable for the project.

Painting shall not be done in frosty or foggy weather or when humidity is such as to cause condensation on the surfaces to be painted. Before painting of steel, which is delivered unpainted, is commenced, all surfaces to be painted shall be dried and thoroughly cleaned from all loose scale and rust.

All field rivets, bolts, welds, and abrasions to the shop coat shall be spot painted with the same paint used for the shop coat. Where specified, surfaces, which will be in contact after site assembling, shall receive a coat of paint (in addition to the shop coat, if any) and shall be brought together while the paint is still wet.

Surface, which will be inaccessible after field assembly shall receive the full, specified protective treatment before Bolts and fabricated steel members who are galvanized or otherwise treated and steel members to be encased shall not be painted.

The final painting shall be of tow coats of Synthetics Enamel painting or Aluminium paint of approved manufacture as per the approved "Schedule of Painting". The shades shall also be as per the approved schedule. Synthetic enamel paint shall conform to IS: 2932.

3.05.00 Final cleaning up

Upon completion of erection and before final acceptance of the work by the Engineer, the contractor shall remove free of cost all false work, rubbish and all Temporary Works resulting in connection with the performance of his work.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 General

Loading tests shall be carried out on erected structures, if required by the Engineer, to check adequacy of fabrication and/or erection. Any structure or a part thereof found to be unsuitable for acceptance as a result of the test shall have to be dismantled and replaced with suitable member as per the Contract and no payment towards the cost of the dismantled portion and any connected work shall be made to the contractor. In course of dismantling, if any damage is done to any other parts of the structure or to any fixtures, the same shall be made good free of cost by the Contractor, to the satisfaction of the Engineer. The Cost of the tests specified hereinafter shall be borne by the Owner; but if the structure fails to pass the tests, the cost of the tests shall be recovered from the Contractor. Any extra claim due to loss of time, idle labour, etc. arising out of these testing operations shall not be entertained, however, only reasonable and appropriate time extensions will be allowed.

The structure or structural member under consideration shall be loaded with its actual dead load for as long a time as possible before testing and the tests shall be conducted as indicated in the following sub-clauses 4.01.01, 4.01.02 and 4.01.03. The method of testing and application of loading shall be as approved by the Engineer.

4.01.01 Stiffness Test

In this test, the structure or member shall be subjected, addition to its actual dead load, to a test load equal to 1.5 times the specified superimposed load, and this loading shall be maintained for 24 hours. The maximum deflection attained during the test shall be within the permissible limit. If, after removal of the test load, the member or structure does not show a recovery of at least 80 per cent of the maximum strain or deflection shown during 24 hours under load, the test shall be repeated. The structure or member shall be considered to have sufficient stiffness, provided that the recovery after this second test is not less than 90 per cent of the maximum increase in strain or deflection recorded during the second test.

4.01.02 Strength Test

The structure or structural member under consideration shall be subjected, in addition to its actual dead load, to a test load equal to the sum of the dead load and twice the specified superimposed load, and this load shall be maintained for 24 hours.

In the case of wind load, a load corresponding to twice the specified wind load shall be applied and maintained for 24 hours, either with or without the vertical test load for more severe condition in the member under consideration or the structure as a whole. Complete tests under both conditions may be necessary to verify the strength of the structure. The structure shall be deemed to have adequate strength if, during the test, no part fails and if on the removal of the test load, the structure shows a recovery of at least 20 per cent of the maximum deflection or strain recorded during the 24 hours under load.

4.01.03 Structure of same design

Where several structures are built to the same design and it is considered unnecessary to test all of them, one structure, as a prototype, shall be fully tested, as described in previous Sub-clauses, but in addition, during the first application of the test load, particular note shall be taken of the strain or deflection when the test load 1.5 times the specified superimposed load has been maintained for 24 hours. This information is required as a basis of comparison in any check test carried out on samples of the structure.

When a structure of the same type is selected for a check test, it shall be subjected, in addition to its actual dead load, to a superimposed test load, equal to 1.5 time the specified live load, in a manner and to an extent prescribed by the Engineer. This load shall be maintained for 24 hours, during which time, the maximum deflection shall be recorded. The check test shall be considered satisfactory, provided that the maximum strain or deflection recorded in the check test does not exceed by more than 20% of the maximum strain or deflection recorded at similar load in the test on the prototype.

4.01.04 Repair for subsequent test and use after strength tests

An actual structure which has passed the "Strength Test" as specified in Sub-clause 4.1.2 hereinbefore and is subsequently to be erected for use, shall be considered satisfactory for use after it has been strengthened by replacing any distorted members and has subsequently satisfied the 'Stiffness Test' as specified in Sub-clause 4.01.01 hereinbefore.

4.02.00 Tolerances

Some variation is to be expected in the finished dimensions of structural steel frames. Unless otherwise specified, such variations are deemed to be within the limits of good practice when they are not in excess of the cumulative effect of detailed erection clearances, fabricating tolerances for the finished parts and the rolling tolerances for the profile dimensions permitted under the Specifications for fabrication of structural steel work applicable to this Project and as specified below: The specified tolerance is mainly for welded erection. In case of bolted erection, no tolerance is desired so that all prefabricated bolt holes are matched on erection.

I. For Buildings Containing Cranes

Component	Description	Variation Allowed
1.	2.	3.
Main columns	a) shifting of column axis at foundation level with respect to building line	
	i) In longitudinal direction	i) ± 3.0 mm
	ii) In lateral direction	ii) ± 3.0 mm
	b) Deviation of both major column axis from vertical between foundation and	

	other member connection levels:	
	i) For a column upto and including 10M height	i) ± 3.5 mm from true vertical
	ii) For a column greater than 10M but less than 40M height	ii) ± 3.5 mm from true vertical for any 10 M length measured between connection levels, but not more than ±7 mm per 30m length.
	c) For adjacent pairs of columns across the width of the building prior to placing of truss	± 9.0 mm on true span.
	d) For any individual column deviation of any bearing or resting level from levels shown on drawings.	± 3.0 mm
	e) For adjacent pairs of columns either across the width of building or longitudinally level difference allowed between bearing or seating	3.0 mm
Trusses	a) Deviation at centre of span of upper chord member from vertical plane running through centre of bottom chord.	1/1500 of the span or greater than 10mm whichever is the least.
Trusses	b) Lateral displacement of top chord at center of span from vertical plane running through center of supports.	1/250 of depth of truss or 20 mm which ever is the - least.
Crane Cirders	a) Difference in levels of crane rail measured between adjacent columns.	2.0 mm.
	b) Deviation to crane rail-gauge	± 3.0 mm

	c) Relative shifting of ends of adjacent crane rail in plan and elevation after thermite welding.	1.0 mm.
	d) Deviation of crane rail axis from centre line of web.	± 3.5 mm
Setting of Expansion gaps	At the time of setting of the expansion gaps, due regard shall be taken of the ambient temperature above or below 30°C. The coefficient of expansion or contraction shall be taken as 0.000012 per °C per unit length.	

iv) For Building without Cranes

The maximum tolerances for line and level of the steel work shall be ±3.0 mm on any part of the structure. The structure shall not be Out of Plumb more than 3.5 mm on each lox section of height and not more than 7.0 mm per 30 m section.

These tolerances shall apply to all parts of the structure unless the drawings issued for erection purposes state otherwise.

4.03.00 Acceptance

Structures and members have passed the tests and conform to all requirements specified in the foregoing Sub-clause 4.01.00, 4.01.01, 4.01.02, 4.01.03 and 4.01.04 and other applicable provisions of this specification and are within the limits of tolerances specified in Sub-clause 4.02.00 and/or otherwise approved by the Engineer shall be treated as approved and accepted for the purpose of fulfillment of the provisions of this contract.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 Before Tender

5.01.01 Tentative Programme

The Tenderer shall submit a tentative programme based on the information available in the Tender Document and visit to site indicating the structure-wise erection schedule proposed to be maintained by the Contractor to complete the job in time in accordance with the Contract.

5.01.02 Constructional Plant and Equipment, Tools, Temporary works & manpower A detailed list Of all constructional plant and equipment like cranes, derricks, winches, welding sets, erection tools etc. along with their make, model, present condition and location available with the Tenderer which he will be able to employ on the job to maintain the progress of work in accordance with the Contract shall be submitted along with the Tender. The total number of each category of experienced personnel like fitters, welders, riggers etc. that he will be able to employ on the job shall also be indicated.

5.01.03 Erection Yard

A site plan showing the layout and location of the erection yard proposed to be established by the tenderer shall also be attached with the tender indicating the storage space for fabricated steel materials, site-fabrication and repair shop, covered stores, offices, locations of erection equipments and other facilities. The Engineer shall have the right to modify the arrangement and location of the proposed yard to suit site conditions and the Contractor shall comply with the same without any claim whatsoever.

5.02.00 After award of the Contract

After award of the contract, the Contractor shall submit the following:

5.02.01 Detailed Programme

The Contractor shall submit a detailed erection programme within a month of the award of the Contract for completion of the work in time in accordance with the Contract. This will show the target programme, with details of erection proposed to be carried out in each fortnight, details of major equipment required, and an assessment of required strength of various categories of workers in a proforma approved by the Engineer.

5.02.02 Fortnightly Progress Report

The Contractor shall submit fortnightly progress reports in triplicate to the Engineer showing along with necessary photographs, 125 mm x 90 mm size, and all details of actual achievements against the target programme specified in Sub-clause 5.02.01 above. Any shortfall in the achievement in a particular fortnight must be made up within the next fortnight. Along with this report, the Contractor shall also furnish details of fabricated materials in hand at site and the strength of his workers.

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GENERAL NOTES: –

1. ALL ELEVATIONS ARE WITH RESPECT TO EL. (+)0.00m, FINISHED GROUND FLOOR LEVEL OF TG BUILDING AND MILL BAY, WHICH CORRESPONDS TO RL XXXX m . FINISHED GROUND FLOOR LEVEL (PAVING LEVEL) OF BOILER AND ESP AREAS ARE AT (–)XXXXm, WHICH CORRESPONDS TO RL. XXXX m. FINISHED GROUND FLOOR LEVEL (PAVING LEVEL) OF MILL BAY AND CHIMNEY AREA(INSIDE) ARE AT (+)0.00m, WHICH CORRESPONDS TO RL XXXX m.
2. FOR ALL INFORMATION & DIMENSIONS, SEE REFERENCE DRAWINGS.
3. ALL DUCT DIMENSIONS ARE TO THE INSIDE OF DUCT PLATES.
4. ALL INSIDE DUCT RADII TO BE 600mm, UNLESS NOTED.
5. ALL FURNACE OPENINGS ARE IN BOTH SIDES OF FURNACE, UNLESS NOTED.
6. ALL PLATFORM ELEVATIONS ARE TO TOP OF GRATING, UNLESS NOTED.
7. ACCESS DOOR SIZES TO BE:
   - 500mm X 500mm IN TUBE WALLS
   - 500mm x 500mm IN DUCTS
   - 610mm X 610mm IN ENCLOSURES
   - 610mm x 610mm – FURNACE ROOF ENCLOSURE HEAT REMOVAL DOORS
   - 813mm X 1397mm – WATER–COOLED SCAFFOLD DOOR IN UPPER FURNACE SIDEWALL
   - 610mm X 762mm – WATER–COOLED SCAFFOLD DOOR IN LOWER FURNACE SIDEWALL
8. CENTERLINE OF ALL DUCT ACCESS DOORS TO BE LOCATED 600mm ABOVE BOTTOM INSIDE OF DUCT PLATES UNLESS NOTED.
9. IT IS THE INTENT OF THE GEN. ARRGTS. TO SHOW ONLY THE MAJOR BOILER EQUIPMENT COMPONENTS AND ACCESSORIES. ALL OTHER EQUIPMENT IS SHOWN TO A LIMITED EXTENT AND ONLY WHERE IT AFFECTS THE BOILER EQUIPMENT ARRANGEMENT.
10. ALL SIZES AND DIMENSIONS SHOWN ARE IN MILLIMETERS.

BOILER PARAMETERS (BMCR)

STEAM FLOW AT SUPER HEATER OUTLET	– 2585 T/Hr
PRESSURE AT SUPER HEATER OUTLET	– 255 Kg./SQ.cm(G)
TEMPERATURE AT SUPERHEATER OUTLET	– 568 °C
STEAM FLOW AT REHEATER OUTLET	– 2042 T/h
PRESSURE AT REHEATER INLET	– 62.35 Kg./SQ.cm(G)
TEMPERATURE AT REHEATER INLET	– 355.3 °C
PRESSURE AT REHEATER OUTLET	– 59.95 Kg./SQ.cm(G)
TEMPERATURE AT REHEATER OUTLET	– 596.0 °C
FEED WATER INLET TEMPERATURE	– 299.2 °C

DESCRIPTION OF UNIT

FIVE UNITS OF 800 MW ONCE THROUGH SUPERCRITICAL, HAVING TWO PASS, SPIRAL WATER WALL TUBE, TOP SUPPORTED, SINGLE REHEAT, TANGENTIAL CORNER FIRED FURNACE WITH DIRECT PULVERIZED COAL FIRING, BALANCE DRAFT, RADIANT DRY BOTTOM (WATER IMPOUNDED) AND SEMI OUTDOOR TYPE.

LEGEND

ALL THE OPENINGS SHOWN ARE APPLICABLE FOR BOTH THE SIDES, UNLESS IT IS SPECIFICALLY WRITTEN.

✳	LRSB	LONG RETRACTABLE SOOT BLOWER
✳½	F	FURTURE LONG RETRACTABLE SOOT BLOWER
⊕	WB.	WALL BLOWER
⊕F	F	FUTURE WALL BLOWER
▲	TP	TEMPERATURE PROBE
⊠	AD.	ACCESS DOOR–REFER NOTES
▮	OBD.	OBSERVATION DOOR– 100X250
✥	ASLD	ACOUSTIC STEAM LEAK DETECTION CHANNEL
TP		TERMINAL POINT UNDER BOILER SCOPE
	MBL	MAIN BRACE LEVEL
	WP.	WORK POINT
	BS	BUCK STAY
◉		TV CAMERA
●	IN	INSTRUMENT INSERTS
E		ELEVATOR LANDING

REFERENCE DRAWINGS

DESCRIPTION	DRAWING NO.
GEN ARRGT. OF BOILER SECTIONAL PLAN SEC–AA	0–00–022–77365
GEN ARRGT. OF BOILER SECTIONAL PLAN SEC–BB	0–00–022–77366
GEN ARRGT. OF BOILER SECTIONAL PLAN SEC–CC	0–00–022–77367
GEN ARRGT. OF BOILER SECTIONAL PLAN SEC–DD	0–00–022–77368
GEN ARRGT. OF BOILER FRONT ELEVATION SEC–FF	0–00–022–77369
BOILER EQUIPMENT DESIGNATION	1–00–020–71641

SIDE ELEVATION –"E–E"

CUSTOMER No.:1823 TO 1827

CUSTOMER: TELANGANA STATE POWER GENERATION CORPORATION LTD

PROJECT : YADADRI THERMAL POWER STATION-5X800MW
NALGONDA DIST.,TELANGANA STATE, INDIA

BHARAT HEAVY ELECTRICALS LTD
HIGH PRESSURE BOILER PLANT
TIRUCHIRAPALLI-620014, INDIA

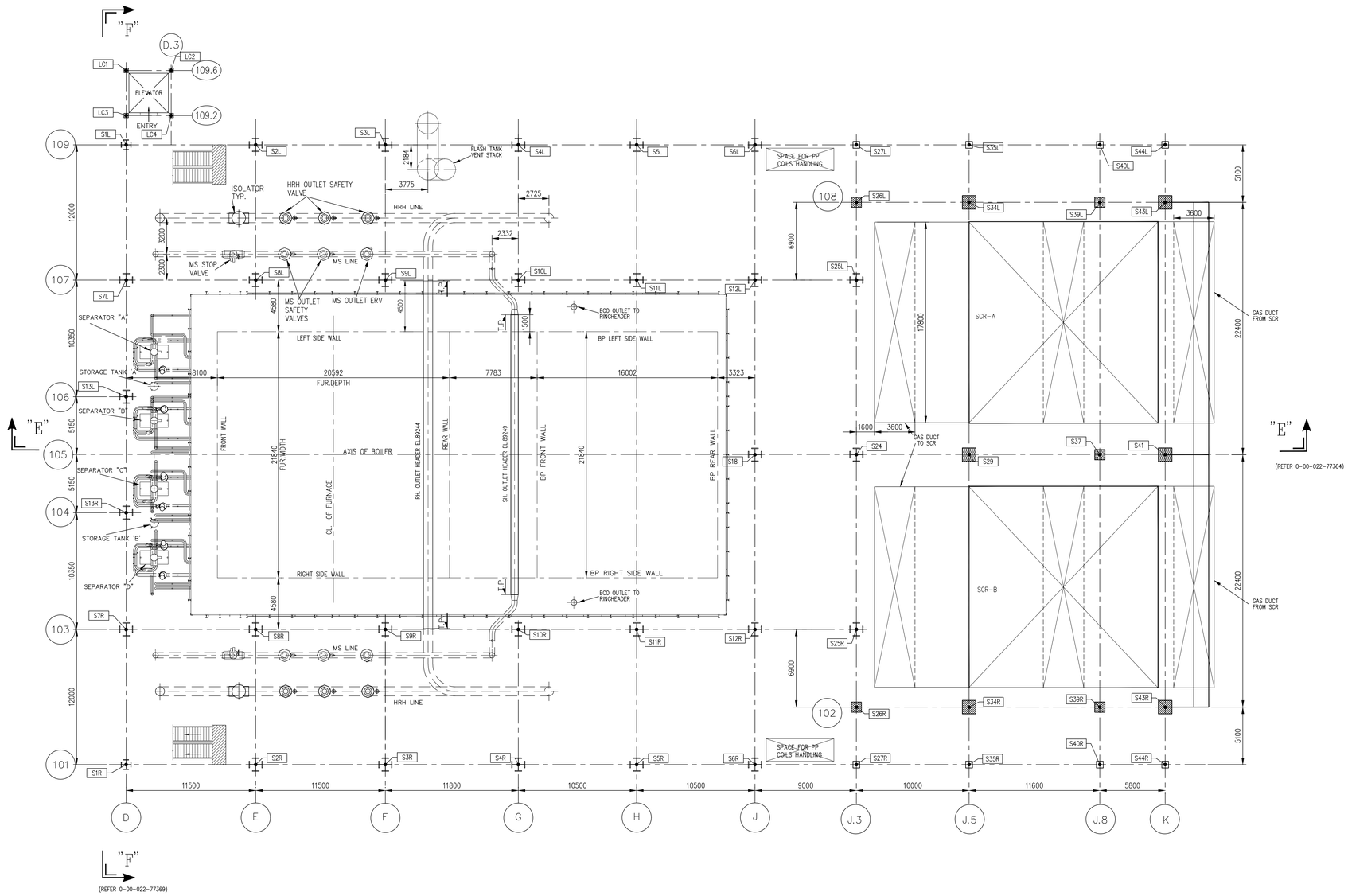
DEPT CODE		NAME	SIGN	DATE
	DRWN	LOKESH	Sd/-	30.10.2017
–	CHD	S.KAILASH	Sd/-	30.10.2017
	APPD	K.A.PALANIYAPPAN	Sd/-	31.10.2017

TITLE: GENERAL ARRGT.OF BOILER SEC.SIDE ELEVATION – SECTION EE

DEPT. SCALE 150 | DRAWING NO. 0-00-022-77364
SIGN
SHEET 1 OF 1 OF | REV. 00
SIZE–A0

REV.	STATUS	TYPE	REASONS FOR REVISION	DRAWN	CHECKED	APPROVED	DATE

DWG. NO. 0-00-022-77368 REV. 00



SECTIONAL PLAN –SECTION DD

(REFER 0–00–022–77364)

REFERENCE DRAWINGS

DESCRIPTION	DRAWING NO.
GEN ARRGT. OF BOILER SEC. SIDE ELEVATION SEC–EE	0–00–022–77364
GEN ARRGT. OF BOILER SECTIONAL PLAN SEC–AA	0–00–022–77365
GEN ARRGT. OF BOILER SECTIONAL PLAN SEC–BB	0–00–022–77366
GEN ARRGT. OF BOILER SECTIONAL PLAN SEC–CC	0–00–022–77367
GEN ARRGT. OF BOILER FRONT ELEVATION SEC–FF	0–00–022–77369
BOILER EQUIPMENT DESIGNATION	1–00–020–71641

REV.	STATUS	TYPE	REASONS FOR REVISION	DRAWN	CHECKED	APPROVED	DATE

CUSTOMER No.:1823 TO 1827

CUSTOMER: TELANGANA STATE POWER GENERATION CORPORATION LTD

PROJECT : YADADRI THERMAL POWER STATION-5X800MW
NALGONDA DIST.,TELANGANA STATE, INDIA

BHARAT HEAVY ELECTRICALS LTD
HIGH PRESSURE BOILER PLANT
TIRUCHIRAPALLI-620014, INDIA

DEPT CODE	NAME	SIGN	DATE
DRWN	S.KAILASH	Sd/-	30/10/17
CHD	S.KAILASH	Sd/-	30/10/17
APPD	K.PALANIAPPAN	Sd/-	31/10/17

TITLE: GENERAL ARRGT.OF BOILER SEC.PLAN–DD

DEPT. SCALE 150 DRAWING NO. 0-00-022-77368
SIGN
SHEET 1 OF 1 OF REV. 00
SIZE–A0

A0 (1189 x 841)

NO DEVIATION CERTIFICATE

(To be typed and submitted in the Letter Head of the Company/Firm of Bidder)

To,

(Write Name & Address of Officer of BHEL inviting the Tender)

Dear Sir,

Sub : **No Deviation Certificate**
Ref : 1) NIT/Tender Specification No: ……,
2) All other pertinent issues till date

We hereby confirm that we have not changed / modified / materially altered any of the tender documents as downloaded from the website/ issued by BHEL and in case of such observance at any stage, it shall be treated as null and void.

We also hereby confirm that we have neither set any Terms and Conditions and nor have we taken any deviation from the Tender conditions together with other references applicable for the above referred NIT/Tender Specification.

We further confirm our unqualified acceptance to all Terms and Conditions, unqualified compliance to Tender Conditions, Integrity Pact (if applicable) and opening of price bid submitted in the E-tendering portal https://www.bhel.abcprocure.com.

We confirm to have submitted offer in accordance with tender instructions and as per aforesaid references.

Thanking you,

Yours faithfully,

(Signature, date & seal of authorized
representative of the bidder)