

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
1	LICA	Absorber Level		m	HH	7.0	Overflow	Normal Level + 1.0 m	
					H	6.3	H ANN	CH Level + 0.2 m	
					CH2	6.3	Start Permission for 1st Absorber Circulation Pump	The value that does not drop to L level after startng pump.	
					CH	6.1	Absorber make-up water supply stop	Normal Level + 0.1 m	
					N	6.0		Design Level (Normal Level)	
					CL	5.9	Absorber make-up water supply start	Normal Level - 0.1 m	
					L	5.7	L ANN	CL Level - 0.2 m	
					LL1	4.5(*1)	INT : Absorber Recirculation Pump Stop LL1 ANN		Pump Protection
					LL2	3.2(*1)	INT : Absorber Agitator Stop LL2 ANN	(Agitator installation Level :1.6m) + (Impeller dia.:1.6m)	Agitator Protection
					LL3	1.5(*1)	INT : Absorber Bleed Pump Stop LL3 ANN		Pump Protection
2	LICA	Belt Filter Washing Tank Level		m	ΔH	0.4	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
					HH	2.8	Over flow	Top level - 0.5m	
					H	2.6	H ANN	HH Level - 0.2 m	
					CH	2.4	Make-up water supply stop	H Level - 0.2 m	
					CL	1.4	Make-up water supply start	L Level + 0.2 m	
					L	1.2	L ANN	LL Level + 0.2 m.	
					LL	1.0(*1)	INT : Pump Stop LL ANN		Pump Protection
					ΔH	0.2	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection

※1 : Assumed value. To be finalized based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
3	LICA	Filtrate Water Sump Level		m	HH	3.5	Over flow	Top level - 0.5m	
					H	3.3	H ANN	HH Level - 0.2 m	
					CH	3.1	Absorber Return Valve Open	H Level - 0.2 m	
					CL	1.4	Absorber Return Valve Close	L Level + 0.2 m	
					L	1.2	L ANN	LL Level + 0.2 m.	
					LL	1.0(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
					ΔH	0.2	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
4	LICA	Secondary Waste Water Hydrocyclone Feed Tank Level		m	HH	4.9	Over flow	Top level - 0.5m	
					H	4.7	H ANN	HH Level - 0.2 m	
					CH	4.5	Hydro-cyclone Feed start	H Level - 0.2 m	
					CL	1.5	Hydro-cyclone Feed Stop	L Level + 0.2 m	
					L	1.3	L ANN	LL Level + 0.2 m.	
					LL	1.1(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
					ΔH	0.3	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
5	LICA	Waste Water Storage Tank Level		m	HH	6.5	Over flow	Top level - 0.5m	
					H	6.3	H ANN	HH Level - 0.2 m	
					CH1	6.1	Filtrate Water Tank Feed Start	H Level - 0.2 m	
					CL1	5.6	Filtrate Water Tank Feed Stop	CH1 Level - 0.5 m	
					CH2	2.2	Waste Water Treatment Feed Start	CL2 Level + 0.5 m	
					CL2	1.7	Waste Water Treatment Feed Stop	L Level + 0.2 m	
					L	1.5	L ANN	LL Level + 0.2 m.	
					LL	1.3(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
					ΔH	0.4	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
6	LICA	Lime Silo Level		m	HH	Later(*1)	Over flow		
					H	Later(*1)	H ANN		
					CH	Later(*1)	Bucket Elevator stop		
					CL	Later(*1)	Bucket Elevator start		
					L	Later(*1)	L ANN		
					LL	Later(*1)			
					B	Later(*1)	Reference Level-Silo Bottom		
					ΔH	Later(*1)	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
7	LICA	Neutralization Tank Level		m	HH	Later(*1)	Over flow		
					H	Later(*1)	H ANN		
					CH	Later(*1)	Process water feed Valve-Open		
					CL	Later(*1)	Process water feed Valve-Close		
					L	Later(*1)	L ANN		
					LL	Later(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
					ΔH	Later(*1)	H ANN		Prevention for Meter Deflection
8	LICA	Limestone Silo Level		m	HH	11.3	Over flow		
					H	10.8	H ANN		
					CH	10.6	Feed conveyor stop		
					CL	4.4	Feed conveyor start		
					L	4.2	L ANN		
					LL	4.0	Wet ball mill stop		
					B	0	Reference Level-Silo Bottom		
					ΔH	0.60	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
9	LICA	Mill Circuit Tank Level		m	HH	Later(*1)	HH ANN	To be finalize by BHEL based on vedor information.	Silo & Bag Filter Protection
					H	Later(*1)	H ANN	To be finalize by BHEL based on vedor information.	
					L	Later(*1)	L ANN	To be finalize by BHEL based on vedor information.	
					LL	Later(*1)	LL ANN	To be finalize by BHEL based on vedor information.	
10	LICA	Limestone Slurry Storage Tank Level		m	HH	10.4	Over flow	Top level - 0.8m	
					H	10.2	H ANN	HH Level - 0.2 m	
					CH	9.7	Wet Limestone Grinding Mill stop	H Level - 0.5 m	
					CL	7.0	Wet Limestone Grinding Mill start	Required volume in 6 hours	
					L	1.4	L ANN	LL Level + 0.2 m.	
					LL	1.2(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
11	LIC	Absorber Area Drain Sump Level		m	HH	3.5	Over flow	Top level - 0.5m	
					H	3.3	H ANN	HH Level - 0.2 m	
					CH	3.1	Absorber Area Drain Sump Pump Start	H Level - 0.2 m	
					CL	1.8	Absorber Sump Pump Stop	L Level + 0.2 m	
					L	1.6	L ANN	LL Level + 0.2 m.	
					LL	1.4(*1)	INT : Agitator & Pump Stop LL ANN		Pump protection Agitator Protection

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
10	LIA	Auxiliary Absorbent Tank Level		m	HH	12.8	Over flow	Top level - 0.8m	
					H	12.6	H ANN	HH Level - 0.2 m	
					L	4.4	L ANN	LL1 Level + 0.2 m	
					LL1	2.0(*1)	INT : Agitator Stop LL1 ANN		
					LL2	1.0(*1)	INT : Pump Stop LL2 ANN		Pump Protection
					ΔH	0.7	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
11	LICA	Gypsum Area Drain Sump Level		m	HH	3.5	Over flow	Top level - 0.5m	
					H	3.3	H ANN	HH Level - 0.2 m	
					CH	3.1	Absorber Area Drain Sump Pump Start	H Level - 0.2 m	
					CL	1.8	Absorber Sump Pump Stop	L Level + 0.2 m	
					L	1.6	L ANN	LL Level + 0.2 m.	
					LL	1.4(*1)	INT : Agitator & Pump Stop LL ANN		Pump protection Agitator Protection
12	LICA	Limestone Area Drain Sump Level		m	HH	3.5	Over flow	Top level - 0.5m	
					H	3.3	H ANN	HH Level - 0.2 m	
					CH	3.1	Absorber Area Drain Sump Pump Start	H Level - 0.2 m	
					CL	1.8	Absorber Sump Pump Stop	L Level + 0.2 m	
					L	1.6	L ANN	LL Level + 0.2 m.	
					LL	1.4(*1)	INT : Agitator & Pump Stop LL ANN		Pump protection Agitator Protection

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
13	LICA	Process Water Tank Level		m	HH	4	Over flow	Top level - 0.5m	
					H	3.8	H ANN	HH Level - 0.2 m	
					CH	3.6	Make-up water supply stop	H Level - 0.2 m	
					CL	3.1	Make-up water supply start	CH Level - 0.5 m	
					L	1.5	L ANN	LL Level + 0.2 m.	
					LL	1.3(*1)	INT : Pump Stop LL ANN		Pump Protection
					ΔH	0.3	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
14	LICA	Emergency Water Tank Level		m	HH	4.9	Over flow	Top level - 0.5m	
					H	4.7	H ANN	HH Level - 0.2 m	
					CH	4.5	Make-up water supply stop	H Level - 0.2 m	
					CL	4.3	Make-up water supply start	CH Level - 0.2 m	
					L	0.5	L ANN	Bottom + 0.5 m	
					ΔH	0.3	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection

※ This set point list does not include unit equipments. (for example Vacuum Belt Filter, Oxidation Air Blower, etc..) BHEL shall add set point for unit equipment and finalize the list according to the vender information.

※ 1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Others

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
1	AICA	Absorber pH		–	H	6.5	H ANN	Normal pH + α	
					N	Later	Set point for pH control	Commissioning adjustment value	
					L	Later	L ANN, Set point for minimum pH	Commissioning adjustment value	
2	DICA	Absorber Density		wt.%	H	35	H ANN	Normal Density + 5 wt.%	Pump & Belt Filter Protection
					CH	32	Absorber Slurry Bleed Start	Normal Density + 2 wt.%	
					N	30	Set point for Density Control	Design Density	
					CL	28	Absorber Slurry Bleed Stop	Normal Density – 2 wt.%	
					L	25	L ANN	Normal Density – 5 wt.%	
3	AICA	FGD Outlet SO2		mg/Nm ³ @ 6% O2	H	100	H ANN	Design FGD Outlet SO2 concentration	
					N	Later	Set point for SO2 control	Commissioning adjustment	

✖This set point list does not include unit equipments. (for example Vacuum Belt Filter, Oxidation Air Blower, etc..) BHEL will add set point for unit equipment and finalize the list according to the vender information.

01	11.06.21	Revision	PK	VMR	KK
00	31.03.21	Fresh Issue	PK	VMR	KK
REV	DATE	DESCRIPTION /NOTE	PRD	CHD	APD

REVISIONS

TITLE:

GENERAL ARRANGEMENT OF FGD DUCT

OWNER/PROJECT: **TELANGANA STATE POWER GENERATION CORPORATION LTD**



**KOTHAGUDEM (1X800 MW) THERMAL POWER PLANT-
FGD SYSTEM PACKAGE**

CONSULTANT:



**DEVELOPMENT CONSULTANTS PRIVATE LIMITED
KOLKATA**

EPC CONTRACTOR:



**BHARAT HEAVY ELECTRICALS LTD.
BOILER AUXILIARIES PLANT, RANIPET**

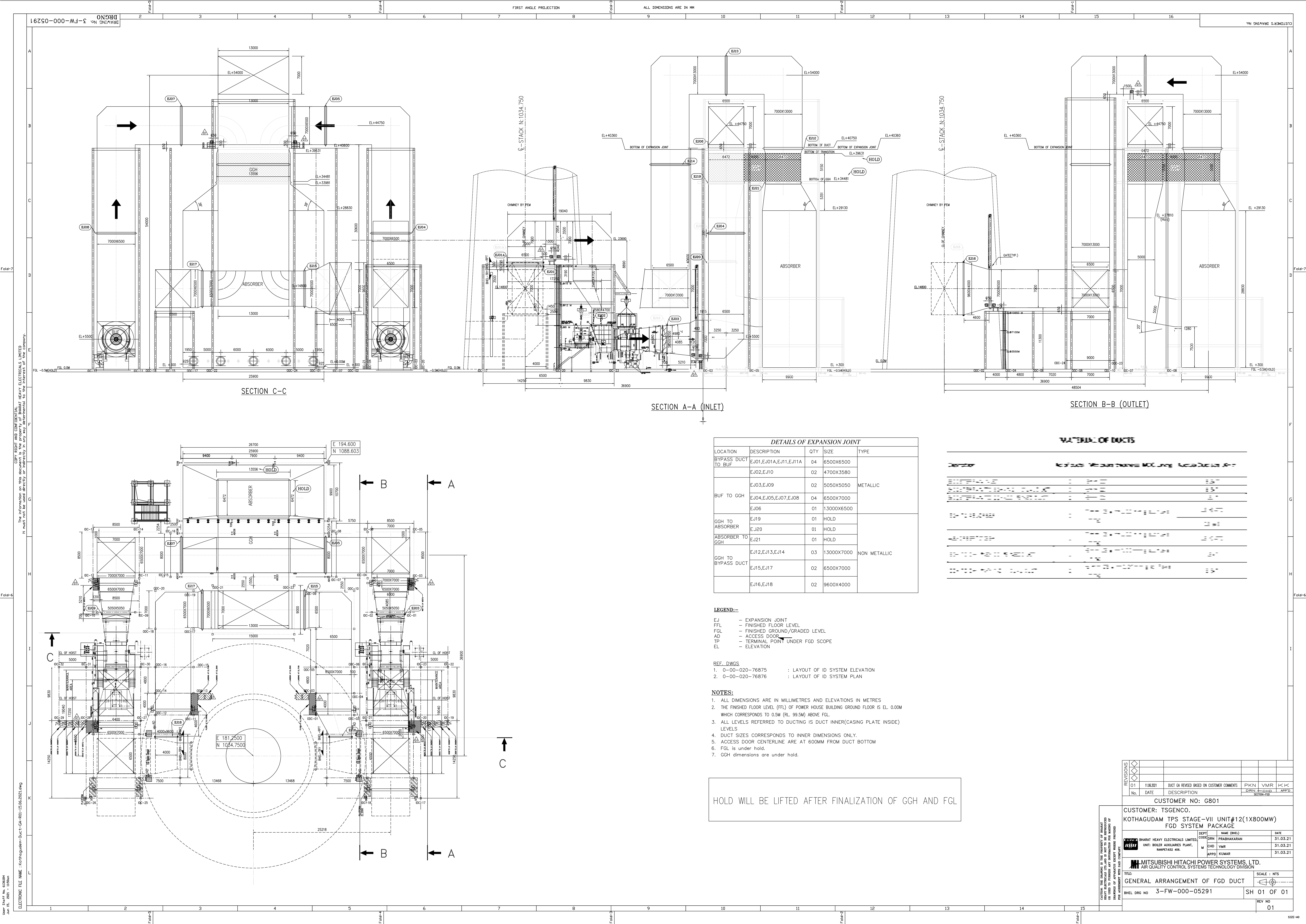
COLLABORATOR



MITSUBISHI HITACHI POWER SYSTEMS, LTD
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

	BHEL	Date	
PREPARED BY	Prabhakaran	31.03.2021	STATUS : <i>FOR APPROVAL</i>
CHECKED BY	VMR	31.03.2021	BHEL CUST NO : G801
APPROVED BY	Kumar K	31.03.2021	BHEL DOC NO : 03-FW-000-05291
			REV NO :01

REPLY SHEET		
PROJECT : KOTHAGUDEM FGD		
DRAWING : GENERAL ARRANGEMENT OF FDG DUCT		
DRAWING NO: 03-FW-000-05291/00		
SL NO	CUSTOMER COMMENTS	BHEL REPLY
1	Please submit isometric drawing for better understanding	It is our general practice to give plan, elevation and side views for Duct GA drawing, which covers required complete details.
2	Please indicate access door locations (TYP)	Noted and included
3	Please indicate supporting structure details for supporting duct along with ladders , floor EL etc. (TYP).	Supporting columns and column name indicated. Ladders and staircases are included for access door. Supporting structure details covered in detailed drawing.
4	Clear hold point for GGH to absorber and absorber to GGH portion	GGH is in ordering stage. Due to unavailability of GGH drawing, Hold for GGH to absorber and absorber to GGH portion will be lifted after getting drawing from vendor.



DETAILS OF EXPANSION JOINT				
LOCATION	DESCRIPTION	QTY	SIZE	TYPE
BYPASS DUCT TO BUF	EJ01,EJ01A,EJ11,EJ11A	04	6500X6500	METALLIC
	EJ02,EJ10	02	4700X3580	
	EJ03,EJ09	02	5050X5050	
BUF TO GGH	EJ04,EJ05,EJ07,EJ08	04	6500X7000	NON METALLIC
	EJ06	01	1300X6500	
GGH TO ABSORBER	EJ19	01	HOLD	
ABSORBER TO GGH	EJ20	01	HOLD	NON METALLIC
	EJ21	01	HOLD	
GGH TO BYPASS DUCT	EJ12,EJ13,EJ14	03	1300X7000	
	EJ15,EJ17	02	6500X7000	
	EJ16,EJ18	02	9600X4000	

- LEGEND:-
- EJ - EXPANSION JOINT
 - FFL - FINISHED FLOOR LEVEL
 - FGL - FINISHED GROUND/GRADED LEVEL
 - AD - ACCESS DOOR
 - TP - TERMINAL POINT UNDER FGD SCOPE
 - EL - ELEVATION

- REF. DWGS
- 0-00-020-76875 : LAYOUT OF ID SYSTEM ELEVATION
 - 0-00-020-76876 : LAYOUT OF ID SYSTEM PLAN

- NOTES:
- ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS IN METRES
 - THE FINISHED FLOOR LEVEL (FFL) OF POWER HOUSE BUILDING GROUND FLOOR IS EL 0.00M WHICH CORRESPONDS TO 0.5M (RL 99.5M) ABOVE FGL
 - ALL LEVELS REFERRED TO DUCTING IS DUCT INNER(CASING PLATE INSIDE) LEVELS
 - DUCT SIZES CORRESPONDS TO INNER DIMENSIONS ONLY.
 - ACCESS DOOR CENTERLINE ARE AT 600MM FROM DUCT BOTTOM
 - FGL is under hold.
 - GGH dimensions are under hold.

HOLD WILL BE LIFTED AFTER FINALIZATION OF GGH AND FGL

TABLE OF DUCTS		
NO.	DESCRIPTION	SIZE
01	DUCT FROM GGH TO ABSORBER	6500X7000
02	DUCT FROM ABSORBER TO GGH	6500X7000
03	DUCT FROM GGH TO BYPASS DUCT	1300X7000
04	DUCT FROM BYPASS DUCT TO GGH	1300X6500
05	DUCT FROM GGH TO ABSORBER	6500X7000
06	DUCT FROM ABSORBER TO GGH	6500X7000
07	DUCT FROM GGH TO BYPASS DUCT	1300X7000
08	DUCT FROM BYPASS DUCT TO GGH	1300X6500
09	DUCT FROM GGH TO ABSORBER	6500X7000
10	DUCT FROM ABSORBER TO GGH	6500X7000
11	DUCT FROM GGH TO BYPASS DUCT	1300X7000
12	DUCT FROM BYPASS DUCT TO GGH	1300X6500
13	DUCT FROM GGH TO ABSORBER	6500X7000
14	DUCT FROM ABSORBER TO GGH	6500X7000
15	DUCT FROM GGH TO BYPASS DUCT	1300X7000
16	DUCT FROM BYPASS DUCT TO GGH	1300X6500
17	DUCT FROM GGH TO ABSORBER	6500X7000
18	DUCT FROM ABSORBER TO GGH	6500X7000
19	DUCT FROM GGH TO BYPASS DUCT	1300X7000
20	DUCT FROM BYPASS DUCT TO GGH	1300X6500

REVISIONS					
D1	11/05/2021	DUCT GA REVISED BASED ON CUSTOMER COMMENTS	PKN	VMR	KK
No.	DATE	DESCRIPTION	DRN	CHKD	APPD
CUSTOMER NO: G801					
CUSTOMER: TSGENCO.					
KOTHAGUDAM TPS STAGE-VII UNIT#12(1X800MW)					
FGD SYSTEM PACKAGE					
DEPT	NAME (BHEL)	DATE			
CDR	PRABHAKARAN	31.03.21			
CHKD	VMR	31.03.21			
APPD	KUMAR	31.03.21			
MITSUBISHI HITACHI POWER SYSTEMS, LTD.					
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION					
TITLE: GENERAL ARRANGEMENT OF FGD DUCT					
SCALE: 1/10					
BHEL DRG NO: 3-FW-000-05291					
SH 01 OF 01					
REV NO: 01					

04	02.12.21	Replied to customer comments	KMK	PR	PNR
03	10.11.21	Replied to customer comments	KMK	PR	PNR
02	28.09.21	Revised as per customer comments	KMK	PR	PNR
01	15.09.21	Replied to the customer comments	KMK	PR	PNR
00	26.06.21	Fresh Issue	KMK	PR	PNR
REV	DATE	DESCRIPTION /NOTE	PRD	CHD	APD

REVISIONS

TITLE:

P&ID_FLUE GAS DUCTING & DAMPER SYSTEM

OWNER/PROJECT: **TELANGANA STATE POWER GENERATION CORPORATION LTD**



KOTHAGUDEM (1X800 MW) THERMAL POWER PLANT–
FGD SYSTEM PACKAGE

CONSULTANT:



DEVELOPMENT CONSULTANTS PRIVATE LIMITED
KOLKATA

EPC CONTRACTOR:



BHARAT HEAVY ELECTRICALS LTD.
BOILER AUXILIARIES PLANT,RANIPET

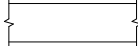
COLLABORATOR



MITSUBISHI HITACHI POWER SYSTEMS, LTD
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

	BHEL	Date	
PREPARED BY	Kabilash	02.12.21	STATUS : <i>FOR APPROVAL</i>
CHECKED BY	Raju Puram	02.12.21	BHEL CUST NO : G801
APPROVED BY	P Naveen R	02.12.21	BHEL DOC NO : 00-FW-000-00320
			REV NO :04

LINE SYMBOLS

SYMBOLS	NAME
	PIPE LINE
	CAPILLARY TUBING
	ELECTRIC SIGNAL
	SOFTWARE LINK
	PRESSURE LEAD
	DUCT

PIPING VALVE SYMBOLS

SYMBOLS		NAME
		GATE VALVE (NOR.CLOSED)
		GLOBE VALVE (NOR.CLOSED)
		BALL VALVE (NOR.CLOSED)
		BUTTERFLY VALVE (NOR.CLOSED)
		DIAPHRAGM VALVE (NOR.CLOSED)
		PINCH VALVE (NOR.CLOSED)
		NEEDLE VALVE (NOR.CLOSED)
		CHECK VALVE
		CHECK VALVE (WAFER)
		PRESSURE RELIEF VALVE

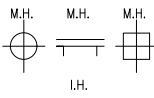
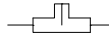
INSTRUMENT VALVE SYMBOLS

SYMBOLS	NAME
	ACTUATED BY AIR
	ACTUATED BY MOTOR
	ACTUATED BY MOTOR (INCHING)
	AIR CONTROL VALVE
	SOLENOID ACTUATOR
	SELF REGULATING VALVE
	SELF REGULATING VALVE

TRENCH SYMBOLS

SYMBOLS	NAME
 A	TO ABSORBER AREA DRAIN SUMP
 D	TO GYPSUM AREA DRAIN SUMP
 L	TO LIMESTONE AREA DRAIN SUMP

SYMBOLS FOR PIPING PARTS & INSTRUMENT PARTS

SYMBOLS	NAME
	STEAM TRAP
	AIR TRAP
	Y-STRAINER
	T-STRAINER
	TEMPORARY STRAINER
	REDUCER
	EXPANSION JOINT
	DUCT EXPANSION JOINT
	FLEXIBLE HOSE
	SPOOL PIECE
	VENT
	HOSE CONNECTION
	BLIND FLANGE
	REDUCING FLANGE
	CAP (BW)
	CAP (SCR)
	TRENCH
	SIGHT GLASS
	SILENCER
	ORIFICE
	DIAPHRAGM
	MAGNETIC FLOW METER
	VORTEX FLOW METER
	PH METER
	FILTER
	MANHOLE
	INSPECTION HOLE
	PITOT TUBE
	SAMPLING POT
	SAMPLING NOZZLE
	RESTRICTION ORIFICE
	ROTIMETER TYPE FLOW METER

SYMBOLS FOR VALVE OPERATION

SYMBOLS	NAME
	FAILURE OPEN (THE VALVE OPENS WHEN AIR OR ELECTRICITY FOR ACTUATOR FAILS.)
	FAILURE CLOSE (THE VALVE CLOSES WHEN AIR OR ELECTRICITY FOR ACTUATOR FAILS.)

INSULATION SYMBOLS

SYMBOLS	DESCRIPTION
H10	THERMAL INSULATION (100°C & LOWER)
H15	THERMAL INSULATION (101°C ~ 150°C)
H20	THERMAL INSULATION (151°C ~ 200°C)
H25	THERMAL INSULATION (201°C ~ 250°C)
H30	THERMAL INSULATION (251°C ~ 300°C)
H35	THERMAL INSULATION (301°C ~ 350°C)
HF	INSULATION FOR ANTI FREEZING
ET	ELECTRIC TRACE
ST	STEAM TRACE (LOW PRESSURE STEAM)
P10	PERSONAL PROTECTION (100°C & LOWER)
P15	PERSONAL PROTECTION (101°C ~ 150°C)
P20	PERSONAL PROTECTION (151°C ~ 200°C)
P25	PERSONAL PROTECTION (201°C ~ 250°C)
P30	PERSONAL PROTECTION (251°C ~ 300°C)
P35	PERSONAL PROTECTION (350°C ~ 400°C)

DELIVERY LIMITS

SYMBOLS	NAME
	BETWEEN CLIENT AND CONTRACTOR
	BETWEEN SUB CONTRACTOR AND VENDOR

SYSTEM

NUMBER	NAME
1	FLUE GAS SYSTEM
2	SO ₂ ABSORPTION OXIDATION SYSTEM
3	REHEATING SYSTEM
4	GYPSUM DEWATERING HANDLING SYSTEM
5	LIMESTONE PREPARATION SYSTEM
6	BLANK
7	SUMP SYSTEM
8	UTILITY SYSTEM

FLUID NAME

FLUID SYMBOL	FLUID NAME	FLUID SYMBOL	FLUID NAME
AA	ANTIFOAM AGENT	WCS	COOLING WATER SUPPLY
AC	COMPRESSED AIR	WCR	COOLING WATER RETURN
AF	FLUIDIZER AIR	WC	Ca(OH) ₂
AI	INSTRUMENT AIR	WP	PROCESS WATER
AO	OXIDATION AIR	WR	RAW WATER
AS	SEAL AIR	WW	WASTE WATER
DD	DUCT DRAIN	VG	VACUUM PUMP VENT
FS	FILTRATE SLURRY	VBG	BELT FILTER VENT GAS
GS	GYPSUM SLURRY	LD	LIMESTONE DEDUSTING
LS	LIMESTONE SLURRY	LOL	LUBE OIL (LOW PRESSURE)
FG	FLUE GAS	LOH	LUBE OIL (HIGH PRESSURE)

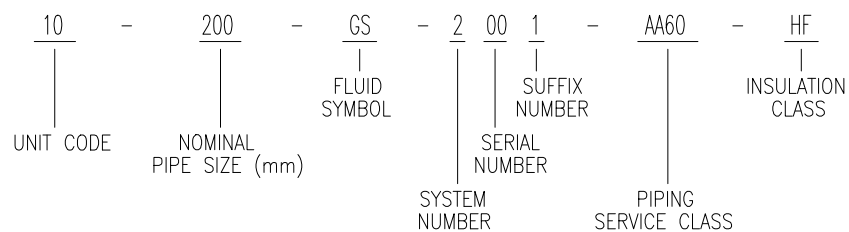
SERVICE CLASS

SERVICE CLASS	MATERIAL	FLUID SYMBOL
AA40	IIR RUBBER LINED PIPING	LS, WP, WC
AA60	IIR RUBBER LINED PIPING	GS,FS,WW,DD
BA01	Gr.304 STAINLESS STEEL / GI PIPING	AI, LOL
BA02	Gr.304 STAINLESS STEEL / GI PIPING	LOH
BA03	Gr.316L STAINLESS STEEL PIPING	WP, AO
CA01	CARBON STEEL GENERAL PIPING	AS,AO,AC,AF,LD
CC01	CARBON STEEL PRESSURE PIPING	WP,WR,WCS,WCR, VG, AA
DA60	FRP PIPING (PIPE DIA UPTO 400 NB)	GS,FS,WW,DD
DA40	FRP PIPING (PIPE DIA UPTO 400 NB)	LS, WP, WC

UNIT CODE

SYMBOLS	UNIT IDENTIFICATION
00	COMMON
10	UNIT-1 FGD SYSTEM AND AUXILIARIES

EXPRESSION OF PIPING LINE



CUSTOMER NOS:G801

CUSTOMER: TSGENCO.
PROJECT: KTPS 1X800 MW FGD SYSTEM PACKAGE

 BHARAT HEAVY ELECTRICALS LIMITED, UNIT: BOILER AUXILIARIES PLANT, RANIPET-632 406.	DEPT		NAME (BHEL)	DATE
	CODE	DRN	KM.KABILASH	04.03.21
	M	CHD	P.RAJU	04.03.21
		APPD	PNR/ACR/RSB	04.03.21



MITSUBISHI HITACHI POWER SYSTEMS, LTD.
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

P & ID - SYMBOL MARK (1/2)

SCALE : NTS

TITLE: _____
FILE NO 03-FW-000-00605

REV NO	00

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INSTRUMENT ABBREVIATION

	FIRST-LETTER		SUCCEEDING-LETTERS		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
B	BURNER, COMBUSTION		BLANK	BLANK	BLANK
C	BLANK			CONTROL	
D	BLANK	DIFFERENTIAL			
E	VOLTAGE		SENSOR (PRIMARY ELEMENT)		
F	FLOW RATE	RATIO (FRACTION)			
G	BLANK		GLASS, VIEWING DEVICE		
H	HAND				HIGH
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT		LOW
M	BLANK	MOMENTARY			MIDDLE, INTERMEDIATE
N	BLANK		BLANK	BLANK	BLANK
O	BLANK		ORIFICE, RESTRICTION		
P	PRESSURE, VACUUM		POINT(TEST) CONNECTION		
Q	QUANTITY	INTEGRATE, TOTALIZE			
R	RADIATION		RECORD		
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION, MECHANICAL ANALYSIS			VALVE, DAMPER, LOUVER	
W	WEIGHT, FORCE		WELL		
X	UNCLASSIFIED	X AXIS	UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED
Y	EVENT, STATE OR PRESENCE	Y AXIS		RELAY, COMPUTE, CONVERT	
Z	POSITION, DIMENSION	Z AXIS		DRIVER, ACTUATOR, UNCLASSIFIED FINAL CONTROL ELEMENT	

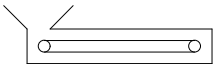
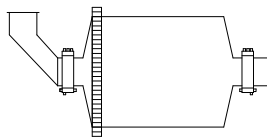
INSTRUMENT SYMBOLS

SYMBOLS	NAME
	FIELD MOUNTED
	FOR CONTROL ROOM
	FOR LOCAL CONTROL PANEL
	FOR DCS
	INTERLOCK LOGIC

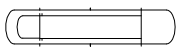
PNEUMATIC VALVE ACTUATOR

CODE NO.	ACTUATION
FLXXWA-D	DOUBLE SOLENOID NO LIMIT SWITCH
FLXXWA-DL	DOUBLE SOLENOID WITH LIMIT SWITCH
FLXXWA-S	SINGLE SOLENOID NO LIMIT SWITCH
FLXXWA-SL	SINGLE SOLENOID WITH LIMIT SWITCH

MACHINARY SYMBOLS

SYMBOLS	NAME
	PUMP
	FAN / BLOWER
	AGITATOR (FLAT BLADE)
	AGITATOR (PROPELLOR)
	ROTARY VALVE
	CRUSHER
	BELT FEEDER
	BELT FILTER
	BALL MILL
	CYCLONE
	MIST ELIMINATOR

EQUIPMENT SYMBOLS

SYMBOLS	NAME
	BAG FILTER
	SILO
	SLIDE GATE
	TANDEM LOUVER DAMPER (MULTIVANE)
	SINGLE STAGE LOUVER DAMPER (MULTIVANE)
	LOUVER DAMPER (SINGLE VANE)
	DISTRIBUTION BOX (3WAY)
	DISTRIBUTION BOX (2WAY)
	SUMP
	HEAT EXCHANGER
	SHELL AND TUBE HEAT EXCHANGER
	AIR DRYER
	FILTER
	SPRAY NOZZLE

DRIVER SYMBOLS

SYMBOLS	NAME
	AIR MOTOR
	ELECTRIC MOTOR

OTHER SYMBOLS

SYMBOLS	NAME
	INSERT PIPE / LANCE
	CHUTE
	TRUCK

CUSTOMER NOS:G801

CUSTOMER: TSGENCO.
PROJECT: KTPS 1X800 MW FGD SYSTEM PACKAGE

 BHARAT HEAVY ELECTRICALS LIMITED, UNIT: BOILER AUXILIARIES PLANT, RANIPET-632 406.	DEPT		NAME (BHEL)	DATE
	CODE	DRN	KM.KABILASH	04.03.21
	M	CHD	P.RAJU	04.03.21
		APPD	PNR/ACR/RSB	04.03.21

MITSUBISHI HITACHI POWER SYSTEMS, LTD.
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

P & ID - SYMBOL MARK (2/2)



FILE NO 03-FW-000-00605

REV NO	00

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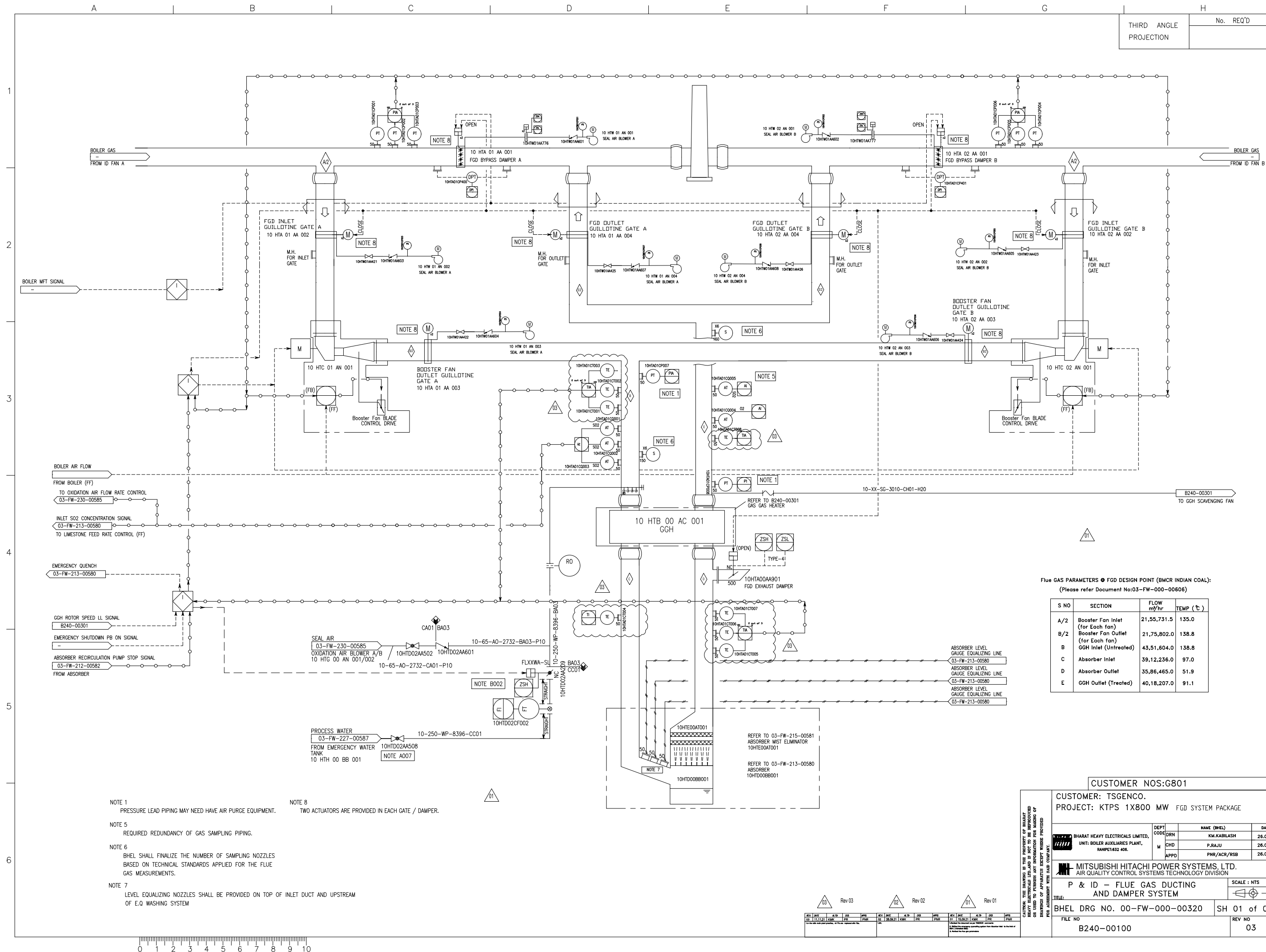


THIRD ANGLE
PROJECTION

No. REQ'D

A3

DRAWING No.



Flue Gas PARAMETERS @ FGD DESIGN POINT (BMCR INDIAN COAL):
(Please refer Document No:03-FW-000-00606)

S NO	SECTION	FLOW m ³ /hr	TEMP (°C)
A/2	Booster Fan Inlet (for Each fan)	21,55,731.5	135.0
B/2	Booster Fan Outlet (for Each fan)	21,75,802.0	138.8
B	GGH Inlet (Untreated)	43,51,604.0	138.8
C	Absorber Inlet	39,12,236.0	97.0
D	Absorber Outlet	35,86,465.0	51.9
E	GGH Outlet (Treated)	40,18,207.0	91.1

- NOTE 1
PRESSURE LEAD PIPING MAY NEED HAVE AIR PURGE EQUIPMENT.
- NOTE 5
REQUIRED REDUNDANCY OF GAS SAMPLING PIPING.
- NOTE 6
BHEL SHALL FINALIZE THE NUMBER OF SAMPLING NOZZLES
BASED ON TECHNICAL STANDARDS APPLIED FOR THE FLUE
GAS MEASUREMENTS.
- NOTE 7
LEVEL EQUALIZING NOZZLES SHALL BE PROVIDED ON TOP OF INLET DUCT AND UPSTREAM
OF E.Q. WASHING SYSTEM
- NOTE 8
TWO ACTUATORS ARE PROVIDED IN EACH GATE / DAMPER.

CUSTOMER NOS:G801			
CUSTOMER: TSGENCO.			
PROJECT: KTPS 1X800 MW FGD SYSTEM PACKAGE			
DEPT	NAME (BHEL)	DATE	
CODE DRN	KM.KABILASH	26.06.21	
M	P.RAJU	26.06.21	
APPD	PNR/ACR/RSB	26.06.21	
MITSUBISHI HITACHI POWER SYSTEMS, LTD.			
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION			
P & ID - FLUE GAS DUCTING AND DAMPER SYSTEM			
TITLE:			
BHEL DRG NO. 00-FW-000-00320		SH 01 of 01	
FILE NO		REV NO	
B240-00100		03	

Rev 03 Rev 02 Rev 01

REV	DATE	BY	CHKD	APPD	REV	DATE	BY	CHKD	APPD
03	15/03/21	SAC	PNR	PNR	02	15/03/21	SAC	PNR	PNR
01	26/06/21	SAC	PNR	PNR	01	26/06/21	SAC	PNR	PNR

Write Up

Purpose: The purpose of this is to introduce flue gas to reheating system (GGH) and SO₂ absorption oxidation system (absorber).

This system consists of the following equipments

Equipment List:

S. No.	Description	Item No.	Qty
1.	Booster Fan	10/HTC 01/02 AN 001	2
2.	FGD inlet gate	10 HTA 01/02 AA 001	2
3.	BUF outlet gate	10 HTA 01/02 AA 003	2
4.	FGD bypass damper	10 HTA 01/02 AA 001	2
5.	FGD Outlet gate	10 HTA 01/02 AA 002	2

Operation Write Up:

FGD inlet gate, BUF outlet gate, FGD outlet Gate and by pass damper are provided to direct the flue gas in to FGD system for SO₂ absorption.

Booster Fan (BUF) is envisaged to develop the required pressure to introduce the flue gas from ID fan to Gas –Gas Heater (Un treated side) and absorber system from where it is sent to the Gas - Gas Heater (Treated side) and back to chimney.

FGD system is taken into operation by closing the bypass damper and exhaust damper and by opening the FGD inlet, BUF outlet and FGD outlet gates.

FGD exhaust damper is opened after booster fan stopped and FGD Outlet gate closed for heat release.

Control write up

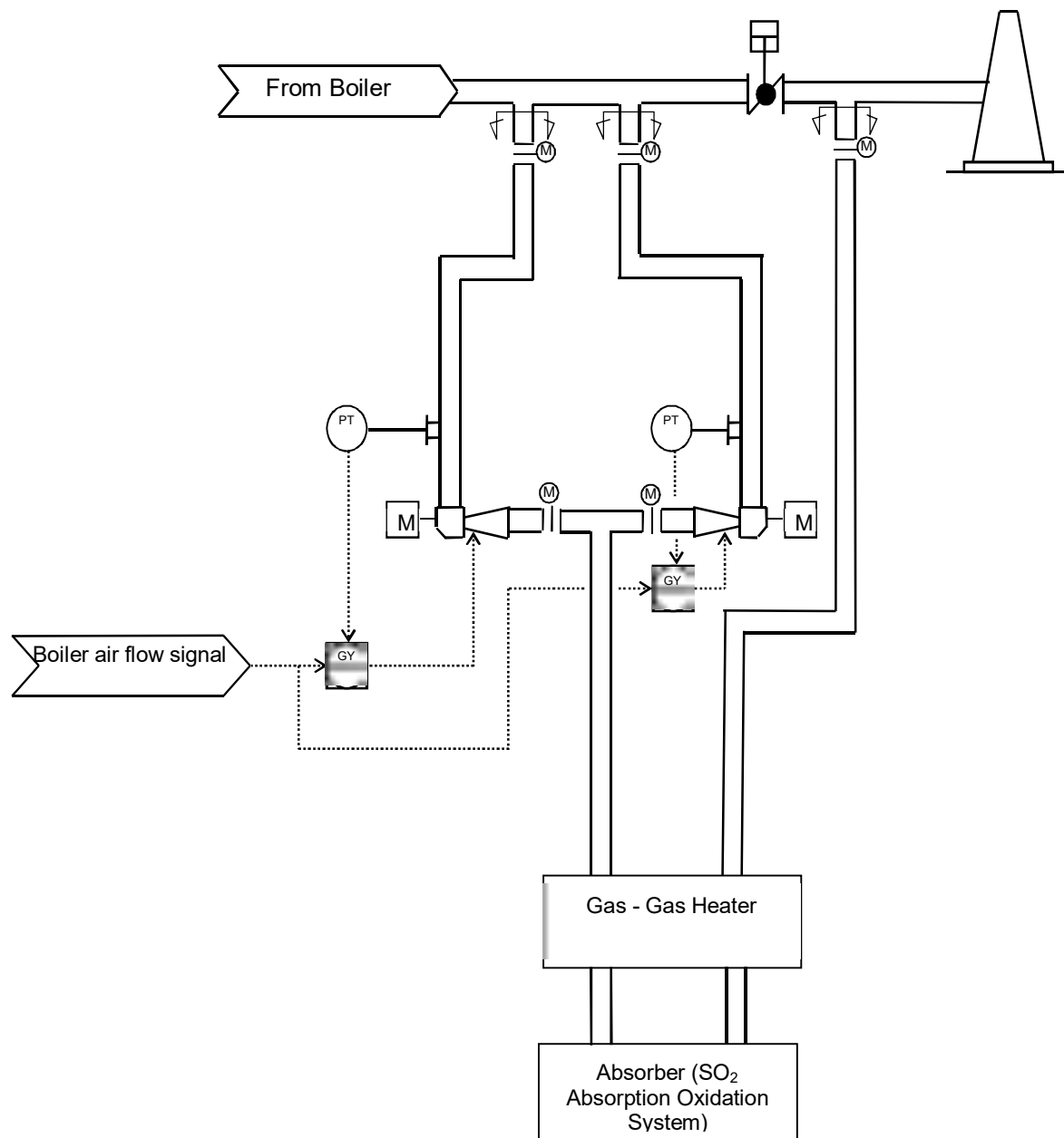
Process Control Method

The control system is designed to provide safe and reliable operation of the FGD plant. The FGD plant is designed not to interfere on the boiler operation and to maintain the specified desulfurization performance, in spite of the boiler load-change by controlling the absorbent feed rate to the absorber.

Follow up Control to Boiler Load

Induced flue gas flow rate to FGD plant is controlled by rotor blade angle of Booster fan. Since the operation of FGD plant has to correspond with the boiler load variation, it has to estimate the flue gas flow rate at FGD plant inlet. Then the flue gas flow rate is calculated by the function transformation of boiler air flow signal as a feed forward signal. Furthermore, to prevent the untreated gas short passing through bypass damper, the FGD inlet pressure is controlled to maintain it constantly as feed-back signal.

Typical diagram for Follow up Control to Boiler Load



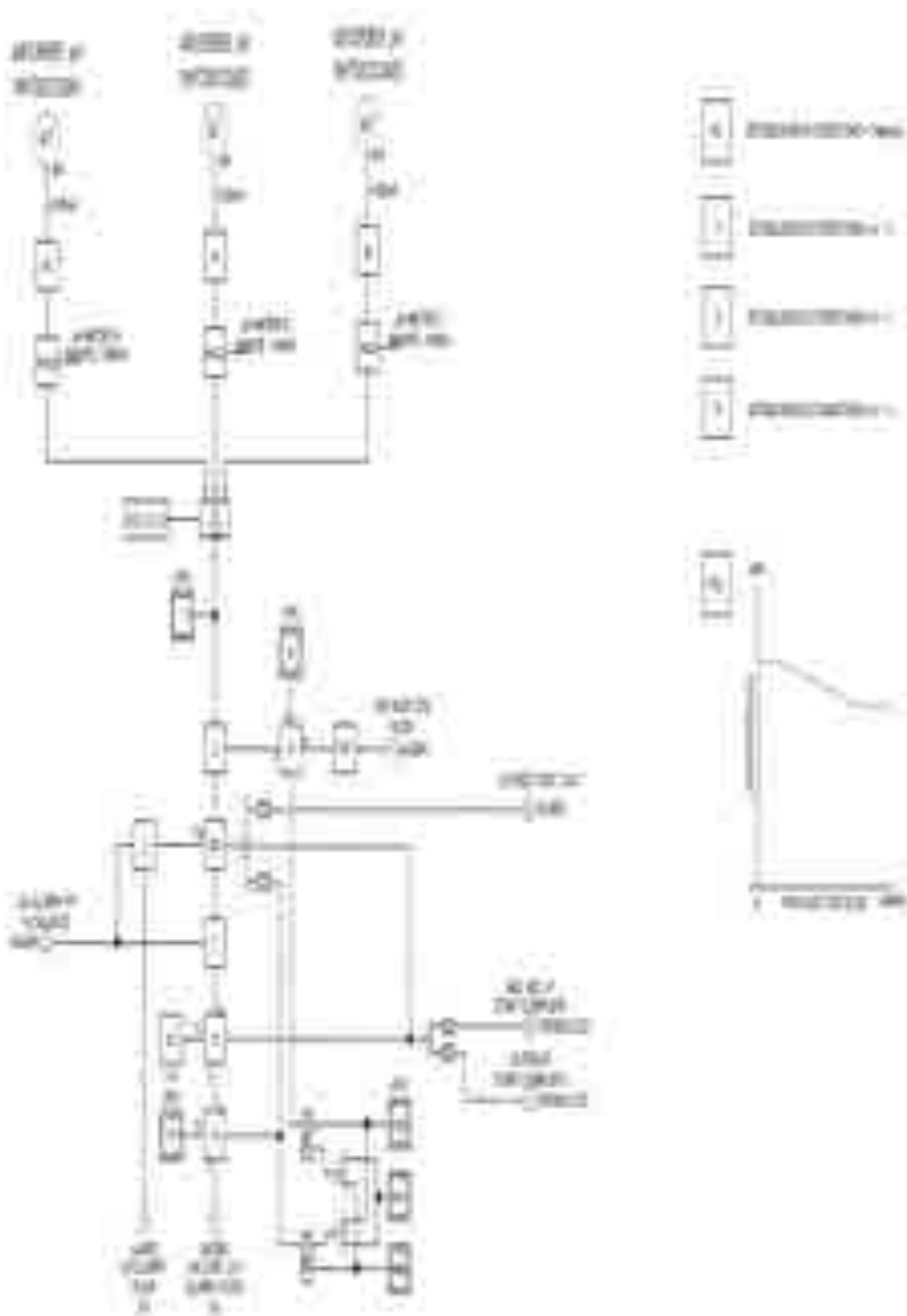
Control Philosophy of Boiler MFT:

Separate DCS is envisaged for FGD. Signal exchange from Main boiler DCS to FGD DCS takes place. Whenever the Master fuel trip (MFT) is initiated in main boiler DCS, this signal is transmitted to FGD DCS also. After receiving MFT from FGD DCS, following changes takes place.

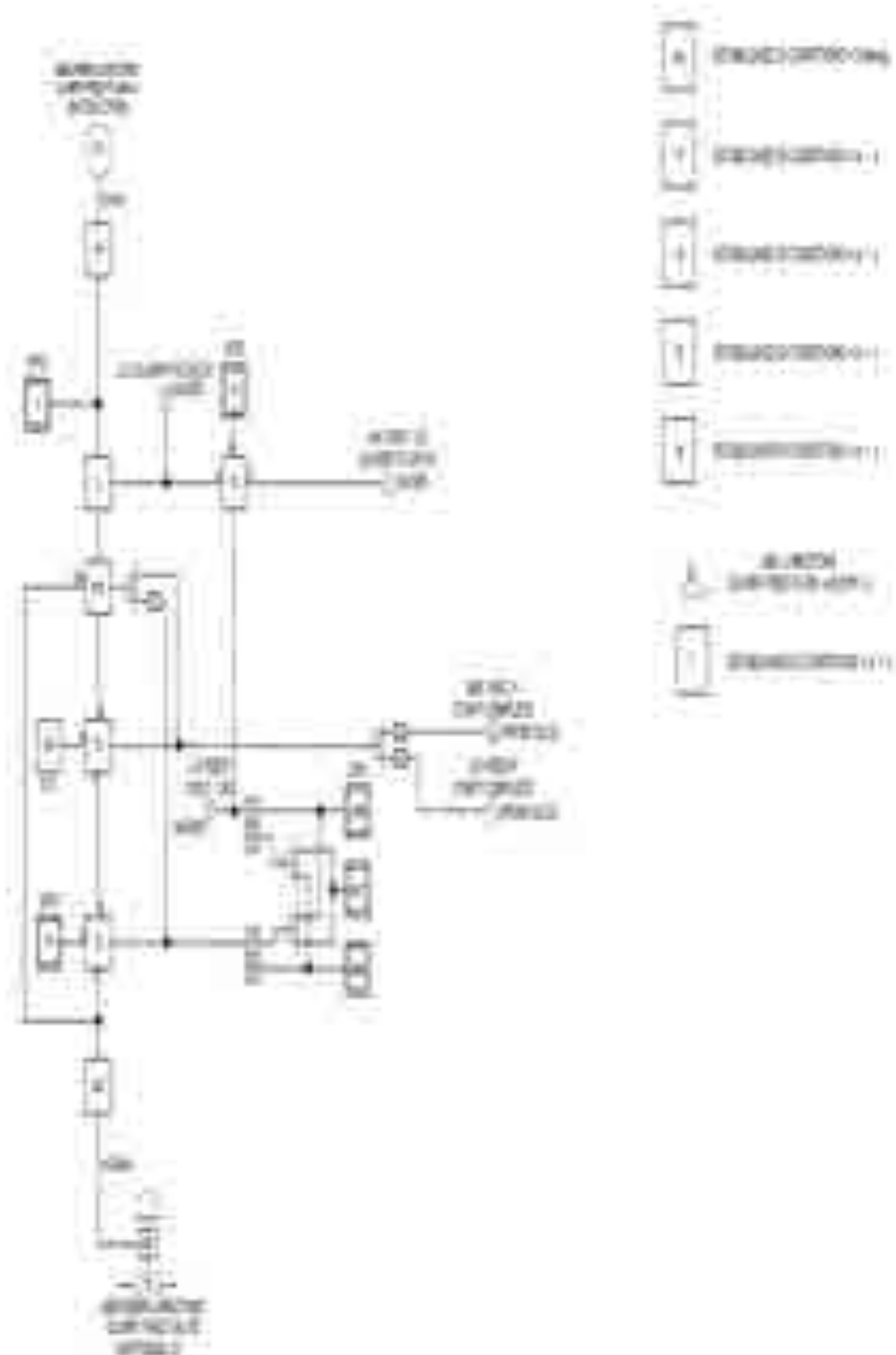
1. Emergency quench valve opens for emergency quench system to reduce the Flue gas temperature (if the temperature of flue gas exceeds the limits).
2. Bypass damper opens &
3. Inlet & Outlet gates are closed.
4. Booster fans are stopped



2.2. Limestone feed control logic based on absorber pH value



2.3. Limestone slurry feed valve operation control logic



Instruments List

Sl.No	KKS Code	Description of instrument	Quantity
01	10HTA01CP001/008	Pressure Transmitter	08 Nos
02	10HTA01CP400/401	Differential Pressure Transmitter	02 Nos
03	10HTA01CT001/008	Temperature Element	08 Nos
04	10HTA01CQ001/003 & 10HTA01CQ005	SO2 analyzer Transmitter	04 Nos
05	10HTA01CQ004	O2 analyzer Transmitter	01 Nos

Table 3.3 Set Point List

Pressure

No.	Tag no.	Service	Range	Unit	Set Point	Value	Action	Basis	Remark
1	PIA	BUF Inlet Pressure		kPa	HH	6.3	INT : FGD Bypass Demper Open HH ANN	Mechanical design pressure of FGD inlet duct: +6.47 kpa	
					H	1.5	H ANN		
					N	0.30		To be finalized during commissioning	
					L	-1.0	L ANN		
					LL	-1.3	INT : FGD Bypass Demper Open LL ANN	Mechanical design pressure of FGD inlet duct: - 1.47 kpa	
					ΔH	Later	H ANN	PT measuring range x 0.05 (5%)	
2	PIA	Absorber Inlet Pressure		kPa	H	3.5	H ANN	Normal pressure + 1.0 kPa	
					N	2.5			
					L	1.5	L ANN	Normal pressure - 1.0 kPa	
					LL	1	L ANN	During Single Fan Operation	
3	PDIA	Mist Eliminator Differential Pressure		kPa	H	(*1)	H ANN	(Design pressure of ME +0.10kPa(Dirty)) x 1.1 ²	
4	PDIA	GGH Untreated Side Differential Pressure		kPa	H	(*1)	H ANN	Design Pressure (dirty condition)	
5	PIA	Instrumentation Air Pressure		MPa	H	0.8	H ANN	Design Pressure	
					L	(*1)	L ANN	Minimum pressure of solenoid valve +0.5 MPa	

※1 : Will be provided later based on the vendor information.

Table 3.3 Set Point List

Temperature

No.	Tag no.	Service	Range	Unit	Set Point	Value	Action	Basis	Remark
1	TIA	FGD Inlet Temperature		deg.C	HH	300	Interlock	Maximum temperature in AH mechanical trip condition	Emergency Spray valve open
					H	290	H ANN	Maximum temperature in AH mechanical trip condition – 10 deg.C	
					ΔH	(*1)	H ANN	TE measuring range × 0.05 (5%)	prevention for meter deflection
2	TIA	FGD Outlet Temperature		deg.C	HH	70	Interlock	Heat-resistant value of Absorber internal material	Emergency Spray valve open
					H	65	H ANN	Heat-resistant value of Absorber internal material – 5 deg.C	
					ΔH	(*1)	H ANN	TE measuring range × 0.05 (5%)	prevention for meter deflection

※1 : Will be provided later based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
1	LICA	Absorber Level		m	HH	7.0	Overflow	Normal Level + 1.0 m	
					H	6.3	H ANN	CH Level + 0.2 m	
					CH2	6.3	Start Permission for 1st Absorber Circulation Pump	The value that does not drop to L level after startng pump.	
					CH	6.1	Absorber make-up water supply stop	Normal Level + 0.1 m	
					N	6.0		Design Level (Normal Level)	
					CL	5.9	Absorber make-up water supply start	Normal Level - 0.1 m	
					L	5.7	L ANN	CL Level - 0.2 m	
					LL1	4.5(*1)	INT : Absorber Recirculation Pump Stop LL1 ANN		Pump Protection
					LL2	3.2(*1)	INT : Absorber Agitator Stop LL2 ANN	(Agitator installation Level :1.6m) + (Impeller dia.:1.6m)	Agitator Protection
					LL3	1.5(*1)	INT : Absorber Bleed Pump Stop LL3 ANN		Pump Protection
2	LICA	Belt Filter Washing Tank Level		m	ΔH	0.4	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
					HH	2.8	Over flow	Top level - 0.5m	
					H	2.6	H ANN	HH Level - 0.2 m	
					CH	2.4	Make-up water supply stop	H Level - 0.2 m	
					CL	1.4	Make-up water supply start	L Level + 0.2 m	
					L	1.2	L ANN	LL Level + 0.2 m.	
					LL	1.0(*1)	INT : Pump Stop LL ANN		Pump Protection
					ΔH	0.2	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection

※1 : Assumed value. To be finalized based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
3	LICA	Filtrate Water Sump Level		m	HH	3.5	Over flow	Top level - 0.5m	
					H	3.3	H ANN	HH Level - 0.2 m	
					CH	3.1	Absorber Return Valve Open	H Level - 0.2 m	
					CL	1.4	Absorber Return Valve Close	L Level + 0.2 m	
					L	1.2	L ANN	LL Level + 0.2 m.	
					LL	1.0(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
					ΔH	0.2	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
4	LICA	Secondary Waste Water Hydrocyclone Feed Tank Level		m	HH	4.9	Over flow	Top level - 0.5m	
					H	4.7	H ANN	HH Level - 0.2 m	
					CH	4.5	Hydro-cyclone Feed start	H Level - 0.2 m	
					CL	1.5	Hydro-cyclone Feed Stop	L Level + 0.2 m	
					L	1.3	L ANN	LL Level + 0.2 m.	
					LL	1.1(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
					ΔH	0.3	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
5	LICA	Waste Water Storage Tank Level		m	HH	6.5	Over flow	Top level - 0.5m	
					H	6.3	H ANN	HH Level - 0.2 m	
					CH1	6.1	Filtrate Water Tank Feed Start	H Level - 0.2 m	
					CL1	5.6	Filtrate Water Tank Feed Stop	CH1 Level - 0.5 m	
					CH2	2.2	Waste Water Treatment Feed Start	CL2 Level + 0.5 m	
					CL2	1.7	Waste Water Treatment Feed Stop	L Level + 0.2 m	
					L	1.5	L ANN	LL Level + 0.2 m.	
					LL	1.3(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
					ΔH	0.4	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
6	LICA	Lime Silo Level		m	HH	Later(*1)	Over flow		
					H	Later(*1)	H ANN		
					CH	Later(*1)	Bucket Elevator stop		
					CL	Later(*1)	Bucket Elevator start		
					L	Later(*1)	L ANN		
					LL	Later(*1)			
					B	Later(*1)	Reference Level-Silo Bottom		
					ΔH	Later(*1)	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
7	LICA	Neutralization Tank Level		m	HH	Later(*1)	Over flow		
					H	Later(*1)	H ANN		
					CH	Later(*1)	Process water feed Valve-Open		
					CL	Later(*1)	Process water feed Valve-Close		
					L	Later(*1)	L ANN		
					LL	Later(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
					ΔH	Later(*1)	H ANN		Prevention for Meter Deflection
8	LICA	Limestone Silo Level		m	HH	11.3	Over flow		
					H	10.8	H ANN		
					CH	10.6	Feed conveyor stop		
					CL	4.4	Feed conveyor start		
					L	4.2	L ANN		
					LL	4.0	Wet ball mill stop		
					B	0	Reference Level-Silo Bottom		
					ΔH	0.60	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
9	LICA	Mill Circuit Tank Level		m	HH	Later(*1)	HH ANN	To be finalize by BHEL based on vedor information.	Silo & Bag Filter Protection
					H	Later(*1)	H ANN	To be finalize by BHEL based on vedor information.	
					L	Later(*1)	L ANN	To be finalize by BHEL based on vedor information.	
					LL	Later(*1)	LL ANN	To be finalize by BHEL based on vedor information.	
10	LICA	Limestone Slurry Storage Tank Level		m	HH	10.4	Over flow	Top level - 0.8m	
					H	10.2	H ANN	HH Level - 0.2 m	
					CH	9.7	Wet Limestone Grinding Mill stop	H Level - 0.5 m	
					CL	7.0	Wet Limestone Grinding Mill start	Required volume in 6 hours	
					L	1.4	L ANN	LL Level + 0.2 m.	
					LL	1.2(*1)	INT : Agitator & Pump Stop LL ANN		Pump Protection Agitator Protection
11	LIC	Absorber Area Drain Sump Level		m	HH	3.5	Over flow	Top level - 0.5m	
					H	3.3	H ANN	HH Level - 0.2 m	
					CH	3.1	Absorber Area Drain Sump Pump Start	H Level - 0.2 m	
					CL	1.8	Absorber Sump Pump Stop	L Level + 0.2 m	
					L	1.6	L ANN	LL Level + 0.2 m.	
					LL	1.4(*1)	INT : Agitator & Pump Stop LL ANN		Pump protection Agitator Protection

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
10	LIA	Auxiliary Absorbent Tank Level		m	HH	12.8	Over flow	Top level - 0.8m	
					H	12.6	H ANN	HH Level - 0.2 m	
					L	4.4	L ANN	LL1 Level + 0.2 m	
					LL1	2.0(*1)	INT : Agitator Stop LL1 ANN		
					LL2	1.0(*1)	INT : Pump Stop LL2 ANN		Pump Protection
					ΔH	0.7	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
11	LICA	Gypsum Area Drain Sump Level		m	HH	3.5	Over flow	Top level - 0.5m	
					H	3.3	H ANN	HH Level - 0.2 m	
					CH	3.1	Absorber Area Drain Sump Pump Start	H Level - 0.2 m	
					CL	1.8	Absorber Sump Pump Stop	L Level + 0.2 m	
					L	1.6	L ANN	LL Level + 0.2 m.	
					LL	1.4(*1)	INT : Agitator & Pump Stop LL ANN		Pump protection Agitator Protection
12	LICA	Limestone Area Drain Sump Level		m	HH	3.5	Over flow	Top level - 0.5m	
					H	3.3	H ANN	HH Level - 0.2 m	
					CH	3.1	Absorber Area Drain Sump Pump Start	H Level - 0.2 m	
					CL	1.8	Absorber Sump Pump Stop	L Level + 0.2 m	
					L	1.6	L ANN	LL Level + 0.2 m.	
					LL	1.4(*1)	INT : Agitator & Pump Stop LL ANN		Pump protection Agitator Protection

※1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Level

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
13	LICA	Process Water Tank Level		m	HH	4	Over flow	Top level - 0.5m	
					H	3.8	H ANN	HH Level - 0.2 m	
					CH	3.6	Make-up water supply stop	H Level - 0.2 m	
					CL	3.1	Make-up water supply start	CH Level - 0.5 m	
					L	1.5	L ANN	LL Level + 0.2 m.	
					LL	1.3(*1)	INT : Pump Stop LL ANN		Pump Protection
					ΔH	0.3	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection
14	LICA	Emergency Water Tank Level		m	HH	4.9	Over flow	Top level - 0.5m	
					H	4.7	H ANN	HH Level - 0.2 m	
					CH	4.5	Make-up water supply stop	H Level - 0.2 m	
					CL	4.3	Make-up water supply start	CH Level - 0.2 m	
					L	0.5	L ANN	Bottom + 0.5 m	
					ΔH	0.3	H ANN	LT measuring range × 0.05 (5%)	Prevention for Meter Deflection

※ This set point list does not include unit equipments. (for example Vacuum Belt Filter, Oxidation Air Blower, etc..) BHEL shall add set point for unit equipment and finalize the list according to the vender information.

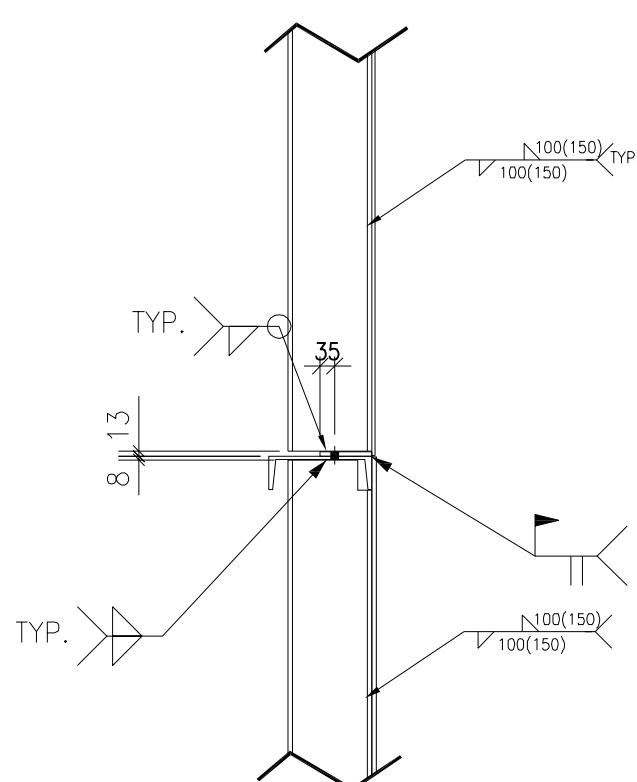
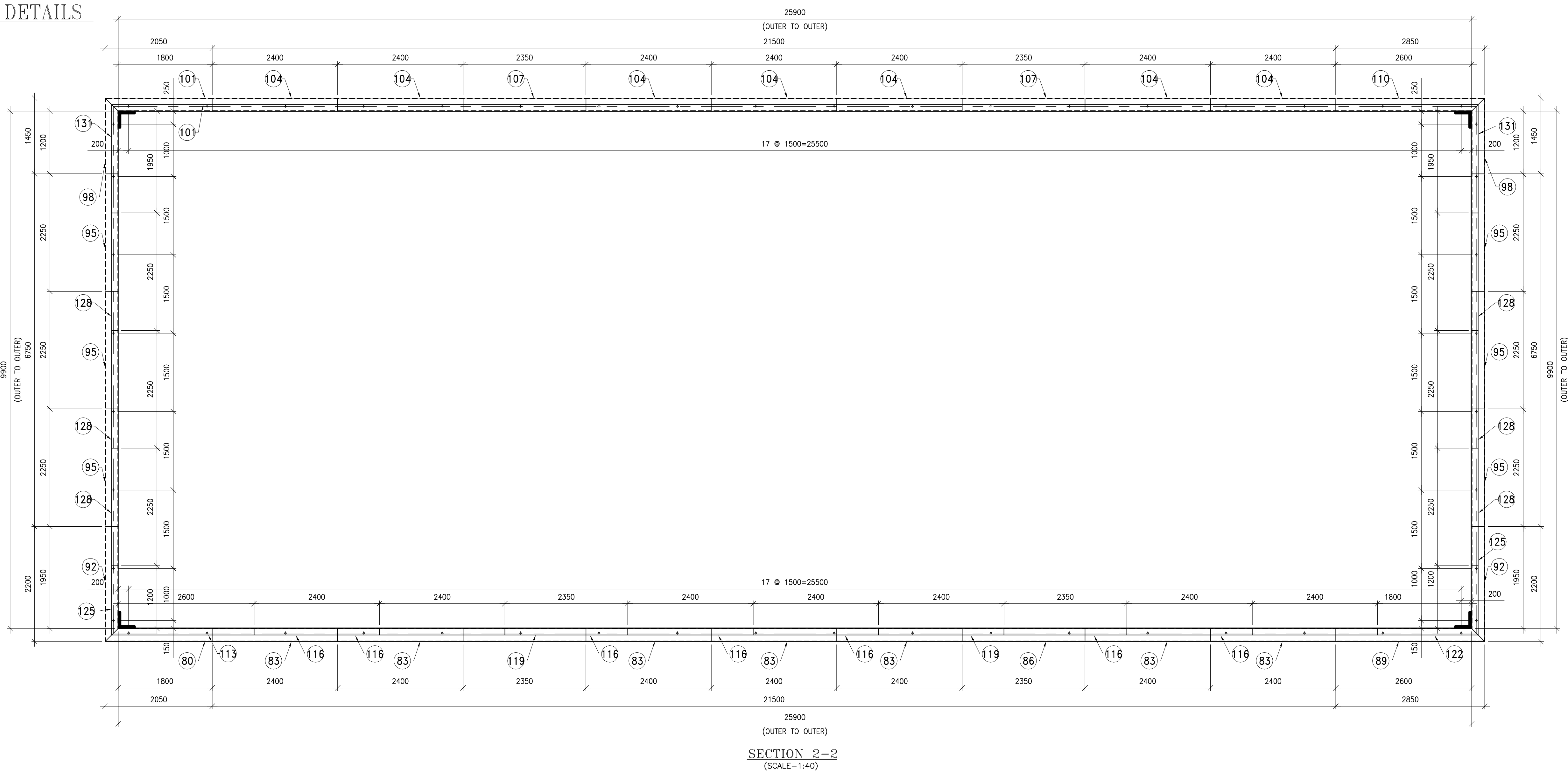
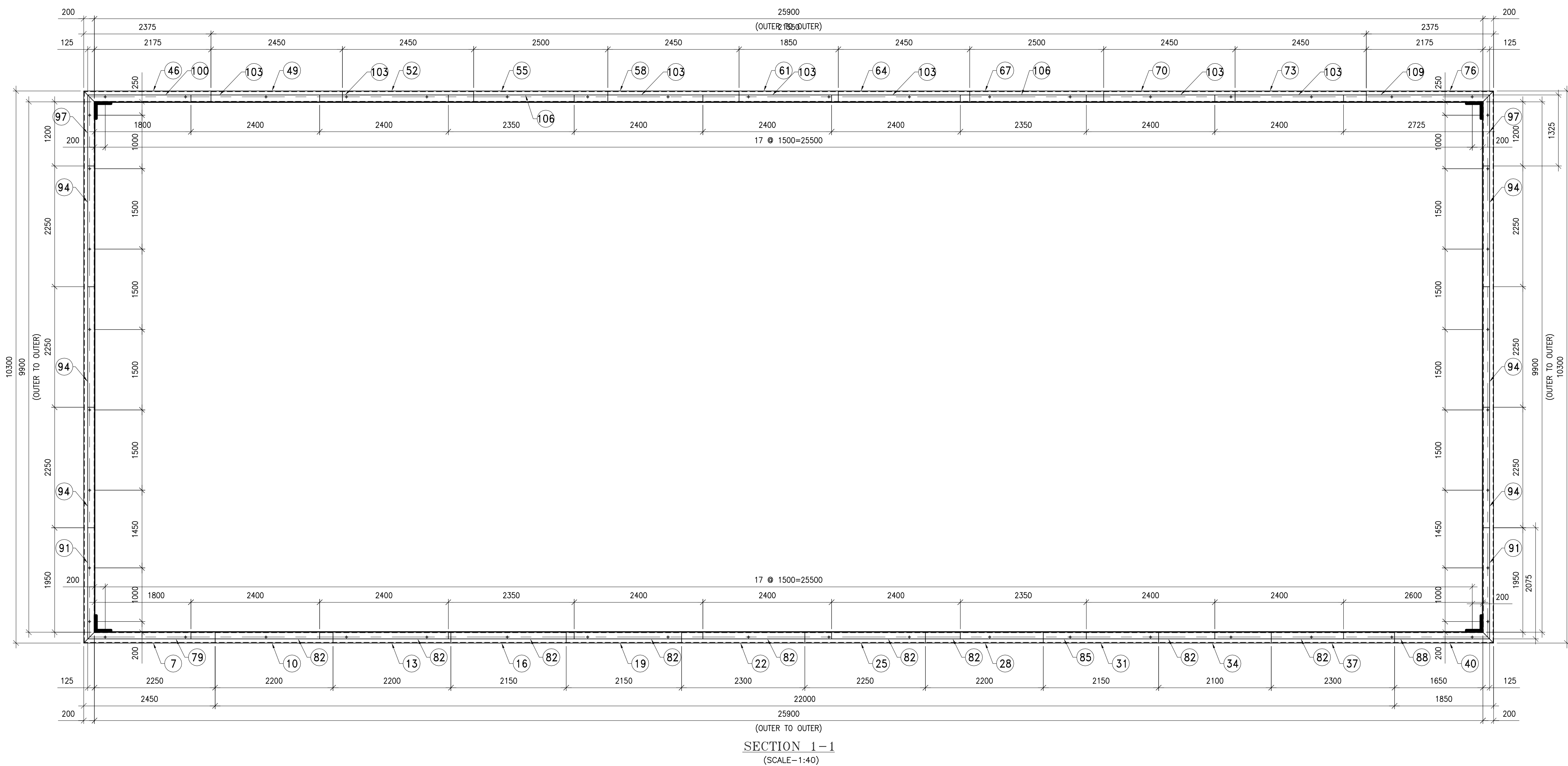
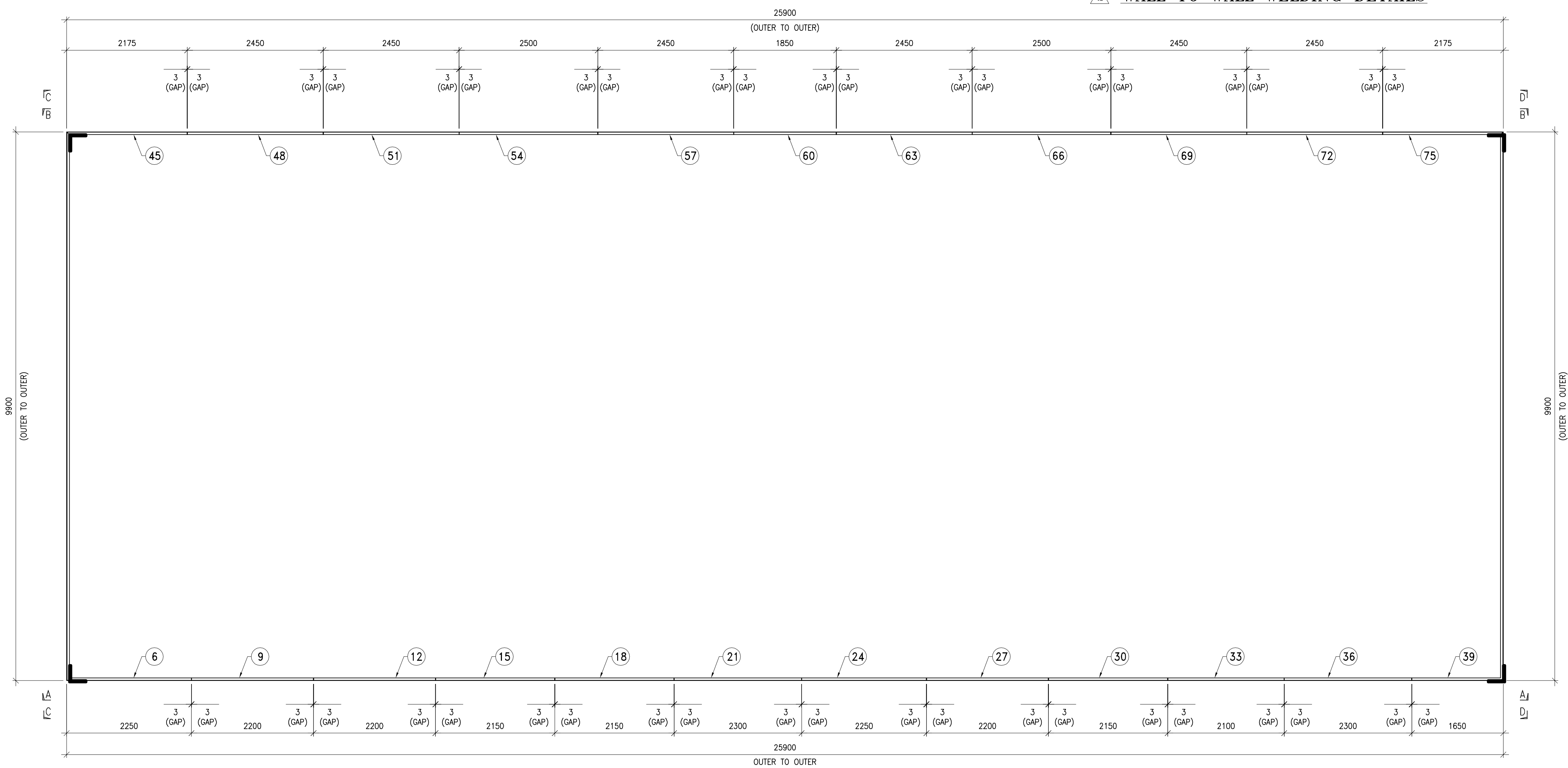
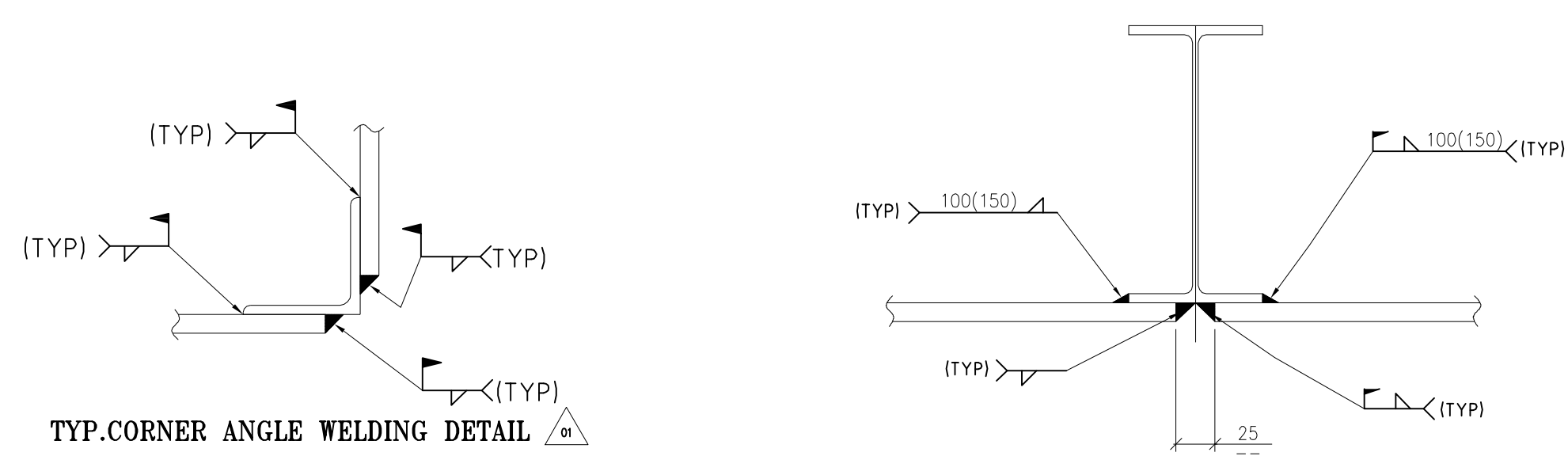
※ 1 : Assumed value. To be finalized by BHEL based on the vendor information.

Table 3.3 Set Point List

Others

No.	Tag no.	Service	Range	Unit	Set Point		Action	Basis	Remark
					Point	Value			
1	AICA	Absorber pH		–	H	6.5	H ANN	Normal pH + α	
					N	Later	Set point for pH control	Commissioning adjustment value	
					L	Later	L ANN, Set point for minimum pH	Commissioning adjustment value	
2	DICA	Absorber Density		wt.%	H	35	H ANN	Normal Density + 5 wt.%	Pump & Belt Filter Protection
					CH	32	Absorber Slurry Bleed Start	Normal Density + 2 wt.%	
					N	30	Set point for Density Control	Design Density	
					CL	28	Absorber Slurry Bleed Stop	Normal Density – 2 wt.%	
					L	25	L ANN	Normal Density – 5 wt.%	
3	AICA	FGD Outlet SO2		mg/Nm ³ @ 6% O2	H	100	H ANN	Design FGD Outlet SO2 concentration	
					N	Later	Set point for SO2 control	Commissioning adjustment	

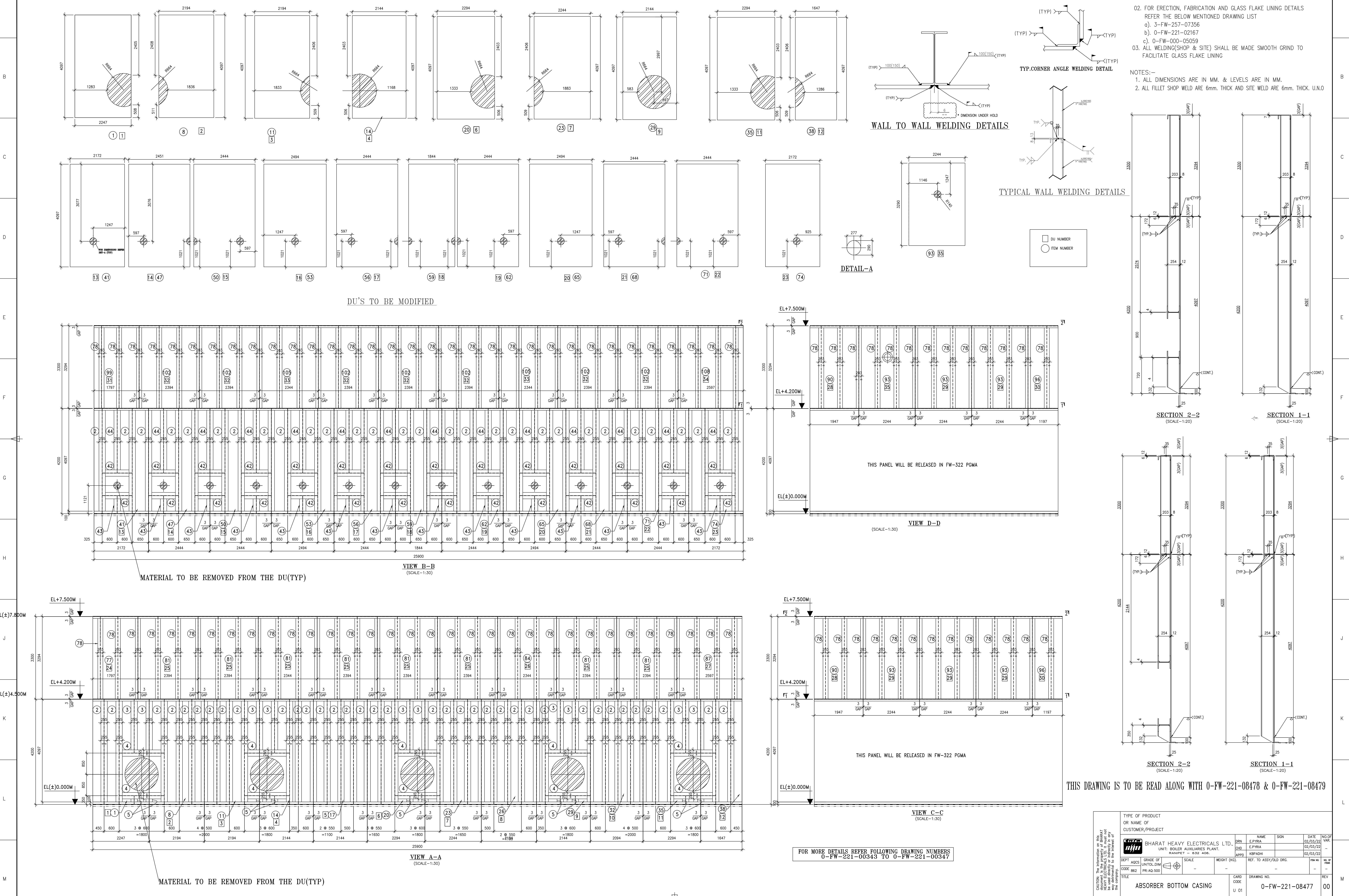
✖This set point list does not include unit equipments. (for example Vacuum Belt Filter, Oxidation Air Blower, etc..) BHEL will add set point for unit equipment and finalize the list according to the vender information.



REG. DATE	ALTERED	WARRANTY	DATE	NO.
OR 20/11/2018/CX/20		WARRANTY		
TYPICAL WELDING BEAMS CORRECTED				
ZONE				
8				
REG. DATE	ALTERED	WARRANTY	DATE	NO.
OR 15/11/2018/CX/20		WARRANTY		
TYPICAL WELDING BEAMS INDESTRUCTIBLE				
ZONE				
8				

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UNIT NO.		BHARAT HEAVY ELECTRICALS LTD.	
DRAWING NO.		BHARAT HEAVY ELECTRICALS LTD.	
REVISION		BHARAT HEAVY ELECTRICALS LTD.	
DATE		BHARAT HEAVY ELECTRICALS LTD.	
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**TECHNICAL DIRECTIVES ON
SAFETY PROTECTION AND FIRE INCIDENT PREVENTION
DURING ERECTION AND MAINTENANCE WORK OF
FGD ABSORBER AND ITS INTERNALS**



BHARAT HEAVY ELECTRICALS LIMITED

UNIT: BOILER AUXILIARIES PLANT (BAP)

RANIPET – 632406, TAMILNADU

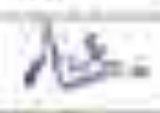
BREL : SAP : SAMPEY
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TECHNICAL DIRECTIVES ON SAFETY
 PROTECTION AND FIRE INCIDENT
 PREVENTION DURING ERECTION AND
 MAINTENANCE WORK OF FGD
 ABSORBER AND ITS INTERNALS



TD NO. 001

DOCUMENT NO.	4-FW-00041352 REV 00
DOCUMENT TITLE	TECHNICAL DIRECTIVES ON SAFETY PROTECTION AND FIRE INCIDENT PREVENTION DURING ERECTION AND MAINTENANCE WORK OF FGD ABSORBER AND ITS INTERNALS

REV. NO.	PARTICULARS	PREPARED BY	CHECKED BY	APPROVED BY	REMARKS
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	SIGNATURE				
	DATE	06.08.2022	06.08.2022	06.08.2022	

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TECHNICAL DIRECTIVES ON SAFETY
PROTECTION AND FIRE INCIDENT
PREVENTION DURING ERECTION AND
MAINTENANCE WORK OF FGD
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1. INTRODUCTION

The purpose of this document is to provide general guidelines to be implemented during erection, commissioning, operation and maintenance of **FGD DCFS Absorber** to ensure the safety and to avoid any fire hazard.

The **Absorbers** are generally made of carbon steel with corrosion resistant lining. The corrosion resistant lining of absorber are basically of two types.

- Non-metallic lining (like rubber lining or glass flake lining).
- Metallic lining (like C276 wall paper lining or C276 clad plate).

The **Absorbers** generally have the following internals.

- Spray pipe system [pipes & nozzles].
- ME system [Mist eliminators(ME), ME wash pipes & nozzles and washing pipe supports].
- Baffle wall [grating].

The immediate upstream and downstream item of an absorber is generally Non Metallic expansion joints(NMEJ).

This technical directive is issued in view of the importance of safeguarding the Absorber, Absorber internals and immediate upstream and downstream items (like NMEJ) from any fire incidents during Absorber Erection, FGD Operation and Maintenance.



FRP Spray pipe & nozzles



Polypropylene or Polysulfone
Mist Eliminators and wash
pipes



FRP grating in baffle wall

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2. BASIC INFORMATION

Wet FGD process is used to capture SO₂ in flue gas creating an acidic, high chloride, high sulphide environment inside FGD Absorbers. The materials selected for this construction of wet FGD equipment must be able to withstand this extremely corrosive environment. Generally, materials like Rubber, Glass flake, FRP, Polypropylene, Polysulfone etc. have been most successful in FGD application considering both economic and performance advantages. However, these materials have comparatively lesser temperature resistance. Hence, in the event of an ignition source available, these materials are prone to fire incidents.

The following materials are inflammable in nature which are being used in FGD Absorber system

1. FRP
2. Polypropylene(PP)
3. Polysulfone
3. Rubber lining
4. Glass flake lining
5. Glues, Solvents, Primers & Adhesives

The potential ignition sources in the vicinity of absorbers during erection, operation and maintenance are

1. Welding, flame Cutting, and grinding.
2. Heaters
3. Electric system for lighting etc
4. Short circuit in the Cable used during welding
5. Smoking



Table-1 : Typical data on Heat Resistant temperature of items

S.No	Items	Material	Heat Resistant Temp
1	Spray Pipe / ME Wash headers / Baffle grating	FRP	100 deg C
2	Rubber Lining	Butyl rubber	80 to 90 deg C
3	Glass flake lining	Glass flake vinyl ester resin based	80 to 90 deg C
4	Mist Eliminator, wash pipes and its supports	Polypropylene (PP)	80 to 90 deg C
		Polysulfone	180 to 250 deg C

NB: The data in the above table is only indicative. The MSDS of each material shall be referred for precise information.

3. RECOMMENDED ERECTION STRATEGY

The following are the recommended erection strategy which may be adopted for efficient utilization of time schedule and avoiding of hot works after lining or absorber internal erection. These points are provided to enhance safety aspect of absorber erection and are not exhaustive erection procedure. Separate document shall be referred for erection procedure of absorber.

1. Preassembly of absorber outlet Hood (cone / elbow) & duct connected to absorber may be started along with absorber shell.
2. Pre-assemble the duct and duct support (for Inlet & Outlet) near to the absorber. Generally Hot working during duct installation work surrounding absorber (both inlet & outlet) is unavoidable. Hence, duct erection shall be completed prior to absorber lining (in case of Rubber/Glass flake lining) works and absorber internals erection.
3. Pre-assembly of the outlet hood (cone / elbow) and outlet duct pieces to be done nearest to the ground level. This ensures lesser crawler crane capacity and does not require construction holds on the associated facilities.
4. External insulation, if applicable, shall be completed prior to lining (in case of Rubber/Glass flake lining) works and internals erection
5. Non-metallic lining work and/or absorber internals installation shall only be started after all hot work on the Absorber(inside and outside) are completed, including NDT, and the same is jointly certified by all stakeholders.



4. GENERAL SAFETY INSTRUCTIONS

The safety instruction mentioned in this clause shall be followed in all type of activities including absorber lining, absorber internal erection, absorber operation and maintenance etc.

1. All safety precautions as per the applicable statutory requirements shall be strictly followed while working inside and around the absorber.
2. Considering danger of Electric shock, install earthing devices, short-circuit breakers, overload protectors etc., properly. It shall be noted that the defective wiring may cause short- circuits, electric shock, fire etc. Hence wiring shall be done properly under supervision of qualified persons.
3. Caution should be taken about working in places having inadequate oxygen supply, and use of fire. During carrying out work inside absorber, tanks, pits, ducts etc., the site safety standards should strictly be observed to avoid human injuries.
4. When manholes are opened, internal oxygen concentration and inside temperature should be correctly confirmed and steps shall be taken to ensure that nobody other than the concerned persons would have access through the manholes. This shall be done under supervision of concerned supervisor. After completion of the work, it shall be confirmed that no worker has been left behind. After reassuring that nobody is inside the absorber, all the manholes shall be closed properly. Absorber shall be taken into operation only after the above.
5. The entire absorber area should be monitored by an efficient firefighting mechanism.
6. **The fire extinguishers shall be fitted at all visible places in adequate quantity as per the applicable safety/statutory regulations and/or as per applicable standards.**
7. The sufficient quantity of hydrants, jet pipes etc with adequate length of pipes shall be ensured considering the absorber height and surrounding area for easy movement and access to the fire brigade.
8. Considering the high hazard in the absorber area, different fire extinguishing systems shall be planned in advance Viz
 - a. Sprinkler systems
 - b. Water Spray Systems
 - c. Foam Extinguishing systems. (For Glues, Adhesives and solvents)



- d. Inert Gas extinguishing systems.(For electrical system)
9. All naked light shall be avoided; instead, 24V safety lamps (or any recommended safety lamps) shall be used in and around the absorber.
 10. Any combustible substance shall not be stored in the close vicinity of lights.
 11. Staircase access to each levels shall be completed and shall be free of any obstructions.
 12. Designated platforms around the absorber shall be completed for easy access to the staircase.
 13. All electrical equipment used should meet the requirements for use in explosive hazardous areas as applicable as per relevant safety standards. Electrical distribution cabinets shall be used outside the absorber. All equipment or apparatus or objects which are subjected to electrostatic discharges shall be properly earthed in order to avoid any ignitable discharges. Site lights shall be installed ensuring that they will not fall on combustible substances in case of failure.
 14. The entire absorber area shall be enclosed in order to prevent access to unauthorized persons e.g. by means of a safety fence. The access shall permanently guarded.
 15. NMEJ connecting absorber and outlet duct shall be of bolted connections. The hot works shall not be allowed nearby areas during NMEJ erection.
 16. A sign board with '**HOT WORKS NOT ALLOWED**' shall be displayed in all areas of possible access from commencement of non-metallic lining (or Absorber internal erection in case of metallic lining) till absorber is in regular operation.
 17. Hot works shall only be allowed with prior permission from concerned stakeholders. Strict supervision and adequate safety measures shall be ensured in the vicinity of non-metallic lining, lining storage or internal storage area for a radius of 10m which is considered as safety zone.
 18. All combustible materials shall be stored away from this 10m safety zone only.
 19. The safety precaution drill shall be conducted before commencement of any activity like lining commencement, absorber internal erection etc.
 20. All hot works immediate to the absorber, both upstream and downstream shall also be completed in all aspects (including NDT if applicable), before

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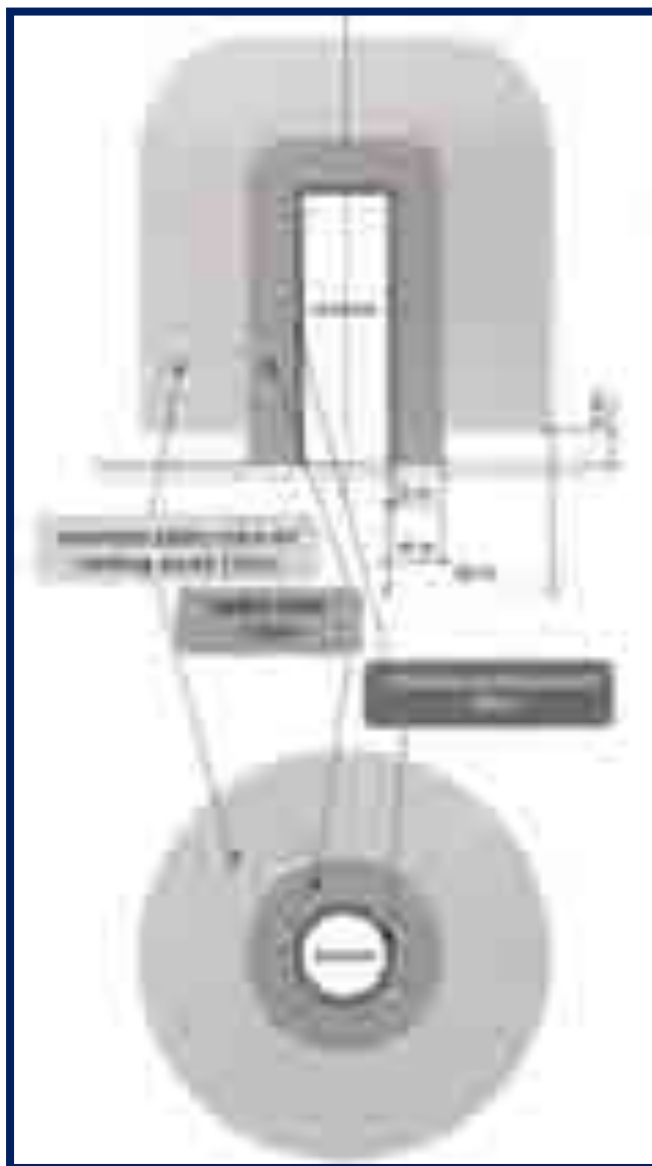


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commencement of lining application (or commencement of internal erection in case of metallic lining) and during maintenance.

21. Smoking inside the absorber 'from commencement of non-metallic lining, Absorber internal erection, till absorber is taken into full operation' shall strictly be prohibited. '**NO SMOKING**' sign board shall be displayed in all areas of possible access.
22. Ensure moisture free surfaces inside the absorber to eliminate any electric shock.

5. SPECIAL SAFETY INSTRUCTIONS DURING NON-METALLIC LINING APPLICATION (RUBBER, GLASS FLAKE ETC)



Typical Safety zones around absorber during rubber lining, operation and Maintenance

The safety instructions mentioned in Cl No 4 (GENERAL SAFETY INSTRUCTIONS) shall be followed during non-metallic lining.

Additionally, the following instructions shall necessarily be taken care during the application of non-metallic lining (rubber lining, glass flake lining etc).

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1. Site shall prepare a check list of Hot works to be completed in the Absorber and all hot works shall be completed prior to rubber/glass flake lining.
2. Lining shall only be commenced after conducting the safety precaution drill.
3. Before and during the application of adhesives, solutions and lining, frequent checks shall be conducted with Gas tester (or any suitable measuring device) to ensure that there is no inflammable gas exists within the limit.
4. Smoking shall be prohibited adjacent areas to the lining or where lining materials stored.
5. Aeration and venting inside the absorber shall be ensured by continuous measurements with explosimeters by employing a dedicated person.
6. Each working group is equipped with Fire extinguishers and a fire extinguishing blanket.
7. When the lining is under progress, a close watch by dedicated safety personnel shall guard the absorber. Guards round the absorber on regular interval to look for any safety regulation violations.
8. Before commencing the lining, all firefighting equipment shall be made operational. Workplace shall be equipped with sufficient and suitable fire extinguishers.
9. The entire absorber area where lining is being carried out shall be enclosed in order to prevent access to unauthorized persons e.g. by means of a safety fence. The access shall permanently guarded.
10. Only half quantity of a day's requirement of Glues, Adhesives and solvents etc shall be kept in the work place and others shall be stored at a safe distance from the workplace to bring as and when required.
11. Inflammable objects shall necessarily be kept away from the Spark Test area.
12. Spark test shall never be conducted in open areas during raining.
13. Responsible safety person(s) shall be in place in the absorber area to co-ordinate all safety related issues, shortcomings if any, are to be addressed without any compromise. Safety instructions to all task performers before start of the work.



6. SAFETY INSTRUCTIONS DURING ABSORBER INTERNAL ERECTION

The safety instructions mentioned in Cl.No 4 (GENERAL SAFETY INSTRUCTIONS) shall be followed during absorber internal erection also.

The following shall necessarily be taken care during the erection of absorber internals(spray pipe system, ME system, baffle wall etc). This shall be ensured for the absorbers lined with metallic lining or non-metallic lining.

1. **NO HOT WORKS** during absorber internal erection in the vicinity of absorber at a distance minimum 2m radius from Absorber or internals which is considered as explosion protection zone.
2. All hot works on the absorber shall be completed in all aspects prior to internal erection.
3. Hot works in inlet or outlet duct shall be prohibited.
4. Frequent checks shall be conducted with Gas tester (or any suitable measuring device) to ensure that there is no inflammable gas exists within the limit.
5. Smoking shall also be prohibited adjacent areas to the lined surfaces and where absorber internals are installed or stored.
6. The storage area of absorber internals shall be suitably protected from free access.
7. FRP baffle grating shall be erected only after entire lining (especially metallic lining in baffle support and absorber bottom) is completed in all areas. This is to ensure that FRP grating is not exposed to heat due to hot works of metallic lining.
8. JAS shall also be erected after the entire lining work is completed similar to FRP baffle grating

7. SPECIAL SAFETY INSTRUCTIONS FOR HOT WORKS AFTER LINING AND/OR INTERNAL ERECTION.

It shall be noted that all HOT WORKS shall necessarily be completed prior to non-metallic lining and/or internal erection. It is advised **not to a carry out any hot works** in and around absorber after lining and/or internal erection is completed. However, in case hot works are warranted due to unavoidable circumstances, the following shall strictly be adhered. The same precautions shall be ensured during



absorber maintenance or repair activities also.

1. During the shutdown any maintenance work inside the absorber (with metallic lining or non-metallic lining) , utmost care and precaution have to be taken to prevent any incidents damaging the absorber and the equipment.
2. In case any hot works need to be carried out in the **non-metallic lined surfaces**, utmost care shall be taken to ensure that other nearby lined areas are covered by fire blankets so that NO HOT WORKS SPARKS land on the surfaces of the surrounding lined surfaces and absorber internals.
3. In case any hot works need to be carried out in the **metallic lined surfaces** during or after erection of absorber internals, utmost care shall be taken to ensure that other nearby areas and internals are covered by fire blankets so that NO HOT WORKS SPARKS land on the absorber internals.
4. If any hot works is carried out in the wet dry interface duct(inlet duct), lining termination areas at absorber inlet shall be properly covered with suitable fire blankets.
5. In case of any hot works between the spray pipe system and ME system, the spray pipes shall be fully covered with fire blankets protecting from any hot sparks or hot spatters or hot metal pieces damaging spray pipes/nozzles which may leading to untoward fire incidents.
6. While carrying out any hot works between the ME system and the absorber roof, the entire Mist eliminator panels & ME Wash pipes, supports shall be fully covered with fire blankets protecting from any hot sparks or hot spatters or hot metal pieces damaging the Mist eliminator panels/wash pipes/supports which may lead to untoward fire incidents.

The ME panels near to casing wall adjacent to the hot works(at all levels) are recommended to be removed during the hot works on absorber casing in-between ME levels and near to ME system. This shall be decided considering potential damages to the lined surfaces and ME wash pipes/supports during the removal of ME panels.
7. In case the outlet duct is of FRP or lined with non-metallic lining and hot works is required at the absorber outlet area, the absorber outlet cross section shall be covered with fire blankets protecting downstream duct or NMEJ from any hot sparks or hot spatters or hot metal pieces.
8. Suitable and Sufficient quantity of portable fire extinguishers, water buckets, hydrants, water hoses with adequate length of pipes shall be



ensured during the entire duration of the hot work till exit of all manpower from inside absorber.

9. If the hot works are required to be carried out outside the absorber, all absorber accessories, rubber lined pipes, electrical items etc shall be protected with fire blankets. Suitable and Sufficient quantity of portable fire extinguishers, water buckets, hydrants, water hoses with adequate length of pipes shall be ensured during the entire duration of the hot work.

8. SAFETY INSTRUCTIONS DURING OPERATION.

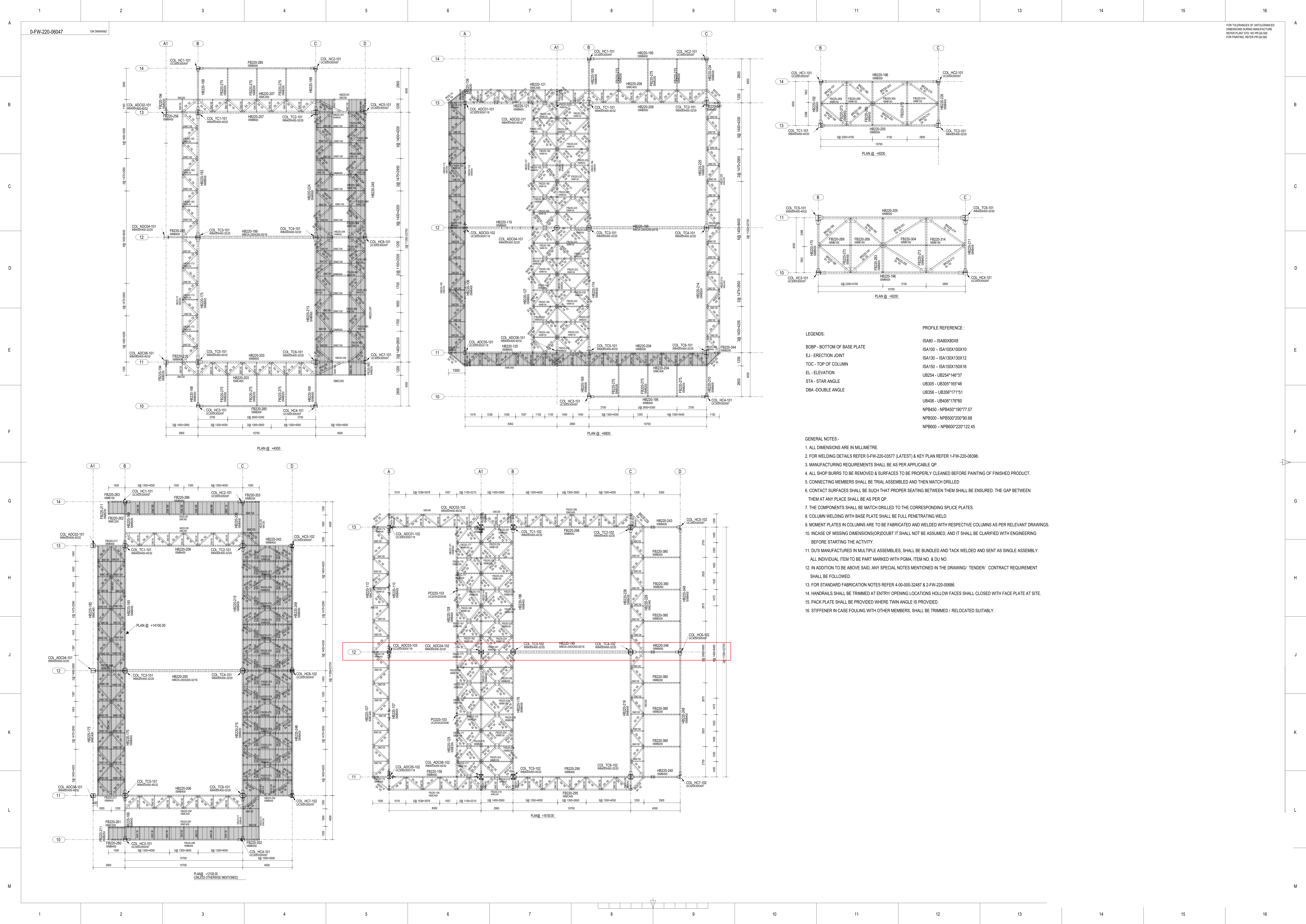
The following safety precaution shall necessarily be ensured during the operation of FGD absorber.

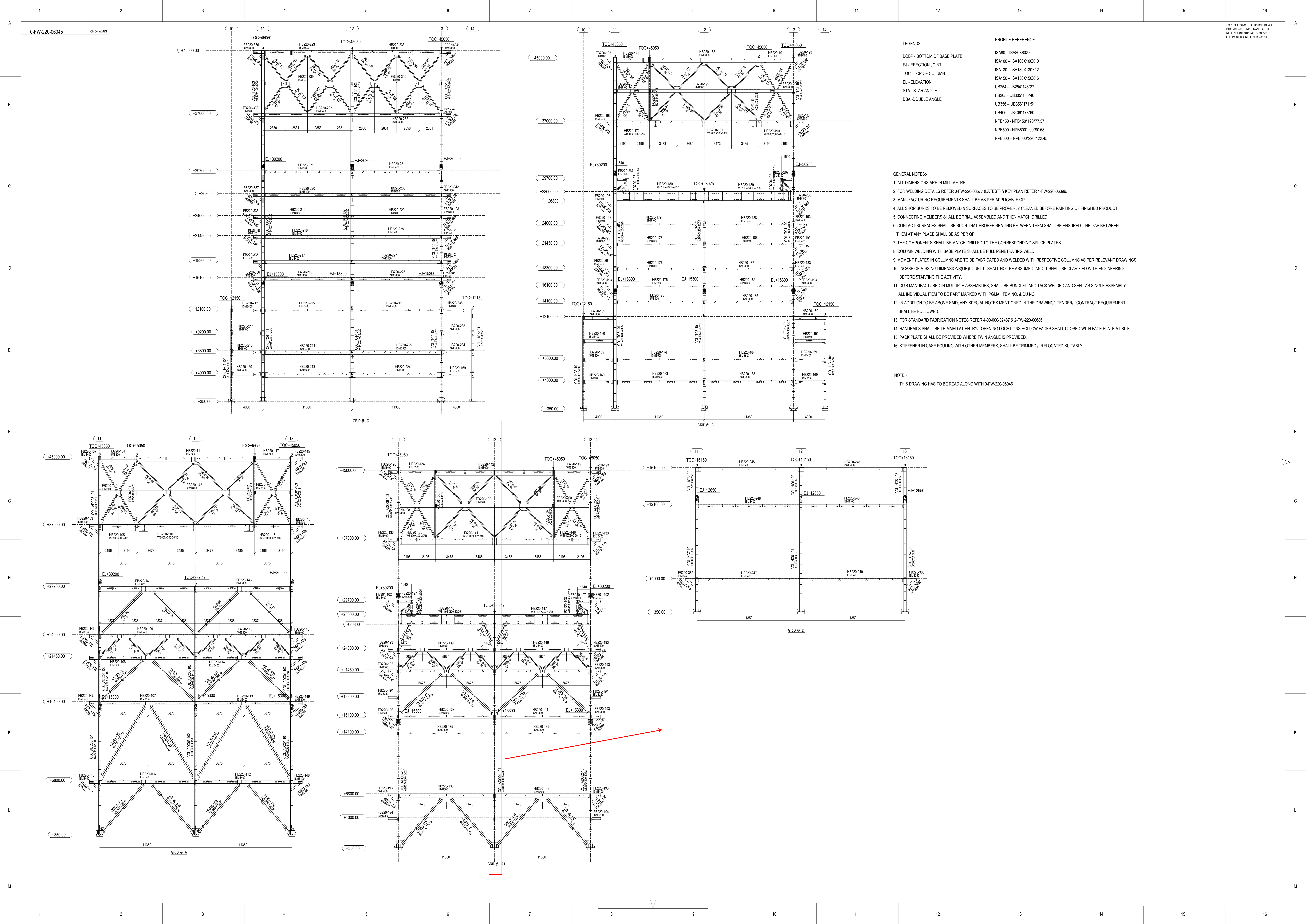
1. **NO HOT WORKS** in the vicinity of absorber at a distance minimum 2m radius from lined surfaces or internals which is considered as explosion protection zone.
2. A sign board with '**HOT WORKS NOT ALLOWED**' shall be displayed in all areas of possible access.
3. Install caution signs labelled "**NO SMOKING**". Smoking in the vicinity of the absorber shall strictly be prohibited.
4. Cutting, welding, and other hot work is the most likely cause of ignition. Fire prevention during welding, cutting, and other hot work at a minimum, strict work controls should be enforced. Packing should be covered with fire-resistant blankets over sheet metal. Blankets should be kept wet. A charged hose and fire watch should be provided at the work area.
5. The Absorber tank should be maintained with liquid during outage if possible.

9. SAFETY INSTRUCTIONS DURING MAINTENANCE.

The safety instructions mentioned in other clauses of this document shall necessarily be ensured during the maintenance activity of FGD absorber.

1. The ID Fan or BUF outlet gates should be closed during cutting, welding, or other hot work to reduce the induced draft. No hot work should be permitted in the downstream duct or stack. The water supply from a reliable source should be always available during the outage
2. The introduction of combustible materials into the Absorber should be limited and controlled during maintenance and inspection outages.





LEGENDS:

- BOBP - BOTTOM OF BASE PLATE
- EJ - ERECTION JOINT
- TOC - TOP OF COLUMN
- EL - ELEVATION
- STA - STAR ANGLE
- DBA - DOUBLE ANGLE

PROFILE REFERENCE :

- ISA80 - ISA80X80X8
- ISA100 - ISA100X100X10
- ISA130 - ISA130X130X12
- ISA150 - ISA150X150X16
- UB254 - UB254*148*37
- UB305 - UB305*165*46
- UB356 - UB356*171*51
- UB406 - UB406*178*60
- NPB450 - NPB450*190*77.57
- NPB500 - NPB500*200*90.68
- NPB600 - NPB600*220*122.45

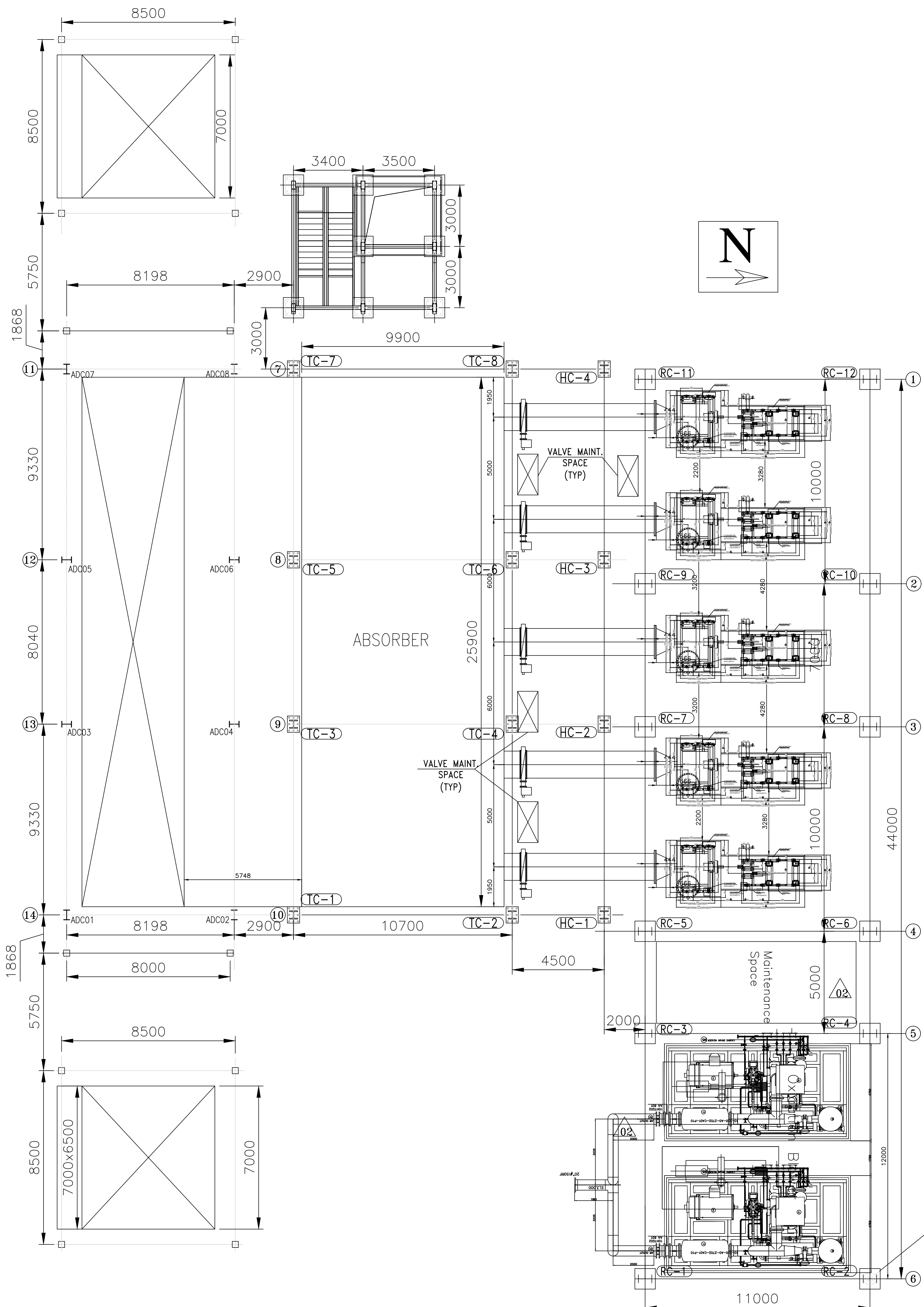
GENERAL NOTES:-

1. ALL DIMENSIONS ARE IN MILLIMETRE.
2. FOR WELDING DETAILS REFER 0-FW-220-03577 (LATEST) & KEY PLAN REFER 1-FW-220-06396.
3. MANUFACTURING REQUIREMENTS SHALL BE AS PER APPLICABLE QP.
4. ALL SHOP BURRS TO BE REMOVED & SURFACES TO BE PROPERLY CLEANED BEFORE PAINTING OF FINISHED PRODUCT.
5. CONNECTING MEMBERS SHALL BE TRIAL ASSEMBLED AND THEN MATCH DRILLED
6. CONTACT SURFACES SHALL BE SUCH THAT PROPER SEATING BETWEEN THEM SHALL BE ENSURED. THE GAP BETWEEN THEM AT ANY PLACE SHALL BE AS PER QP.
7. THE COMPONENTS SHALL BE MATCH DRILLED TO THE CORRESPONDING SPLICE PLATES.
8. COLUMN WELDING WITH BASE PLATE SHALL BE FULL PENETRATING WELD.
9. MOMENT PLATES IN COLUMNS ARE TO BE FABRICATED AND WELDED WITH RESPECTIVE COLUMNS AS PER RELEVANT DRAWINGS.
10. IN CASE OF MISSING DIMENSIONS(OR)DOUBT IT SHALL NOT BE ASSUMED, AND IT SHALL BE CLARIFIED WITH ENGINEERING BEFORE STARTING THE ACTIVITY.
11. DUS MANUFACTURED IN MULTIPLE ASSEMBLIES, SHALL BE BUNDLED AND TACK WELDED AND SENT AS SINGLE ASSEMBLY. ALL INDIVIDUAL ITEM TO BE PART MARKED WITH PGM, ITEM NO. & DU NO.
12. IN ADDITION TO BE ABOVE SAID, ANY SPECIAL NOTES MENTIONED IN THE DRAWING/ TENDER/ CONTRACT REQUIREMENT SHALL BE FOLLOWED.
13. FOR STANDARD FABRICATION NOTES REFER 4-00-000-32487 & 2-FW-220-00686.
14. HANDRAILS SHALL BE TRIMMED AT ENTRY/ OPENING LOCATIONS HOLLOW FACES SHALL CLOSED WITH FACE PLATE AT SITE.
15. PACK PLATE SHALL BE PROVIDED WHERE TWIN ANGLE IS PROVIDED.
16. STIFFENER IN CASE FOULING WITH OTHER MEMBERS, SHALL BE TRIMMED / RELOCATED SUITABLY.

NOTE:-

THIS DRAWING HAS TO BE READ ALONG WITH 0-FW-220-06046

FOR TOLERANCES OF UNTOOLERANCED DIMENSIONS DURING MANUFACTURE REFER PLANT STD. NO. PRC-CA-600 FOR PAINTING, REFER PRC-CA-600



PLAN

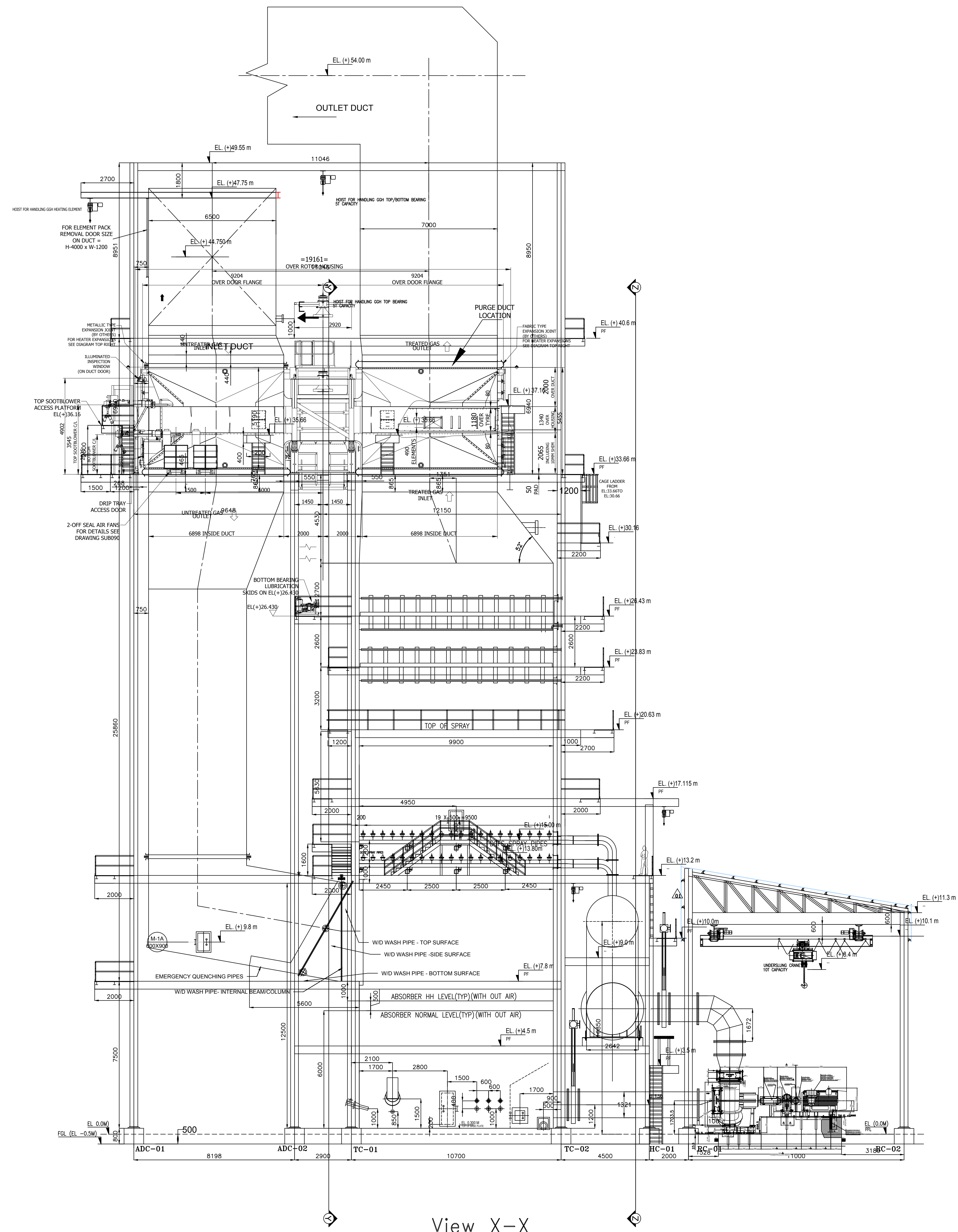
REV.	DATE	ALTD.	CHD.	APPD.
03	20.02.2020	PK	V.M.BAO	KUMAR
02	00.07.21	PK	V.M.BAO	KUMAR
01	18.06.2021	PK	V.M.BAO	KUMAR

NOTES:

- ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS IN METRES
- DIMENSIONS OF GGH IS UNDER HOLD
- DIMENSIONS OF RC PUMP & OXIDATION BLOWER ARE UNDER HOLD

REFERENCE DRAWINGS:

- ABSORBER & DUCT SIZING BASIS - 04-FW-213-00497



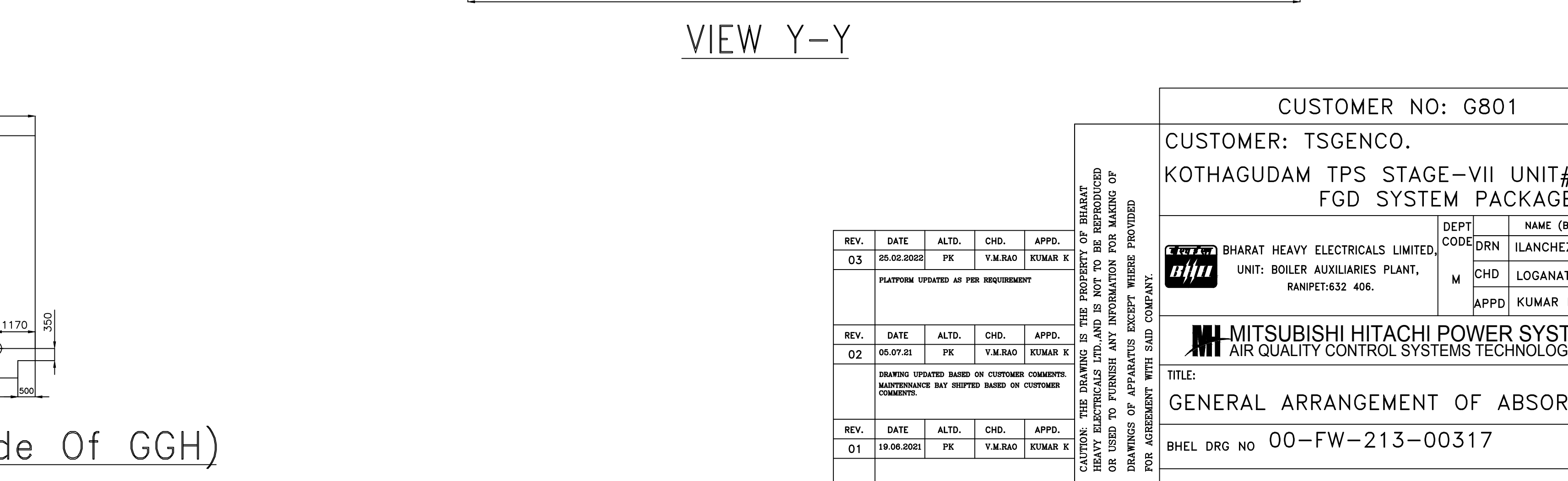
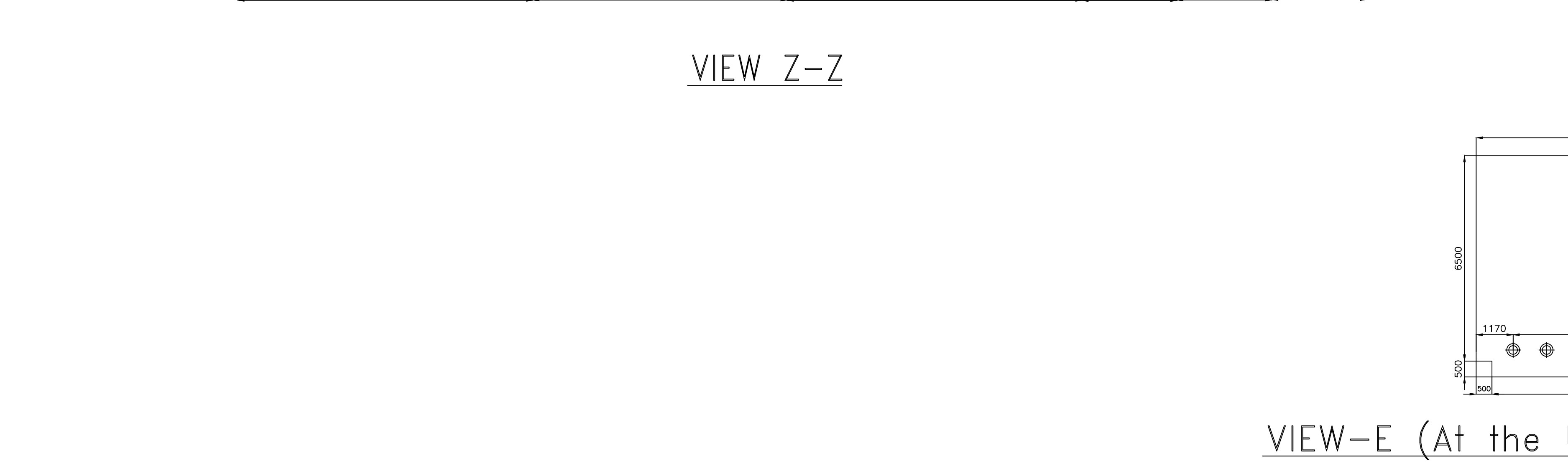
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PROGRESSIVE

REV.	DATE	ALTD.	CHD.	APPD.
03	20.02.2020	PK	V.M.BAO	KUMAR
02	00.07.21	PK	V.M.BAO	KUMAR
01	18.06.2021	PK	V.M.BAO	KUMAR

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CUSTOMER NO: G801			
CUSTOMER: TSGENCO.			
KOTHAGUDAM TPS STAGE-VII UNIT#12(1X800MW) FGD SYSTEM PACKAGE			
DEPT	NAME (BHEL)	DATE	
BHARAT HEAVY ELECTRICALS LIMITED,	ILANCHEZHIAN S	14.05.21	
UNIT: BOILER AUXILIARIES PLANT, RANIPET-632 406.	LOGANATHAN R	14.05.21	
	KUMAR K	14.05.21	
MITSUBISHI HITACHI POWER SYSTEMS, LTD.			
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION			
TITLE: GENERAL ARRANGEMENT OF ABSORBER			SCALE : NTS
BHEL DRG NO 00-FW-213-00317			SH 01 OF 07
			REV NO 04A

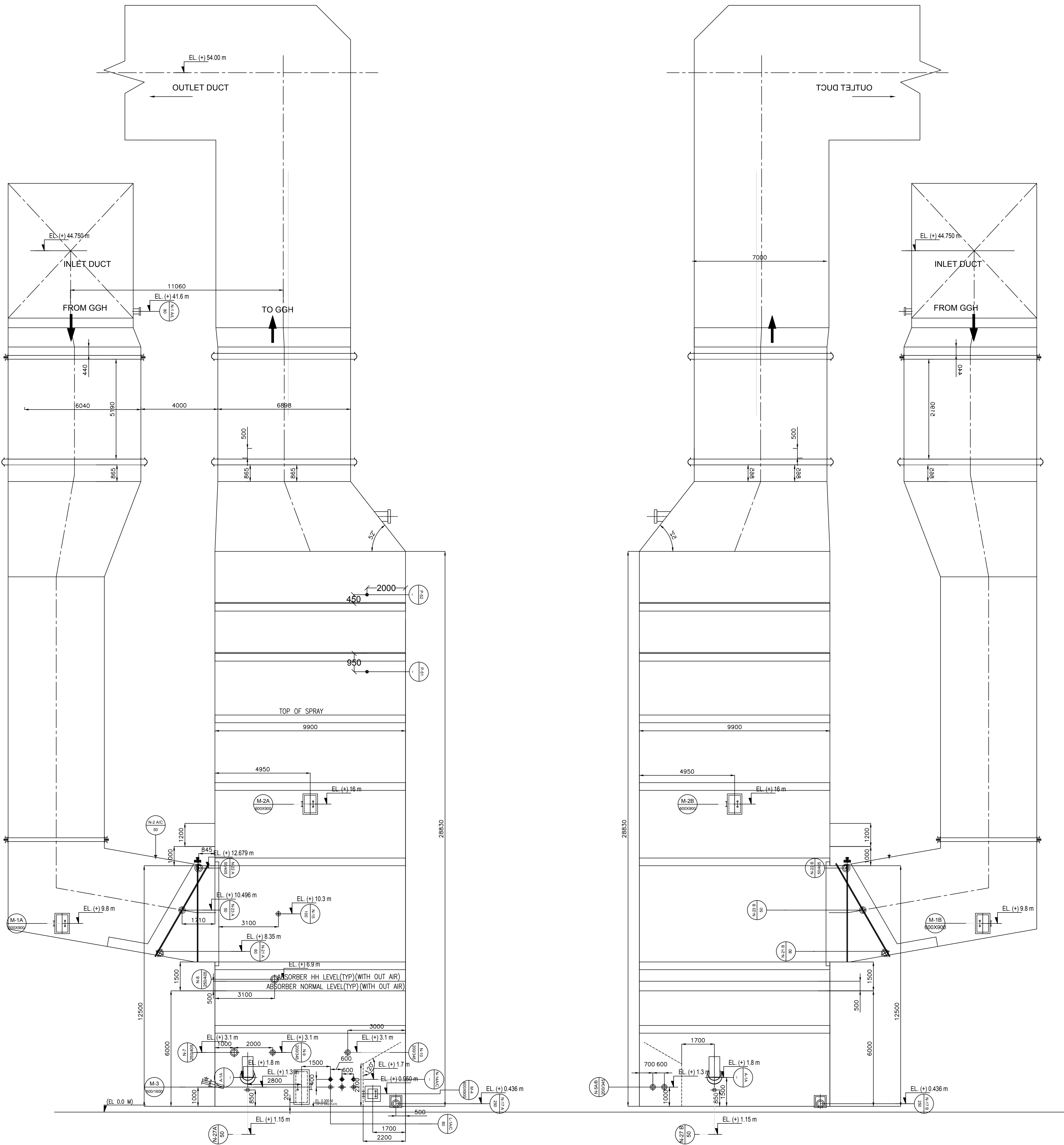


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MITSUBISHI HITACHI POWER SYSTEMS, LTD.
AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

BHEL DRG NO	00-FW-213-00317	SH 02 OF 07

14	15	Size A0 16



FRONT VIEW

REAR VIEW

MARK	NO. REQ'D	SIZE (NB)	RATING	FAC-ING	SERVICE	REMARKS	ELEVATION
NOZZLE AND CONNECTIONS							
ABSORBER							
M-4	2	600x900		FF	MANHOLE (near RG pump baffle area)	WITH HINGE	0.950
M-3	1	600x1600		FF	MANHOLE (near JAS)	WITH HINGE	1.300
M-2	2	600x900		FF	MANHOLE (near spray pipe)	WITH HINGE	16.00
M-1	2	600x900		FF	MANHOLE (inlet duct)	WITH HINGE	9.800
L-1	3	80	ASME 150 ^{Lb} PAD	FF	LT CONNECTION		1.300
A-1	2	—	ASME B16.5 150 ^{Lb} SO	—	AGITATOR	TURN UPWARD 10°	1.800
ABSORBER MIST ELIMINATOR							
M-52		600x900	DETAILS AS PER		MIST ELIMINATOR VENDOR	DRAWING	
M-51		500x500	DETAILS AS PER		MIST ELIMINATOR VENDOR	DRAWING	
S-51	A		DETAILS AS PER		MIST ELIMINATOR VENDOR	DRAWING	
P-52			DETAILS AS PER		MIST ELIMINATOR VENDOR	DRAWING	
P-51			DETAILS AS PER		MIST ELIMINATOR VENDOR	DRAWING	
N-54	A		DETAILS AS PER		MIST ELIMINATOR VENDOR	DRAWING	
N-53	A		DETAILS AS PER		MIST ELIMINATOR VENDOR	DRAWING	
N-52	A		DETAILS AS PER		MIST ELIMINATOR VENDOR	DRAWING	
N-51	A		DETAILS AS PER		MIST ELIMINATOR VENDOR	DRAWING	

N-27	2	50	ASME 150 SO	FF	Agitator Emergency flush		1.15
N-24	4	50/405	ASME 150 ^{Lb} SO	FF	W/D INTERFACE WASHING SPRAY PIPE (COLUMN WASH)		variable
N-23	2	50/405			W/D INTERFACE WASHING SPRAY PIPE (SIDE)		10.496
N-22	2	50/405			W/D INTERFACE WASHING SPRAY PIPE (TOP)		12.679
N-21	2	80/405			W/D INTERFACE WASHING SPRAY PIPE (BOTTOM)		8.35
N-20	26	350	ASME 150 ^{Lb} SO/-		DCFS SPRAY PIPE (UPPER SIDE)		15
N-19	26	350	ASME 150 ^{Lb} SO/-		DCFS SPRAY PIPE (LOWER SIDE)		13.8
N-17	2	250/405	ASME 150 ^{Lb} SO/-		TANK DRAIN		0.436
N-15	1	100/230	ASME 150 ^{Lb} SO		VENT		10.3
N-14	3	—	ASME 150 ^{Lb} PAD		LT WASHING PIPE		1.7
N-12	1	508/699	ASME 150 ^{Lb} SO		EXHAUST DAMPER NOZZLE		30.945
N-11	14	155mm			JAS NOZZLES	TURN UPWARD 15°	
N-10	1	200/345			AUXILIARY ABSORBENT PUMP RETURN	TURN UPWARD 30°	3.100
N-9	1	200/280			ABSORBER AREA DRAIN SUMP PUMP RETURN	TURN UPWARD 30°	3.100
N-8	1	250/405			OVER FLOW (BUBBLE)		6.900
N-7	1	250/405	ASME 150 ^{Lb} SO		OVER FLOW	TURN UPWARD 30°	3.100
N-6	5	1300	AWWA CLASS B		RECIRCULATION PUMP SUCTION		1.500
N-5	2	200/345	ASME 150 ^{Lb} SO		BLEED PUMP SUCTION		1.500
N-4	1	80			LIMESTONE SLURRY FEED	TURN UPWARD 45°	3.100
N-3	1	450			FILTRATE RETURN MANIFOLD	TURN UPWARD 30°	3.100
N-2	3	50	ASME 150 ^{Lb} SO		ABSORBER LEVEL GAUGE EQUALIZING LINE		13.210
N-1	12	80/405	ASME 150 ^{Lb} SO	FF	EMERGENCY QUENCHING SPRAY PIPE		41.60
MARK	NO. REQ'D	SIZE (NB)	RATING	FAC-ING	SERVICE	REMARKS	ELEVATION (m)
NOZZLE AND CONNECTIONS							

ITEM NO.	DESCRIPTION	QTY	UNIT	REMARKS
1	ABSORBER TANK AREA	1	SQ. M	
2	ABSORBER SPRAY PIPE AREA	1	SQ. M	
3	ABSORBER TANK AREA	1	SQ. M	
4	ABSORBER TANK AREA	1	SQ. M	
5	ABSORBER TANK AREA	1	SQ. M	
6	ABSORBER TANK AREA	1	SQ. M	
7	ABSORBER TANK AREA	1	SQ. M	
8	ABSORBER TANK AREA	1	SQ. M	
9	ABSORBER TANK AREA	1	SQ. M	
10	ABSORBER TANK AREA	1	SQ. M	
11	ABSORBER TANK AREA	1	SQ. M	
12	ABSORBER TANK AREA	1	SQ. M	
13	ABSORBER TANK AREA	1	SQ. M	
14	ABSORBER TANK AREA	1	SQ. M	
15	ABSORBER TANK AREA	1	SQ. M	
16	ABSORBER TANK AREA	1	SQ. M	
17	ABSORBER TANK AREA	1	SQ. M	
18	ABSORBER TANK AREA	1	SQ. M	
19	ABSORBER TANK AREA	1	SQ. M	
20	ABSORBER TANK AREA	1	SQ. M	
21	ABSORBER TANK AREA	1	SQ. M	
22	ABSORBER TANK AREA	1	SQ. M	
23	ABSORBER TANK AREA	1	SQ. M	
24	ABSORBER TANK AREA	1	SQ. M	
25	ABSORBER TANK AREA	1	SQ. M	
26	ABSORBER TANK AREA	1	SQ. M	
27	ABSORBER TANK AREA	1	SQ. M	
28	ABSORBER TANK AREA	1	SQ. M	
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36	ABSORBER TANK AREA	1	SQ. M	
37	ABSORBER TANK AREA	1	SQ. M	
38	ABSORBER TANK AREA	1	SQ. M	
39	ABSORBER TANK AREA	1	SQ. M	
40	ABSORBER TANK AREA	1	SQ. M	
41	ABSORBER TANK AREA	1	SQ. M	
42	ABSORBER TANK AREA	1	SQ. M	
43	ABSORBER TANK AREA	1	SQ. M	
44	ABSORBER TANK AREA	1	SQ. M	
45	ABSORBER TANK AREA	1	SQ. M	
46	ABSORBER TANK AREA	1	SQ. M	
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49	ABSORBER TANK AREA	1	SQ. M	
50	ABSORBER TANK AREA	1	SQ. M	
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83	ABSORBER TANK AREA	1	SQ. M	
84	ABSORBER TANK AREA	1	SQ. M	
85	ABSORBER TANK AREA	1	SQ. M	
86	ABSORBER TANK AREA	1	SQ. M	
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93	ABSORBER TANK AREA	1	SQ. M	
94	ABSORBER TANK AREA	1	SQ. M	
95	ABSORBER TANK AREA	1	SQ. M	
96	ABSORBER TANK AREA	1	SQ. M	
97	ABSORBER TANK AREA	1	SQ. M	
98	ABSORBER TANK AREA	1	SQ. M	
99	ABSORBER TANK AREA	1	SQ. M	
100	ABSORBER TANK AREA	1	SQ. M	

CUSTOMER NO: G801

CUSTOMER: TSGENCO.

KOTHAGUDAM TPS STAGE-VII UNIT#12(1X800MW)

FGD SYSTEM PACKAGE

REV. DATE ALTD. CHD. APPD.

03 20.02.2020 PK Y.M.BAO KUMAR

PLATFORM UPDATED AS PER REQUIREMENT

REV. DATE ALTD. CHD. APPD.

02 05.07.21 PK Y.M.BAO KUMAR

DRAWING UPDATED BASED ON CUSTOMER COMMENTS

REV. DATE ALTD. CHD. APPD.

01 18.06.2021 PK Y.M.BAO KUMAR

DRAWING UPDATED BASED ON CUSTOMER COMMENTS

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BHARAT HEAVY ELECTRICALS LIMITED.

UNIT: BOILER AUXILIARIES PLANT, RANIPET-632 406.

MITSUBISHI HITACHI POWER SYSTEMS, LTD.

AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION

TITLE: GENERAL ARRANGEMENT OF ABSORBER

SCALE: NTS

BHEL DRG NO 00-FW-213-00317

SH 03 OF 07

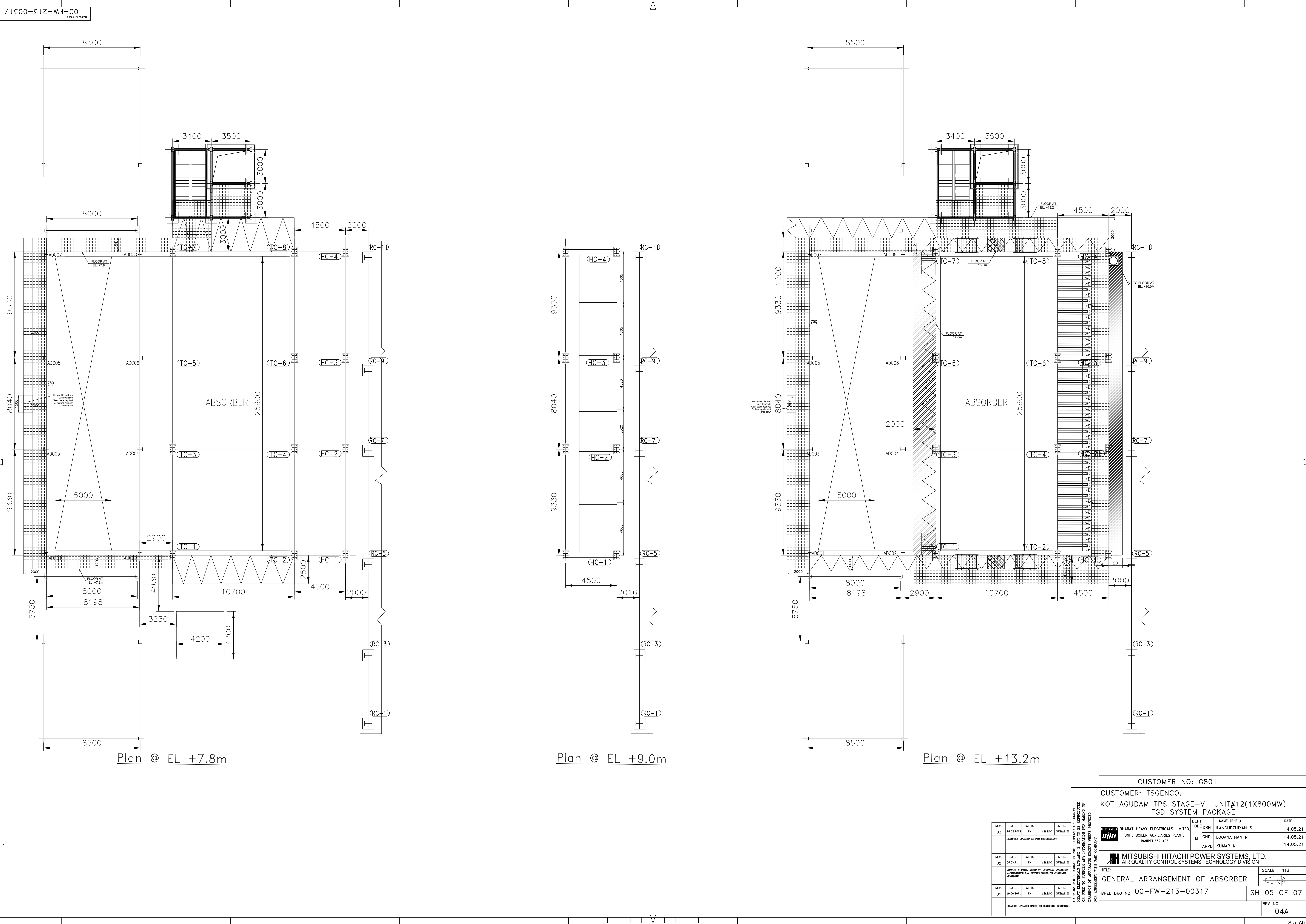
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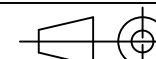
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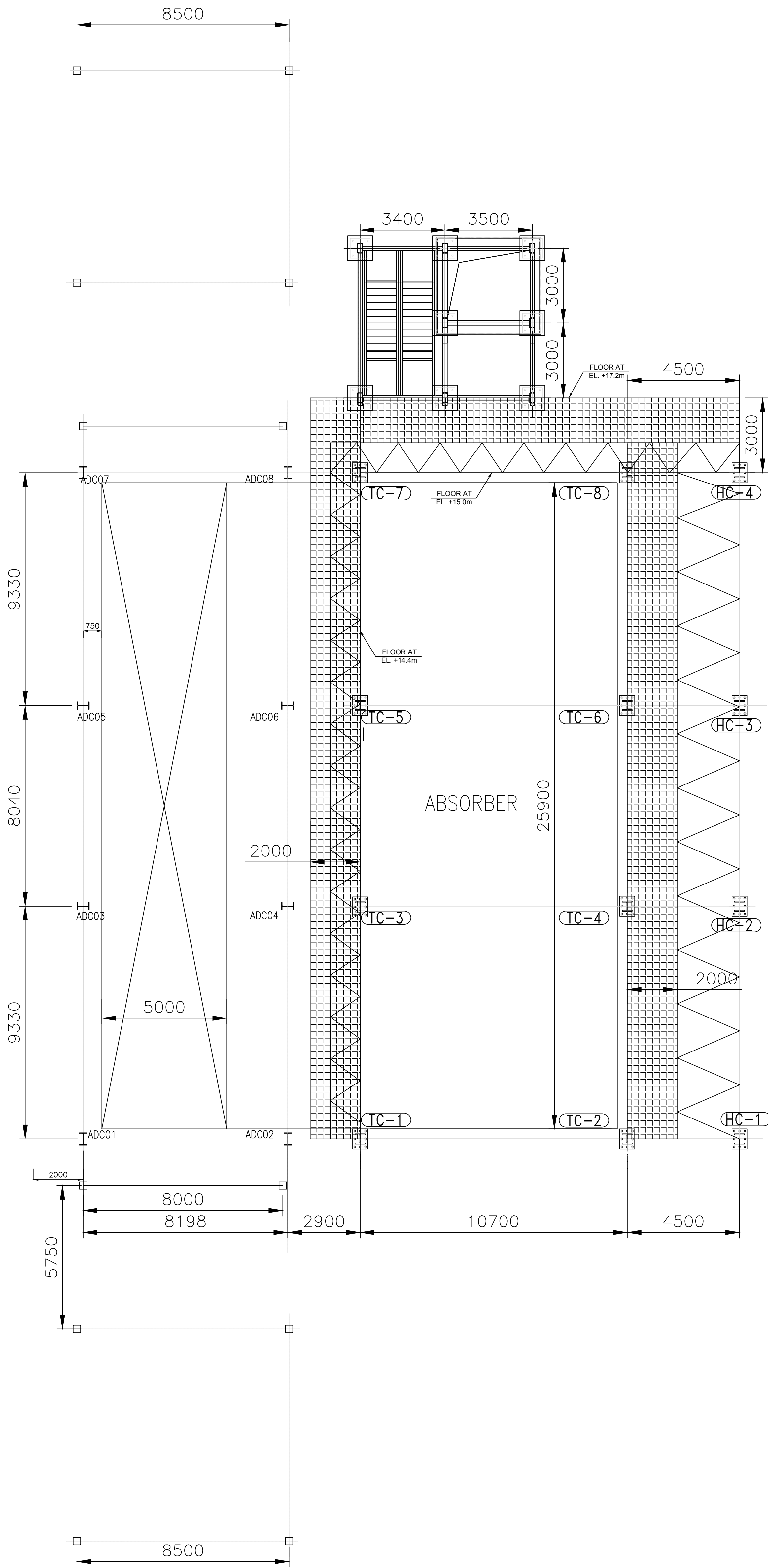
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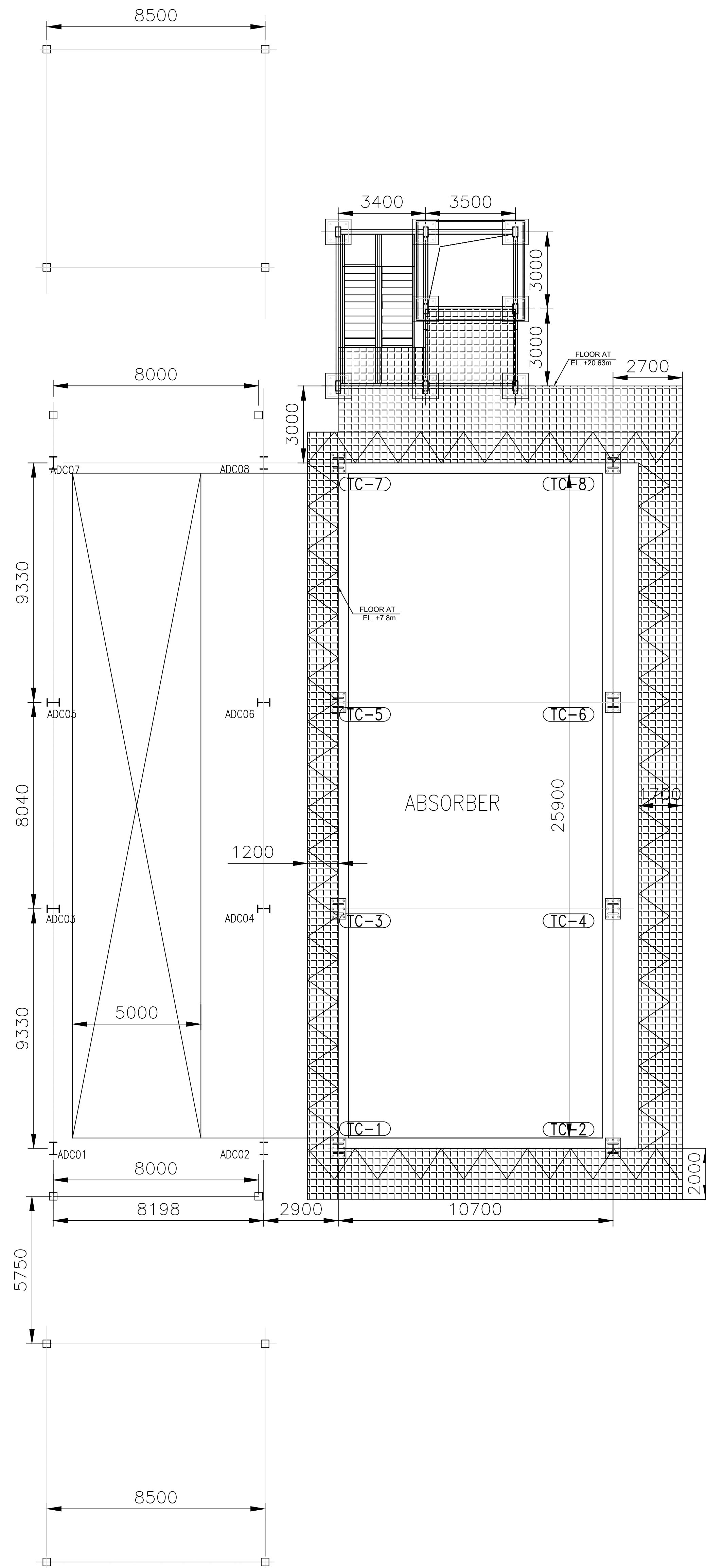
Plan @ EL +13.2m

REV.	DATE	ALTD.	CHD.	APPD.
Q3	25.02.2022	PK	V.M.RAO	KUMAR K
PLATFORM UPDATED AS PER REQUIREMENT				
REV.	DATE	ALTD.	CHD.	APPD.
Q2	05.07.21	PK	V.M.RAO	KUMAR K
DRAWING UPDATED BASED ON CUSTOMER COMMENTS MAINTENANCE BKT SHIPPED BASED ON CUSTOMER COMMENTS				
REV.	DATE	ALTD.	CHD.	APPD.
Q1	19.08.2021	PK	V.M.RAO	KUMAR K
DRAWING UPDATED BASED ON CUSTOMER COMMENTS				

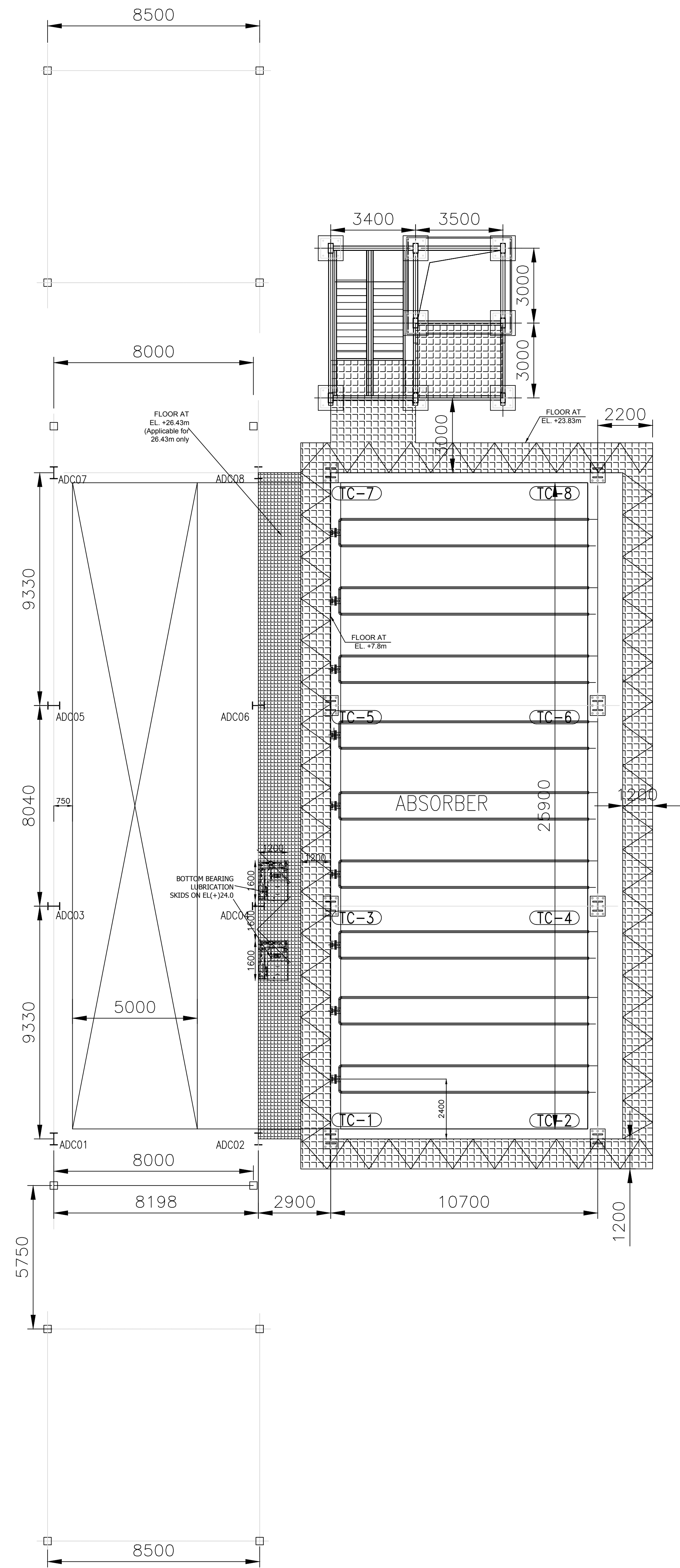
CUSTOMER NO: G801			
CUSTOMER: TSGENCO.			
KOTHAGUDAM TPS STAGE-VII UNIT#12(1X800MW)			
FGD SYSTEM PACKAGE			
 BHARAT HEAVY ELECTRICALS LIMITED, UNIT: BOILER AUXILIARIES PLANT, BANPET-632 406.	DEPT	NAME (BHEL)	DATE
	CODE	DRN	ILANCHEZHIAN S
	M	CHD	LOGANATHAN R
	APPD	KUMAR K	
 MITSUBISHI HITACHI POWER SYSTEMS, LTD. AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION			
TITLE:		SCALE : NTS	
GENERAL ARRANGEMENT OF ABSORBER			
BHEL DRG NO 00-FW-213-00317		SH 05 OF 07	
		REV NO	
		04A	



Plan @ EL +17.115m



Plan @ EL +20.63m



Plan @ EL +23.83m, EL +26.43m

REV.	DATE	ALTD.	CHD.	APPD.
03	26.05.2021	PK	Y.M.RAO	KUMAR R
PURPOSE: UPDATED AS PER REQUIREMENT				
REV.	DATE	ALTD.	CHD.	APPD.
02	05.07.21	PK	Y.M.RAO	KUMAR R
REMARKS: UPDATED BASED ON CUSTOMER COMMENTS. MAINTENANCE BY INSERTED BASED ON CUSTOMER COMMENTS.				
REV.	DATE	ALTD.	CHD.	APPD.
01	18.08.2021	PK	Y.M.RAO	KUMAR R
DRAWING UPDATED BASED ON CUSTOMER COMMENTS.				

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CUSTOMER NO: G801				
CUSTOMER: TSGENCO.				
KOTHAGUDAM TPS STAGE-VII UNIT#12(1X800MW)				
FGD SYSTEM PACKAGE				
	BHARAT HEAVY ELECTRICALS LIMITED, UNIT: BOILER AUXILIARIES PLANT, RANIPET-632 405.	DEPT	NAME (BHEL)	DATE
		DRN	ILANCHEZHIAN S	14.05.21
		M	CHD LOGANATHAN R	14.05.21
		APPD	KUMAR K	14.05.21
		MITSUBISHI HITACHI POWER SYSTEMS, LTD. AIR QUALITY CONTROL SYSTEMS TECHNOLOGY DIVISION		
TITLE: GENERAL ARRANGEMENT OF ABSORBER				
BHEL DRG NO 00-FW-213-00317			SH 06 OF 07	
			REV NO 04A	

00	10.11.20	Fresh Issue			
REV	DATE	DESCRIPTION / NOTE	PRD	CHD	APD

REVISIONS

TITLE : H017887/EM – ERECTION MANUAL FOR GAS-GAS HEATER (GGH) AND ACCESSORIES.

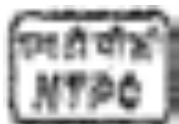
PROJECT : 1X660 MW PANKI THERMAL POWER EXTENSION PROJECT

CUSTOMER:



UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAM LTD

REVIEW CONSULTANT:



NTPC LTD
(A GOVERNMENT OF INDIA ENTERPRISE)

EPC CONTRACTOR:



BHARAT HEAVY ELECTRICALS LTD.
BOILER AUXILIARIES PLANT, RANIPET

GGH VENDOR:



HOWDEN UK LIMITED.

	NAME	DATE	
PREPARED BY	A. Nimmo	10/11/20	STATUS : <i>FOR APPROVAL</i>
CHECKED BY	A. Nimmo	10/11/20	BHEL CUST NO :
APPROVED BY	S Steele	10/11/20	BHEL DOC NO :
			REV NO :00
CUSTOMER DRG./DOC NO.:			



Erection Manual

Project: Vertical Shaft Gas-Gas Heater – Panki FGD
Client: BHEL

Project: H017887 Panki FGD GGH

Howden UK Ltd.
Old Govan Road
PA4 8XJ,
United Kingdom

Tel: +44(0)141 885 7300
Web: www.howden.com

Revolving Around You



Customer: BHEL

Our ref: H017887

Project: Gas Gas Heater

Your ref: RAH-553

Site: Panki FGD, Uttar Pradesh, India

Date: 21.10.2020



REGISTER OF MODIFICATIONS

Issue Ref.	Page	Description of Change	Modified By	Date
0	All	First Issue	AN	10.11.20

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Customer: BHEL

Our ref: H017887

Project: Gas Gas Heater

Your ref: RAH-553

Site: Panki FGD, Uttar Pradesh, India

Date: 21.10.2020



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CONTRACT DETAILS

HUK Contract No.	:	H017887
Client	:	BHEL
End User	:	Panki FGD
Location	:	Uttar Pradesh, India
Application	:	Wet Limestone-Gypsum FGD
Gas Heater Type	:	34.5 GVN 820
No. of Gas Heaters	:	1-off
Erected by	:	Others

(Note – all drawing and document nos referred to within these instructions are preceded by Howden project no. H017887)

1.0 STORAGE AT SITE

For gas-gas heater main shippable assembly dimensions and weights refer to transportation drawings provided (532001 – 532004)

1.1 Protection

The main gas-gas heater assemblies and components will arrive at site with the following protection.

Machined surfaces	Rust Veto 232 or Tectyl 506*
Un-machined surfaces	Painted in accordance with the Contract Paint Specification
Rotor sections	Temporary rust preventative Rust Veto 232 or Tectyl 506
Bottom bearing housing	CorrTec CorrShield VpCI-369 or equivalent, covered & sealed.
Bottom bearing jacking plate, cover plate, shims, hub seal housings	Rust Veto 232 or Tectyl 506*
Bottom Bearing	Crated and sealed in a polythene bag with a plentiful supply of silica gel crystals and a desiccator to give visual indication of the presence of moisture.
Element packs	Palletized and covered with polythene sheets. A maximum stack height of two packs must be maintained. If there is any sign of dampness use silica-gel crystals.
Cleaning Devices, Local Control Panels, Inverters, Rotor Seals, Instrumentation	Crated and sealed in a polythene bag with a plentiful supply of silica gel crystals and a desiccator to give visual indication of the presence of moisture.

*Rust Veto should be removed with solvents before assembly of parts. Storage of these chemicals must be conducted very carefully and safely in accordance with the storage instructions on the product packaging.

***** DO NOT EXCEED the MAXIMUM stack height of two packs of elements. Ensure they are securely and safely balanced during storage. Avoid stacking of other equipment, if at all possible, where space permits non-elevated stacking. If stacking is unavoidable then it must be carried out with the relevant due care and attention of the practicalities of the items being stacked to ensure that they are lifted correctly and there will be no damage caused to these parts during stacking and no risk of toppling.

For storage information on seal air and low leakage fans refer to the separate instructions provided.

1.2 Outdoor Storage

The following heater assemblies can be stored outdoors, clear of surface water (on blocks if necessary). To prevent rainwater collecting on the assemblies a temporary framework covered with P.V.C. sheeting should be fitted.

- Bottom girder and bearing stool
- Top structure**
- Bottom structure
- Rotor spider
- Rotor sections
- End pillars and hinges
- Rotor housing and side pillars
- Transition ducts
- Top and bottom access platforms
- Duct tubular stiffeners
- Low leakage fan ducting

Inspection: On arrival and every four weeks to ensure no deterioration of protective coatings.

** If the top structure has been allowed to fill with rainwater it MUST be emptied prior to installation or serious damage may occur to the GGH upon start-up. Water accumulation in the top sectorplate must be drained.

1.3 Indoor Storage

The following heater assemblies must be stored indoors, preferably heated.

- Bottom bearing assembly
- Top bearing assembly
- Heating surface element packs
- Rotor drive unit
- Cleaning devices
- Local control panel and Inverters
- Instrumentation
- Rotor seals
- Hub seals
- Lubrication unit and piping
- Hydraulic jacks, element slings, needle gauges
- Rotor erection equipment
- Seal air fan and piping
- Low leakage fan
- Low leakage fan system expansion joints
- HP/LP water pumps

For additional storage instructions for the above items refer to manufacturer's instructions in the Howden Subcontractors Manual for this contract.

Inspection: On arrival and every 3 months. If dampness is present inside Polythene renew or install silica-gel crystals.

2.0 ERECTION PROCEDURE

2.1 General Description

The Howden Regenerative Gas-gas heater consists of the following main assemblies:

- a) Top Structure
 - b) Bottom Structure and Beam
 - c) Heating Surface Elements and Containers.
 - d) Rotor in which the element containers are packed.
 - e) Rotor Housing in which the rotor rotates.
 - f) End Pillars and Hinges
 - g) Sealing Arrangements.
 - h) Drive Unit (Rim Drive type).
 - i) Rotor Bearings.
 - j) Ducts and Stiffeners
 - k) Platforms and Handrails
 - l) Sootblowers, LP and HP Water Pumps.
 - m) Low leakage fan and 2 x seal air fans
- a) The top structure consists of two braced steel parallel girders attached at the ends to the top of each end pillar. This framework supports the top sectorplates, the top false sectorplate, and the top steady bearing housing.
- b) The bottom frame consists of two mild steel universal beams that house the bottom support bearing and carry the weight of the rotor. This frame also supports the end pillars, the bottom sectorplate and the bottom false sectorplate via support brackets. The ducts connecting to the underside of the heater are also partly supported from the bottom frame.
- The ends of the bottom girder are bolted directly to the boiler house supporting steelwork, which is levelled by packers and shimmed as required.
- The bottom stool is used to transmit the load of the rotor to the supports.
- c) The heating surface elements are packed into containers to facilitate removal and handling from the rotor. The element packs are supported on steel bars welded to the rotor structure.

- d) The rotor is constructed from Corten steel plates carried on a central hub. The centre section of the rotor, or spider, is an integral part of the hub. Radial plates extending from the hub to the periphery of the rotor, divide the rotor into sectors which, in turn, are sub-divided by partition plates, secondary radial division plates and sector division plates. The compartments so formed are filled with the heating surface elements. The rotor is essentially a large drum of a twenty-four flat sided construction.

To facilitate erection the sectors of the rotor are forwarded to site in sections, and these are assembled to the rotor hub spider at site.

- e) The rotor housing, part of the heater casing, is manufactured from mild steel plates and encloses the outer shell of the rotor. It comprises of six sections, these being assembled between the two end pillars to form a circular construction.

The rotor housing also helps to support the top and bottom transition ducts connecting the heater into the FGD duct system, and supports the drive unit.

- f) The mild steel end pillars support the top frame that centralises the rotor steady bearing.

The end pillars also support the ends of the top false sectorplates and each end pillar carries an axial seal plate, integral with the pillar. The end pillars are connected via large support hinges to the end of the bottom frame the loading being transmitted directly through the girder ends to the gas-gas heater supporting steelwork.

- g) The sealing arrangements consist of top and bottom, circumferential seal strips, radial seal strips that seal against the sectorplates, axial seals that seal against the sectorplates, and hub seals.

The hot end outer circumferential seal seals against the stationary bar welded to the rotor housing. The cold end outer circumferential seal is attached to the duct and seals against the flange of the cold end rotor tyre.

Axial seal strips attached to the vertical edge of the radial plates, which seal against the axial seal plates attached to the end pillars.

The sealing surfaces at the top & bottom and outer circumference of the heater are nonadjustable. The heater has been designed to achieve the minimum seal clearances in these areas with the maximum rotor/housing distortion.

The Erection Supervisor should therefore be aware of the rotor seal clearances indicated on the 'cold seal setting chart', it is essential to attain the best possible rotor and housing geometry to achieve alignment and minimise operating clearances.

Hot End Radial Seals:

Strips of Avesta stainless steel 2 mm thick bolted along the top edges of the 48 radial plates of the rotor, supported by 2 mm thick Avesta plate backing washers and secured by M12 studs and robust mild steel retaining nuts with PTFE washers.

Cold End Radial Seals:

Strips of Avesta stainless steel 2 mm thick bolted along the bottom edges of the radial plates of the rotor, the seals being supported and secured with 2mm thick Avesta plate washers, M12 studs, PTFE washers and robust mild steel cap nuts.

Axial Seals:

Strips of Avesta stainless steel 2 mm thick bolted to the vertical peripheral edges of the radial division plates of the rotor and to the axial seal support bars. Seals supported above and below pin rack in a similar manner to the hot and cold end radial seals.

Inner Circumferential Seals:

Strips of Avesta stainless steel 2 mm thick bolted to an annular support bar around the top and bottom of the rotor hub baffle. The strips seal against the top and bottom sectorplates and are secured by means of 2mm thick Avesta plate washers and robust mild steel cap nuts with PTFE washers.

Outer Circumferential Seals:

Cold end outer circumferential seal of Avesta stainless steel 2 mm thick, bolted to the transition ducts, are provided to close the gap formed between the periphery of the rotor and the rotor housing. Seals secured with 2mm thick Avesta plate washers and robust mild steel cap nuts and PTFE washers.

The hot end is sealed by the outer circumference of the rotor, which is fitted with 2mm thick Avesta seal strips secured with 2mm Avesta plate washers, robust mild steel cap nuts and PTFE washers, and these seal against a series of 6mm thick mild steel bars that are welded to the landing plate of the rotor housing. The bars are lined after installation to protect against corrosion.

Hub Seals:

The hub seals consist of a gland type seal and additional seal strips of Avesta stainless steel 2 mm thick, secured by 6mm thick Corten rings at the hot and cold end. The gland seal comprises of housing, packing material, and housing spigot which are fitted to the top and bottom structure and provide a gas tight seal around the rotor hub tube. The seal strips are fitted in two layers to the top and bottom sectorplate and provide a labyrinth type seal around the rotor hub tube. The annular space between the inner and outer hub seals is pressurised with air from the sealing air system.

- (h) The driving force to the rotor is applied at the rotor periphery via a pin rack and drive pinion arrangement, the pinion being connected to the shaft of a housing mounted, combination gear drive unit with AC main drive and standby air drive.

The drive unit is shipped to site as one complete unit.

The drive motors are flange mounted to the Primary Gear Units.

The non driving end of the main motor is extended for fitting a hand turning device used in maintenance of the Gas-Gas Heater. This must be removed for normal operation of the gas-gas heater.

- (i) The rotor is supported by means of a self-aligning spherical roller thrust bearing which is located in a bearing housing mounted between the bottom girders.

At the top end of the rotor a spherical roller steady or guide bearing is provided. This bearing holds the rotor in position and allows the rotor to expand vertically upwards during operation of plant.

Lubrication to both the top and bottom bearing is by an oil circulating system.

A cooling water supply is required at each lubrication unit.

- (j) Transition ducting is used to guide the treated and untreated gas flow into the rotor. Stiffeners are used to prevent deformation as a result of the differential pressures across the treated and untreated gas ducts. Both are made of mild steel and are lined after installation, except the UTG inlet duct, which is Corten material. An inspection window (illuminated type) is provided at the UTG inlet duct. Internal surfaces of the gas-gas heater static components that come into contact with the process gas are flake glass lined by others to protect them from corrosion. External surfaces are thermally insulated by others to ensure the gas-gas heater expands as designed. Thermal lagging and flake glass lining are not in Howden scope of supply, however installation guidance drawings are provided.
- (k) Platforms and handrails have been supplied to allow access to the top bearing, and bottom bearing. All other platforms and access is by others.
- (l) For cleaning the GGH is provided with two cleaning devices one at the hot end and one at the cold end, a dedicated HP and LP water wash pump and a separate wash pipe local to the drip tray at the cold end.
- (m) A low leakage fan is provided which reduces the leakage by supplying treated gas to the top sectorplate seal area to purge untreated gas from the rotor. 2-off seal air fans are also provided (one main, one standby) to pressurize any areas of the GGH which has the potential for leakage of poisonous gasses.

Note – all electric motors on the GGH (and it's accessories) are provided with associated motor starters

2.2 General Remarks

Unloading and Handling

All components have ample strength to withstand operating conditions and are well protected against damage under normal transit. However rough handling during transit, or thoughtless unloading at site may result in distortion and damage and must be rectified before erection is commenced. Care and good judgement with safety precautions in mind must be exercised when transporting and lifting the various components involved so as to avoid bending or twisting as such distortions will seriously hinder erection and could greatly affect the performance of the completed heater. The main components have been stiffened and protected for transport in accordance with the transportation drawing.

Particular attention should be applied to the element packs and the rotor.

Howden UK cannot be held responsible for any damage due to miss-handling of equipment.

Assembly on Site

Critical Procedures

It is essential that all check sheets are checked and countersigned by a Howden TA or by Howden Engineering Department. Failure to do so can compromise the correct assembly of the heater which in turn will affect the thermal performance and mechanical integrity and may invalidate any associated warranty.

There are five highly critical areas within the erection procedure during which particular attention must be given to ensure that the set up is within the tolerances given.

- 1. Before fully welding the rotor, and with the structure temporarily welded, a full 360-degree dimensional check should be performed on the rotor ([Checkpoint 6](#))**
- 2. After the rotor has been fully welded a 360 degree comprehensive check should be performed ([Checkpoint 7](#))**
- 3. Following installation of all the heat transfer element packs, the setting of the sector and axial sealing plates should be dimensionally checked, prior to fully welding, to verify that the specified clearances between these plates and the rotor have been achieved ([Checkpoint 14](#) and [15](#))**
- 4. Following installation of all the heat transfer element packs, the rotor tyre to sectorplate and axial seal plate clearances should be checked ([Checkpoint 20](#) & [Checkpoint 21](#)).**
- 5. After the installation of all the seals i.e. radial, axial, outer circumferential and inner circumferential, a comprehensive dimensional check should be**

performed to verify that the seal clearances as specified on the cold seal setting drawing are within tolerance. (Checkpoint 22, Checkpoint 23, Checkpoint 24, Checkpoint 25, Checkpoint 26, Checkpoint 27)

The eventual satisfactory operation of the gas-gas heater depends to a large extent on the degree of accuracy maintained during erection. Absolute attention must be applied to the levelling and aligning of all the gas-gas heater components as they are assembled. For example, a misaligned rotor leads to faulty sealing and uneven weight distribution resulting in unnecessary excessive leakage.

Attention should be given to the following points during and after erection:-

1. Ensure that the gas-gas heater connecting ducts are not bearing more weight of ductwork than that agreed and causing strain to the gas-gas heater. Undue strain can impair alignment of rotor sealing surfaces.
2. The rotor housing should be aligned correctly and uniformly with the rotor extremities. The sealing plate clearances should be adequate to accommodate expected rotor expansions as specified.
3. The drive unit rotates in the direction indicated. Check against the GA drawing.
4. Ensure that all transit straps have been removed from clients duct expansion joints, and the side pillars and end pillar hinges. This is important otherwise distortion of gas-gas heater sealing surfaces can result.
5. Ensure that the top of the rotor is covered immediately after the installation of the heating surface element packs, to protect against choking or damage during erection. This will protect the enamelled element sheets.
6. Ensure that no debris is left inside the gas-gas heater before proceeding with erection. All items painted black are for transport purposes only and must therefore be removed as necessary during the various stages of erection.
7. During erection the gas-gas heater should be rotated a few revolutions once a week to protect the roller race surfaces by means of the hand turning device which is connected to the extension shaft of the main drive motor.
8. Ensure that external surfaces that are not insulated are correctly protected against corrosion by renewing or repairing any damaged coatings.
9. Ensure that the external insulation and cladding are correctly applied and secured to the gas-gas heater casing and that removable panels are provided where access doors and tapping points are provided.

Note: The supply and application of insulation is out with Howden UK's contractual commitment.

WARNING: No operation of the FGD system should take place until the Gas-gas heater and associated ducting is fully insulated and clad.

10. If prolonged delay is expected between completion of erection and commissioning of plant ensure that full instructions with regard to protection of plant are requested from Howden UK.
11. It should be noted that many of the heater fabrications are large and cannot be kept completely rigid during transportation from the factory to site. It is therefore most probable that some adjustment/manipulation will be necessary during installation at site in order to achieve the required assembly tolerances.
12. Where exposed threaded studs are welded into assemblies, such as the studs on the duct for seal adjustment. These may require to be re-threaded as found necessary after erection.
13. The majority of the rotor housing, ducts, and top and bottom structure flow surfaces can be flake glass lined as individual components at ground level. However where these components have welded joints on assembly the lining must be kept away from the joints until the welds are performed. The lining contractor should advise on size of unlined area at joints to prevent welding damaging lining. The welded joint is then lined after assembly. It is important that all welds and edges are prepared to an acceptable standard, (refer to drawings 175001 - 175003), prior to lining being applied.

Alternatively the lining can be applied after the gas-gas heater has been assembled which means most of the welding can be done prior to applying the lining. This method also minimises the risk of damaging the lining when handling the components during assembly. **However the sealing surfaces on the top and bottom sectorplates and axial seal plates should be lined prior to assembly as these areas will become inaccessible after the rotor is assembled to the gas heater.** The following instructions are written based on the lining being applied after components have been assembled.

2.3 Erection Facilities

This erection manual has been compiled specifically for the purpose of providing a guide to the erection procedure of a gas-gas heater and has been based on Howden past experience. The manual has been compiled with safety precautions in mind; however it is the responsibility of the personnel involved in carrying out the erection to ensure that all safety precautions are taken at site during lifting and fitting of all assemblies.

The capacity and position of erection lifting beams and availability for cranes and winches greatly determines the method that can be adopted for the erection of the heat exchanger.

If space permits at datum level it could be beneficial to use a mobile crane to lift the heavy assemblies into position. Failing this an erection beam would be required at a suitable point above the heater capable of absorbing direct and side loads to enable the heater parts to be swung into position.

All personnel should be made fully aware of the available erection facilities and the schedule of erection, which should have been planned well in advance of the commencement date of erection. All site personnel should also be fully conversant with all Howden UK erection drawings and the various stages of erection involved prior to commencement of erection. **It**

is dangerous to work under or walk under suspended loads and personnel should be made aware of this hazard.

All site welding should be performed in accordance with the welding instructions given in Appendix 2 of these instructions.

Where space permits it is advantageous to assemble the some parts at ground level and carry out as much work as possible before lifting the assembly into position.

2.4 Inspection

A number of dimensional tolerances are called for in the following Erection Instructions which are given to ensure that the desired sealing performance will be achieved and that there is adequate clearance between the rotor and all sealing surfaces for thermal expansion. Where tolerances cannot be achieved as stated, Howden Technical Advisor should be consulted or the Howden UK Office informed.

All inspection checks should be made by an appointed Surveillance Engineer but, where stage checks are called for; it is recommended that these should be made by Customer's Surveillance Engineer in conjunction with an independent representative.

A record of all stage check results must be forwarded to the Howden UK Offices for record purposes. Site Erection Quality Check Sheets are supplied with this Manual. These specific dimensional checks must be carried out during assembly and the measurements recorded on the check sheets provided.

2.5 Viton Seals

Viton seals, (or gaskets), are provided at access doors and some duct bolted joints. These seals are cut to size and should not require to be trimmed at site. If however trimming is required cut with a sharp knife or shears.

Grinding of Viton should be avoided since the fine dust resulting from the abrading of Viton can generate toxic decomposition products if burned. Inhalation of dust particles should be avoided. As with all grinding operations, respirators and safety goggles should be worn, and adequate ventilation should be used. Neoprene gloves must be worn.

Welding close to Viton or intentional burning of Viton should be avoided because of the formation of highly toxic and corrosive combustion products.

In the event of a fire involving Viton, hydrogen fluoride, carbonyl fluoride, carbon monoxide, and low molecular weight fluorocarbon fragments can be generated. Personnel fighting such a fire must wear face masks and self-contained breathing apparatus. All unprotected personnel must leave the area immediately. Anyone exposed to fumes from the fire must be moved to fresh air at once and treated by a doctor.

Anyone handling residues of Viton, which have been involved in a fire, **MUST** wear Neoprene gloves to avoid skin contact with these highly corrosive residues which likely include hydrogen fluoride. The gloves **MUST** be discarded after use.

First Aid:-

Skin contact

- Wash with soap and water after handling Viton.

Eye contact

- Immediately, flush the eyes for at least 15 minutes, with water.

Inhalation

- Remove to fresh air. If in respiratory distress, get medical aid.

Ingestion

- DO NOT INDUCE VOMITING. GET MEDICAL AID.

Aspiration

- Get medical aid immediately.

2.6 Erection Drawings (all drawings preceded by H017887)

GENERAL DESCRIPTION	HUK DRAWING NO.
General Arrangement Drawing	001001
General Arrangement of Low Leakage Fan	000001
Site Assembly of Heater	001002
Site Assembly of Heater	001003
Site Assembly of Heater	001004
Site Assembly of Rotor	001007
Site Assembly of Rotor	001008
Position of Mechanical Terminal Points	001010
Functional Control Description for Gas-Gas Heater	FCD
Electrical Instrumentation Terminal Points	088009
P&ID	088012
Instrument Schedule	088013
Valve Schedule	088014
Panel Schematic Wiring Diagram	088030
Electrical Interconnection Block Diagram	088031
Assembly of Centre Section	104001
Detail of Tubular Duct Stiffeners	116001/116002
Arrangement and Detail of Rotor Housing	126001
Assembly of Top Bearing and Drive	136001
Assembly of Bottom Bearing	144001
Guidance for Hydraulic Jacking of Rotor	154001
Site Assembly of Pin Rack	155001
Assembly of Pinion Drive	155005
Arrangement of Top Platform	159001
Assembly of Bottom Bearing Access Platform	163001
Arrangement of Insulation	174001
Arrangement of Insulation	174002
Arrangement of Glass Flake Lining	175001
Lined surfaces on Gas Heater	175002
Details of Finishing Requirements on Welds & Edges of Lined Surfaces	175003
Detail of Rotor Identification and Transportation	180003
Assembly Hub Seals	182001
Assembly of Radial, Axial and inner Circ. Seals	186001
Assembly and Detail of Radial Seal Setting Bar	186003
Assembly and Detail of Axial Seal Setting Bar	186004
Cold Seal Setting Diagram	186005
Assembly of Top and Bottom Outer Circ. Seals	189001
Assembly and Detail of Tie Bars	191001
Assembly and detail of Rotor Stop Alarm	196001
Handling Arrangement Elements, Drive Unit and Bottom bearing	200001
Guidance for Bottom Bearing Removal	200002
Assembly of Cleaning Device and Support	240002

Arrangement of Cleaning Device Drip Tray	240010
Arrangement of Seal Air Piping	330001 (4 sheets)
Transportation of Main Assemblies	532001
Transportation of Main Assemblies	532002
Transportation of Main Assemblies	532003 (3 sheets)
Transportation of Main Assemblies	532004
Arrangement of Purge Ducting	543001
Input/Output List	ELEC1
Motor Datasheets for GGH and Accessories	ELEC2
Arrangement of Drive Unit and Air Motor Ancillaries	SUB001 & SUB002
Arrangement of Cleaning Devices	SUB010 (2 sheets)
Cleaning Device Terminal Box Wiring Schematic	SUB014
Arrangement of Cleaning Device Control Panel	SUB015
Cleaning Device Control Panel Wiring Diagram	SUB016
General Arrangement of Local Control Panel	SUB020
Control Panel Internal Arrangement	SUB021
Control Panel Terminal Block Arrangement	SUB022
VSD Panel General Arrangement	SUB024
VSD Schematic	SUB025
VSD Schematic – Terminal Layout	SUB026
Arrangement of High Pressure Pump	SUB040
High Pressure Pump Control Panel Wiring Diagram	SUB041
Arrangement of Seal Air Fan	SUB090
Detail of Element Slings	TMP030
Gas Heater Nameplate	TMP034
General Arrangement of LP Water Pump	SUB400
General Arrangement of Bearing Lubrication Unit	SUB080
Arrangement of Purge Duct Expansion Joints	SUB340-343
Electrical Load List	ELEC3
Arrangement of HP Water Piping	335001
Arrangement of LP Water Piping	336001
Arrangement of Lubrication Oil Piping	150001 (2 sheets)

Copies of these drawings can be found in the Gas-Gas heater Drawing Manual for this project.

2.7 Erection Procedures

NOTE: THE FOLLOWING IS A TYPICAL ERECTION PROCEDURE WHICH, IF REQUIRED, CAN BE ALTERED TO SUIT INDIVIDUAL SITE AMENITIES.

SAFETY: AT NO TIME SHOULD ANY PERSONNEL BE INSIDE THE GAS-GAS HEATER WHEN THE ROTOR IS BEING TURNED. DETAILED HEATER TURNING PROCEDURES ARE INCLUDED IN [APPENDIX 3](#) ALL ROTOR TURNING OPERATIONS WITHIN THIS ERECTION PROCEDURE MUST BE CARRIED OUT IN ACCORDANCE WITH [APPENDIX 3](#)

FOR ERECTION CHECKPOINTS REFER TO [APPENDIX 1](#)

STAGE 1 PREPARING SUPPORTING STEELWORK

Refer to the following drawings

Drawing No.

General Arrangement Drawing

001001

1. Check orientation of gas-gas heater with supporting steelwork in accordance with the General Arrangement Drawing.
2. Check that the level of the supporting steelwork at the load points forming the gas-gas heater foundation are correct and mark out gas-gas heater centrelines. Install support plates (104/120, 001/118) by welding to steelwork as indicated on the drawings, ensuring correct orientation of the support plates.

Level support points using shims provided to within tolerance stated on Check Sheet 1.

If supporting steelwork is found to be out of level it must be reported to the Surveillance Engineer and to the Main Contractor's Resident Engineer immediately for rectification.

The above levels are to be rechecked after erection of gas-gas heater casing and later when the elements are loaded.

3. Using the packers and shim material provided level out the landing points on the supporting steelwork and tack weld packing/levelling material in position ready for the gas-gas heater centre section.

Measure and record the levelness of the 'H' and 'K' load points on the client's supporting steelwork (check sheet 1)

STAGE 2 FLAKE GLASS LINING – TOP & BOTTOM STRUCTURES & END PILLARS

Refer to the following drawings	<u>Drawing No.</u>
Arrangement of Flake Glass Lining	175001
Lined Surfaces on Gas-Gas Heater	175002
Details Showing Finishes Required on Welds and Edges of Surfaces Being Flake Glass Lined	175003
Transportation of Main Assemblies	532001 to 004

It may be preferable to line the majority of the top and bottom structure flow surfaces at this stage whilst they are at ground level. The application of flake glass lining normally requires controlled ambient conditions with regards to temperature and humidity which may be easier to control in a tented area at ground level.

The following joints require to be left unlined to allow the setting of the sectorplates and axial seal plates, (after setting, the joints will be welded and then lined):-

1. Between the top sectorplate and the top structure.
2. Between the bottom sectorplate and the bottom structure.
3. Between the axial seal plates and the rotor housing.
4. Between the top & bottom sectorplate and the axial seal plates.
5. Between sections of the drip tray

Also protect any welded studs from the lining.

STAGE 3 GAS-GAS HEATER BOTTOM CENTRAL SECTION

Refer to the following drawings

Drawing No.

Site Assembly of Heater	001002
Site Assembly of Heater	001003
Assembly of Centre Section	104001
Assembly of Bottom Bearing	144001
Transportation of Main Assemblies	532001 to 004
Assembly of Bottom Bearing Access Platform	163001

1. Assemble both bottom girders with the bottom bearing stool. Note that the bearing stool and bottom girder assemblies are match marked and must be assembled with the correct stool to the correct bottom girder assembly and in the correct orientation.
2. Lift the bottom girder assembly onto steelwork and secure with 8-off holding down bolts provided.
3. Remove the bottom bearing from its transport protection ready to fit into the bottom bearing housing. Thoroughly clean inside the bearing housing and fit the bottom nylon shim. Fit the bearing into the housing (see Subcontractor Manual for bearing manufacturers installation instruction – note that a special fabricated bearing installation cradle is provided to assist installation of the bearing into the housing). Complete the assembly by fitting the second nylon washer, cover plate, and housing seal.
4. The bottom bearing assembly can now be positioned and bolted to the bearing stool. It should be centralised with respect to the girder ends (end pillar hinge mounting holes) and the beam webs, and shimmed to the reference height shown on drawings.

Note: Do NOT weld plate washers to the bearing stool at this point.

5. Carefully install the jacking plate supplied with the rotor, ensuring that cover plate spigot is correctly located in the jacking plate (refer to drawing 144001).
6. Assemble the four end pillar hinges to the top face of the bottom girder. Shim to achieve height as shown in the drawing and secure with the bolts provided. Leave transportation stiffeners (painted black) in place.
7. Measure and record the levelness of the end pillar hinges ([Checkpoint 2](#))
8. Assemble bottom bearing access platform to bottom girder as shown on the drawing.
9. Position 4 jacks on top flange of girder, to support bottom structure, and pack to a height of 480mm approx. to enable jacking to 500mm.
10. Lift bottom structure onto jacks and centralise outer diameter of sectorplate with respect to the bottom beam and bottom bearing. ([See Figure 1](#))
11. Weld bottom structure mounting plates to top flange of girder

Note: Do NOT weld mounting plates to bottom structure supports at this stage.

12. Adjust height of bottom false sectorplate to level of top of end pillar hinges using jacks. Ensuring that level is maintained along entire length of false sectorplate ([Figure 2](#)).

13. Secure this level by bolting through support plates and centralising beams, then remove jacks.

Positioning of Bottom Structure

Position the bottom structure by ensuring that it's outside radius is in a central location with respect to the bottom beam and bottom bearing.

Tolerance = $\pm 2\text{mm}$

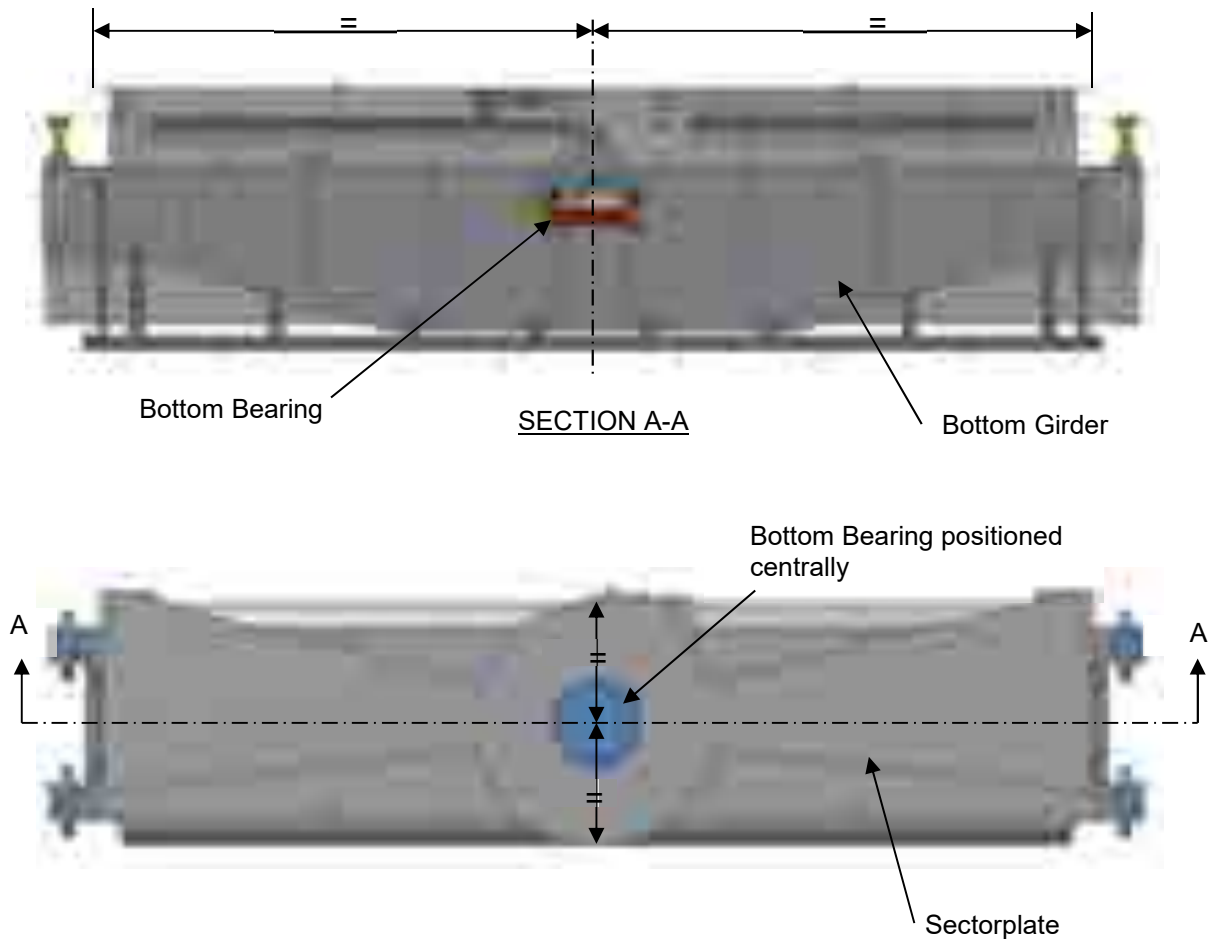
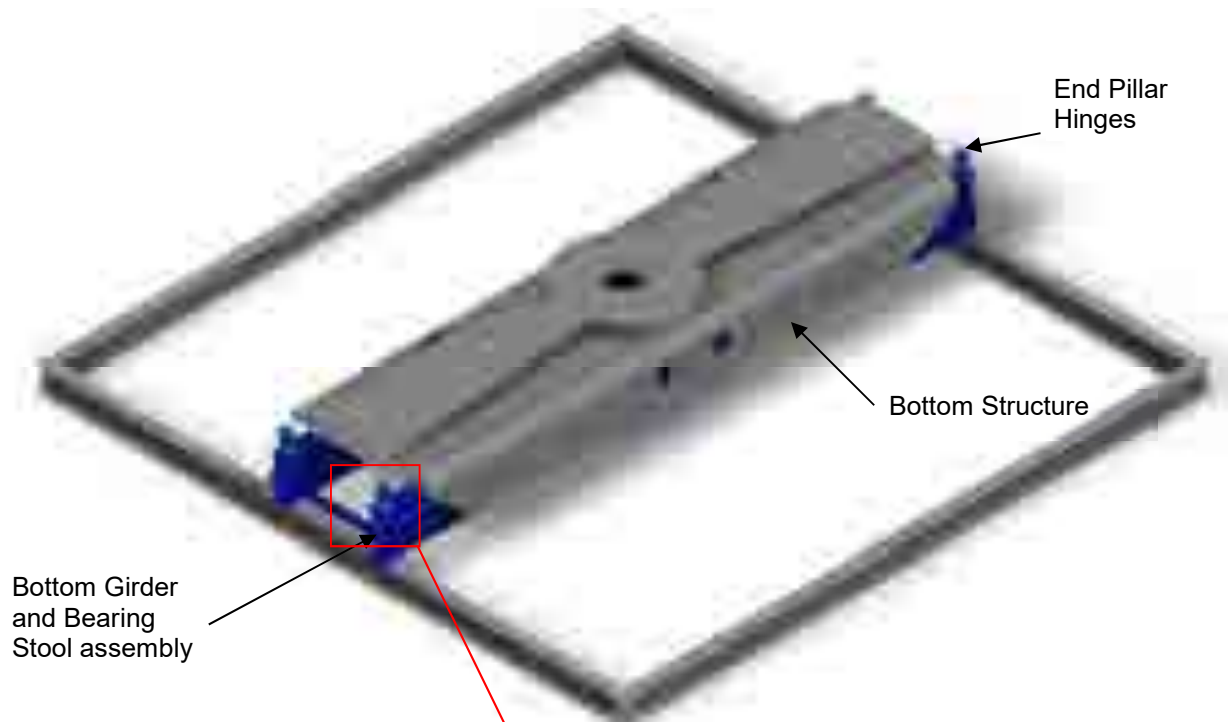
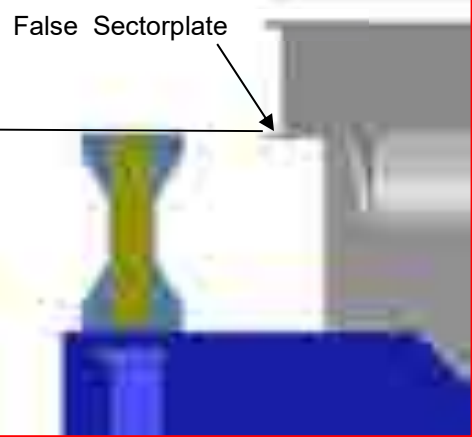


Figure 1 – Positioning of Bottom Structure and Bottom Bearing



End Pillar Hinge shimmed to level shown on drawing. False Sectorplate top surface set level with top of end pillar

False Sectorplate



STAGE 4 END PILLARS

Refer to the following drawings

Drawing No.

Site Assembly Drawing

001002

Centre Section Assembly

104001

1. Ensure that all end pillar hinges are locked in the vertical position.
2. Sling and lift one combined end pillar and axial seal plate assembly on top of hinges.

Note: Ensure the correct orientation of end pillars.

3. Adjust the axial seal plate position if necessary to obtain a close fit with the outer radius of the bottom sectorplate. Install the bolts and torque as per [APPENDIX 4](#).
4. Fit temporary stays to secure the vertical location of the end pillar assembly.
5. Repeat Steps 1 to 4 for remaining end pillar.
6. Check that both end pillars are vertical and that the dimension between them is correct. If not then adjust the temporary stays as required. This may involve removal of the hinge locking brackets, if so, these must be replaced and welded back in position.

Measure and record the plumbness of the end pillars ([Checkpoint 3](#)).

STAGE 5 ROTOR SPIDER

Refer to the following drawings

Drawing No.

Site Assembly of Heater

001002

Site Assembly of Rotor

001007

Assembly of Centre Section

104001

Assembly of Bottom Bearing

144001

Transportation of Main Assemblies

532001 to 004

1. Sling and lift the rotor spider from its transportation cradle using the lifting lug provided.
2. Carefully lower the rotor spider through the hole in the bottom sectorplate and false sectorplate.
3. Care must be taken when lowering the rotor spider to ensure that the recess in the bottom face of the rotor hub correctly locates with the spigot on the jacking plate.
4. After ensuring that the rotor spider is level, install temporary props to hold the rotor spider level until the top steady bearing is installed ([See Figure 3](#))
5. Remove lifting lug from top of rotor spider.

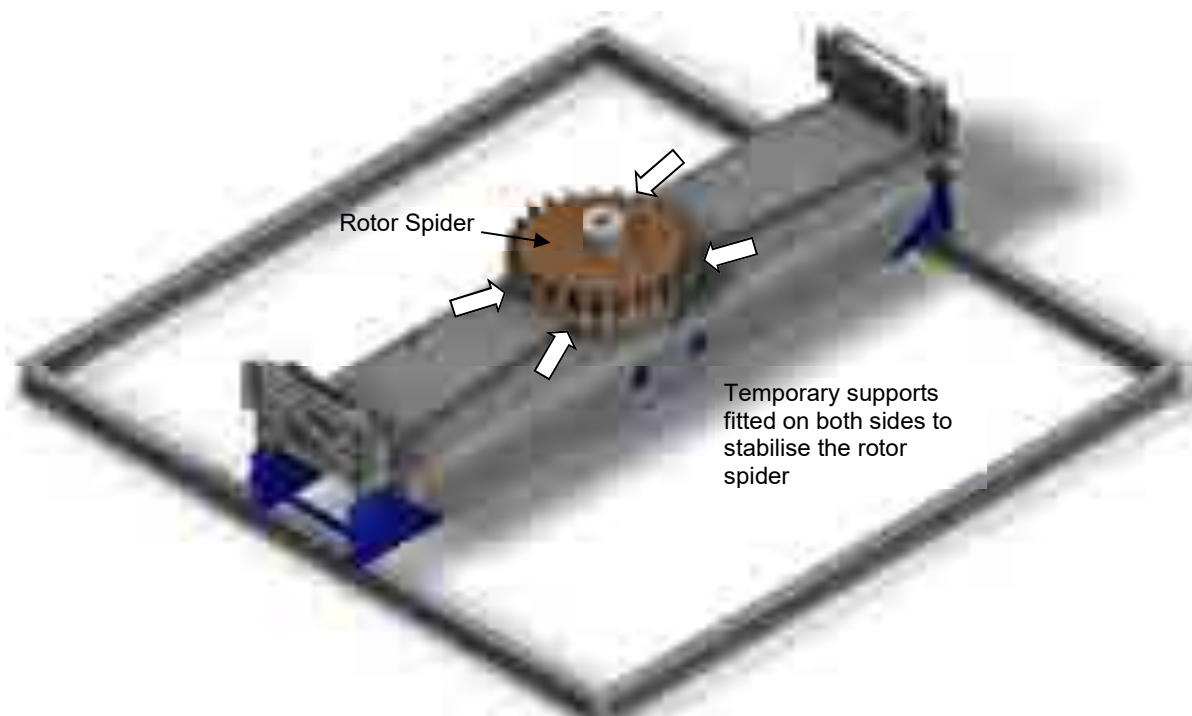


Figure 3 – Fitting Rotor Spider

STAGE 6 TOP STRUCTURE AND TOP PLATFORM

Refer to the following drawings

Drawing No.

Site Assembly of Heater

001002

Assembly of Centre Section

104001

Assembly of Top Bearing Access Platform

159001

Transportation of Main Assemblies

532001 to 004

Note: The top sectorplate is set at works assembly to a dimension which will allow the rotor to be fully assembled at site without fouling the sectorplate. When fully loaded with elements the bottom girder will deflect and the rotor will require to be jacked up and the bottom bearing shimmed to allow the correct clearance to be achieved between the rotor mean radial plate and the rotor housing ([Checkpoint 13](#)) once [STAGE 19](#) is reached.

1. The four support angles at the top of each end pillar column should be positioned and levelled to within 1mm. After the correct position of the angle has been achieved, each angle must be welded to the end pillar columns (See drawing 104001 and [Figure 4](#))
2. Position slings at the four lifting points on the top structure.
3. Lift top structure to position, ensuring that sectorplate locates over top of rotor hub and that the holes in the top false sectorplate align with support angles at the top of the end pillars.
4. Locate bolts through top false sectorplate and support angles.
5. After ensuring that top structure is correctly installed tighten bolts at end pillars.
6. Weld top structure to end pillars (see drawing 104001).
7. Remove temporary stays from end pillars.

Note: The end pillar hinge holding bars **must not** be removed until the Gas-gas heater is fully assembled.

8. Install the top platform onto the top structure. This procedure may be carried out at ground level if room and craneage is available (see [Figure 5](#). Note that the Panki gas-gas heater has it's drive unit located at the rotor periphery, not as shown.)

Note – it is recommended that the top structure ,once erected, is protected against rain and water accumulation by temporary tarpaulins until lagging and cladding is completed.

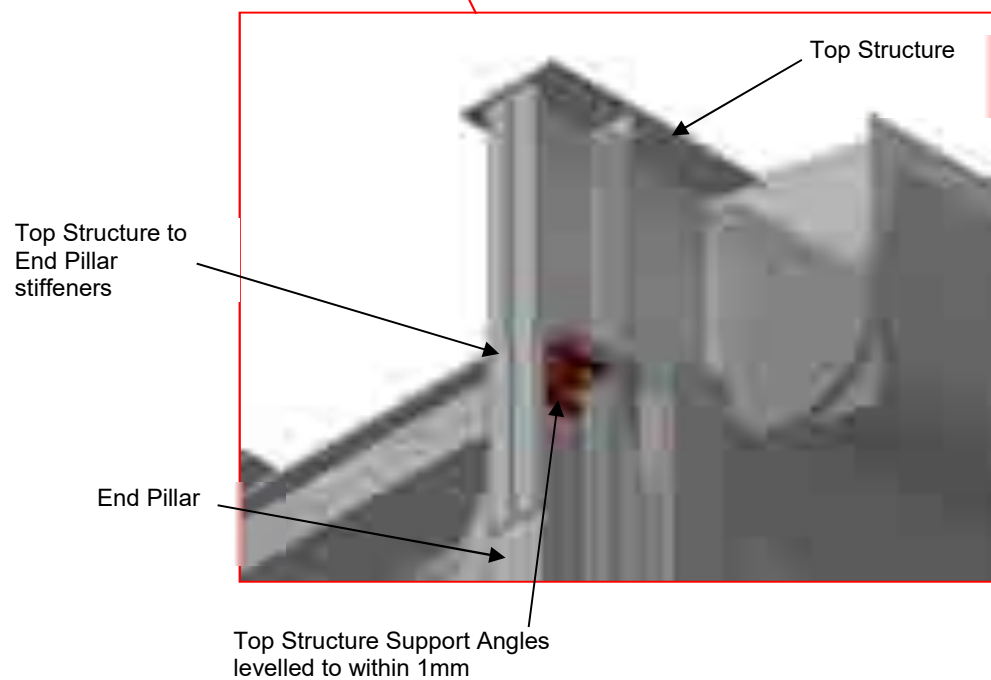
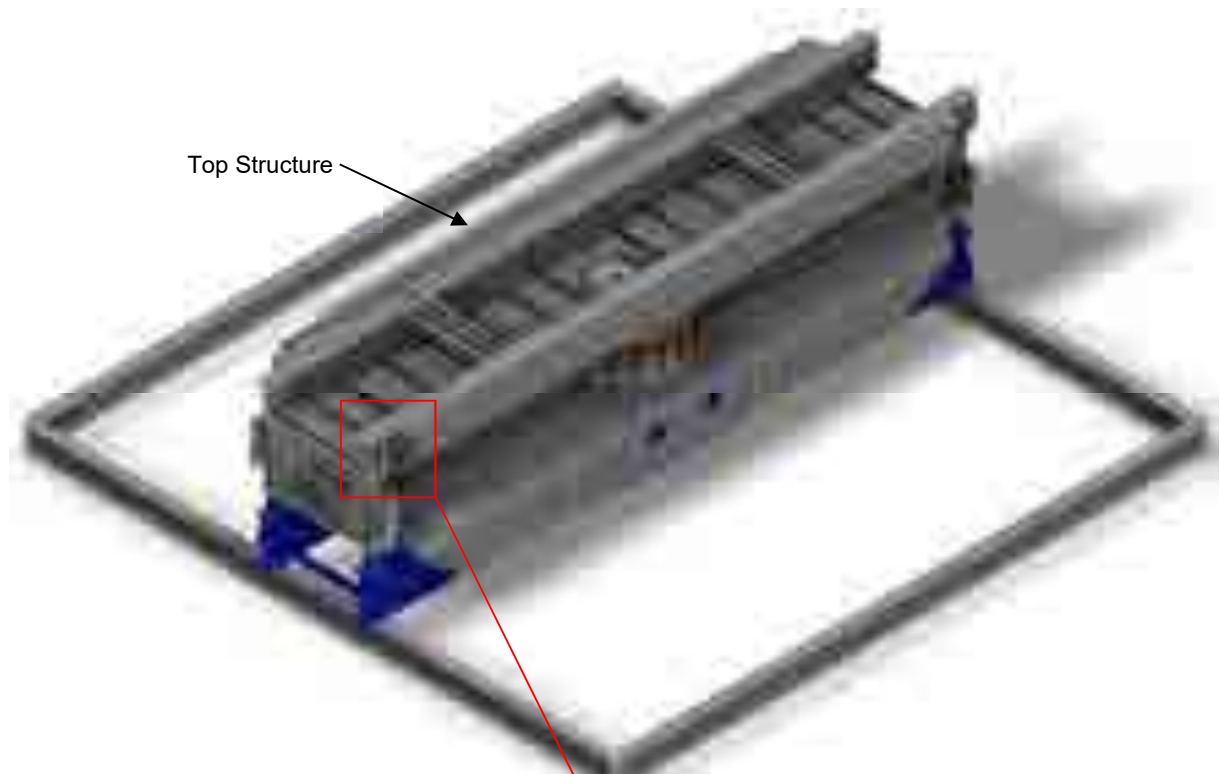
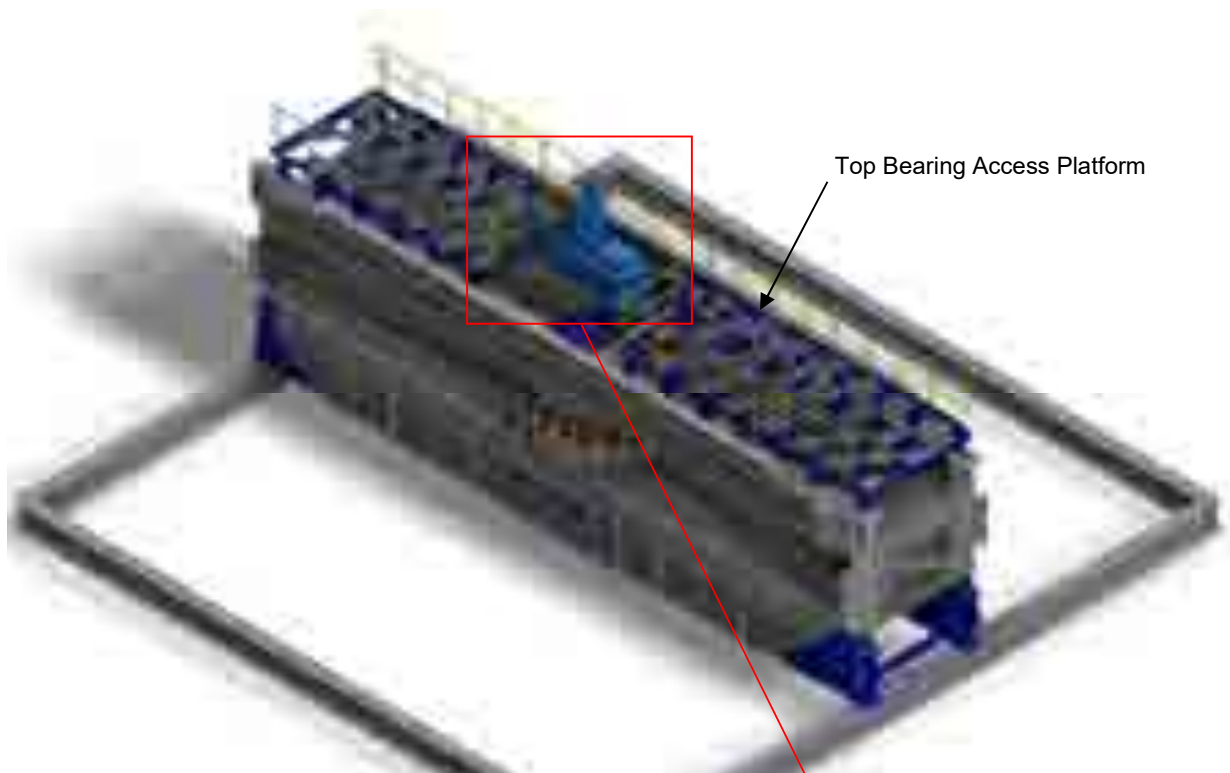


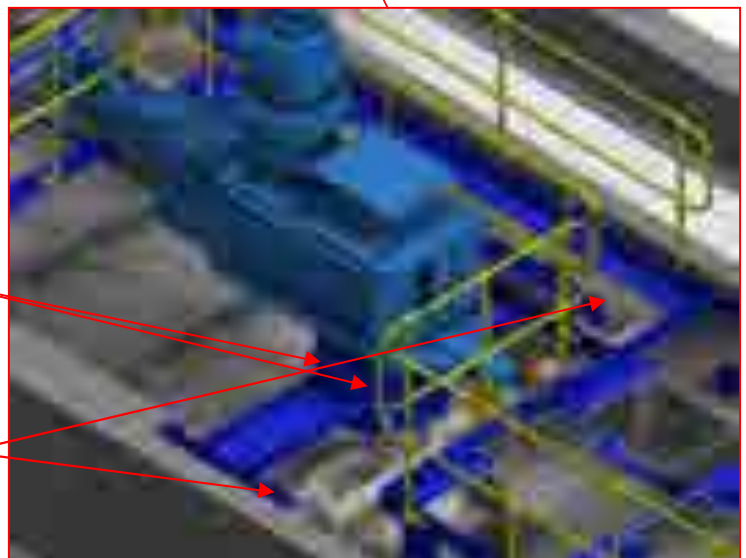
Figure 4 – Fitting Top Structure



Top Bearing Access Platform

Top Bearing Assembly

Adjuster Brackets



STAGE 7 TOP STEADY BEARING ASSEMBLY

Refer to the following drawings

Drawing No.

Site Assembly of Heater	001002
Assembly of Centre Section	104001
Assembly of Top Bearing	136001
Transportation of Main Assemblies	532001 to 004
Rotor Stop Alarm Assembly	196001

1. Lift the steady bearing assembly by means of the M36 eye bolt on the main shaft and gently lower into position ensuring that the correct orientation of flanges is being followed as shown on drawing 136001. Care must be taken to ensure that spigot in drive shaft locates correctly with recess in rotor hub.

WARNING: Assembly must only be lifted by means of the eyebolt. To support the steady bearing housing and prevent the weight of the housing resting on the bearing the housing outriggers should be slung to the M36 eyebolt by chain blocks and straps. On no account should the assembly be lifted by the steady bearing housing.

2. Fit the 12-off special bolts connecting stub shaft to rotor hub. Do not torque bolts at this stage.
3. Fit shims between top structure and bearing housing support legs such that the bearing housing is level and the top cover of the bearing housing lines up with the -10 graduation mark on the mounting bell (see drawing 136001). The bearing housing height will be readjusted after element loading at [STAGE 19](#).
4. Check and record the holes in the top and bottom sectorplates are concentric with the rotor hub to ensure the hub seals will fit. Measure and record the levelness of the spider. Make adjustments to position of rotor spider if required. ([Checkpoint 4](#)).

Note: If erector fails to centralise the bottom structure, axial seal plates, and rotor hub the outer radius of the bottom sectorplate may require to be trimmed to allow repositioning of the axial seal plates. The axial seal plates must be concentric with the rotor or correct setting of the axial seals (later in the build) will be compromised.

5. Once the spider is aligned drill clearance holes in the top structure and fit bolts and plate washers to secure the bearing housing to the top structure (see drawing 136001).

Note: Do NOT weld plate washers to the top structure at this stage. These will be welded after elements have been loaded and final alignment of the rotor has taken place during [STAGE 19](#).

6. Position and weld the top bearing stool adjusters to the top structure to support the rotor spider and top bearing assembly.
7. Install shrink disc as per instructions on drawing 136001.
8. Torque tighten special bolts connecting stub shaft to rotor hub. These bolts should be tightened using a diametrically opposite configuration.

9. Remove eye bolt, carefully label for future identification and send to Station Store for safe keeping.

10. Remove temporary props from rotor spider and fit rotor stop alarm target plate and weather shield.

Note: When top steady bearing assembly is installed it must be protected from dust and moisture ingress until the GGH unit is ready to be commissioned.

STAGE 8 OIL LUBRICATION – BEARINGS

Refer to the following drawings

Drawing No.

Site Assembly of Heater

001002

Assembly of Top Bearing

136001

Assembly of Bottom Bearing

144001

At this stage the top and bottom bearings should be filled with the correct grade and quantity of lubricant using a clean plastic tube inserted into the oil inlets. Once filled, the oil inlet and outlet for each bearing should be blanked off until the lubrication piping is connected. Oil is provided by Howden for first fill of lubricant.

1. Top Steady Bearing Housing

Quantity: 20 litres

Grade:

ISO VG 460 + EP Additives

(Fill to level glass – Do **not** overfill)

2. Bottom Support Bearing Housing

Quantity: 105 litres

Grade:

ISO VG 460 + EP Additives

(Fill to level glass – Do **not** overfill)

Oil lubrication tanks (4-off) to be each filled with 110 litres of oil of same grade as above.

3. Rotor Drive Gear Units (fitted at stage 13)

By using the combined oil breather/filler units fill the gear units to the correct level. Refer to Howden document Mech5 and drive suppliers IOM for oil quantities and grades

4. General

Do not over fill any of the above, and do not mix mineral and synthetic oils.

STAGE 9 UNTREATED GAS SIDE ROTOR HOUSING & SIDE PILLARS

Refer to the following drawings

Drawing No.

Site Assembly of Heater

001002

Site Assembly of Heater

001003

Site Assembly of Heater

001004

Arrangement of Rotor Housing

126001

The rotor housing sections should be suitably grouped for ease of handling into position. Two hinged side pillars support the rotor housing normal to the end pillars (See [Figure 6](#))

1. Assemble hinged side pillars, (2 off) in position as indicated on drawings and secure to supporting steelwork using 4 – Bolts. Shim hinged pillars as required to align top bracket plate with landing plate extension on end pillars.

Note: Each hinged side pillar is provided with 4 Temporary Holding Bars that render the assembly rigid during initial erection. **These bars must be removed on completion of gas-gas heater erection.**

2. Using surveyor's level gauge check level of side pillars to reference point.
3. Add temporary ties to each side pillar after levelling to stabilise them during erection of housing sections.
4. Raise the untreated gas side housing sections, local to the end pillars, into position and secure to appropriate end pillar using bolts, locate on hinged side pillars and bolt sections together Butt weld adjacent landing plates together.

Note: If the top and bottom landing plates do not butt correctly for welding, temporary angles should be welded to the plates to enable them to be drawn together.

5. Measure and record the distance from the face of the terminal flanges to the landing plates on the rotor housing local to end pillars ([Checkpoint 5](#)).
6. At this stage the top side pillar brackets should be tack welded to the rotor housing.



Figure 6 – Untreated Gas Side Rotor Housing

STAGE 10 UNTREATED GAS SIDE DUCTS

Refer to the following drawings

Drawing No.

Site Assembly of Heater

001002

Site Assembly of Heater

001003

Site Assembly of Heater

001004

The untreated gas ducts compromise multiple sections which are joined together with a bolted flange and seal welded. The recommended method of installation is to install each individual duct section in turn. Depending on duct size and weight, ducts can be bolted together on the ground and lifted into position. Any distortion caused during this lifting must however be corrected to ensure that the ducts are correctly aligned.

The ducts are presented to the respective top and bottom housing landing plates, correctly positioned, and welded in place as indicated on drawings (see

Figure 7)

Bottom Untreated Gas Duct Sections:

With the bottom duct sections the location is important to ensure that a regular shape is maintained all round in relationship to the bottom rotor tyre for circumferential sealing.

1. Select the duct sections and position these below the housing.
2. Sling and lift one of the duct sections into position and draw the plate flange of the duct section against the bottom landing plate.

If there is difficulty getting the duct section to take up the correct position use adjuster bracket to draw or push the section into correct position for welding.

One adjuster bracket can be bolted to the landing plate with the other welded to the duct flange.

Note: The duct plate flange should overlap the housing landing plate by 20mm when correctly positioned. See site assembly drawings.

3. With the section of duct tack welded in position, carry out an alignment check.
4. Weld the duct section to the landing plate and wing plate before releasing slings. Remove all clamps and adjuster brackets.
5. Position, sling, and lift the next duct section up to its location against the landing plate, bolting this section to the previously installed section at their vertical flange connection.
6. Repeat the adjusting procedure and alignment check as before to achieve the correct location on the landing plate and weld duct section in position.
7. Repeat the lifting, adjusting, and alignment check procedures for all remaining bottom untreated gas duct sections until the bottom treated gas duct is complete.
8. Submit the complete duct assembly for an alignment check.

9. Complete all welding of the bottom untreated gas duct to the housing landing plate and the duct wing plate and seal weld vertical bolted flange joints between the duct sections.

10. Remove all adjuster brackets and grind smooth all temporary welds.

Top Untreated Gas Duct Sections

Install the top untreated gas duct by repeating the process described above.

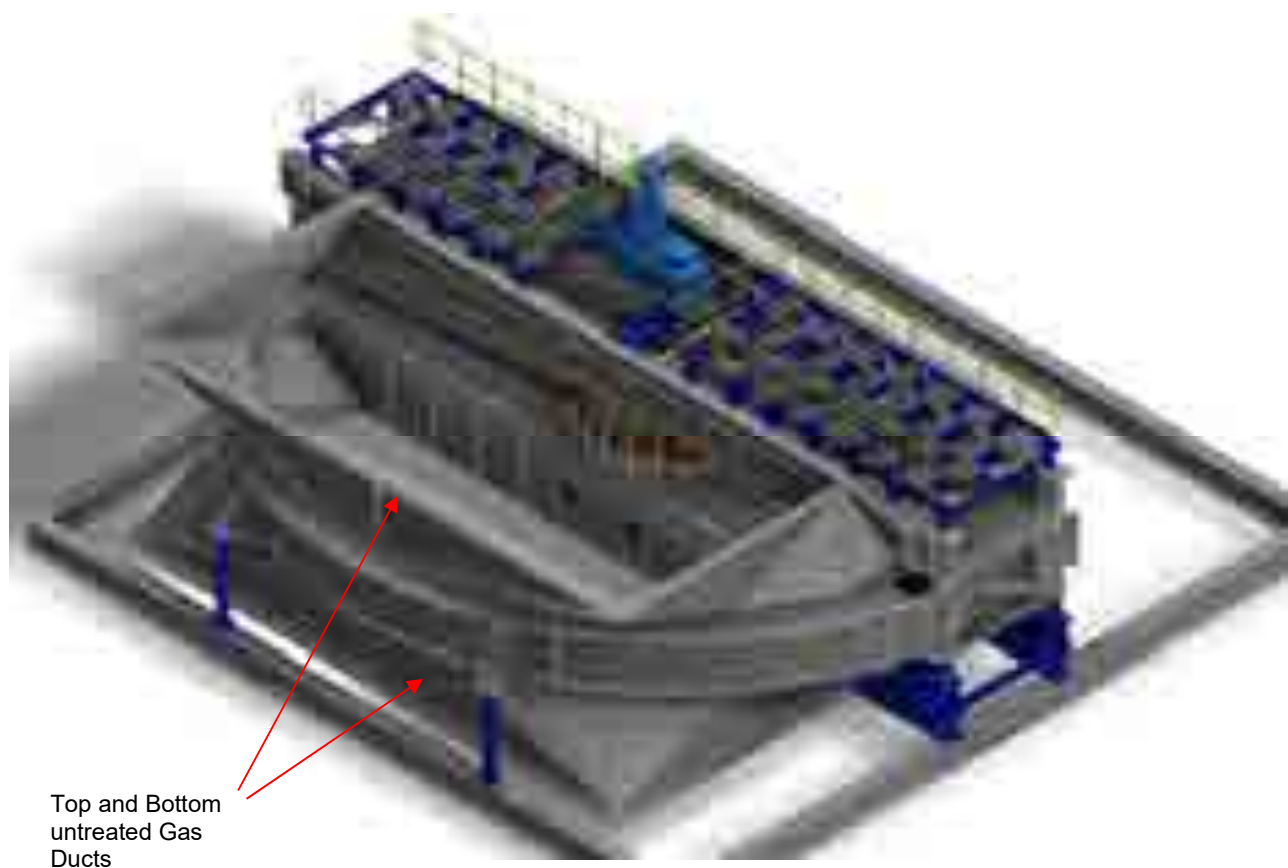


Figure 7 – Untreated Gas Ducts

STAGE 11 ROTOR ASSEMBLY/PIN RACK INSTALLATION

Refer to the following drawings

Drawing No.

Site Assembly of Heater	001002
Site Assembly of Rotor	001007
Site Assembly of Rotor	001008
Rotor Identification and Transportation	180003
Detail of Tie Bars and Rotor Supports	191001
Site Assembly of Pin Rack	155001

1. Before commencing site assembly of rotor, particular care should be exercised to ensure identification is carefully followed. Refer to key plan view on Rotor Site Assembly Drawing. As the drive unit cannot be installed until after the rotor is installed and pin rack segments fitted, turning activities should be carried out using temporary chain blocks and attachments to rotate the rotor sectors to the desired position.

Ensure also that there are safe temporary platforms local to rotor assembly point.

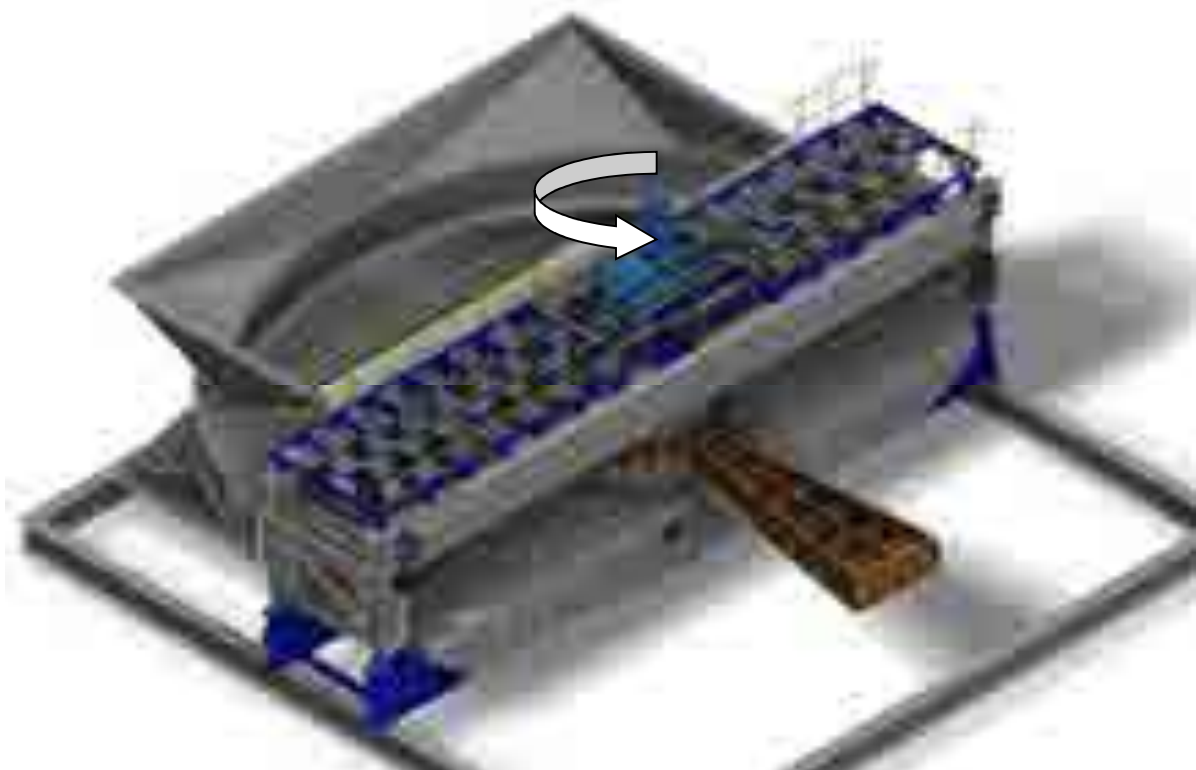
2. During site welding of rotor it is essential that the earth connection is coupled directly to the rotor and not to the structure as this could cause electric arcing at the support bearings and could result in premature bearing failure.
3. Rotate rotor, to the required position i.e. position suitable for lifting rotor outer section Ref. 180/0/1 into position related to temporary erection platform.
4. Raise first rotor outer section Ref. 180/0/1 into position by means of the lifting lugs provided.

Level off at correct height relative to rotor spider and secure to rotor spider with temporary butt straps and bolts.

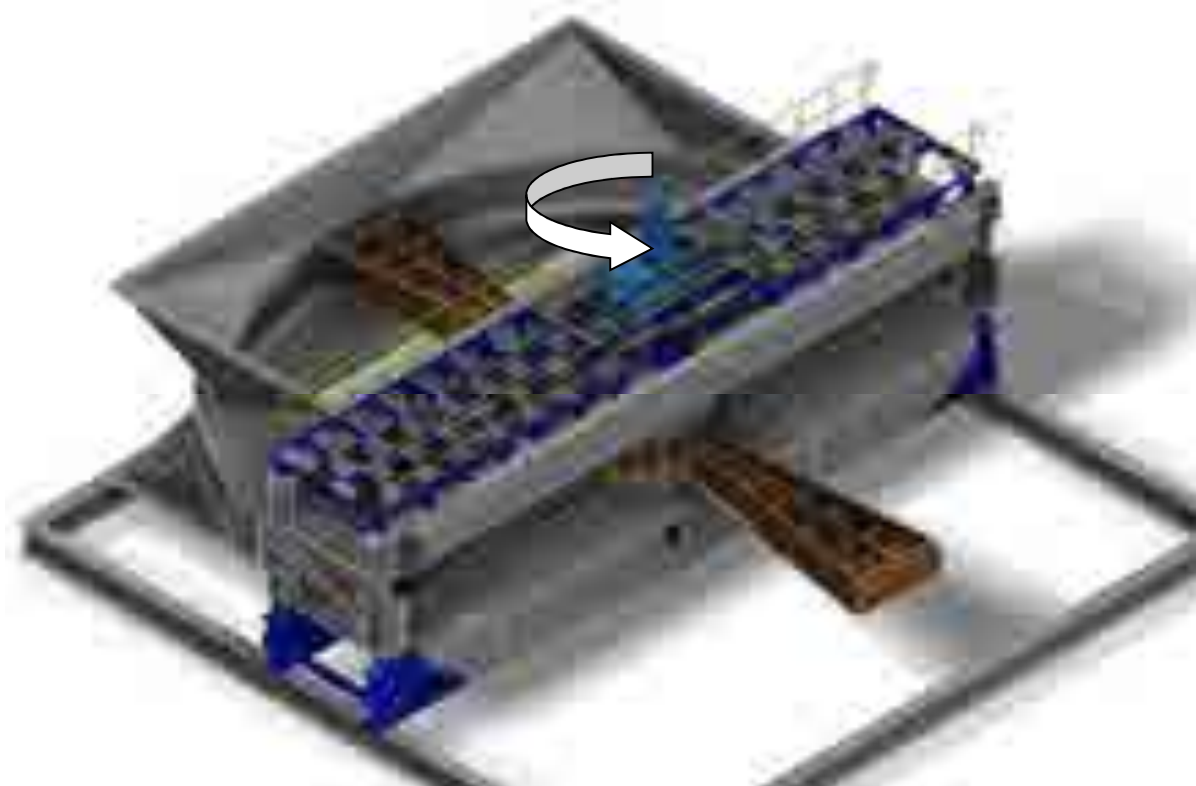
5. Rotate rotor through 180°.
6. Lift second rotor outer section Ref. 180/0/7, level off and secure to rotor spider with fitted bolts and temporary butt straps (see [Figure 8](#)).
7. Repeat until all rotor outer sections are installed. **Ensure sections are fitted in a sequence which keeps the rotor balanced** (see [Figure 8](#) and 9 – Rotor Assembly Outer Sections
8.).
9. Fit temporary brackets Ref. 191/01 (if not already installed at shop) and temporary ties ref. 191/101 between the assembled rotor sectors, adjust and equalise spacing between sectors.
 - a) Check circularity of rotor, top and bottom, local to radial division plates. Maximum radial out of true should be checked from a point on the end pillar tolerance ± 3 mm.
 - b) Check rotor axial fluctuation, top and bottom, when rotated over a fixed point tolerance ± 2 mm. It may be necessary to fit shims between the bolted connections

at the spider to achieve this tolerance. The shims will require to be cut from shim material supplied.

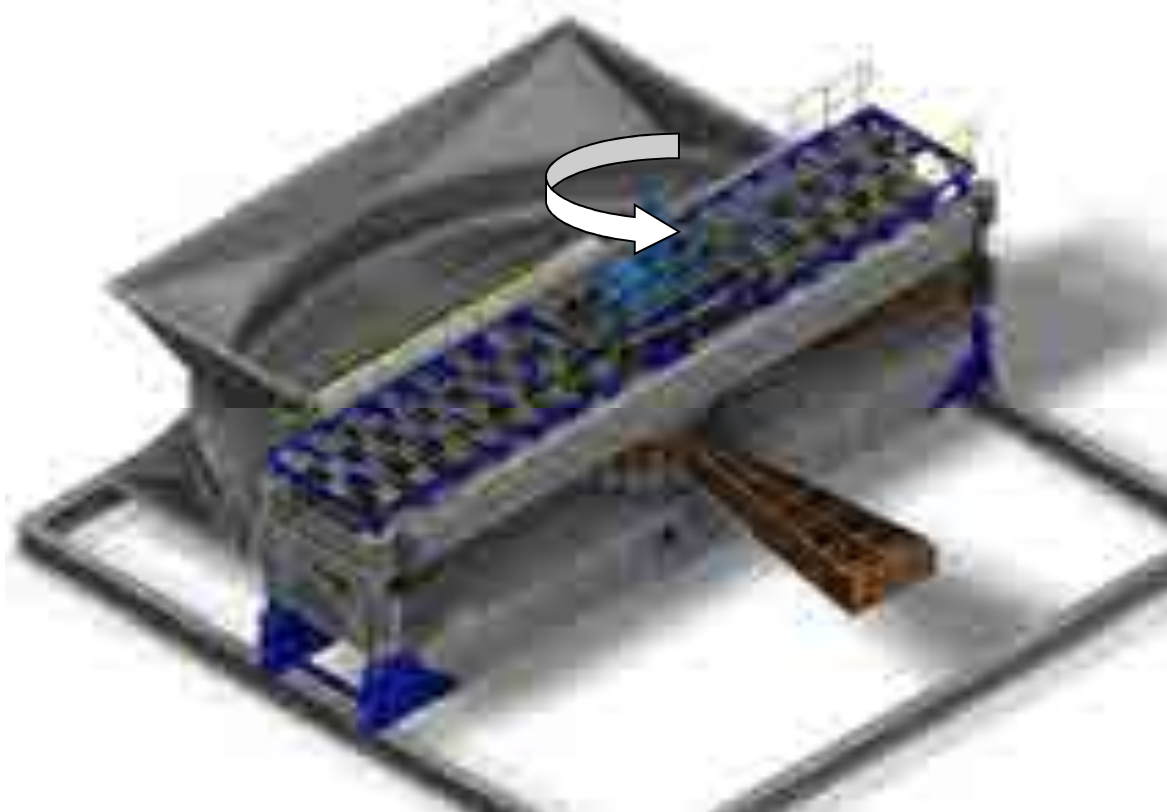
10. Turn rotor until the gap between erected rotor sectors Nos. 180/0/1 and 180/0/2, is in position in relation to temporary access platform.
11. Fit and tack weld "open" site welded rotor sections in a balanced sequence
12. Remove temporary ties after fitting and tack welding each open rotor section.
13. Submit assembly to surveillance engineer for a dimensional check.
14. Measure and record circularity and swash ([Checkpoint 6](#))
15. Fully weld rotor assembly in accordance with drawing. Do not weld until the above has been passed by the responsible Engineer.
16. Ensure all top and bottom rotor tyre bars are fitted to the rotor periphery.
Note: The tyre bars cannot be finally set until after the element packs have been loaded into the rotor, therefore do not fully tighten securing bolts at this stage.
17. Remove all erection aids such as locating stops, butt strap blocks and temporary stiffeners painted black.
18. Check rotor after welding to ensure tolerance remains within that defined under ([Checkpoint 7](#))
19. Submit assembly for an independent check.
20. Install pin rack segments in accordance with instructions on drawing 155001. These are installed as 2 long sections , then 1 short section. Check clearance between pins of adjacent sections using the supplied pin rack checking gauge. Adjustment can be made using the integral pin segment adjusters on each pin rack segment.



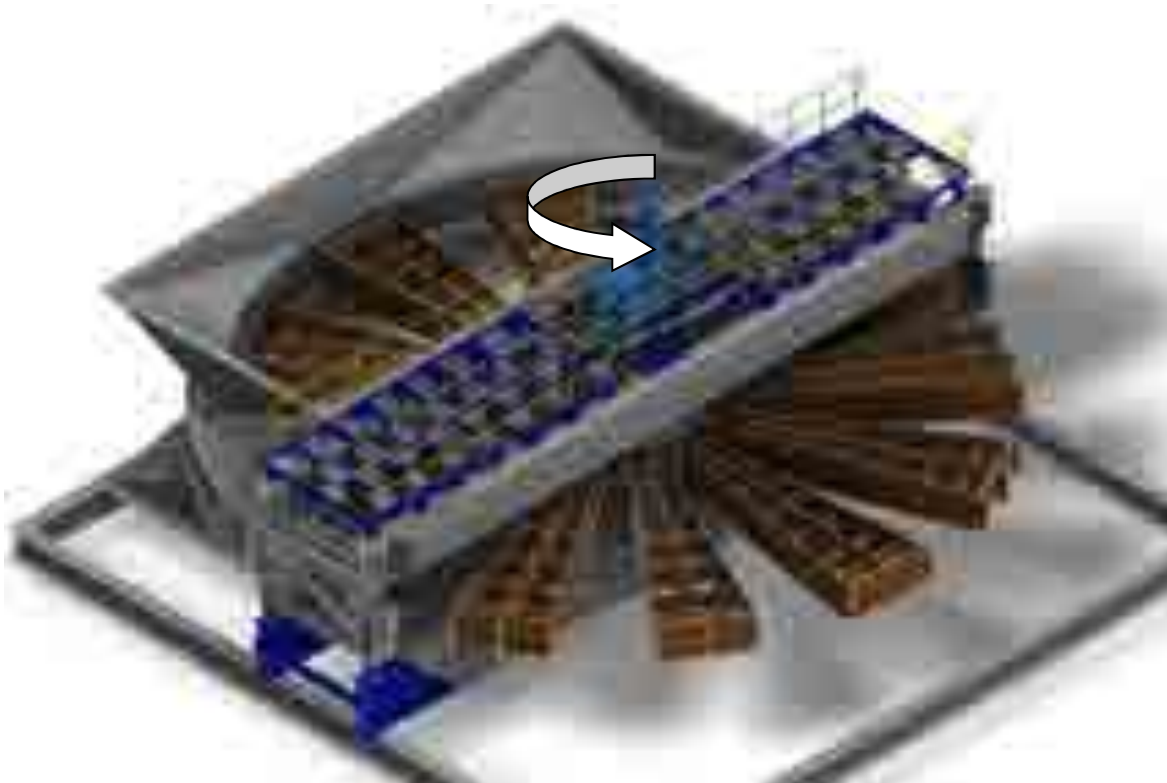
Bolt first Outer Rotor Section to Rotor Spider and rotate 180°



Bolt Second Outer Rotor Section to Rotor Spider. Note: Rotor with 12 Outer Sections is shown here (rotate 90°). Rotor can have 6 or 8 Outer Sectors depending on gas-gas heater size.

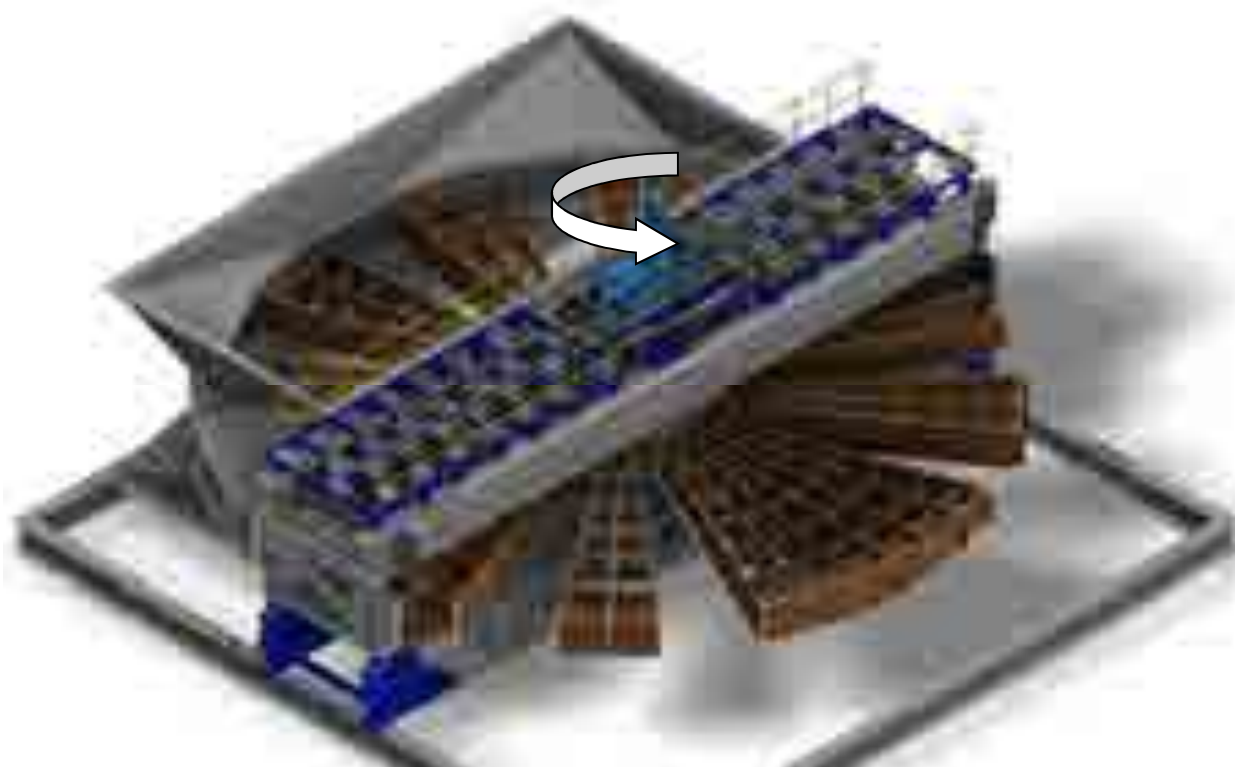


Bolt third Outer Rotor Section to Rotor Spider and rotate 180°

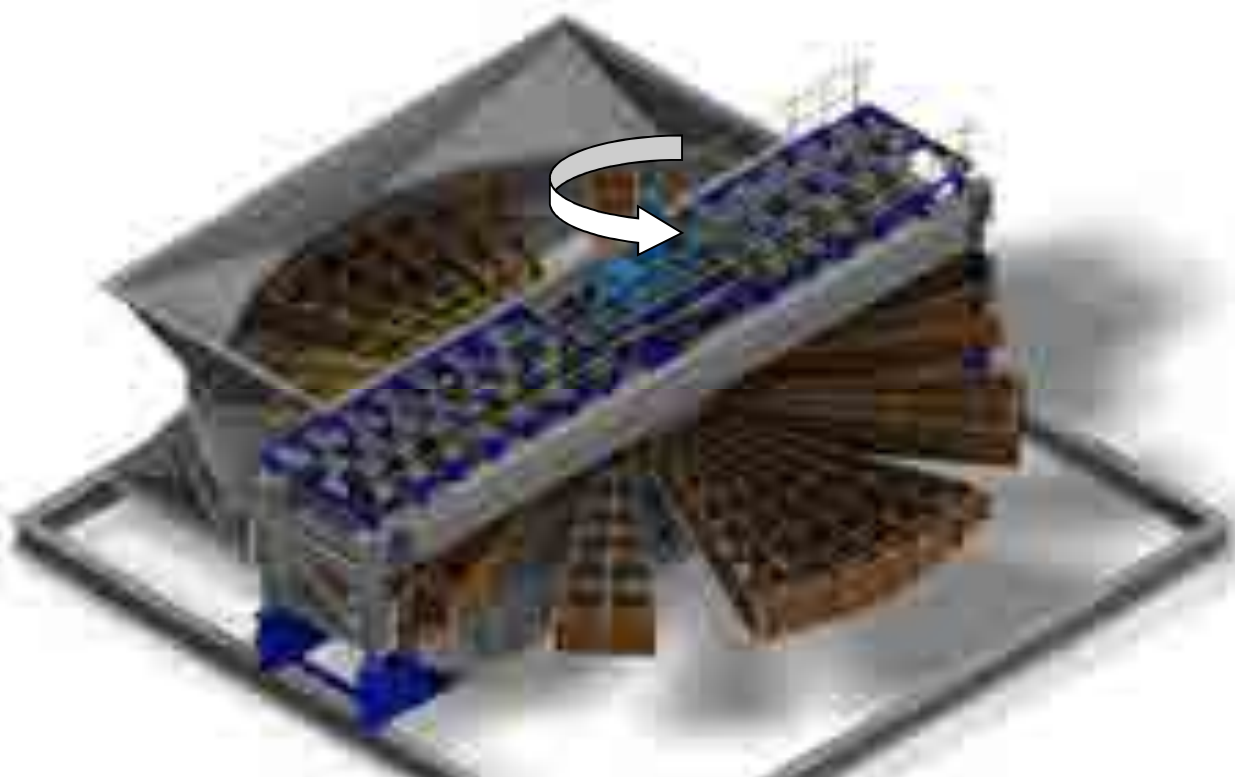


Repeat process until all Outer Rotor Sections are installed then rotate rotor to first Site Welded Rotor Section

Figure 8 and 9 – Rotor Assembly Outer Sections

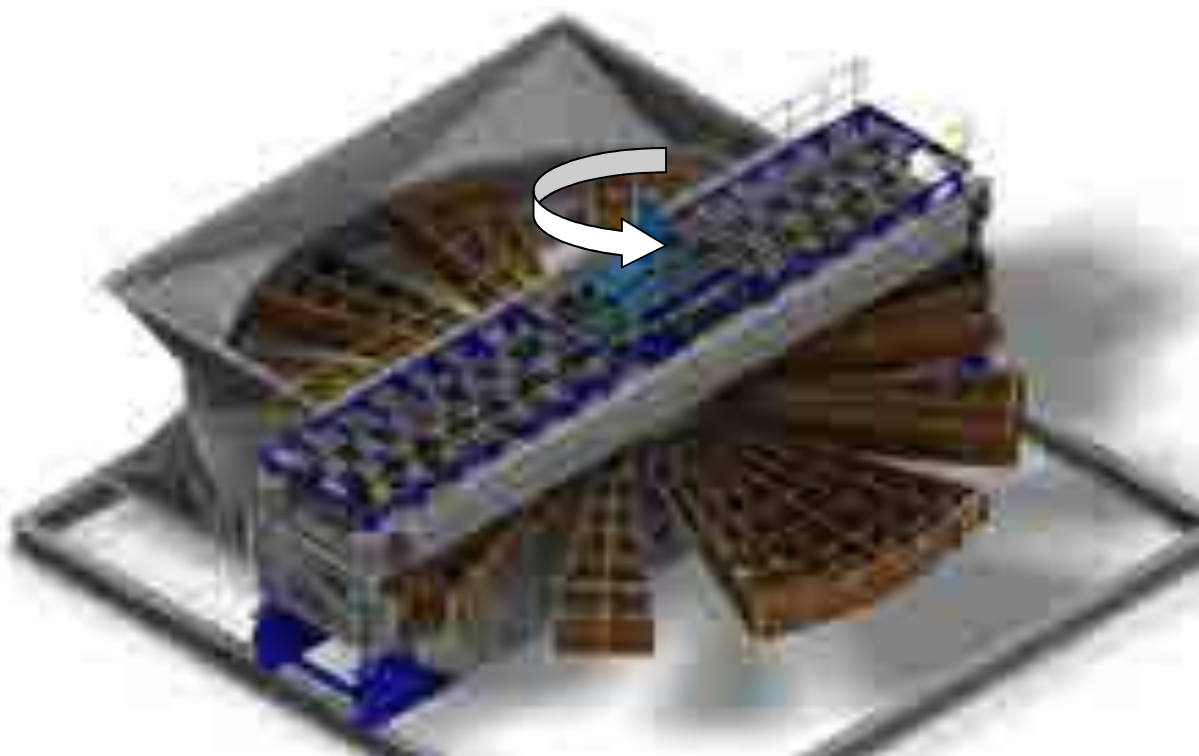


Fit first Site Welded Rotor Section and rotate 180°

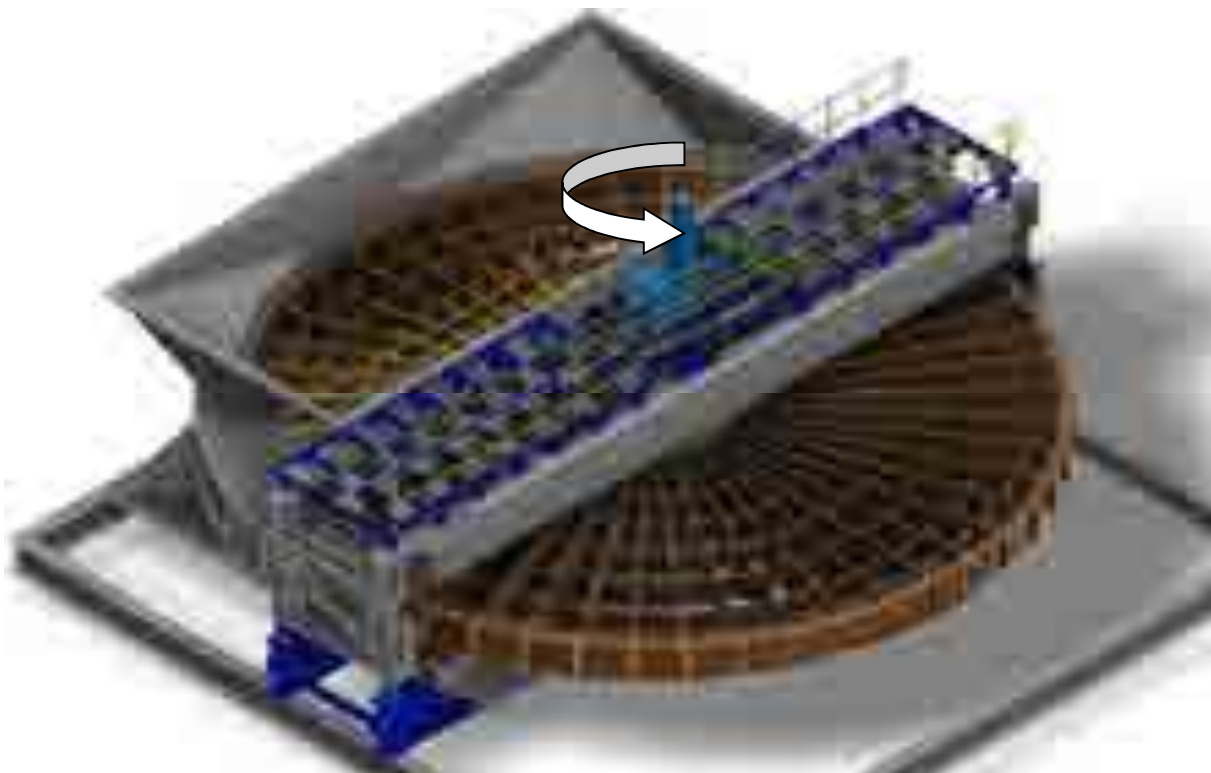


Fit second Site Welded Rotor Section Note: Rotor with 12 Site Welded Sections is shown here (rotate 90°). Rotor can have 6 Site Welded Sectors depending on gas-gas heater size.

Figure 9 – Rotor Assembly Site Welded Sections



Fit third Site Welded Rotor Section to Rotor Spider and rotate 180°



Repeat process until all Site Welded Rotor Sections are installed.

Figure 10 – Rotor Assembly Site Welded Sections

STAGE 12 TREATED GAS SIDE ROTOR HOUSING AND HINGED SIDE PILLARS

Refer to the following drawings

Drawing No.

Site Assembly of Heater

001002

Site Assembly of Heater

001003

Site Assembly of Heater

001004

Arrangement of Rotor Housing

126001

The rotor housing sections should be suitably grouped for ease of handling into position.

Two hinged side pillars support the rotor housing normal to the end pillars (see [Figure 11](#))

1. Assemble hinged side pillars, (2 off) in position as indicated on drawings and secure to supporting steelwork using 4 – Bolts. Shim hinged pillars as required to align top bracket plate with landing plate extension on end pillars.

Note: Each hinged side pillar is provided with 2 Temporary Holding Bars that render the assembly rigid during initial erection. These bars must be removed on completion of gas-gas heater erection.

2. Using surveyors level gauge check level of side pillars to reference point.
3. Add temporary ties to each side pillar after levelling to stabilise them during erection of housing sections.
4. Raise the treated gas side housing sections, local to the end pillars, into position and secure to appropriate end pillar using bolts, locate on hinged side pillars and bolt sections together Butt weld adjacent landing plates together.

Note: If the top and bottom landing plates do not butt correctly for welding, temporary angles should be welded to the plates to enable them to be drawn together.

5. Measure and record the distance from the face of the terminal flanges to the landing plates on the rotor housing local to end pillars ([Checkpoint 8](#)).
6. At this stage the top side pillar bracket should be tack welded to the rotor housing.

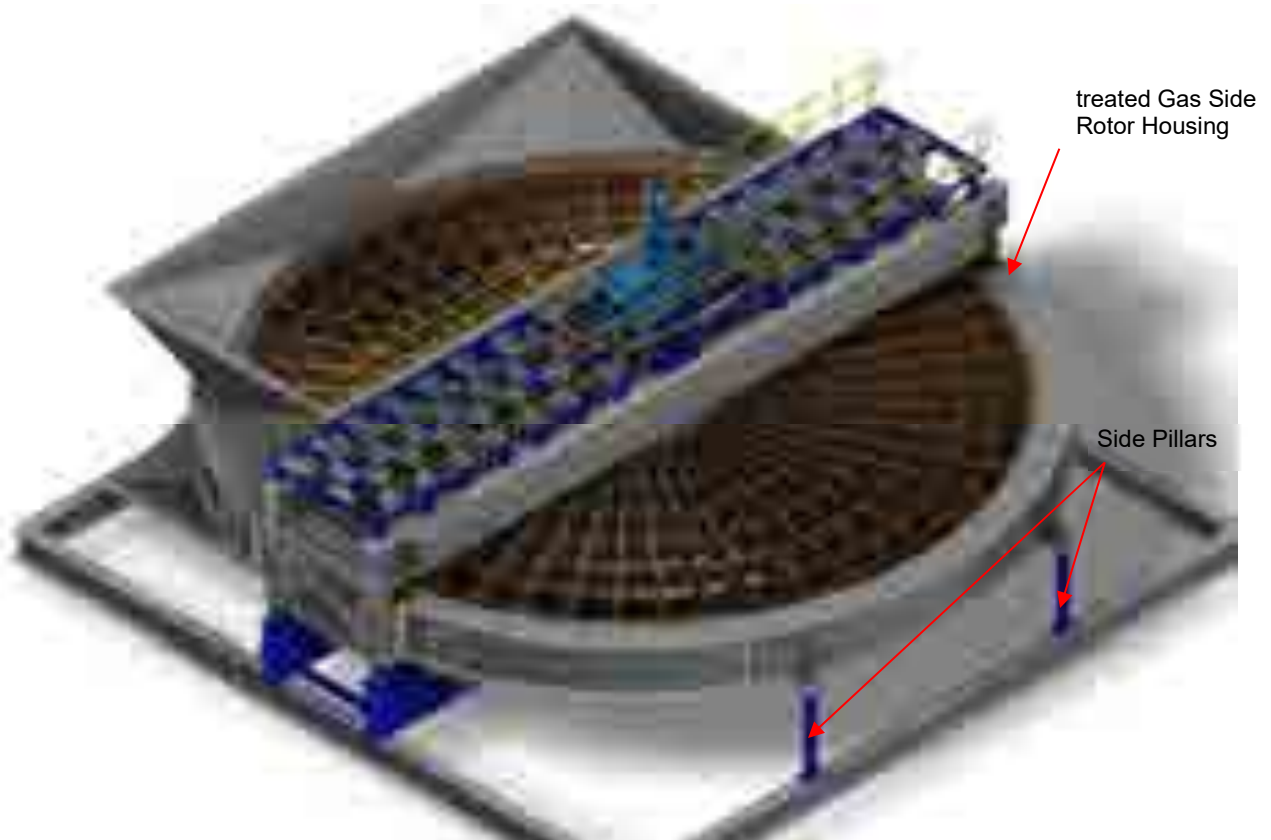


Figure 11 – Treated Gas Side Rotor Housing

STAGE 13 ROTOR DRIVE UNIT

Refer to the following drawings

Drawing No.

Site Assembly of Heater

001002

Assembly of Pinion Drive

155005

Arrangement of Drive Unit

SUB001

1. The peripheral drive assembly is fitted on the untreated gas side housing.
2. It is recommend that the drive unit is fitted to the pinion support and then the complete assembly lifted into position and welded onto the rotor housing.
3. Fit carbon seal housing to support top plate, ensuring carbon ring is in correct orientation. Install drive unit onto support top plate, and secure in place.
4. Install pinion wheel to shaft of drive unit and secure as indicated on detail C of drawing 155005.(see SCM instructions for installation of Ringfeder lock assembly)
5. Lift the complete drive unit and support assembly into position using the integral lifting lugs on the support – **do not lift by the drive unit only**.
6. Weld the complete assembly in position to the rotor housing of the gas gas heater as shown in detail D on drawing 155005
7. Use the adjusting brackets at each corner of the drive unit to position the drive unit and the pinion wheel at the correct distance from the pin rack on the rotor.(20mm nom.)
8. Once all the alignment checks have been completed, dowel the drive unit in location as indicated in section F-F on drawing 155005.
9. After lubricating the bearings and drive unit (refer to [STAGE 8](#) for oil requirements) the rotor spider should be turned through one complete revolution to prove freedom, using the hand turning device supplied with the drive unit.

STAGE 14 TREATED GAS SIDE DUCTS

Refer to the following drawings

Drawing No.

Site Assembly of Heater

001002

Site Assembly of Heater

001003

Site Assembly of Heater

001004

Each duct comprises of four sections which are joined together with a bolted flange, and seal welded on the inside. The recommended method of installation is to install each individual duct section in turn. Depending on duct size and weight, ducts can be bolted together on the ground, such that they form two corner sections, and lifted into position. Any distortion caused during this lifting must be corrected to ensure that the ducts are correctly aligned.

The ducts are presented to the respective top and bottom housing landing plates, correctly positioned, and welded to place as indicated on drawings (see [Figure 12](#))

Bottom treated Gas Duct Sections

With the bottom treated gas duct sections the location is important to ensure that a regular shape is maintained all round in relationship to the bottom rotor tyre for circumferential sealing.

1. Select the duct sections and position these below the housing.
2. Sling and lift one of the duct sections into position and draw the plate flange of the duct section against the bottom landing plate.

If there is difficulty getting the duct section to take up the correct position use adjuster bracket to draw or push the section into correct position for welding.

One adjuster bracket can be bolted to the landing plate with the other welded to the duct flange.

Note: The duct plate flange should overlap the housing landing plate by 20mm when correctly positioned. See site assembly drawings.

3. With the section of duct tack welded in position, carry out an alignment check.
4. Weld the duct section to the landing plate and wing plate before releasing slings. Remove all clamps and adjuster brackets.
5. Position, sling, and lift the next duct section up to its location against the landing plate, bolting this section to the previously installed section at their vertical flange connection.
6. Repeat the adjusting procedure and alignment check as before to achieve the correct location on the landing plate and weld duct section in position.
7. Repeat the lifting, adjusting, and alignment check procedures for all remaining bottom treated gas duct sections until the bottom treated gas duct is complete.
8. Submit the complete duct assembly for an alignment check.
9. Complete all welding of the bottom treated gas ducts to the housing landing plate and the duct wing plate and seal weld vertical bolted flange joints between the duct sections.
10. Remove all adjuster brackets and grind smooth all temporary welds.

Top treated Gas Duct Sections

Install the top treated gas ducts by repeating the process described above for the bottom treated gas ducts.

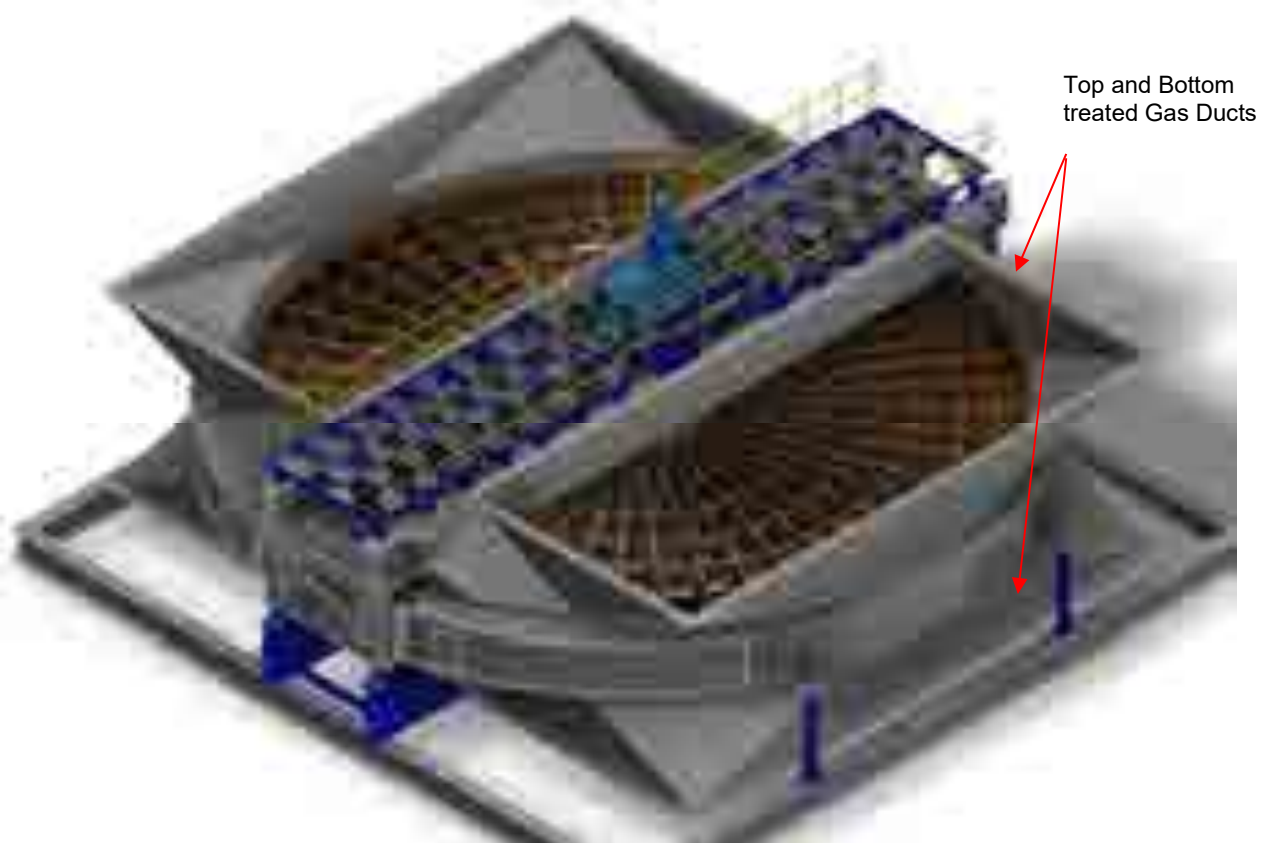


Figure 12 – Gas Ducts

STAGE 15 FINAL ROTOR HOUSING AND DUCT CHECKS AND WELDING

Refer to the following drawings

Drawing No.

Site Assembly of Heater

001002

Site Assembly of Heater

001003

Site Assembly of Heater

001004

1. Check level of rotor housing relative to rotor by selecting 22 points round the top or bottom landing plates and checking against the rotor ([Checkpoint 9](#)).

Adjust shimming under side pillars where necessary.

2. Check 'circularity' of the cold end duct/landing plate to the circularity of the rotor by placing a straight edge from the duct onto the rotor tyre ([Checkpoint 10](#)).

Note: The dimension from the duct wall to the heel of rotor tyre bar (in the horizontal plane) is 80mm nominally, but must not be less than 50 mm.

3. Fully weld hinged side pillar top brackets to the rotor landing plate. Refer to drawings.
4. Fully weld top duct to rotor housing and to duct wing plate on centre section. The vertical bolted flange connection joining the two sections of duct is also seal welded on the inside. Refer to drawings.
5. Fully weld rotor housing joints between housing sections and at the end pillars. Refer to Drawings.
6. All temporary adjuster brackets and all temporary stiffeners to be removed and associated welds to be removed and smooth.

STAGE 16 DUCT EXPANSION JOINTS

Refer to suppliers Instructions. These items are not in Howden UK supply.

However it is of the utmost importance that any expansion joint flow sleeves are sufficiently clear of the top duct mating flanges. Failure to allow sufficient clearance will prevent the top structure expanding as designed and may ultimately cause the rotor to jam in its housing. ([Checkpoint 28](#))

STAGE 17 ELEMENT LOADING

Refer to the following drawings	<u>Drawing No.</u>
Site Assembly of Heater	001002
Site Assembly of Heater	001003
Site Assembly of Heater	001004
Assembly of Top Bearing	136001
Assembly of Hydraulic Jacking of Rotor	154001
Handling Arrangement Elements, Drive Unit, Bottom Bearing	200001

1. Weld bottom false sectorplate to end pillar landing plate.
2. Slacken bolts on bottom false sectorplate support brackets and angle brackets at centralisers.
3. See site assembly drawing for identification of element packs. Remove element access door in client top ducting (if ducting is installed) and install lifting beam and tackle into duct as required (not Howden supply).

Note: Elements can be loaded before client ducts above heater have been fitted.

To maintain rotor balance the element packs are loaded from the hub outwards; the packs being installed in a diametrically opposed pattern, a ring at a time. The packs should therefore be stacked in numerical order for ease of handling. A maximum stack height of two packs must be maintained during handling. Do not remove the steel banding on the element packs.

4. Using the hand turning crank, align the rotor with a sector on the centre line of the lifting beam.
5. Element packs should be loaded using the slings provided. Attach the shackles of the sling to diagonally opposite lifting holes on the first pack and with the lifting gear, raise the pack up into top duct. Lower the pack carefully down inside the gas-gas heater transition duct and manhandle the pack into position in the rotor.
6. Repeat Procedure No. 5 for the remaining 47-off No. 1 element packs installing the packs in pairs in a diametrically opposed pattern.
7. In a similar manner repeat the procedure for second innermost ring of packs (No. 2), again in a diametrically opposed pattern.
8. Repeat procedure for the remaining rings element packs.
9. The rotor will require to be jacked up and shims placed under the bottom bearing housing to raise the rotor back to its original height relative to the top sector sealing plate at the hub. Rotor jacking and bearing shimming may require to be carried out on more than one occasion during element loading. Jacking of the rotor is as shown on drawing 154001. Install lifting bolts through lugs on the bottom bearing housing. The rotor can now be jacked up and the bearing housing will be lifted along with rotor, shims can now be inserted or withdrawn as applicable.

Note: Under no circumstances shall the gas-gas heater rotor be turned by means of the hand turning device, or any other means, when personnel are inside ducting.

The clearances at the periphery of the rotor will alter after element loading, i.e. the top will increase and the bottom will decrease.

10. When all the elements have been loaded into the rotor, check for rotor tilt at the periphery by hand turning the rotor. The rotor should be aligned by means of adjusting screws on top bearing housing stool ([Checkpoint 11](#)).
11. After final rotor positioning (height and level) the bolts securing the top bearing housing to the top structure can be torque tightened to the value shown on drawing 136001 and the plate washers welded to the bearing housing and top structure. The bottom bearing plate washers should also be welded to the bearing stool.
12. Measure and record the axial seal plate concentricity. Adjust seal plate position if required. ([Checkpoint 12](#)). Once set weld the end pillar side plates to the wing plates, and position and weld the housing axial seal plate sealing strips.
13. Recheck the supporting steelwork level at the 'H' and 'K' points as in Checkpoint 1. Adjust shimming at these points if required.

STAGE 18 DUCT TUBULAR STIFFENERS AND DRIP TRAY

Refer to the following drawings

Drawing No.

Site Assembly of Heater	001002
Arrangement of Top Duct Tubular Stiffeners	116001
Arrangement of Bottom Duct Tubular Stiffeners	116002
Assembly of Sootblower Drip Tray	240010

1. Select the appropriate tubular stiffeners and their associated cruciform brackets and install as indicated on the drawings above.
2. Weld external stiffing webs to the rotor housing landing plates and duct wall as indicated on the drawings.
3. On bottom tubular stiffeners which pass through the bottom wing plate and are welded to the bottom beam, closing plates should be fitted as indicated.
4. Install the bottom sootblower drip tray and associated water washing pipe following the 15 step erection procedure outlined on drawing 240010. The required lining of the drip tray and supports can be done at stage 22 with the other lined heater structures.

Note: All bottom duct tubular stiffeners and cruciforms must not be welded until after the elements have been loaded into the rotor and the bottom sector plate has been set in the final position.

Top duct stiffeners and cruciforms which are welded to the sector plate primary seals must not be welded until the top sector plate has been set in the final position.

STAGE 19 ROTOR POSITION ADJUSTMENT AND SECTORPLATE SETTING

Refer to the following drawings

Drawing No.

Site Assembly of Heater	001002
Site Assembly of Heater	001003
Site Assembly of Heater	001004
Assembly of Top Bearing	136001
Assembly of Hydraulic Jacking of Rotor	154001
Assembly of Radial, Axial and Inner Circ. Seals	186001
Cold Seal Setting Chart	186005

1. The rotor should be jacked and shimmed such that the zero graduation mark on the mounting bell lines up with the top cover of the bearing housing (see drawing 136001). The dimension between the mean radial division plate, when the zero graduation mark is accomplished, and the rotor housing top landing plate should be approximately 120mm ([Checkpoint 13](#))
2. Tighten bolts on bottom false sectorplate support bracket and also at angle bracket for centralisers.
3. The top sectorplate should now be adjusted to the settings as indicated on drawing 186005, plus 40mm, from the mean radial plate.
4. The bottom sectorplate should now be adjusted to the settings as indicated on drawing 186005, plus 40mm, from the mean radial plate.
5. Weld top & bottom sectorplate seals to sectorplate.
6. Measure and record the dimension between the top and bottom sectorplates and the mean rotor radial plate at the radii indicated on drawing.

Top measurement Checkpoint 14
Bottom measurement Checkpoint 15
7. Weld the bottom structure supports to the mounting brackets on the top flange of the bottom girder and at angle brackets for centralisers as shown in drawing.

STAGE 20 ROTOR TYRE ALIGNMENT

Refer to the following drawings

Drawing No.

Site Assembly of Heater	001002
Site Assembly of Heater	001003
Site Assembly of Heater	001004
Assembly of Top and Bottom Outer Circumferential Seals	189001
Cold Seal Setting Chart	186005

1. Set top tyre vertical position. The top surface of the tyre should be set clear of the top sectorplate sealing surface as indicated on the cold seal setting chart.

Procedure:

- a. Set up one section of rotor tyre at the nominated clearance from the top sectorplate surface, using a flat bar gauge to ensure that the tyre clearance is maintained all across the surface of the sectorplates, and tighten up the securing nuts.
- b. Turn rotor until this section of tyre is in alignment with an axial seal access door and record clearances between tyre and housing landing plate at three fixed reference points.
- c. Using top landing plate reference points adjust the remaining 23 tyre segments to this height.

Note: If the clearance cannot be achieved, adjustment should be carried out to the slotted holes to ensure an even sealing surface all round the tyre.

- d. Ensure that all nuts are tight and re-check height to fixed reference points.

2. Set bottom tyre vertical position. The bottom surface of the tyre should be set clear of the bottom sectorplate sealing surface as indicated on the cold seal setting chart.

Procedure:

- a. Set up one section of rotor tyre at the nominated clearance from the bottom sectorplate surface, using a flat bar gauge to ensure that the tyre clearance is maintained all across the surface of the sectorplates, and tighten up the securing nuts.
- b. Turn rotor until this section of tyre is in alignment with an axial seal access door and from inside the bottom duct check the clearance between the tyre and the bottom landing plate at three fixed reference points.
- c. Using the reference points, set up the remaining 23 sections of bottom tyre to this height
- d. Ensure that all nuts are tight and re-check height to fixed reference points.

3. The following measurement should now be performed using the procedure described below.

To allow measurements to be accurately taken the following instruments will be required;

- A set of feeler gauges or a pair of inside callipers.
- A 300mm steel rule or an accurate steel tape measure.

WARNING: Under no circumstances shall the gas-gas heater rotor be turned by means of the hand turning device, or any other means, when personnel are inside ducting.

- a. Measure and record the flatness of the hot end rotor tyre and identify its highest point ([Checkpoint 16](#)).

Once all measurements are complete and within tolerance, mark the position of the high point on the top rotor tyre. This position should be marked 'H'.

- b. Measure and record the concentricity of the hot end rotor tyre (HE outer circ seals) and identify its extreme radial position ([Checkpoint 17](#)).

Once all measurements are complete and within tolerance, mark the position of the most extreme point on the top rotor tyre. This position should be marked 'RT'.

- c. Measure and record the flatness of the cold end rotor tyre and identify its lowest point ([Checkpoint 18](#)).

Once all measurements are complete and within tolerance, mark the position of the lowest point on the bottom rotor. This position should be marked 'L'.

- d. Measure and record the concentricity of the cold end rotor tyre and identify its extreme radial position ([Checkpoint 19](#)).

Once all measurements are complete and within tolerance, mark the position of the most extreme point on the bottom rotor. This position should be marked 'RB'.

- e. Rotate point 'H' on the top rotor tyre to each edge of the top sectorplate in turn and measure the gap between position 'H' on the tyre and the sectorplate sealing surface.

The smallest measurement recorded should be equal to the dimension given on the cold seal setting chart.

The clearance between position 'H' and the central portions of the top sectorplate should be checked by using a feeler gauge manufactured from 1meter long round bar with diameter equal to the cold seal setting clearance. If the minimum clearance cannot be achieved then either the rotor tyre of the sectorplate will require to be reset. ([Checkpoint 20](#))

- f. Rotate point 'L' on the bottom rotor tyre to each edge of the bottom sectorplate in turn and measure the gap between position 'L' on the tyre and the sectorplate sealing surface.

The smallest measurement recorded should be equal to the dimension given on the cold seal setting chart.

The clearance between position 'L' and the central portions of the bottom sectorplate should be checked by using a feeler gauge manufactured from 1meter long round bar with diameter equal to the cold seal setting clearance. If the minimum clearance cannot be achieved then either the rotor tyre or the sectorplate will require to be reset. ([Checkpoint 21](#))

4. After final alignment of rotor tyres is carried out, filler plates require to be trimmed and fitted to suit the profile of the tyres at the radial division plate 'check outs' and at the ends of the axial seal support bars (See drawing 186001)

The rotor tyres should **not** be welded to either the outer sector division plates of the rotor or butt welded to each other.

Re-check that top and bottom rotor tyres are within tolerance after final welding filler plates.

STAGE 21 CLOSING PLATES

Refer to the following drawings

Drawing No.

Site Assembly of Heater

001002

Site Assembly of Heater

001003

Site Assembly of Heater

001004

All closing plates, as detailed on site assembly drawings, should be installed.

STAGE 22 FLAKE GLASS LINING

Refer to the following drawings

Drawing No.

Site Assembly of Heater

001002

Arrangement of Flake Glass Lining

175001

Lined Surfaces on Gas-Gas Heater

175002

Details Showing Finishes Required on Welds and Edges of
Surfaces Being Flake Glass Lined

175003

In preparation for the application of flake glass lining, ensure all joint welds and edges are dressed / prepared to the required standard. Refer to details of requirements on drawing 175003.

Ensure the rotor elements are suitably protected / covered to prevent damage to / or fouling of the elements while the inside of the heater is being lined. The lining contractor is responsible for the supply of suitable protection for the elements during the lining process.

All surfaces inside the heater, including the drip tray, that are exposed to the gas, (excluding the rotor, top and bottom sector plate sealing surface and untreated gas inlet duct), are to be lined. Refer to details on drawings 175001, 175002 & 175003.

Note: Insulation cleats and spikes must be welded to the external surfaces of the gas-gas heater before application of the flake glass lining.

STAGE 23 ROTOR SEALS

Refer to the following drawings

Drawing No.

Site Assembly of Heater	001002
Assembly of Hub Seals	182001
Assembly of Radial, Axial and Inner Circ. Seals	186001
Assembly and Detail of Radial Seal Setting Bar	186003
Assembly and Detail of Axial Seal Setting Bar	186004
Cold Seal Setting Chart	186005
Assembly of Top and Bottom Outer Circ. Seals	189001

Refer to drawings of arrangement of Hub Seals, Circ. Seals, Radial and Axial Seals. Actual clearances to be set to cold seal setting diagram 186005.

Seal setting bars are supplied to be fitted, on a temporary basis, to the gas ducts. An axial seal-setting bar, which is temporarily fitted in the rotor housing, is also supplied.

The rotor seals comprise radial, axial, circumferential and hub seals.

These seals require to be set to operate with a minimum clearance when the rotor is subject to thermal distortions.

The radial and inner circumferential seals are attached to the rotor and seal against the top and bottom sectorplates.

The axial seals are attached to the vertical outer edge of the rotor radial division plates and seal against the axial seal plates that are an integral part of the end pillars.

The hot end outer circumferential seal is formed by sealing strips fixed to the periphery of the rotor tyre sealing against a series of curved bar sections bolted to the relevant landing plate on the rotor housing.

The cold end outer circumferential seal is mounted off the cold end ducts, local to the landing plate and seals against the cold end tyre on the rotor.

Note: Temporary staging is required in both the bottom duct connections.

Note: When seals and cover plates are being fitted it may be necessary to trim the ends which butt together in order to achieve the required positioning and elongate any existing holes for adjustment.

1. Hub Seals

- a. Position the Inner Seal, Holding Ring, Outer Seal and Holding Ring. Assemble and secure by means of the screws.
- b. Set the seals tight to the Rotor Hub and tighten the screws.
- c. Reposition Hub Gland Seal Assembly and secure tightly with screws.
- d. Follow the Hub Gland Seal assembly notes on the drawing. Tighten the Gland packing by the nuts as required.

2. Inner Circumferential Seals (Top and Bottom)

- a. Select the sections of inner circumferential seal 2mm thick, fit seals to support bar and secure with the supplied nuts and PTFE washers.
- b. Set seals clear of the sectorplate as indicated on cold seal setting chart 186005.

3. Radial Seals

- a. Assemble the seal setting bars and set clear of rotor (finger tight).
- b. Identify all radial seals, backing strips and associated fasteners from drawing.
- c. Select a 'full length' radial division plate and assemble a set of top seals to the leading edge of the radial plate.
- d. Trim the inner edge of the seal to the profile of the inner circumferential seal.
- e. Hand turn the rotor until the seals are in alignment with the edge of the top sectorplate and set the seals to the settings indicated on the seal setting chart.
- f. Turn the rotor across all edges of the sectorplates rechecking the clearances at each edge and make any necessary adjustments. The seals should be set to the minimum values from all edges
- g. Turn the rotor until the 'set' seals are in alignment with the seal setting bars and set the bar against the seals.

Note: The setting bars can be shimmed away from the set seals to make hand turning of the rotor easier.
- h. With the top setting bar assembly set up to the seals, turn the rotor until the next seal is in alignment with the setting bars and set the seals to the bars.
- i. The above procedure 'b' through to 'h' is repeated for the bottom radial seals.

4. Axial Seals

- a. Set up the axial seal setting bar as indicated on the drawing.

Note: Check that the filler plates are fitted and welded to place on the seal supports on the rotor.
- b. Select a section of axial seal.
- c. Turn the rotor by hand turning device until a radial division plate is in alignment with the edge of the axial seal setting bar.
- d. Set up the section of axial seal on the trailing edge of the radial division plate and trim the ends of the seal to fit between the rotor tyres and set up the seal to clearance shown on the cold seal setting chart 186005

- e. Hand tighten the nuts sufficiently to secure the seal then rotate the seal across the axial seal plate and check clearance at the other edge of the plate.
- f. Rotate the seal to the edges of the other axial seal plates and check clearances. The seals should be set to the minimum values from all edges.
- g. Fully tighten the securing nuts.
- h. Turn the rotor until the seal is in alignment with seal setting bar and set the bar to the seal.
- i. Set the remaining axial seals to the seal setting bar.

Note: To ensure that the rotor rotates freely past the seal setting bar shims can be used when setting up the seal bar.

5. Cold End Outer Circumferential Seals

- a. Select the end sections of circumferential seal together with the plate & PTFE washers and steel nuts. These seals are the end sections which butt against the axial seal plates.
- b. Fit the seals to the cold end ducts with plate washers and nuts and set clearance to that indicated on cold seal setting chart, trimming where necessary.
- c. Fit the remaining sections of cold end outer circumferential seal and plate washers and secure with the locking nuts. Set the clearances as indicated on cold seal setting chart.

6. Hot End Outer Circumferential Seals

Hot End Outer Circumferential sealing is affected by the clearance between the hot end rotor tyre and the seal flange which is welded to the underside of the top landing plates of the rotor housing.

Positioning of the seal flange:

- a. From point RT on the rotor outer circumferential seals (found in [STAGE 20](#)) position the seal flanges to achieve the clearance specified on the cold seal setting chart.

7. Final Seal Check

- a. Rotate rotor using hand turning crank on drive unit to check freedom of movement.
- b. Recheck to ensure all fasteners are secure.
- c. Perform the following checks;
 - Top and bottom inner circumferential seal setting ([Checkpoint 22](#))
 - Top and bottom radial seal setting ([Checkpoint 23](#) & [Checkpoint 24](#))
 - Axial seal setting ([Checkpoint 25](#))
 - Cold end outer circumferential seal setting ([Checkpoint 26](#))
 - Hot end outer circumferential seal setting ([Checkpoint 27](#))
 - Hot end outer circumferential seals to axial seal plate clearance
 - Cold end rotor tyre to axial seal plate clearance
- d. Remove all seal setting bars and tools etc., before submitting for an inspection check.
- e. Following the inspection check remove all temporary scaffolding from lower duct connections and replace access doors.

STAGE 24 ROTOR STOP ALARM

Refer to the following drawings

Drawing No.

Electrical/Instrumentation Terminal Points

088009

P&ID

088012

Instrument Schedule

088013

Assembly and Detail of Rotor Stop Alarm

196001

Local Control Panel Internal Arrangement

SUB021

Local Control Panel Terminal Block Arrangement

SUB022

Refer to Rotor Stop Alarm Drawings:

- a. Check that the sensor target plate is correctly attached to the top drive shaft.
- b. Attach the sensors to the weather shield and adjust until a gap of 8-10mm is achieved between the sensors and the sensor target plate.
- c. The proximity sensors are wired back to the local control panel.

STAGE 25 CLEANING DEVICES

Refer to the following drawings

Drawing No.

Site Assembly of Heater	001002
Assembly of Cleaning Device and Supports	240002
Arrangement of Cleaning Devices	SUB010
Cleaning Device Terminal Box Wiring Schematic	SUB014
Arrangement of Cleaning Device Control Panel	SUB015
Cleaning Device Control Panel Wiring Diagram	SUB016

The cleaning devices are installed in the untreated gas side at both the hot end and cold end of the gas-gas heater.

The cleaning devices and associated control panel should be installed in accordance the manufacturer's instructions contained within the Subcontractors Manual for this project, and the above drawings. Ensure to install the check valves supplied loose by Howden to the air purge line at the HP water 3-way valve supplied by Clyde Bergemann with the cleaning devices.

Note: Do not fully secure the supports to the support steelwork until the sootblowers are located correctly in relation to the rotor.

STAGE 26 BEARING TEMPERATURE PROBES

Refer to the following drawings

Drawing No.

Electrical/Instrumentation Terminal Points	088009
P&ID	088012
Instrument Schedule	088013
Assembly of Top Bearing	136001
Assembly of Bottom Bearing	144001
Local Control Panel Internal Arrangement	SUB021
Local Control Panel Terminal Block Arrangement	SUB022

The gas-gas heater Rotor Bearing Housings are tapped to suit the temperature probes.

The sensor thermowells were fitted during [STAGE 13](#).

- a. Install the temperature probes into the top and bottom bearing housing thermowells. Refer to Suppliers Instructions contained within Subcontractor Manual.
- b. Connect the probes back to the local control panel.

STAGE 27 SEAL AIR FAN & PIPING SYSTEM

Refer to the following drawings

Drawing No.

Electrical/Instrumentation Terminal Points	088009
P&ID	088012
Instrument Schedule	088013
Arrangement of Seal Air Piping (4 sheets)	330001
Local Control Panel Terminal Arrangement	SUB022
General Arrangement of Seal Air Fan	SUB090

The system consists of a sealing air fan and motor complete with support frame and AV mountings. Thermoplastic (ABS) (and where appropriate steel) piping, valves, pressure indicators, pressure switch, pipe supports, clips and fasteners are included. A second standby seal air fan is also provided.

The sealing air from the fan is piped to the following parts of the gas gas heater to prevent the ingress of corrosive gases;

- a. To the annular space in both the top and bottom hub seals.
- b. To the connection on the side of the Cleaning Devices. From here the air is piped to the wall box where the Cleaning Device lance enters the GGH.
- c. To the shaft seal at the drive unit gearbox output shaft.

The following procedure should be followed:-

1. Check that all system items are available.
2. Check support structure where fan are positioned is complete and is fully welded.
3. Check that the fan mounting positions are correct and within tolerance.
4. Check orientation of fan is correct.
5. Assemble seal air fan, AV mounts, inlet filter, etc to position on support structure. Position, level and secure to plant steelwork.
6. Establish pipe runs for the various sealing air points and position pipe supports in accordance with drawing 330001 (4 sheets).
7. Install the piping system in accordance with 330001 and the manufacturer's instructions for the design, installation and general recommended working practice for a piping system.
8. Fit instrumentation in accordance with 330001 and the contract P&I diagram and associated valve and instrument lists

STAGE 28 POSITIONING OF GAS-GAS HEATER LOCAL CONTROL AND INVERTER PANELS

Refer to the following drawings

Drawing No.

Electrical/Instrumentation Terminal Points
Local Control Panel General Arrangement
Inverter Panel General Arrangement

088009
SUB020
SUB024

The above electrical panels should be positioned as required in an air conditioned room local to the GGH. All necessary cabling will have to be completed (by others).

STAGE 29 TOP AND BOTTOM BEARING GUARD

Refer to the following drawings

Drawing No.

Assembly of Centre Section

104001

Install bearing guards at top and bottom bearings as per drawing referenced above.

STAGE 30 INSTALLATION OF HP & LP WATER PUMP AND PIPE WORK

Refer to the following drawings

Drawing No.

P&ID
Arrangement of Cleaning Devices
Arrangement of High Pressure Pump
High Pressure Pump Control Panel Wiring Diagram
Assembly of High Pressure Pipework
Assembly of Low Pressure Pipework

088012
SUB010
SUB040
SUB041
335001
336001

Install HP water pump in designated location, according to instructions supplied with the unit. Secure to concrete foundation using the supplied anchor bolts.

Install LP water pump in designated location, according to instructions supplied with the unit. Secure to concrete foundation using the supplied anchor bolts.

Pipe work should be fitted with reference to drawings SUB010, 040, 041 & 088012 and also drawings 335001 and 336001. Ensure pipes and valves are adequately supported and flexible connections installed where indicated. Pipework should be thoroughly cleaned by flushing after installation.

Install pipes between the HP water pump and the cleaning devices and the LP water pump and the cleaning devices and drip tray wash pipe. Suitable supports for the pipework should be installed at suitable points on the pipework installation.

STAGE 31 INSTALLATION OF LOW LEAKAGE FAN AND DUCTING

Refer to the following drawings	<u>Drawing No.</u>
General Arrangement of Low Leakage Fan	000001
Arrangement of Insulation	174001
Arrangement of Purge Ducting	543001
Arrangement of Purge Ducting Expansion Joints	SUB340-343

Check supporting steelwork position for Low Leakage Fan. Check level of steelwork.

Position and install the Low Leakage Fan in accordance with the instructions supplied with the fan.

Install sections of purge ducting, supports and hangers as shown on drawing 543001. Note hangers and supports are not provided by Howden.

Connect Low Leakage Fan inlet duct section to the GGH treated gas outlet duct with expansion joints fitted as indicated on the drawings – refer to drawings Sub340-343.

Install all expansion joints in the locations shown on drawing 543001.

When complete, the Low Leakage Fan casing and ducting are to be lagged in accordance with the details shown on drawing 174001 (Lagging not supplied by Howden UK).

STAGE 32 AIR MOTOR PIPING

Refer to the following drawings	<u>Drawing No.</u>
Site Assembly of Heater	001004
Assembly of Air Motor Ancillaries	SUB002

Install Air Motor Piping to the air motor ancillaries assembly as per drawings above.

STAGE 33 LUBRICATION UNITS & LUBE OIL PIPING

Refer to the following drawings	<u>Drawing No.</u>
Assembly of Lube Oil Piping	150001
Assembly of Lubrication Unit	SUB080
Lubrication Unit Wiring Diagram	SUB081

For installation and set up of lubrication units (4-off) refer to Subcontractors Manual. Lubrication piping to be installed and routed as shown on drawing 150001.

It is important to flush the lubrication system and piping with flushing oil prior to coupling the flexible pipes to the bearings. Install spare filter element on the main tank and carry out flushing procedure as per the manufacturer's operations manual or instructions contained in the commissioning manual provided.

Note: The bearing manufacturer recommends the following oil cleanliness specification – ISO 4406 with an ISO Code of 17 / 15 / 12

Explanation;

17 = minimum 64000 to maximum 130000 particles/100ml => 4µm

15 = 16000 to 32000 particles/100ml => 6µm

12 = 2000 to 4000 particles/100ml => 14µm

STAGE 34 DIFFERENTIAL PRESSURE TRANSMITTERS & PIPEWORK

Install differential pressure monitors and piping are not Howden supply.

STAGE 35 LAGGING & CLADDING

Refer to the following drawings

Drawing No.

Site Assembly of Heater

001002

Arrangement of Insulation

174001

Arrangement of Insulation

174002

Insulation should be applied to the external surfaces of the gas-gas heater casing as indicated on the drawings showing “Typical Site Insulation”, as well as to the purge fan and ducting.

The reason is to minimise heat loss and to maintain uniform temperatures for the centre sections of the casing which house the sealing plates.

The insulation material should be applied over the external surfaces of the Rotor Housing which include the centre sections of the Rotor Housing (false sectorplates) and the End Pillars and also over the Transition Ducts, the purge ducting and the purge fan casing.

The thickness of the insulation material depends on the type of material selected and on the acceptable maximum surface temperature.

Insulation panels should be securely attached to the casing and overlapped for expansion at suitable junctions. Removable sections are required for all excess openings, tapping points and where access is required for maintenance.

Note: In order to prevent water ingress it is imperative that the metal sheet cladding is properly sealed and watertight.

3.0 APPENDICES

- APPENDIX 1 - ERECTION CHECKSHEETS
- APPENDIX 2 – WELDING AND NON-DESTRUCTIVE TESTING
- APPENDIX 3 - HEATER TURNING PROCEDURES
- APPENDIX 4 - TABLE OF RECOMMENDED BOLT TIGHTENING TORQUE

Customer: BHEL

Our ref: H017887

Project: Gas Gas Heater

Your ref: RAH-553

Site: Panki FGD, Uttar Pradesh, India

Date: 21.10.2020



APPENDIX 1 - ERECTION CHECKSHEETS

HOWDEN UK LTD.

ERECTION CHECK SHEET



Heater Identification:

Contract No.

Checkpoint 1 – Support Steelwork Level

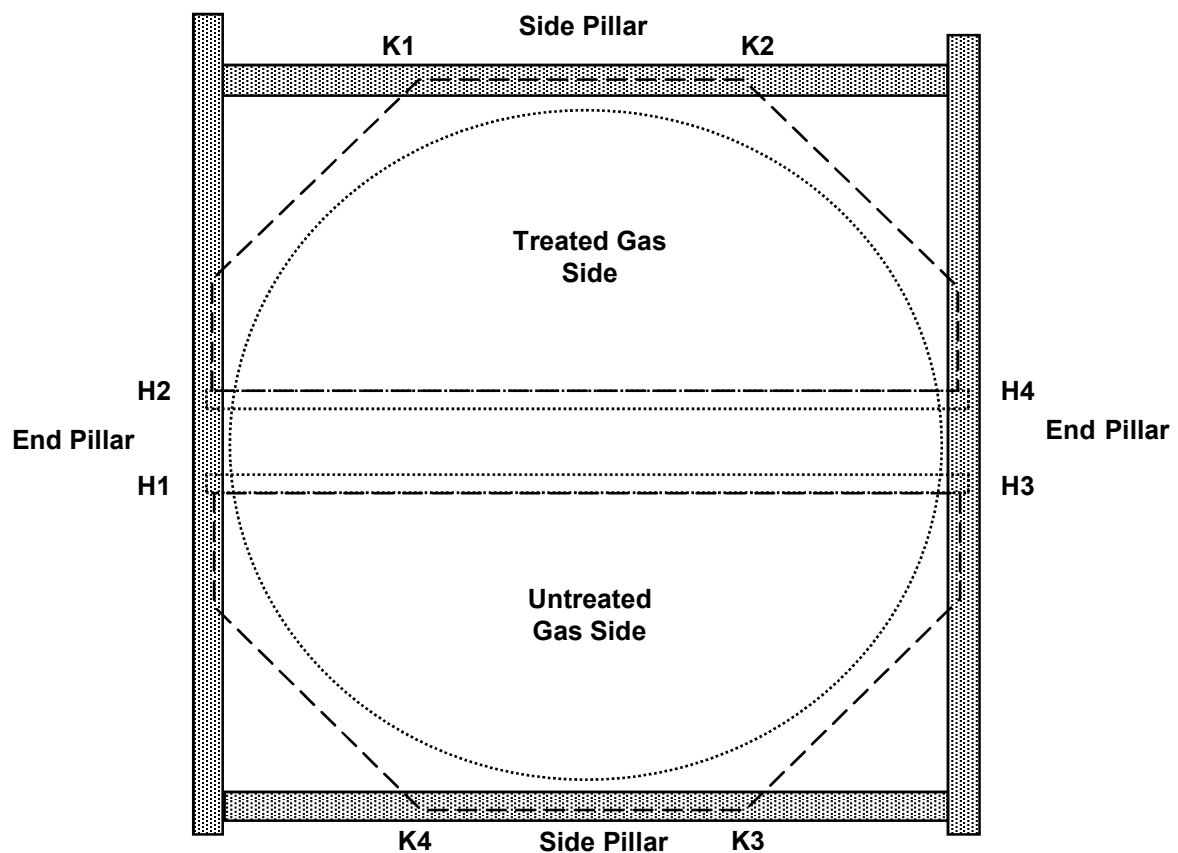
Measure and record the relative levelness of the supporting steelwork using the highest point as the datum.

Tolerance on steelwork levels (shimmed) at support points = $\pm 1\text{mm}$

The differential deflections must not exceed the values stated on the GA after the heater has been fully assembled with the elements loaded

H1
H2
H3
H4
K1
K2
K3
K4

Before Element Loading		After Element Loading
As Found	After Shims	
Signed by Client:		Signed by Client:
Signed by HUK:		Signed by HUK:
Date:		Date:



HOWDEN UK LTD.

ERECTION CHECK SHEET

Heater Identification:

Contract No.

Checkpoint 2 – End Pillar Hinge Level

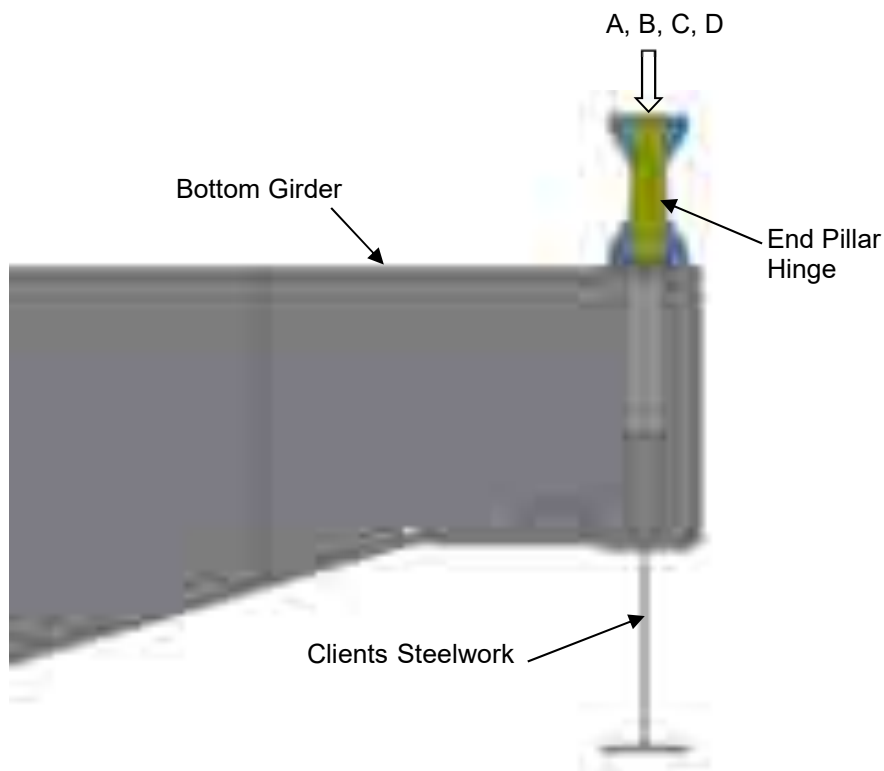
Measure and record the relative level of each end pillar hinge mounting face.

Tolerance = $\pm 1\text{mm}$

- Shim 4 hinges as per drawing
- Use lowest hinge as the datum
- Remove shims from other 3 hinges to achieve level.

A
B
C
D

Signed by Client:
Signed by HUK:
Date:



HOWDEN UK LTD. **ERECTION CHECK SHEET**



Heater Identification:

Contract No.

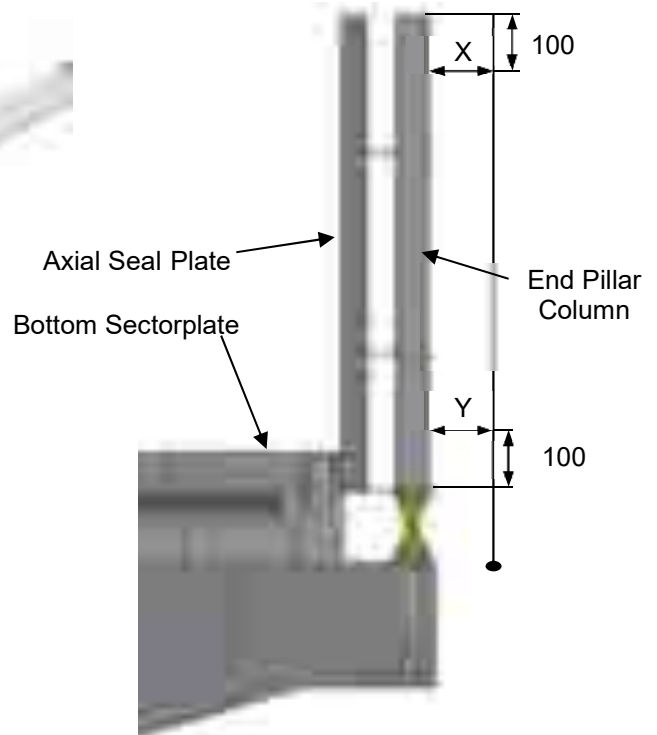
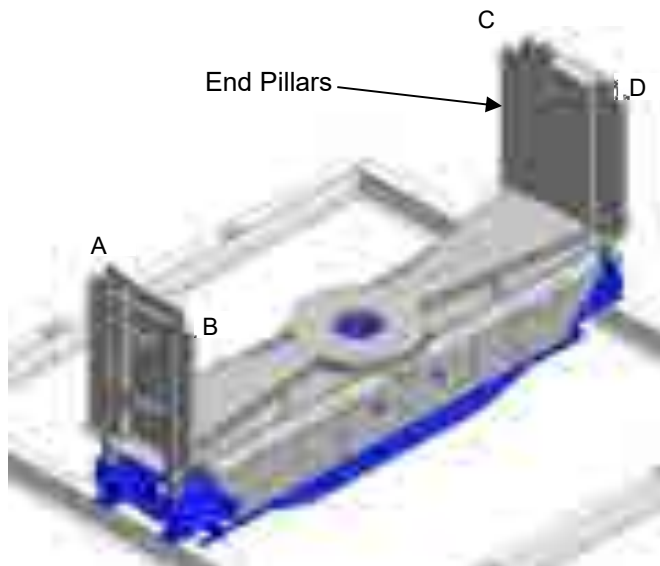
Checkpoint 3 – Vertical Alignment of End Pillar

Measure and record the vertical alignment of each of the end pillar columns

Tolerance between X & Y readings
= 3mm Max.

A
B
C
D

X	Y
Signed by Client:	
Signed by HUK:	
Date:	



HOWDEN UK LTD.

ERECTION CHECK SHEET



Heater Identification:

Contract No.

Checkpoint 4 – Rotor Spider Axis Alignment and Concentricity Check

Measure and record the rotor rotational axis alignment using an optical survey device and the concentricity of the rotor hub in relation to the hole in the top and bottom sectorplates

Axis Alignment Tolerance = 4mm Variation

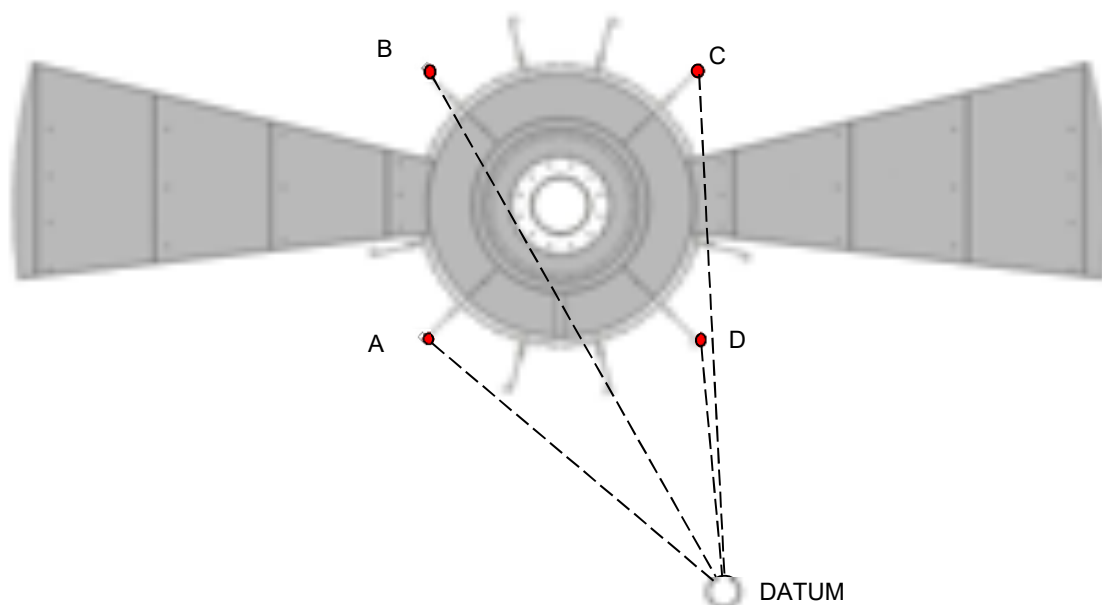
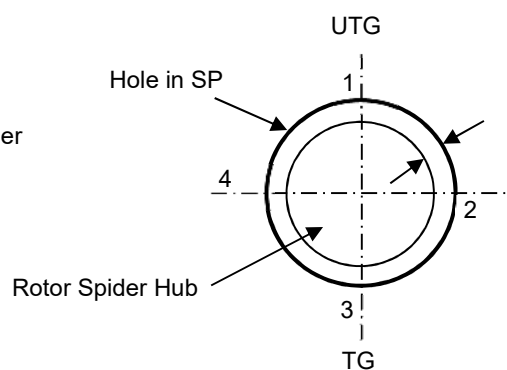
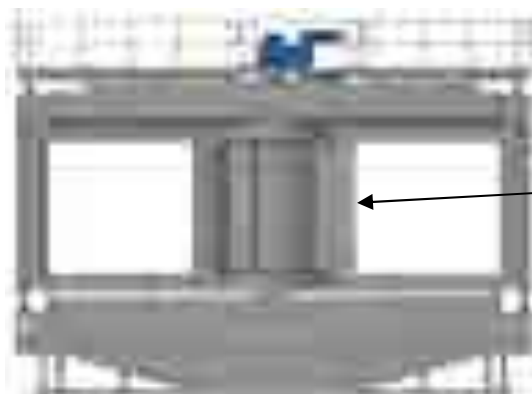
Concentricity Tolerance = 2mm

		Top	Bottom
A		1	
B		2	
C		3	
D		4	

Signed by Client:

Signed by HUK:

Date:



HOWDEN UK LTD. ERECTION CHECK SHEET



Heater Identification:

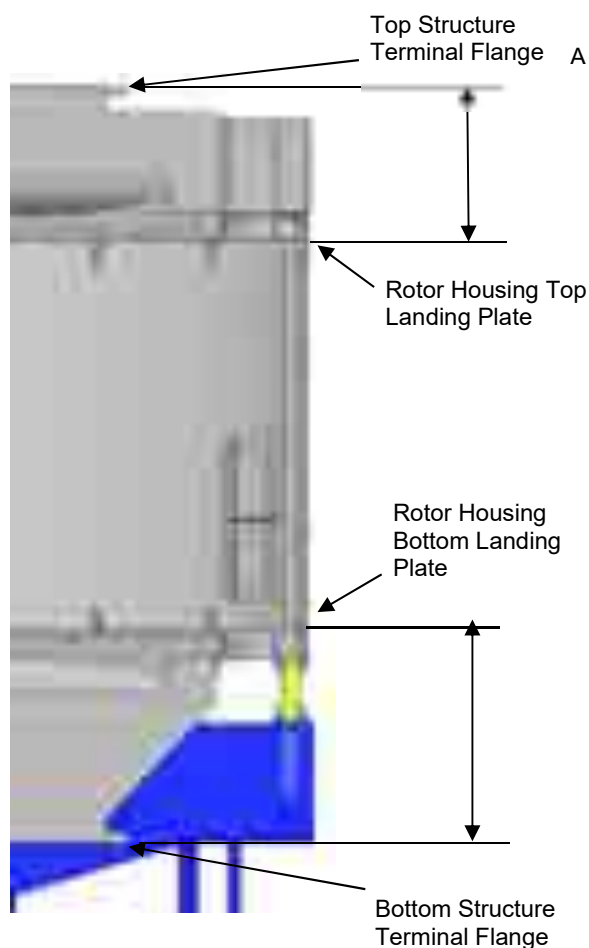
Contract No.

Checkpoint 5 –Treated Gas Side Dimensional Check

Measure and record the distance from the top face of the top structure terminal flange to the top rotor housing landing plate local to each end pillar column. Repeat this for the bottom structure.

A
B

Top	Bottom
Signed by Client:	
Signed by HUK:	
Date:	



VIEW ON ARROW X



HOWDEN UK LTD.

ERECTION CHECK SHEET



Heater Identification:

Contract No.

Checkpoint 6 – Rotor Circularity and Swash Check (Before Welding)

Measure and record the dimension from the outer edge of each of the main rotor radial plates to a fixed point on one axial seal plate.

	X	Y		X	Y
1			13		
2			14		
3			15		
4			16		
5			17		
6			18		
7			19		
8			20		
9			21		
10			22		
11			23		
12			24		

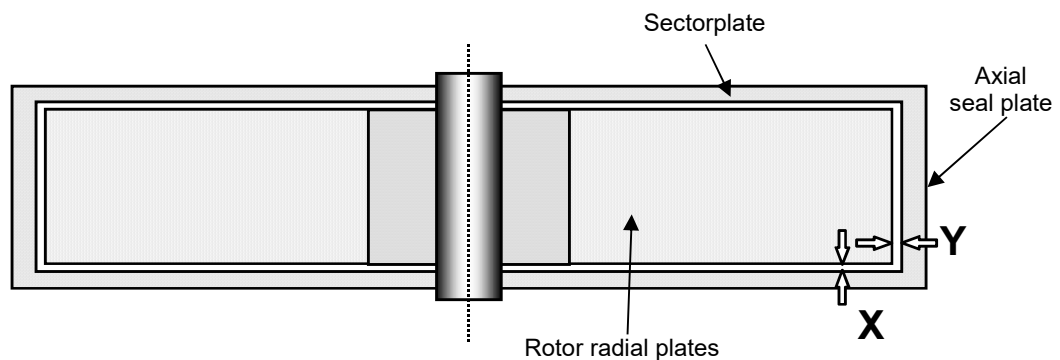
Swash (X) =

Circularity (Y) =

Signed by Client:

Signed by HUK:

Date:

Tolerance: $X = \pm 2\text{mm}$, $Y = \pm 3\text{mm}$ 

HOWDEN UK LTD.

ERECTION CHECK SHEET



Heater Identification:

Contract No.

Checkpoint 7 – Rotor Circularity and Swash Check (After Welding)

Measure and record the dimension from the outer edge of each of the main rotor radial plates to a fixed point on one axial seal plate.

	X	Y		X	Y
1			13		
2			14		
3			15		
4			16		
5			17		
6			18		
7			19		
8			20		
9			21		
10			22		
11			23		
12			24		

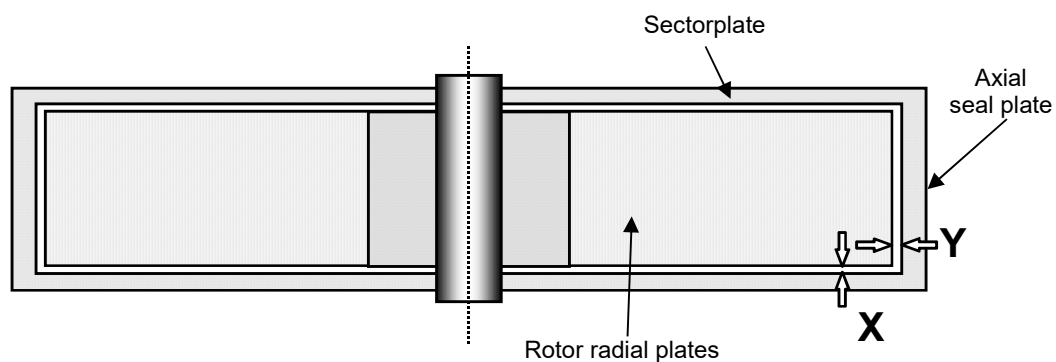
Swash (X) =

Circularity (Y) =

Signed by Client:

Signed by HUK:

Date:

Tolerance: $X = \pm 4\text{mm}$, $Y = \pm 4\text{mm}$ 

HOWDEN UK LTD.

ERECTION CHECK SHEET



Heater Identification:

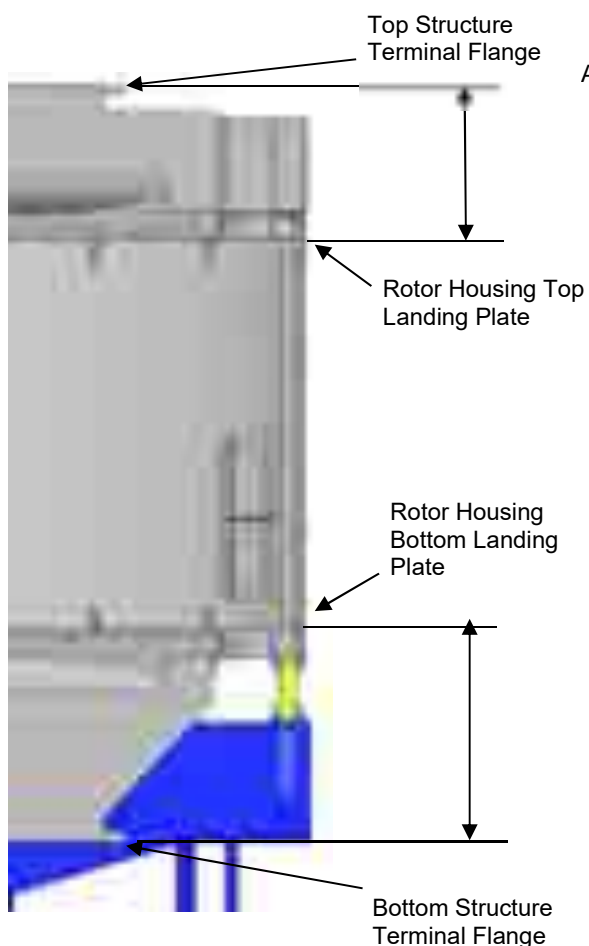
Contract No.

Checkpoint 8 – Untreated Gas Side Dimensional Check

Measure and record the distance from the top face of the top structure terminal flange to the top rotor housing landing plate local to each end pillar column. Repeat this for the bottom structure.

A
B

Top	Bottom
Signed by Client:	
Signed by HUK:	
Date:	



VIEW ON ARROW X



HOWDEN UK LTD.

ERECTION CHECK SHEET



Heater Identification:

Contract No.

Checkpoint 9 – Rotor Housing level check relative to Rotor.

Check level of rotor housing relative to rotor by selecting 8 points around the top or bottom landing plates and measuring to the rotor.

Adjust shims under side pillars and bottom bearing as required to achieve drawing dimension.

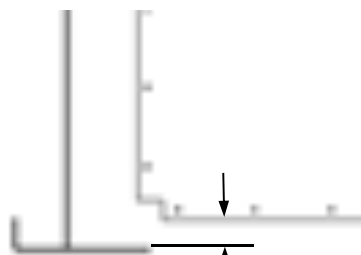
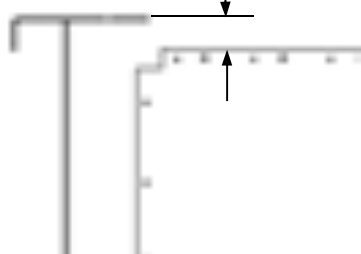
1
2
3
4
5
6
7
8

Signed by Client:

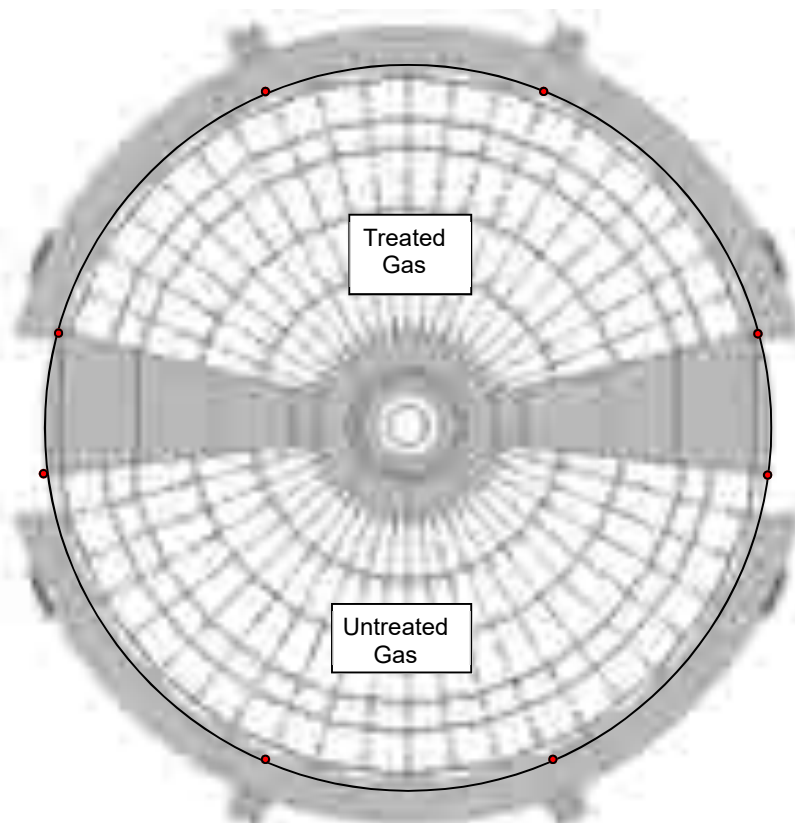
Signed by HUK:

Date:

Top landing plate



Bottom landing plate



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ERECTION CHECK SHEET

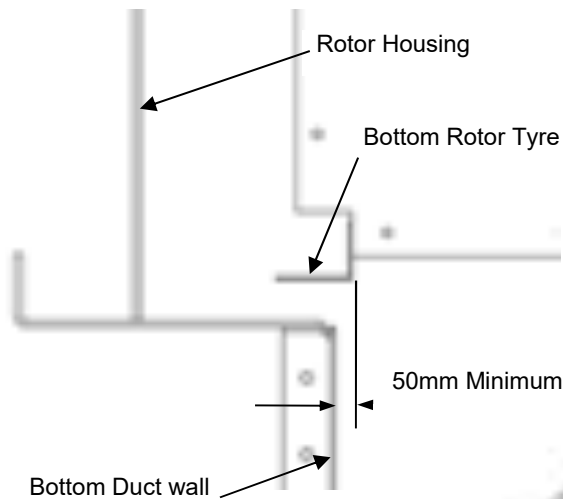


Heater Identification:

Contract No.

Checkpoint 10 – Circularity of CE Ducts relative to circularity of Rotor

Rotate the rotor to ensure that the minimum clearance between the cold end duct wall and the innermost edge of the rotor tyre is not less than 50mm at any point.

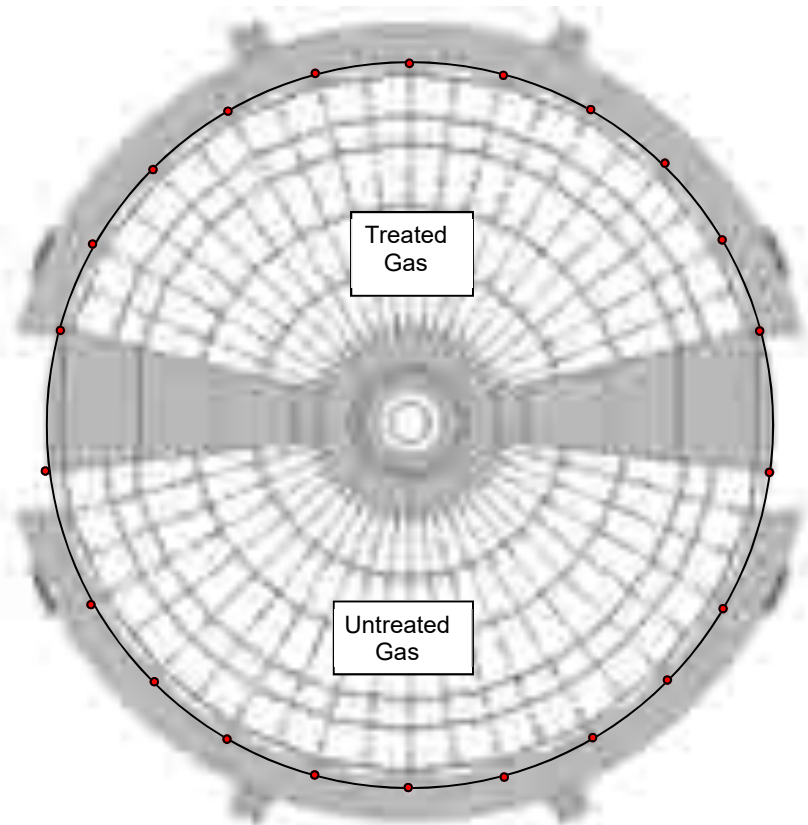


1		12	
2		13	
3		14	
4		15	
5		16	
6		17	
7		18	
8		19	
9		20	
10		21	
11		22	

Signed by Client:

Signed by HUK:

Date:



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ERECTION CHECK SHEET



Heater Identification:

Contract No.

Checkpoint 11 – Rotor Axis Alignment Check

Measure and record the rotor rotational axis alignment using an optical survey device.

Record deviations at positions A, B, C, and D.

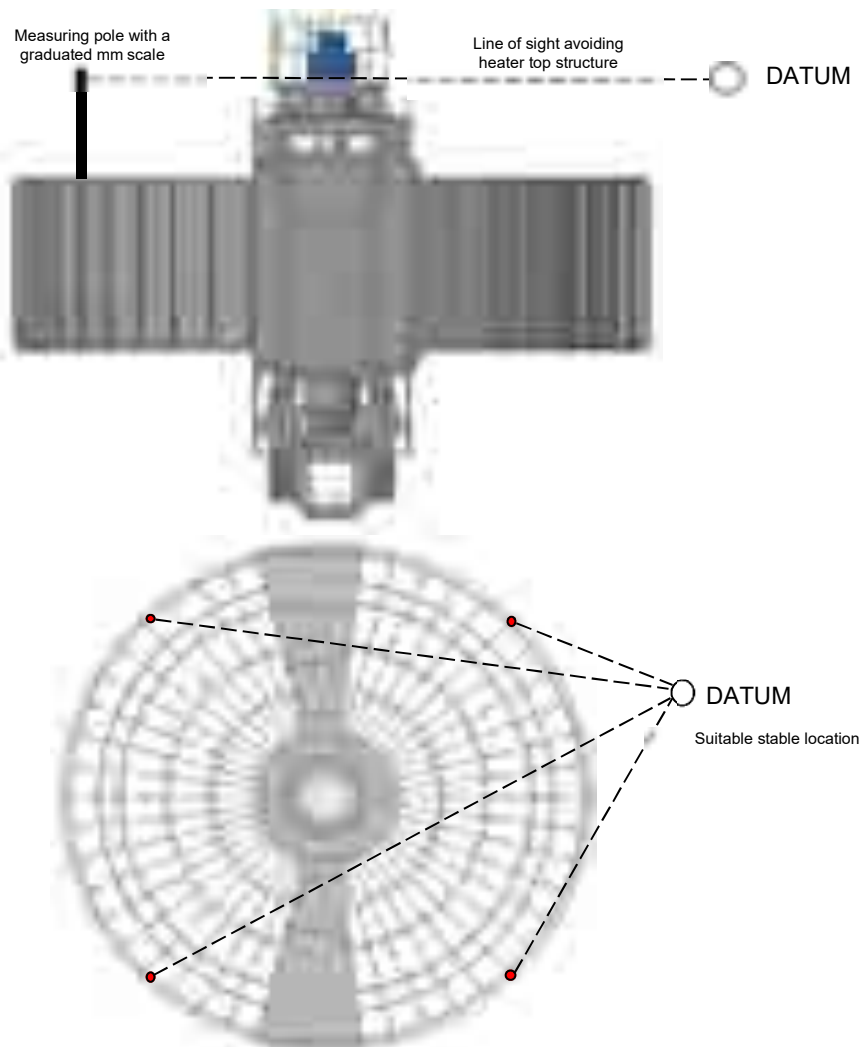
Tolerance = $\pm 2\text{mm}$

A
B
C
D

Signed by Client:

Signed by HUK:

Date:



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ERECTION CHECK SHEET



Heater Identification:

Contract No.

Checkpoint 12 – Axial Seal Plate Concentricity Check

Measure and record the Axial Seal Plate concentricity.

Measure the gap between the axial seal plate sealing surface and the outer edge of the mean radial plate, at the positions indicated (top and bottom), as rotor is rotated to each axial seal plate in turn.

Tolerance = 4mm Variation

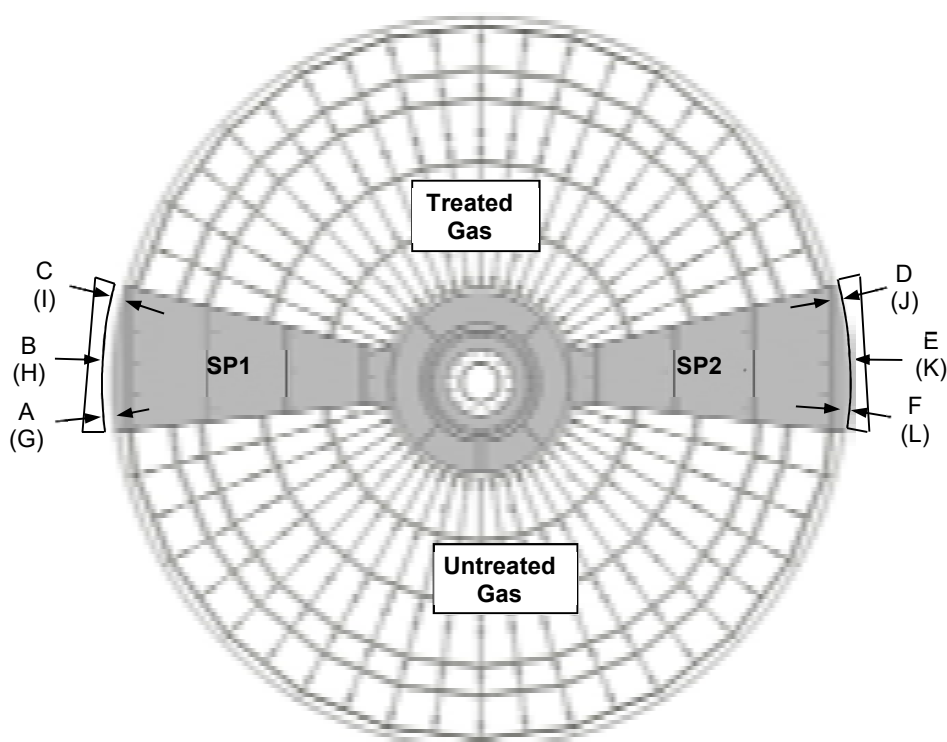
*Measure centre points using fingerplates

A		G	
B		H	
C		I	
D		J	
E		K	
F		L	

Signed by Client:

Signed by HUK:

Date:



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ERECTION CHECK SHEET



Heater Identification:

Contract No.

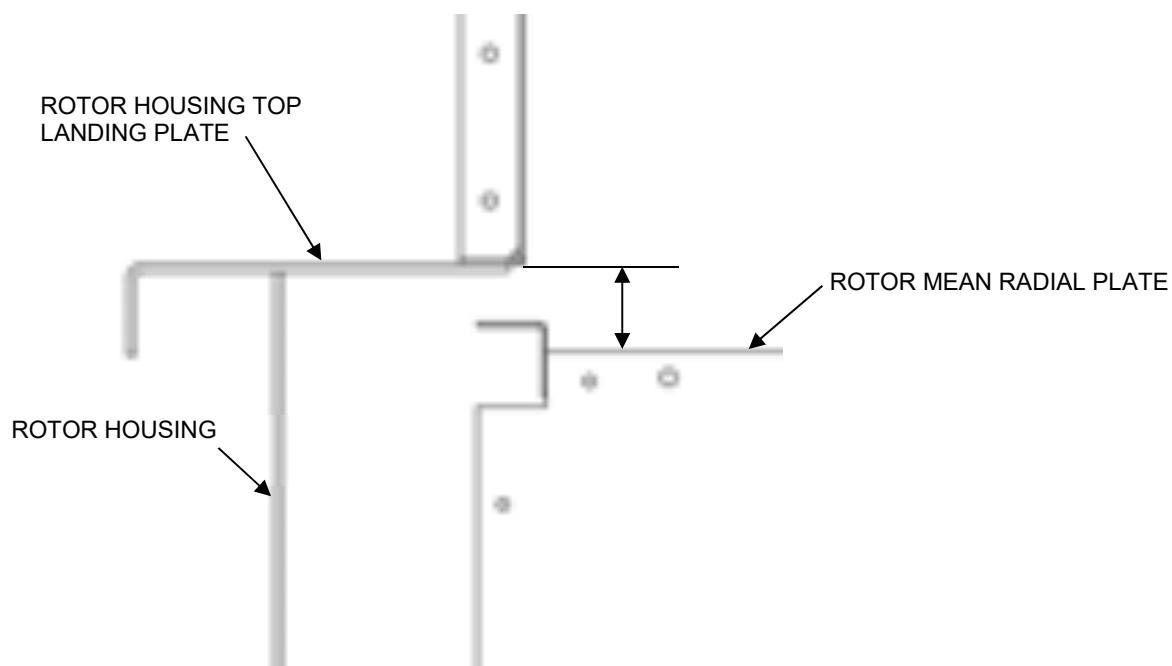
Checkpoint 13 – Rotor height relative to Rotor Housing

The rotor should be jacked and shimmed such that the zero graduation mark on the mounting bell lines up with the top cover of the bearing housing (see drawing 136001). The dimension between the mean radial division plate, when the zero graduation mark is accomplished, and the top surface of the rotor housing top landing plate should be **95mm**

Signed by Client:

Signed by HUK:

Date:



HOWDEN UK LTD.

ERECTION CHECK SHEET

Howden

Heater Identification:

Contract No.

Checkpoint 14 – Top Sectorplate Settings (Before Welding / After Welding)

With the rotor fully loaded with elements, measure and record the clearances between the top sectorplate and the rotor mean radial division plate local to each sectorplate adjuster at all edges of the sectorplate.

Readings are taken from the same fixed points on the rotor as the rotor is turned to each of the sectorplate edges.

Tolerance = $\pm 0.5\text{mm}$ Before welding
 $\pm 3\text{mm}$ After welding

For nominal sizes refer to site assembly drawings

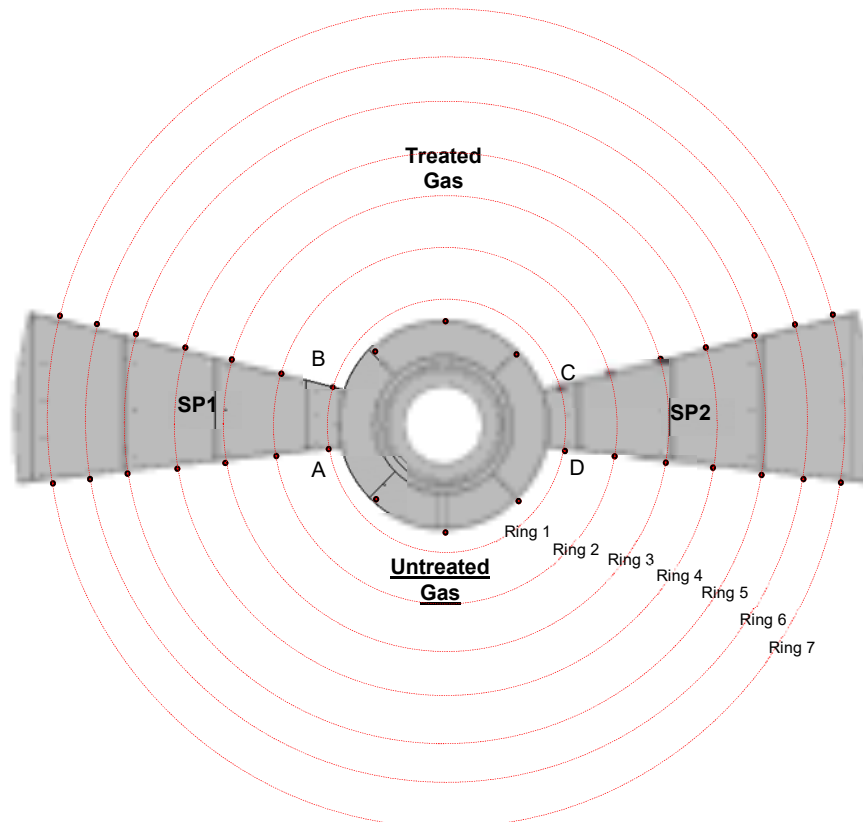
The number of check points will vary with heater size

	A	B	C	D
SP Hub				
Ring 1				
Ring 2				
Ring 3				
Ring 4				
Ring 5				
Ring 6				
Ring 7				

Signed by Client:

Signed by HUK:

Date:



HOWDEN UK LTD.

ERECTION CHECK SHEET

Howden

Heater Identification:

Contract No.

Checkpoint 15 – Bottom Sectorplate Settings (Before Welding / After Welding)

With the rotor fully loaded with elements, measure and record the clearances between the bottom sectorplate and the rotor mean radial division plate local to each sectorplate adjuster at all edges of the sectorplate.

Readings are taken from the same fixed points on the rotor as the rotor is turned to each of the sectorplate edges.

Tolerance = $\pm 0.5\text{mm}$ Before welding
 $\pm 3\text{mm}$ After welding

For nominal sizes refer to site assembly drawings

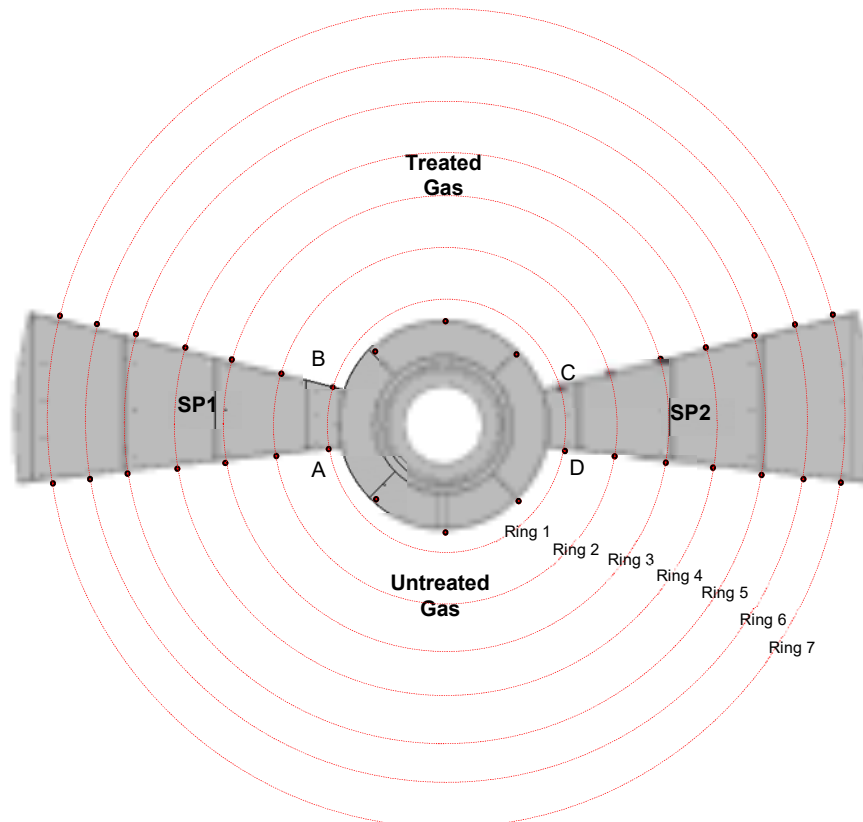
The number of check points will vary with heater size

	A	B	C	D
SP Hub				
Ring 1				
Ring 2				
Ring 3				
Ring 4				
Ring 5				
Ring 6				
Ring 7				

Signed by Client:

Signed by HUK:

Date:



HOWDEN UK LTD.

ERECTION CHECK SHEET



Heater Identification:

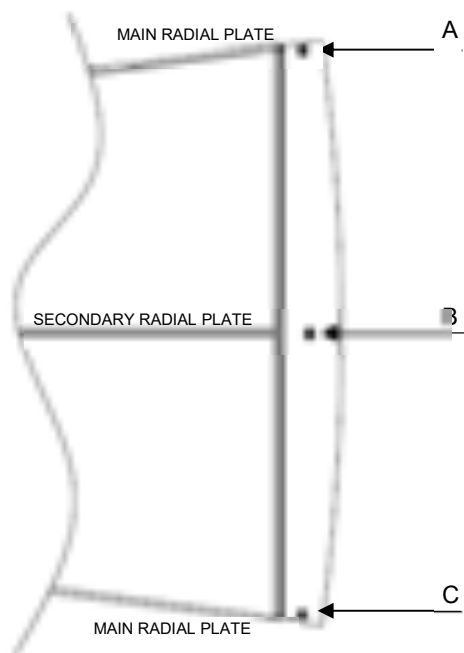
Contract No.

Checkpoint 16 – Hot End Rotor Tyre Swash Check

With the rotor fully loaded with elements rotate the rotor 360° and measure the gap between a fixed point on the rotor housing top landing plate and the top surface of the HE rotor tyre at the 3 points indicated below.

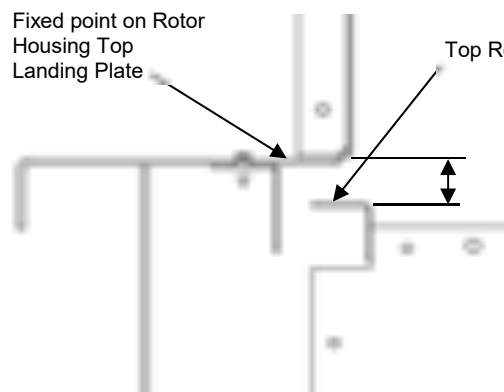
Minimum Value =

Tolerance: Refer to cold seal setting chart, drawing 186005



Fixed point on Rotor Housing Top Landing Plate

Top Rotor Tyre



Tyre	A	B	C
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			

Signed by Client:

Signed by HUK:

Date:

HOWDEN UK LTD.

ERECTION CHECK SHEET



Heater Identification:

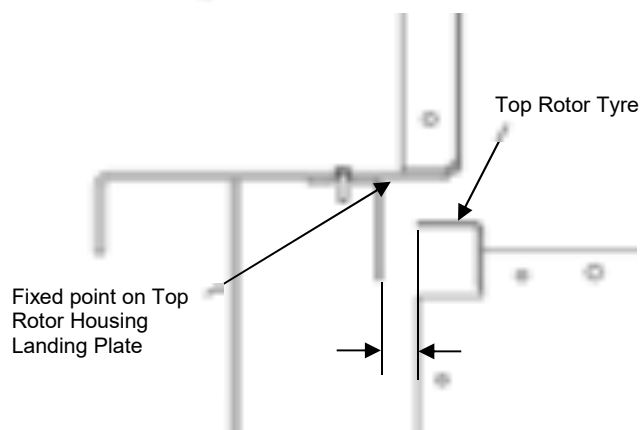
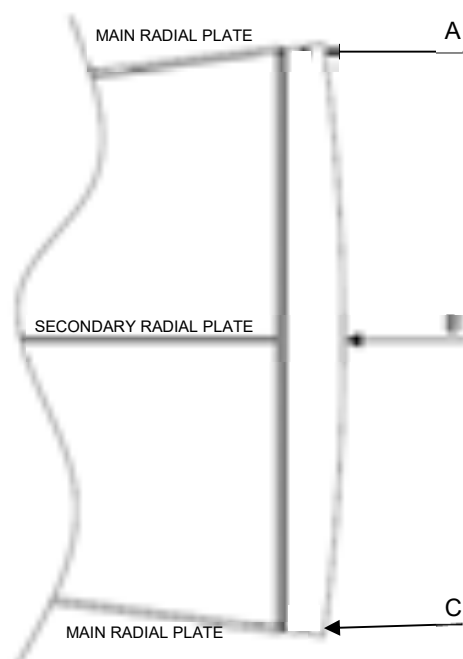
Contract No.

Checkpoint 17 – Hot End Rotor Tyre Circularity Check

With the rotor fully loaded with elements rotate the rotor 360° and measure the gap between a fixed point on the rotor housing top landing plate and the outer edge of the HE rotor tyre at the 3 points indicated below.

Minimum Value = Maximum Value =

Tolerance: Min – Max = 3mm MAX



Tyre	A	B	C
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			

Signed by Client:

Signed by HUK:

Date:

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ERECTION CHECK SHEET



Heater Identification:

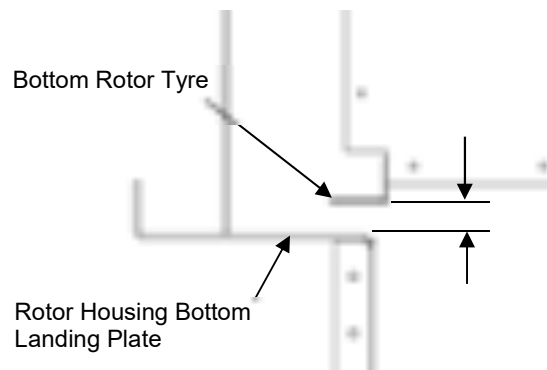
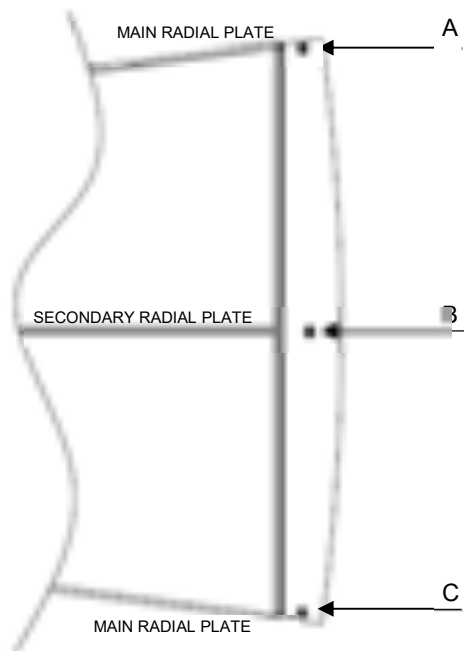
Contract No.

Checkpoint 18 – Cold End Rotor Tyre Swash Check

With the rotor fully loaded with elements rotate the rotor 360° and measure the gap between a fixed point on the rotor housing bottom landing plate and the bottom surface of the CE rotor tyre at the 3 points indicated below.

Minimum Value = Maximum Value =

Tolerance: Min – Max = 3mm MAX



Tyre	A	B	C
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			

Signed by Client:

Signed by HUK:

Date:

HOWDEN UK LTD.

ERECTION CHECK SHEET



Heater Identification:

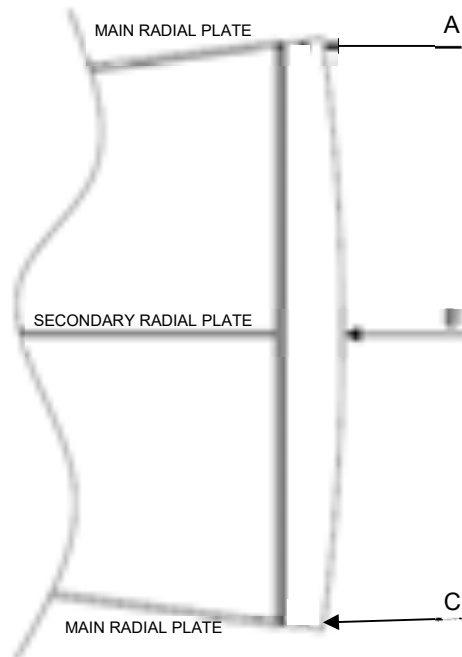
Contract No.

Checkpoint 19 – Cold End Rotor Tyre Circularity Check

With the rotor fully loaded with elements rotate the rotor 360° and measure the gap between a fixed point on the rotor housing bottom landing plate and the bottom surface of the CE rotor tyre at the 3 points indicated below.

Minimum Value =

Tolerance: Refer to cold seal setting chart, drawing 186005



Fixed point on Rotor Housing Bottom Landing Plate

Bottom Rotor Tyre

Tyre	A	B	C
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			

Signed by Client:

Signed by HUK:

Date:

HOWDEN UK LTD.

ERECTION CHECK SHEET



Heater Identification:

Contract No.

Checkpoint 20 – Hot End Rotor Tyre to Sectorplate Clearance Check

With the rotor fully loaded with elements rotate the rotor 360° and measure the gap between the high point (point 'H') on the top rotor tyre and each top sectorplate sealing surface

Minimum Value =

Tolerance: Min value not less than
clearance stated on drawing 186005

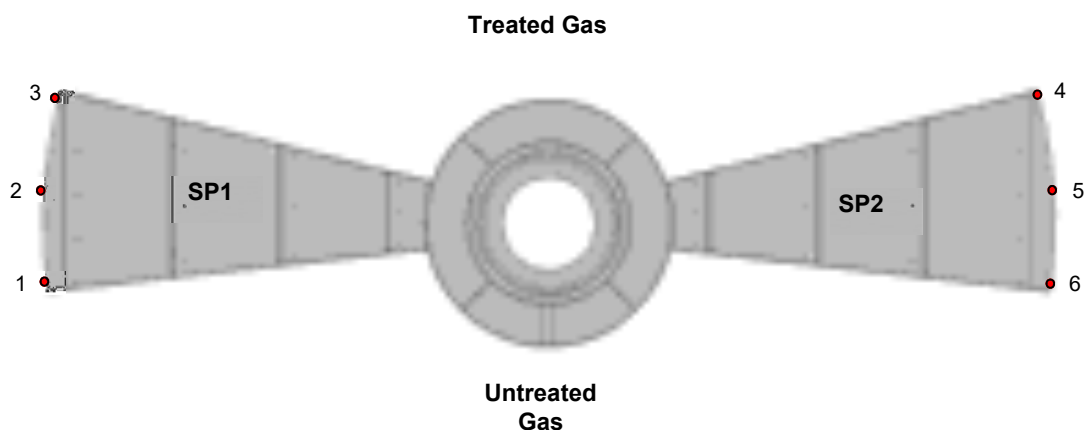
1	
2	
3	
4	
5	
6	

Signed by Client:

Signed by HUK:

Date:

*Measure centre points using fingerplates



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ERECTION CHECK SHEET



Heater Identification:

Contract No.

Checkpoint 21 – Cold End Rotor Tyre to Sectorplate Clearance Check

With the rotor fully loaded with elements rotate the rotor 360° and measure the gap between the low point (point 'L') on the bottom rotor tyre and each bottom sectorplate sealing surface

Minimum Value =

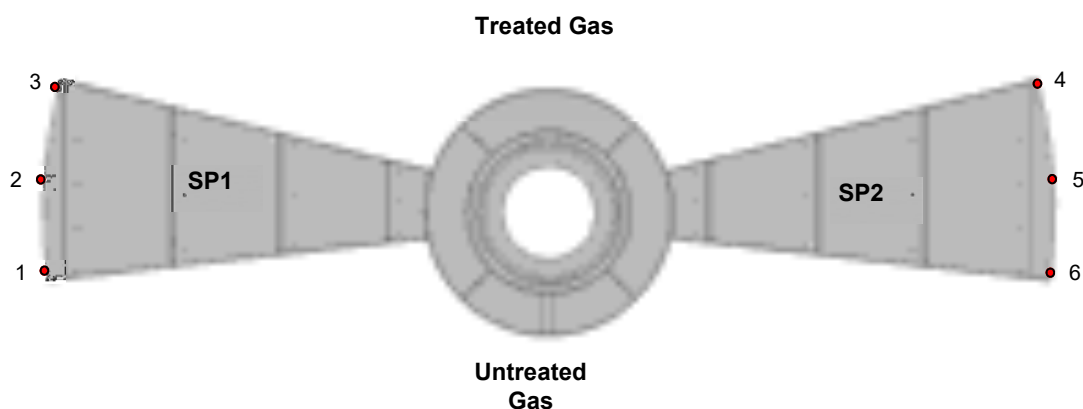
Tolerance: Min value not less than
clearance stated on drawing 186005

1	
2	
3	
4	
5	
6	

Signed by Client:

Signed by HUK:

Date:



HOWDEN UK LTD.

ERECTION CHECK SHEET



Heater Identification:

Contract No.

Checkpoint 22 – Top and Bottom Inner Circumferential Seal Clearance Check

Measure and record the top and bottom inner circumferential seal settings

Compare reading to valves given in the cold seal setting chart.

Tolerance: Not less than clearance stated on drawing 186005 at the tightest position

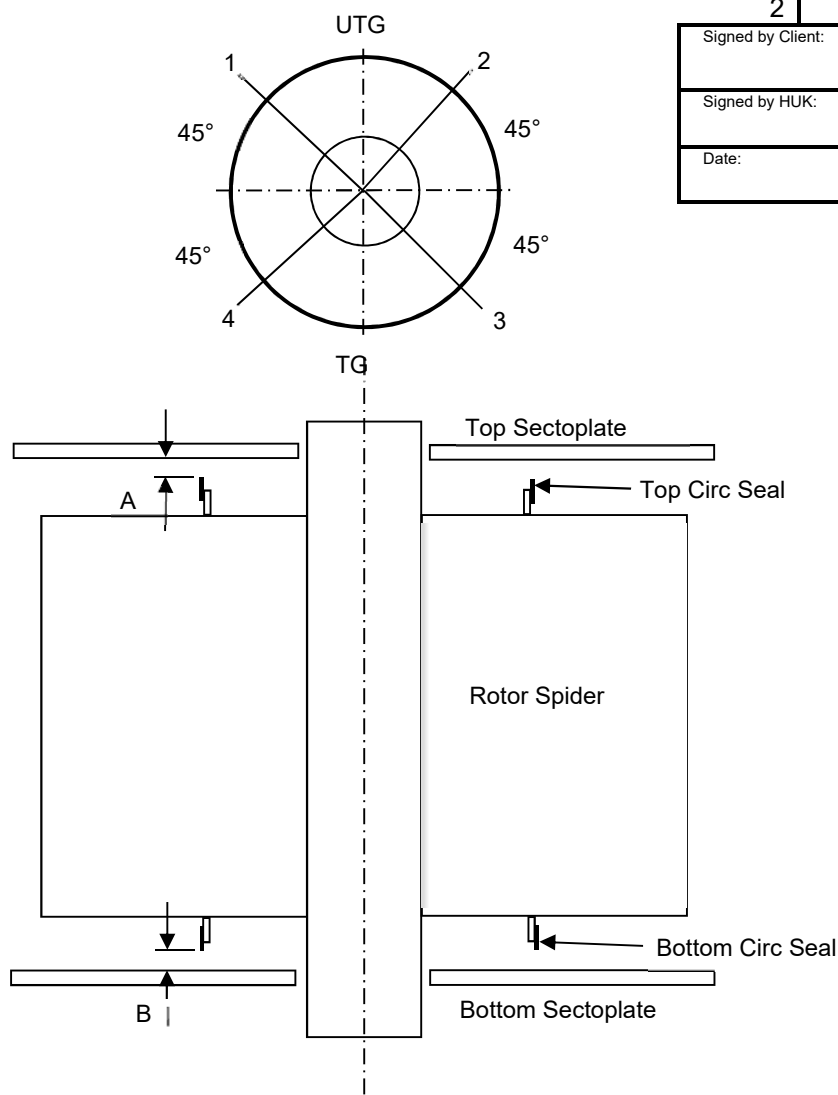
UTG		
	A	B
1		
2		

TG		
	A	B
1		
2		

Signed by Client:

Signed by HUK:

Date:



HOWDEN UK LTD.

ERECTION CHECK SHEET



Heater Identification:

Contract No.

Checkpoint 23 – Top Radial Seal Clearance Check

Howden TA : _____ % of check complete

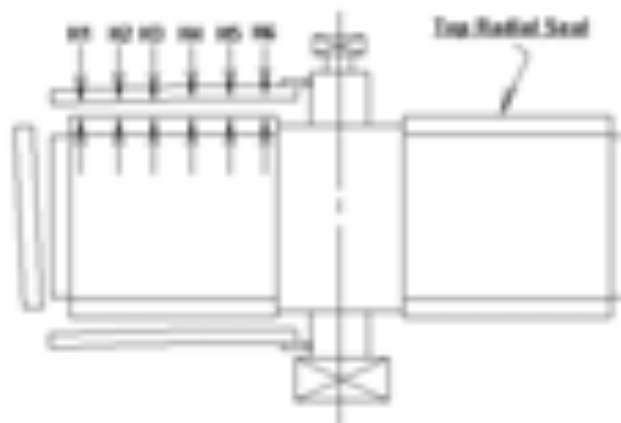
Tolerance = +1mm, -0mm

	H1	H2	H3	H4	H5	H6		H1	H2	H3	H4	H5	H6
1							25						
2							26						
3							27						
4							28						
5							29						
6							30						
7							31						
8							32						
9							33						
10							34						
11							35						
12							36						
13							37						
14							38						
15							39						
16							40						
17							41						
18							42						
19							43						
20							44						
21							45						
22							46						
23							47						
24							48						

Signed by Client:

Signed by HUK:

Date:



HOWDEN UK LTD.

ERECTION CHECK SHEET



Heater Identification:

Contract No.

Checkpoint 24 – Bottom Radial Seal Clearance Check

Howden TA : _____ % of check complete

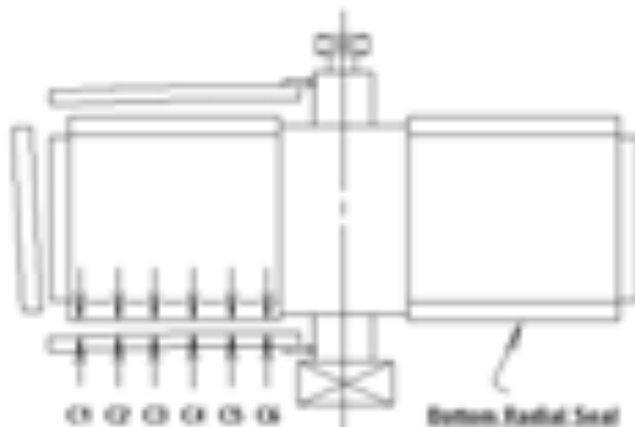
Tolerance = +1mm, -0mm

	C1	C2	C3	C4	C5	C6		C1	C2	C3	C4	C5	C6
1							25						
2							26						
3							27						
4							28						
5							29						
6							30						
7							31						
8							32						
9							33						
10							34						
11							35						
12							36						
13							37						
14							38						
15							39						
16							40						
17							41						
18							42						
19							43						
20							44						
21							45						
22							46						
23							47						
24							48						

Signed by Client:

Signed by HUK:

Date:



HOWDEN UK LTD.

ERECTION CHECK SHEET



Heater Identification:

Contract No.

Checkpoint 25 – Axial Seal Clearance Check

Howden TA : _____ % of check complete

Tolerance: +1mm, -0mm

	A	B		A	B		A	B		A	B
1			13			25			37		
2			14			26			38		
3			15			27			39		
4			16			28			40		
5			17			29			41		
6			18			30			42		
7			19			31			43		
8			20			32			44		
9			21			33			45		
10			22			34			46		
11			23			35			47		
12			24			36			48		

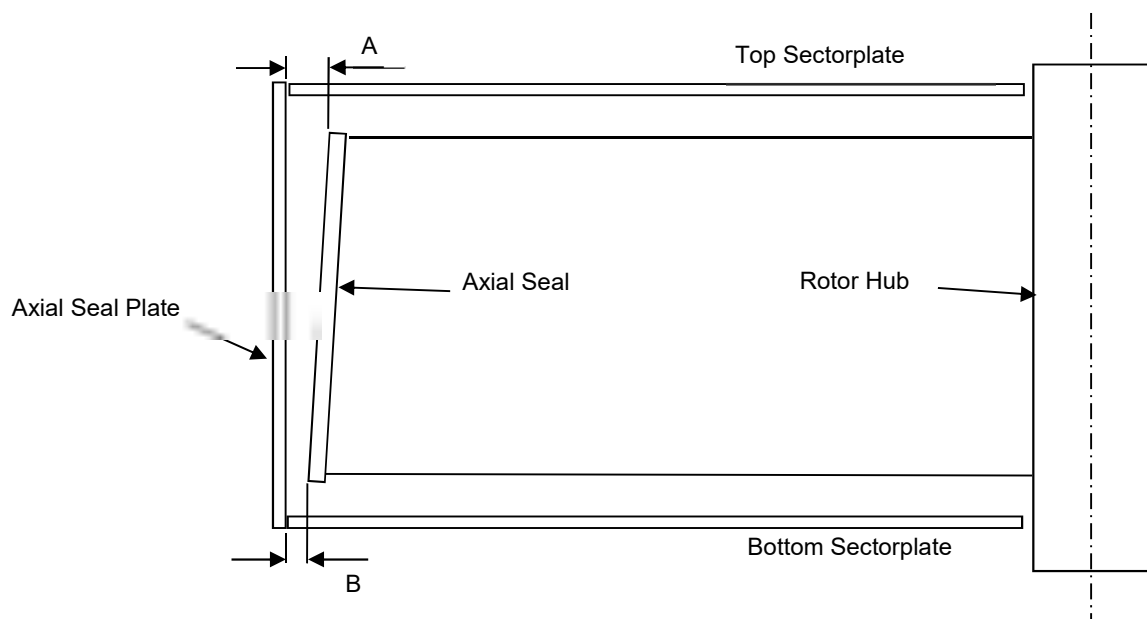
Signed by Client:

Signed by HUK:

Date:

Measure and record the distance between axial seal plates and axial seals at each axial seal plate edge.

Minimum clearance stated on drawing 186005 should be achieved at tightest point



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ERECTION CHECK SHEET



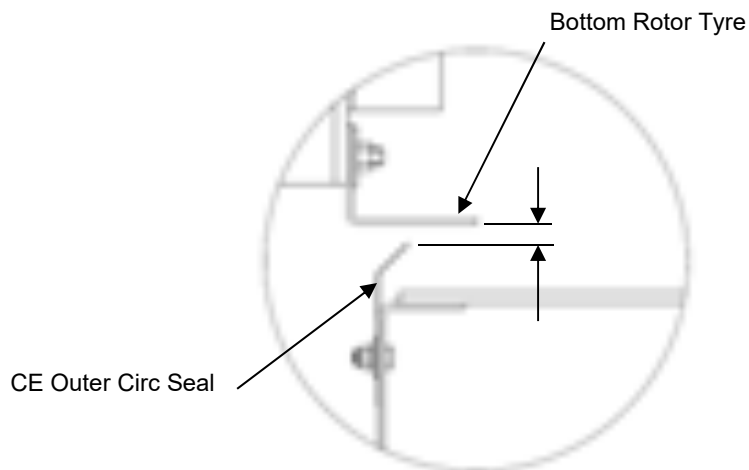
Heater Identification:

Contract No.

Checkpoint 26 – Cold End Outer Circumferential Seal Clearance Check

Measure and record the gap between the lowest point 'L' on the bottom rotor tyre and each CE circumferential seal section. Also check the gap between the most extreme radial point 'RB' on the cold End rotor tyre and each axial seal plate.

Tolerance: +1mm, -0mm



1		13	
2		14	
3		15	
4		16	
5		17	
6		18	
7		19	
8		20	
9		21	
10		22	
11		23	
12		24	

Signed by Client:

Signed by HUK

Date:

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Heater Identification:

Contract No.

Checkpoint 27 – Hot End Outer Circumferential Seal Clearance Check

Measure and record the gap between the most extreme radial point 'RT' on the top rotor tyre and each HE circumferential seal flange.
Also check the gap between point 'RT' and each axial seal plate.

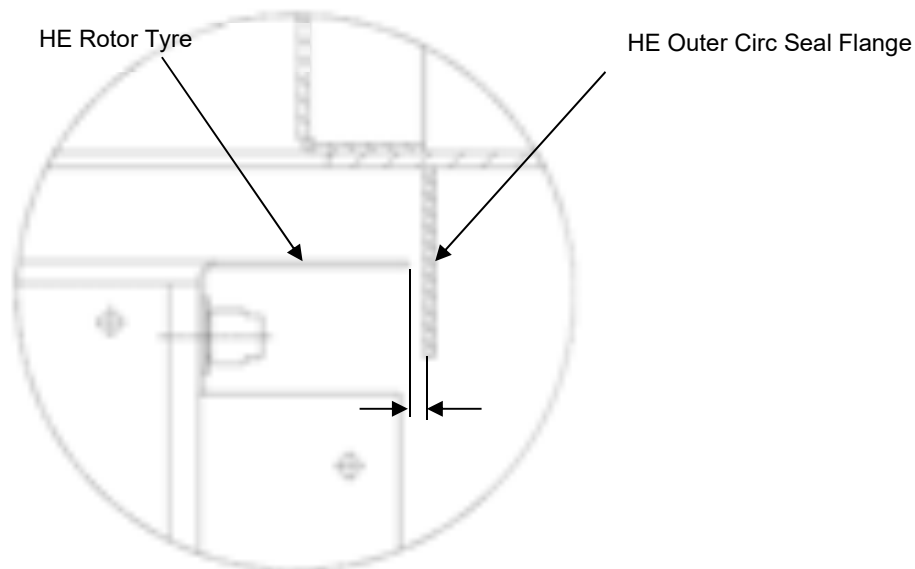
Tolerance: See cold seal setting chart drawing 186005 in Contract Drawing Manual.

1		13	
2		14	
3		15	
4		16	
5		17	
6		18	
7		19	
8		20	
9		21	
10		22	
11		23	
12		24	

Signed by Client:

Signed by HUK

Date:



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ERECTION CHECK SHEET



Heater Identification:

Contract No.

Checkpoint 28 – Top Expansion Joint Flow Sleeve Clearance Check

Measure and record dimensions X and Y between the expansion joint flow sleeves and ducts, top and bottom.

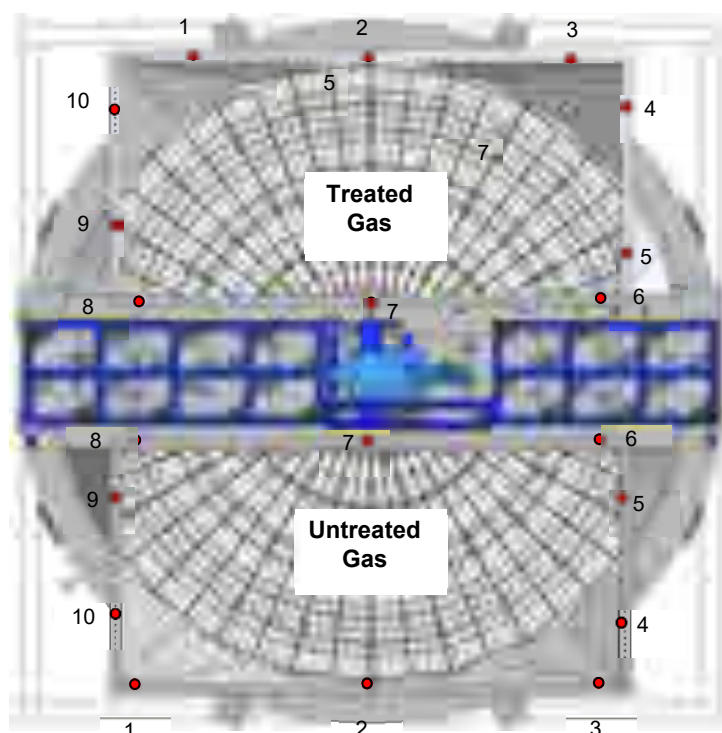
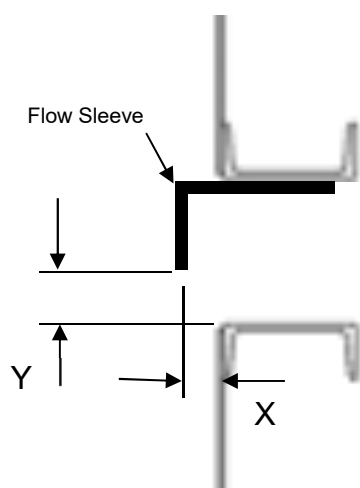
If possible, confirm maximum axial compression of client supplied expansion joints is sufficient to accommodate heater duct and client duct axial expansion.

	TG		UTG	
	X	Y	X	Y
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Signed by Client:

Signed by HUK

Date:



APPENDIX 2 **WELDING & NON-DESTRUCTIVE TESTING INSTRUCTIONS**

1. This section specifies the requirements for arc welding of the fabrications and subsequent NDT on Howden UK products specified previously.
2. ASSOCIATED STANDARDS
 - a. EN 1011-1: Welding – Recommendations for welding of metallic materials – General guidance for arc welding.
 - b. EN 1011-2: Welding – Recommendations for welding of metallic materials – Arc welding of ferritic steels.
 - c. EN 1011-3: Welding – Recommendations for welding of metallic materials – Arc welding of stainless steels.
 - d. EN ISO 2553: Welding and allied processes. Symbolic representation on drawings. Welded joints
 - e. EN ISO 5817: Welding. Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded). Quality levels for imperfections
 - f. EN 9606-1: Qualification testing of welders – Fusion welding – Part 1. Steels.
 - g. EN ISO 14371: Welding coordination. Tasks and responsibilities
 - h. EN ISO 15607: Specification and qualification of welding procedures for metallic materials - General rules.
 - i. EN ISO 15609-1: Specification and qualification of welding procedures for metallic materials - Welding procedure specification – Part 1. Arc welding.
 - j. EN ISO 15614-1: Specification and qualification of welding procedures for metallic materials - Welding procedure test – Part 1. Arc and gas welding of steels and arc welding of nickel and nickel alloys.
 - k. EN ISO 17637: Non-destructive testing of welds – Visual testing of fusion-welded joints
 - l. EN ISO 17638: Non-destructive testing of welds – Magnetic particle testing
 - m. PD CEN ISO/TR 15608: Welding. Guidelines for a metallic materials grouping system
3. The Howden UK Site Assembly drawings identify the material of construction and provide detail on the geometry of site welds in line with EN ISO 2553.
4. It is recommended that the Company nominated to erect the Gas heater ensure that a suitably qualified Welding Coordinator undertakes the responsibilities set out in EN ISO 14371, with respect to all site welding and the implementation of this Appendix.
5. Welding shall be in compliance with the requirements set out in EN 1011.
6. A written Weld Procedure Specification (WPS), giving specific details for each joint, is required.

7. All WPSs shall be supported by a Weld Procedure Qualification Record (WPQR) in accordance with EN ISO 15614-1.
8. If the base material has improved atmospheric corrosion resistance (i.e. PD CEN ISO/TR 15608: Group 1.4), then a matching welding consumable shall be used.
9. All welders shall be approved to EN ISO 9606-1.
10. After 16 hours all welds shall be subject to the following NDT.
 - a. Visual testing (VT) as per EN ISO 17637 – all welds.
 - b. Magnetic particle testing (MT) as per EN ISO 17638 - as prescribed in this manual or in the site assembly drawings and any temporary lifting aids.
11. The acceptance standard shall be EN ISO 5817: Quality level B.
12. The personnel undertaking the testing shall be qualified to a minimum of EN ISO 9712 Level 2 in appropriate method and sector.

Important Notes:

- a. Howden Site Technical Advisory Services offer instructions on methods of construction. They are not qualified as Welding Co-ordinators and hence will not take on the responsibilities set out in EN ISO 14371.
- b. Where specifications are stated above the latest version of these applicable at the time of erection should be used.
- c. The use of other internationally recognised fabrication and welding standards, such as ASME or AWS, may be considered, but this should be clarified with Howden UK before proceeding.
- d. All site welded joints which have been shop painted must be cleaned back at least 30mm on each side from the area to be welded.

APPENDIX 3 - HEATER TURNING PROCEDURES



Heater Turning procedures - Ljungström

HOWDEN GLOBAL

ENGINEERING
EXCELLENCE
WORLDWIDE

V 017 - 17th March 2014

The best method of guaranteeing the safety of personnel during heater turning operations is to ensure that all personnel are outside of the heater whilst turning.

NO PERSONNEL ARE EVER ALLOWED TO REMAIN INSIDE A HEATER DURING TURNING OPERATIONS.

This prohibition applies to ALL turning operations in ALL heaters, including operations where there is a requirement to partially rotate the rotor, in a rotary or Ljungström-type heater.

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1. Introduction

2. Heater rotation and personnel access

3. Safety procedures

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3.2 Access not permitted (with a seized rotor)

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3.4.1 Horizontal shaft Ljungström-type heaters.

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3.5 Procedures to be adopted when rotating Ljungström type heaters with all personnel outside the machine.

3.5.1 Vertical shaft rotary heaters.

3.5.1.1 Rotor turning using a temporary slow-speed geared electric motor

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3.5.1.3 Rotor turning using a temporary air motor

3.5.1.4 Rotor turning using manual methods

3.5.2 Horizontal shaft rotary heaters.

1. Introduction

The following procedures have been developed specifically to cover those operations where it is required to partially rotate the rotor in a Ljungström type heater for erection or maintenance activities.

There already exists within Howden Business Units comprehensive procedures covering a wide array of other in-heater activities and these will not be covered here. Examples of areas not specifically addressed within this document are listed below. This list includes but is not restricted to:

- Heater erection prior to rotor-build completion.
- Rules for working in confined or restricted spaces and emergency rescue plan.
- Local air quality within the heater involving checks for noxious gasses.
- Control and logging of personnel entering and leaving heater duct zones.
- Use of safety harnesses and other safety equipment
- Use of temporary access platforms and scaffolding
- Safety permits
- Potential exposure to asbestos
- Lifting and laying
- Compliance with local country laws
- General hazard and risk assessment prior to commencement of work

NOTE: It is important that these areas must be addressed when carrying out a heater pre-work risk assessment and that safety rules, covering them, are incorporated within all heater safe working procedures.

2. Heater rotation and personnel access

Many of the heater erection and maintenance activities, such as seal clearance checks, fitting and adjusting seals, removal and fitting of baskets, require regular rotor movements. Access and egress arrangements require to be reviewed on a site by site basis to minimise the hazard of repeatedly entering and leaving the heater.

These rules must be incorporated into the local Business Unit's existing overall heater safety procedure document.

The following procedures must also be applied to any rotor turning operation, including assembly after the rotor construction is complete and the drive unit has been installed, during the build sequence for new rotary heaters. Current heater erection instructions for rotary heaters state that the drive unit should be fitted to the drive shaft prior to rotor assembly. This will allow controlled rotation using a temporary drive system, for example by hand-cranking, during subsequent assembly of the rotor.

"Inside the heater" in this procedure not only includes inside the heater housing and transition ductwork, within the heater termination flanges, but also inside connecting ductwork where a platform has been erected to work on the heater.

At some sites other contractors, not controlled by Howden, may be working within the heater and connection duct locations and may also require access within the heater. In such cases it is a requirement of Howden to liaise with these contractors and to make them fully aware of the safety implications.

Where feasible, Howden should seek to obtain control of the working area surrounding heaters and form a secure zone by the use of physical barriers to prevent unauthorised access.

Where Howden is only providing a site supervisor and the work is being carried out by others, it is essential that the supervisor makes the client aware of these procedures and recommends that they are adopted. The site supervisor should also make the procedures available to the client.

The hand turning device in section 3.5.1.2 is included as standard issue. The enhanced turning system in 3.5.1.1 and warning systems may be purchased directly from the local Howden Contact.

3. Safety procedures

3.1 Access permitted

Personnel access within the heater is allowed only when **all** of the following conditions are met:

- When there is a permit to work.
- When the rotor is not going to be rotated and any temporary drive system is disabled.
- When the main rotor drive system has been de-energised and isolated under the PTW.
- When live steam or air supply and or high pressure water supply to cleaning devices has been de-energised and isolated under the PTW.
- If the rotor diameter is greater than 5.43m.
- If the rotor can be turned in both directions.
- When the areas within the heater, where personnel will be located, have been adequately lit to allow good visibility.
- Access into the underside gas or air ducts on vertical shaft units is only allowed after secure temporary platforms are in place.
- On horizontal shaft heaters where a positive rotor locking device has been installed and is operational.
- When a Risk assessment has been conducted and approved.
- When a suitable written and tested emergency rescue plan is in place
- When a Risk assessment, safe work procedures and standards have been discussed with relevant workers and they are aware of all the hazards and risks and how to deal with them.
- When a gas test has been performed, and a gas test permit indicating the absence of gas has been issued.
- When permit conditions are explained to the workers and that they have signed the workers' register as acknowledgment thereof.

3.2 Access not permitted (with a seized rotor)

In addition to not complying with any of the requirements of 3.1, access is also not permitted if the heater rotor becomes seized, for any reason, and cannot be turned freely. Great care must be exercised.

Under these conditions action to free the rotor could result in an uncontrolled rotation of the rotor, which can occur if the blockage is overcome. For these reasons all personnel must be instructed to leave the heater before any procedures are carried out to free the machine.

The team engaged in the work to free the rotor should not enter the heater while they are applying loads to free the machine, and they must work from outside the heater when force is being applied. They must clearly inform the other members of the heater team about their work and insist that all personnel leave the heater prior to any attempt to free the machine. In addition, and after all personnel have left the heater, the team responsible for freeing the rotor must comply with the safe access requirements of Section 3.3.

When the seizure has been cleared, the team engaged in this work will inform the other members of the team that the heater is free and be responsible for removing the physical barriers at all access doors. Further rotational control will then be performed in accordance with the procedures detailed in Sections 3.5.

Note: It is recommended that Howden personnel take full control of access to any heater that they are overhauling. This includes all subcontractors and representatives of the client.

3.3 Safe Access Requirements

Assess whether existing access doors are of an adequate size for the level of entry/egress associated with the task. If the door is deemed inadequate by the risk assessment, install suitable safe access before authorising the work to proceed. Only open access doors which are specifically required to carry out the proposed scope of work. All other access doors are to remain closed as per normal operation (but with additional warning notices).

Once an access door has been opened, a temporary mesh hinged access door must be installed. This door must be capable of being closed and locked in position from the outside. It must be of sufficient physical size that it prevents anyone gaining access to the inside of the heater. See Fig 1 below.

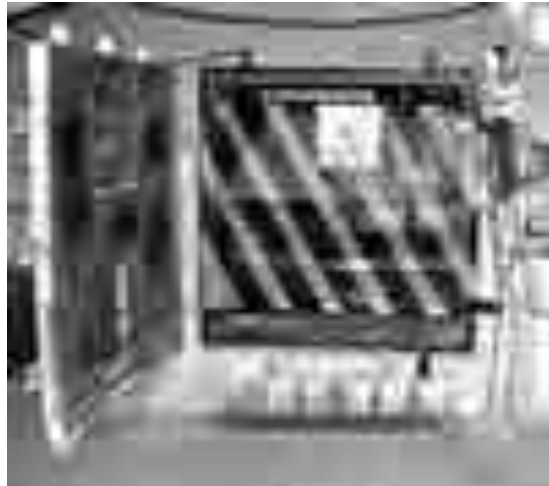


Figure 1 Photo showing a temporary mesh safety door

If the rotor is to be turned, all opened access areas must be evacuated and personnel removal verified from each area prior to their temporary mesh access doors being locked by the responsible person (Site Supervisor or Charge Hand). This person will retain the keys and also be the person responsible for controlling the rotor rotation, viewing the rotation from outside the temporary mesh door.

Prior to any rotor turning operation temporary audible sounders combined with a bright flashing light device must be located at all temporary mesh access doors (light outside and sounder inside) and at the drive unit. A typical temporary warning device which is attached using magnets, is shown in Figure 2. The system is designed such that the warning lamps turn on when the drive is ready to run and the responsible person will operate the sounder with a separate push switch.

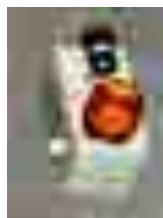


Figure 2 showing a typical audible/flashing light temporary warning device

Note: The Site Supervisor or Charge Hand must carry out tests to ensure that it can be heard clearly by all personnel working in the vicinity.

3.4 Rotor locking devices

It is crucial that during periods when the machine is not being actively turned, that steps be taken to ensure that the rotor cannot be rotated. While the following procedures are careful to deal with this possibility by specifying that, for example, the air supply is disconnected to an air motor, or the hand-cranking handle is removed, there still remains the possibility that the machine could be inadvertently rotated.

In view of this the following rules/guidelines regarding physical locking devices should be followed:

3.4.1 Horizontal shaft Ljungström-type Heaters

Due to the out of balance risk and the tendency for such machines to rotate naturally under the action of gravity, it is mandatory that a physical locking device be used when the rotor is not being turned. Such a device must be robust enough to cope with the significant gravity torques resulting from non symmetrical basket removal loads. In addition and for the same reason, great care must also be taken to ensure that even when the rotor is being rotated, that site personnel take steps to ensure that the rotor movement is controlled/stabilised in both the forward and reverse directions during all turning operations.

3.4.2 Vertical shaft Ljungström-type Heaters

When the heater is not fitted with a physical rotor locking device, it is recommended that a temporary rotor locking device is installed close to the periphery of the rotor to prevent inadvertent machine rotation. Such a device must be sized such that it is capable of withstanding the applied loads resulting from the temporary turning method.

3.5 Procedures to be adopted when rotating Ljungström type heaters with all personnel outside the machine.

3.5.1 Vertical shaft rotary heaters.



Acceptable temporary drive methods for turning heaters are outlined below. The methods can be applied to centre drive heaters and rack & pinion peripheral drive heaters. In each required operation the minimum size and number of turns should be carried out.

3.5.1.1 Rotor turning using a temporary slow-speed geared electric motor

This is the preferred system whereby the person controlling the drive motor can also see the rotor position and removes potential communication problems. The procedure involves the fitting of a temporary geared electric motor to the existing drive motor's shaft extension, connecting through a universal joint and motor shaft adaptor. Such a temporary electric motor must be selected to make certain that it has a slow output speed to ensure that the main rotor turning can be controlled accurately. The geared motor's speed should be of the order of 100 rpm on-load.

An inverter may be used for speed control. Provision must be made to support the auxiliary electric motor and to provide an adequate torque reaction.

Note: It is necessary that the main electrical supply to the drive unit be isolated at all times under a permit to work.

Ensure that the safe access requirements of 3.3 have been satisfied.

Control of the temporary electric motor shall be from outside the heater access door. The electric motor and heater rotor will stop if the emergency stop button is pressed.

It will be the responsibility of the site supervisor / charge hand to control the operation of this device. Prior to the initial rotor turning operation, the operator must establish the direction of the electric motor rotation to obtain either clockwise or anti-clockwise rotation of the heater rotor.

A schematic diagram of the system follows in Figure 3. The system comprises a control cable, incorporating an emergency stop and CCW & CW rotation control.

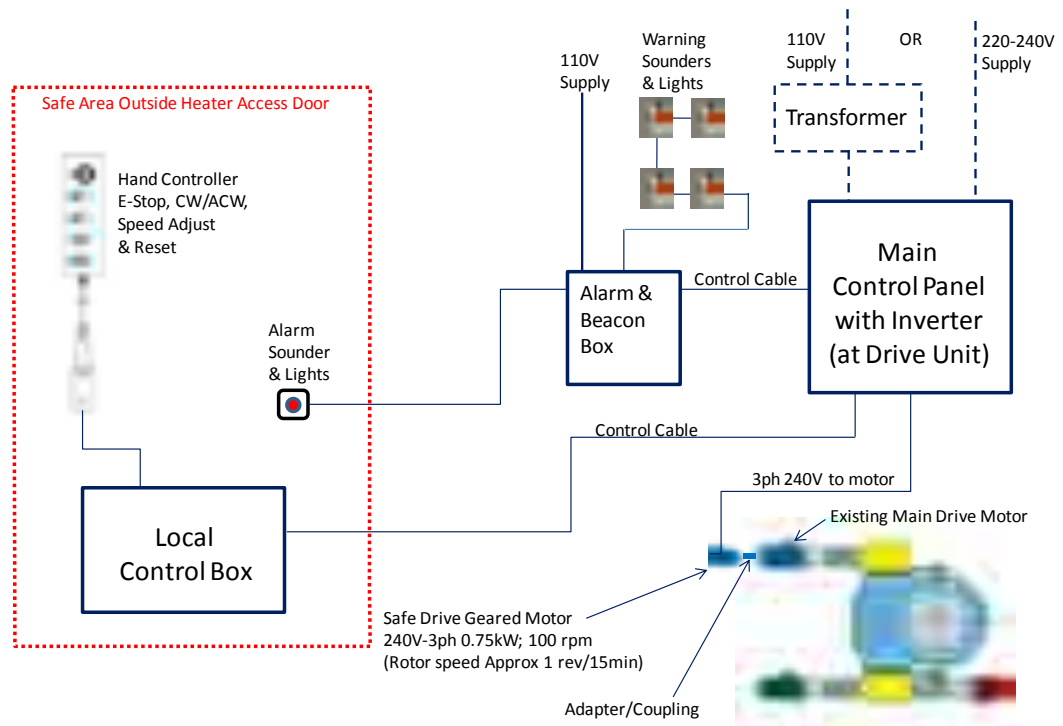


Figure 3. Safe Drive System – Schematic Diagram

When a rotor movement is required:

1. Ensure that equipment is clear of the rotor. In addition checks to be carried out that lights and electrical leads will not foul during the turning process.
2. The Site Supervisor or Charge Hand must verify that all personnel have been evacuated from the heater.
3. The Site Supervisor or Charge Hand to remove any rotor locking devices.
4. The Site Supervisor or Charge Hand must ensure all mesh doors are closed and locked and the safe access requirements of 3.3 have been satisfied.
5. Before the turning operation can proceed, the Site Supervisor or Charge Hand must now complete and sign the Heater Turning Safety Checklist form to confirm that they have fulfilled these requirements
6. Confirm the direction of rotation, clockwise or anti-clockwise.
7. The Site Supervisor or Charge Hand will sound the audible alarms with the push button before the rotor is to start turning. When the drive is ready to turn, the flashing light devices are activated warning everyone that the rotor is about to be rotated. Whilst the rotor is rotating the flashing lights continue to be energised until the motor is stopped.
8. The Site Supervisor or Charge Hand re-sets the system and operates the electric-motor rotor turning device until the required rotor position is achieved and the E-stop de-activates the system. The Site Supervisor or Charge Hand will also re-energise the audible warning devices for a short period, and then switch off all warning devices.
9. If the heater has a pin rack driving system with a locking system or if a rotor locking device has been installed, then it must be engaged to prevent anybody from turning the heater.
10. The Site Supervisor will then unlock the required mesh doors and confirm verbally to all work teams that the rotor is stationary and physically locked in position prior to any work recommencing.

3.5.1.2 Rotor turning using a manual hand crank

This method is achieved by fitting a hand crank to the extended shaft of an electric motor drive on the main gearbox drive unit. See Figure 4. Once engaged the crank can be turned by hand and used to slowly rotate the heater rotor. With a gear ratio, normally of around 1500:1, the crank would require to be rotated approximately thirty times for a 7.5° rotation of the rotor. When a rotor movement is required:



Figure 4 Use of cranking handle

1. Ensure that equipment is clear of the rotor. In addition checks to be carried out that lights and electrical leads will not foul during the turning process.
2. The Site Supervisor or Charge Hand must verify that all personnel have been evacuated from the heater.
3. The Site Supervisor or Charge Hand to remove any rotor locking devices.
4. The Site Supervisor or Charge Hand must ensure all mesh doors are closed and locked and the safe access requirements of 3.3 have been satisfied.
5. It will be the responsibility of the Site Supervisor / Charge Hand to control the operation of the hand crank. Prior to the initial rotor turning operation, the operator must establish the direction of the crank rotation to obtain either clockwise or anti-clockwise rotation of the heater rotor.
6. A radio link is required or a voice relay from the Site Supervisor / Charge Hand at the mesh heater access door to the crank operator.
7. Before the turning operation can proceed, the Site Supervisor or Charge Hand must now complete and sign the Heater Turning Safety Checklist form to confirm that they have fulfilled these requirements
8. The crank operator can then attach the crank and informs the Site Supervisor or Charge Hand outside the mesh access door that the rotor is ready to be turned.
9. The Site Supervisor or Charge Hand will sound the audible alarm/flashing light devices (as per section 3.3) to warn everyone that the rotor is about to be rotated. The audible alarm can then be switched off; however the flashing lights must continue to be energised during the turning operation.
10. The crank operator turns the heater until the Site Supervisor or Charge Hand outside the mesh access door calls for the rotor to be stopped.
11. The crank operator must now remove the crank handle from the drive unit and temporarily re-fit the permanent motor shaft-extension safety cover to prevent accidental/unauthorised use. The Site Supervisor or Charge Hand will also re-energise the audible warning devices for a short period, and then switch off all warning devices.

12. If the heater has a pin rack driving system with a locking system or if a rotor locking device has been installed, then it must be engaged to prevent anybody from turning the heater.
13. The Site Supervisor will then unlock the required mesh doors and confirm verbally to all work teams that the rotor is stationary and physically locked in position prior to any work recommencing.

3.5.1.3 Rotor turning using a temporary air motor

This method is achieved by fitting a temporary air motor to the extended shaft of an electric motor drive on the main gearbox drive unit. The photograph in Figure 5 shows one mounted below a peripheral drive motor.

A throttle valve is used to control the speed and direction of rotation. An isolation valve must be fitted in the air supply line to enable the system to be isolated between turning operations.



Figure 5 Use of temporary air motor

When a rotor movement is required:

1. Ensure that equipment is clear of the rotor. In addition checks to be carried out that lights and electrical leads will not foul during the turning process.
2. The Site Supervisor or Charge Hand must verify that all personnel have been evacuated from the heater.
3. The Site Supervisor or Charge Hand to remove any rotor locking devices.
4. The Site Supervisor or Charge Hand must ensure all mesh doors are closed and locked and the safe access requirements of 3.3 have been satisfied.
5. It will be the responsibility of the site supervisor / charge hand to control the operation of the air motor. Prior to the initial rotor turning operation, the operator must establish the direction of the throttle valve rotation (similar to motorbike grip) to obtain either clockwise or anti-clockwise rotation of the heater rotor.
6. A radio link is required or a voice relay from the Site Supervisor / Charge Hand at the mesh heater access door to the air motor operator.
7. Before the turning operation can proceed, the Site Supervisor or Charge Hand must now complete and sign the Heater Turning Safety Checklist form to confirm that they have fulfilled these requirements.
8. The air motor operator can then open the isolation valve and informs the Site Supervisor or Charge Hand outside the mesh access door that the rotor is ready to be turned.
9. The Site Supervisor or Charge Hand will sound the audible alarm/flashing light devices (as per section 3.3) to warn everyone that the rotor is about to be rotated. The audible alarm can then be switched off; however the flashing lights must continue to be energised during the turning operation.

10. The air motor operator turns the heater until the Site Supervisor or Charge Hand outside the mesh access door calls for the rotor to be stopped.
11. The air motor operator must now isolate the air supply to guard against accidental/unauthorised use. The Site Supervisor or Charge Hand will also re-energise the audible warning devices for a short period, and then switch off all warning devices.
12. If the heater has a pin rack driving system with a locking system or if a rotor locking device has been installed, then it must be engaged to prevent anybody from turning the heater.
13. The Site Supervisor will then unlock the required mesh doors and confirm verbally to all work teams that the rotor is stationary and physically locked in position prior to any work recommencing.

3.5.1.4 Rotor turning using manual methods

In some cases it is not possible to utilise the existing gearbox and motor to attach an auxiliary rotor turning device. This may be as a result of repair work associated with the gearbox drive or if it is a peripheral rack and pinion drive and the rack segments are being replaced. In such cases the rotor must be rotated manually from outside the heater. This can be achieved by using a Tirfor manual winch, as shown in Figure 6, attached to the rotor through the pin rack door or access door.



Figure 6 Use of Tirfor manual winch

When a rotor movement is required:

1. Ensure that equipment is clear of the rotor. In addition checks to be carried out that lights and electrical leads will not foul during the turning process.
2. The Site Supervisor or Charge Hand must verify that all personnel have been evacuated from the heater.
3. The Site Supervisor or Charge Hand to remove any rotor locking devices.
4. Tirfor operator to anchor the Tirfor to suitably robust static part and connect its wire rope to the rotor or pin rack support structure.
5. The Site Supervisor or Charge Hand must ensure all mesh doors are closed and locked (allowing for Tirfor cable route) and the safe access requirements of 3.3 have been satisfied.
6. Before the turning operation can proceed, the Site Supervisor or Charge Hand must now complete and sign the Heater Turning Safety Checklist form to confirm that they have fulfilled these requirements
7. The Site Supervisor / Charge Hand will sound the audible alarm/flashing light devices to warn everyone that the rotor is about to be rotated. The audible alarm can then be switched off; however the flashing lights must continue to be energised during the turning operation.

8. The Site Supervisor or Charge Hand will now instruct the Tirfor operator to start manually turning the rotor by to-and-fro operation of the forward or reverse lever of the Tirfor which provides continuous movement of the rotor.
9. The Site Supervisor or Charge Hand will instruct the operator to stop turning the rotor when the correct position is achieved and de-energise the audible/flashing light warning devices.
10. The pin rack/rotor locking device must be engaged to prevent anybody from turning the rotor.
11. The Tirfor's wire rope must be disconnected from the rotor or pin rack support and removed between turning operations. The Site Supervisor or Charge Hand will also re-energise the audible warning devices for a short period, and then switch off all warning devices.
12. The Site Supervisor will then unlock the required mesh doors and confirm verbally to all work teams that the rotor is stationary and physically locked in position prior to any work recommencing.

3.5.2 Horizontal shaft rotary heaters.

Horizontal shaft rotary heater rotors are inherently unstable due to the fact that the weight distribution will be uneven. This induces a torque on the rotor due to gravity which acts to rotate the machine until the "heavy area" is at bottom dead centre. Even with the machines drive system still connected the torque can be sufficient to rotate the machine.



In view of this, great care must be taken to ensure that the rotor is stabilised and prevented from rotating freely due to gravity in either clockwise or anticlockwise directions during any turning operation or repair/maintenance procedures. Otherwise the step by step turning procedures are the same as those for vertical heaters.

The majority of horizontal heaters are peripheral drive rack and pinions. Similarly to the previously described vertical shaft heaters, the temporary drive electric motor, hand crank or air motor can be fitted to the existing motor's shaft extension. If a temporary electric motor is used it must be selected to make certain that it has a slow output speed to ensure that the main rotor turning can be controlled accurately. In each required operation the minimum size and number of turns should be carried out.

During repair/maintenance procedures, it cannot be overstressed, that it is **essential** to install a rotor locking mechanism capable of restraining the rotor from turning as a result of the worst possible weight mal-distribution. This could be a result of major imbalance due to loading and or unloading of heat-transfer baskets.

APPENDIX 4 - TABLE OF RECOMMENDED BOLT TIGHTENING TORQUE

The following table gives bolt proof loads against size and grade and approximate torque required to induce 85% of proof load. These values should be used on flanged steel, face to face applications only, (not on raised face). Also check the depth of tapped hole, (if applicable), for stressing, where bolt is screwed into softer material.

Nominal Bolt Size	Strength Grade			
	4.6		8.8	
	Proof Load kN	Approx. Torque to induce 85% proof load. Nm	Proof Load kN	Approx. Torque to induce 85% proof load. Nm
mm				
M10	12.8	22	33.1	56
M12	18.7	39	48.1	98
M14	25.50	52	65.60	156
M16	34.80	97	89.60	244
M18	42.60	130	109.80	335
M20	54.30	188	140.00	476
M24	78.20	326	201.00	822
M30	124.00	647	321.00	1633
M36	181.00	1113	466.00	2854

Note: Where specific torque is stated on drawings or in subcontractors literature, then the torques given on the drawings or in subcontractors literature should be used.

Annexure**C1**

DATE:31/08/2021

**REVISED RATES OF T&P HIRE CHARGES FOR CRANES & TRAILERS ETC. FOR
SUB-CONTRACTORS WORKING FOR BHEL FOR DOING BHEL JOBS**

SL NO.	ITEM DESCRIPTION	USEFUL LIFE (IN YRS)	Revised rates (Rs./Hour) valid from 01/09/2021 to 31/8/2023 (WITHIN USEFUL LIFE)	Revised rates (Rs./Hour) valid from 01/09/2021 to 31/8/2023 (BEYOND USEFUL LIFE)
I.	CRANES :-			
1	Portal Gantry Crane 500T	15	24500.00	24500.00
2	100MT Crawler Crane ZOOMLION CRANE-QUY-100	10	11370.00	10940.00
3	Heavy Lift Crawler Crane 600MT Class DEMAG Model CC2800	15	56290.00	53560.00
4	PORTAL CRANE, 360T	15	14070.00	13390.00
5	600MT Class Crawler Crane- Manitowoc Model 18000-UPGRADED	15	55460.00	52770.00
6	600MT Class Crawler Crane- Liebherr Model LR1600-2 (Upgraded)	15	68610.00	65280.00
7	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH RINGER)	15	33510.00	31880.00
8	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH-OUT RINGER)	15	20940.00	19920.00
9	MANITOWOC M-250T TRUCK CRANE	15	30160.00	28690.00
10	270 MT Class Crawler Crane- Manitowoc Model 2250	15	31660.00	30130.00
11	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1	15	26390.00	25110.00
11.A	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1 (UPGRADED)	15	36110.00	34580.00
12	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2	15	15130.00	14390.00
12.A	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2 (UPGRADED)	15	18850.00	18050.00
13	LINKBELT LS- 248H CRAWLER CRANE (180T)	15	16750.00	15940.00
14	MANITOWAC MODEL 888 CRAWLER CRANE (200 MT)	15	21780.00	20720.00
15	CRAWLER CRANE SUMITOMO, 150T	15	10890.00	10360.00
16	All Terrain Crane, 150MT- Liebherr Model LTM1150	15	13400.00	12750.00
17	CRAWLER CRANE, 120 T Fushun Model QUY120	10	10830.00	10420.00
18.A	CRAWLER CRANE 135MT Kobelco Model CK1350- 1F	15	10720.00	10200.00
18.B	CRAWLER CRANE 135MT Kobelco Model CK1350	15	8880.00	8440.00
19	CRAWLER CRANE 120MT - Tata-Sumitomo Model SCX1200-2	15	10050.00	9560.00
20	CRAWLER CRANE 100 T (KH 500)	15	10050.00	9560.00
21	Hydraulic Crawler Crane 80MT, Fushun Model QUY 80B	10	5410.00	5210.00
22	ROUGH TERRAIN CRANE 75T (RT880)	12	6140.00	5880.00
23	CRAWLER CRANE, 75T -Tata Model 955ALC/TFC280	12	5370.00	5150.00
24	Mobile Crane, 55MT (TIL)	12	4410.00	4230.00
25	CRAWLER CRANE, 25T -Tata Model TFC75	10	3030.00	2910.00
26	MOBILE CRANE, 20MT (TIL)	10	2270.00	2180.00
27	MOBILE CRANE, 20MT (ESCORTS)	10	2270.00	2180.00
28	MOBILE CRANE ESCORTS- 14MT	10	710.00	680.00
29	HYDAULIC PICK & CARRY CRANE, 8/9/10/11/12 MT	10	390.00	370.00

Annexure**C1**

DATE:31/08/2021

**REVISED RATES OF T&P HIRE CHARGES FOR CRANES & TRAILERS ETC. FOR
SUB-CONTRACTORS WORKING FOR BHEL FOR DOING BHEL JOBS**

SL NO.	ITEM DESCRIPTION	USEFUL LIFE (IN YRS)	Revised rates (Rs./Hour) valid from 01/09/2021 to 31/8/2023 (WITHIN USEFUL LIFE)	Revised rates (Rs./Hour) valid from 01/09/2021 to 31/8/2023 (BEYOND USEFUL LIFE)
30	FORK LIFT 5T	5	650.00	640.00
31	FORK LIFT 3T	5	540.00	530.00

**REVISED RATES OF T&P HIRE CHARGES FOR CRANES & TRAILERS ETC. FOR
OUTSIDE AGENCIES**

SL NO.	ITEM DESCRIPTION	USEFUL LIFE (IN YRS)	Revised rates (Rs./Hour) valid from 01/09/2021 to 31/8/2023 (WITHIN USEFUL LIFE)	Revised rates (Rs./Hour) valid from 01/09/2019 to 31/8/2021 (BEYOND USEFUL LIFE)
I.	CRANES :-			
1	Portal Gantry Crane 500T	15	27230.00	27230.00
2	100MT Crawler Crane ZOOMLION CRANE-QUY-100	10	12630.00	12160.00
3	Heavy Lift Crawler Crane 600MT Class DEMAG Model CC2800	15	62550.00	59520.00
4	PORTAL CRANE, 360T	15	15630.00	14880.00
5	600MT Class Crawler Crane- Manitowoc Model 18000-UPGRADED	15	61620.00	58630.00
6	600MT Class Crawler Crane- Liebherr Model LR1600-2 (Upgraded version)	15	76230.00	72540.00
7	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH RINGER)	15	37230.00	35420.00
8	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH-OUT RINGER)	15	23270.00	22140.00
9	MANITOWOC M-250T TRUCK CRANE	15	33510.00	31880.00
10	270 MT Class Crawler Crane- Manitowoc Model 2250	15	35180.00	33480.00
11	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1	15	29320.00	27900.00
11.A	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1 (UPGRADED)	15	40120.00	38420.00
12	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2	15	16810.00	15990.00
12.A	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2 (UPGRADED)	15	20950.00	20060.00
13	LINKBELT LS- 248H CRAWLER CRANE (180T)	15	18610.00	17710.00
14	MANITOWAC MODEL 888 CRAWLER CRANE (200 MT)	15	24200.00	23020.00
15	CRAWLER CRANE SUMITOMO, 150T	15	12100.00	11510.00
16	All Terrain Crane, 150MT- Liebherr Model LTM1150	15	14890.00	14170.00
17	CRAWLER CRANE, 120 T Fushun Model QUY120	10	12030.00	11580.00
18.A	CRAWLER CRANE 135MT Kobelco Model CK1350- 1F	15	11910.00	11330.00
18.B	CRAWLER CRANE 135MT Kobelco Model CK1350	15	9860.00	9380.00
19	CRAWLER CRANE 120MT - Tata-Sumitomo Model SCX1200-2	15	11170.00	10620.00
20	CRAWLER CRANE 100 T (KH 500)	15	11170.00	10620.00
21	Hydraulic Crawler Crane 80MT, Fushun Model QUY 80B	10	6010.00	5790.00
22	ROUGH TERRAIN CRANE 75T (RT880)	12	6830.00	6540.00
23	CRAWLER CRANE, 75T -Tata Model 955ALC/TFC280	12	5970.00	5720.00
24	Mobile Crane, 55MT (TIL)	12	4900.00	4700.00
25	CRAWLER CRANE, 25T -Tata Model TFC75	10	3370.00	3240.00
26	MOBILE CRANE, 20MT (TIL)	10	2520.00	2430.00
27	MOBILE CRANE, 20MT (ESCORTS)	10	2520.00	2430.00
28	MOBILE CRANE ESCORTS- 14MT	10	790.00	760.00
29	HYDAULIC PICK & CARRY CRANE, 8/9/10/11/12 MT	10	430.00	410.00

**REVISED RATES OF T&P HIRE CHARGES FOR CRANES & TRAILERS ETC. FOR
OUTSIDE AGENCIES**

SL NO.	ITEM DESCRIPTION	USEFUL LIFE (IN YRS)	Revised rates (Rs./Hour) valid from 01/09/2021 to 31/8/2023 (WITHIN USEFUL LIFE)	Revised rates (Rs./Hour) valid from 01/09/2019 to 31/8/2021 (BEYOND USEFUL LIFE)
30	FORK LIFT 5T	5	720.00	710.00
31	FORK LIFT 3T	5	600.00	590.00

**RATES FOR INTER REGIONAL HIRE CHARGES FOR CRANES OF CAPACITY
75 TON OR MORE FOR PERIOD 01-09-2021 TO 31-08-2023**

Dt : 31/08/2021

SL NO.	ITEM DESCRIPTION	Rates (Rs./MONTH) valid from 01/09/2021 to 31/8/2023
I .	CRANES : -	
1	Portal Gantry Crane 500T	1243192
2	100MT Crawler Crane ZOOMLION CRANE-QUY-100	631183
3	Heavy Lift Crawler Crane 600MT Class DEMAG Model CC2800	2717358
4	PORTAL CRANE, 360T	679333
5	600MT Class Crawler Crane- Manitowoc Model 18000- UPGRADED	2676917
6	600MT Class Crawler Crane- Liebherr Model LR1600-2 (Ungraded version)	3311783
7	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH RINGER)	1617475
8	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH-OUT RINGER)	1010917
9	MANITOWOC M-250T TRUCK CRANE	1455725
10	270 MT Class Crawler Crane- Manitowoc Model 2250	1528508
11	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1	1273758
11.A	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1 (UPGRADED)	1754150
12	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2	730283
12.A	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2 (UPGRADED)	915892
13	LINKBELT LS- 248H CRAWLER CRANE (180T)	808733
14	MANITOWAC MODEL 888 CRAWLER CRANE (200 MT)	1051358
15	CRAWLER CRANE SUMITOMO, 150T	525675
16	All Terrain Crane, 150MT- Liebherr Model LTM1150	646983
17	CRAWLER CRANE, 120 T Fushun Model QUY120	601125
18.A	CRAWLER CRANE 135MT Kobelco Model CK1350- 1F	517592
18.B	CRAWLER CRANE 135MT Kobelco Model CK1350	428625
19	CRAWLER CRANE 120MT - Tata-Sumitomo Model SCX1200-2	485242
20	CRAWLER CRANE 100 T (KH 500)	485242
21	Hydraulic Crawler Crane 80MT, Fushun Model QUY 80B	300558
22	ROUGH TERRAIN CRANE 75T (RT880)	321758
23	CRAWLER CRANE, 75T -Tata Model 955ALC/TFC280	281533

**RATES OF T&P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILERS ETC. FOR
SUB-CONTRACTORS WORKING FOR BHEL FOR DOING BHEL JOBS**

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/09/2021 to 31/8/2023
I.	LIFTING EQUIPMENTS	
1	Strand Jack System for Boiler Drum Lifting	20930
2	MULTI SHEAVE PULLEY BLOCK 40/50T/60T	310
3	MULTI SHEAVE PULLEY BLOCK 100T	630
4	MULTI SHEAVE PULLEY BLOCK 150T	1260
5	ELCTRIC WINCH 5T	1270
6	ELCTRIC WINCH 10T	2360
7	ELECTRIC WINCH 15 T	2150
8	PASSENGER CUM GOODS HOIST 1T	2270
9	FURNACE MAINTENANCE PLATFORM	5040
10	Gang Operated Hydraulic Jack (Set of 4 Jacks - 175 MT each)	2100
II	WELDING & HEAT TREATMENT EQUIPMENT	
1	125KW, 3KHZ, AIR-COOLED INDUCTION HEATING EQUIPMENT	16380
2	75KW, 10 KHZ, COMPACT INDUCTION HEATING EQUIPMENT	8190
3	WELDING GENERATOR 320/300 A	300
4	WELDING RECTIFIER 400A/300A	300
5	WELDING RECTIFIER 600A	400
6	DIESEL WELDING GENERATOR 400A/300A	400
7	TRANSFORMER,600A	300
8	TRANSFORMER 300/400A	200
III	SERVICE PLANTS & ALLIED EQUIPT.	0
1	500KVA DIESEL GENERATOR	3800
2	TRANSFORMER OIL FILTERATION EQUIPMENT 6000LPH CAPACITY WITHOUT STORAGE TANK	6370
3	-DO- , WITH STORAGE TANK	7280
4	OIL FILTERATION M/C, 250/500 LPH (OTHER THAN SILICON OIL)	910
5	OIL FILTERATION M/C, 250GPH/1000LPH (OTHER THAN SILICON OIL)	1360
6	OIL FILTERATION M/C, 500GPH/2500LPH (OTHER THAN SILICON OIL)	1820
7	OIL FILTERATION M/C, 1000GPH/5000LPH (OTHER THAN SILICON OIL)	3640
8	Portable Lube Oil Purification Unit (Centrifuge M/c) Capacity: 750 LPH	1270
9	Low Vacuum de-hydration unit	630
10	DIESEL GENERATING SET,250 KVA	1770
11	DIESEL GENERATING SET,25 KVA	500

**RATES OF T&P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILERS ETC. FOR
SUB-CONTRACTORS WORKING FOR BHEL FOR DOING BHEL JOBS**

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/09/2021 to 31/8/2023
12	VACUUM PUMP(ABSOLUTE V.C.)	540
13	ACID CIRCULATING PUMP WITH MOTOR 120M HEAD, 150T/HR	1090
14	ACID TRANSFER PUMP 20/50 T/HR	540
15	DEWATERING PUMP (Kirloskar make,11KW/15HP)	80
16	HP Air compressor (32 Kg/Sq. Cm, 150 CFM)	4240
17	AIR COMPRESSORS 250/300/330/360/350 CFM	2730
18	AIR COMPRESSORS 140/150/190/210 CFM	910
19	ACID CIRCULATING PUMP WITH MOTOR & STARTER, 200T/HR, 150M, 220 HP	1820
20	Industrial Blower 2000CFM	1270
21	Air Leak Test Blower (Flow: 40000 m³/Hr)	1160
22	Air Blower (Flow: 20000 m³/Hr)	940
IV	METAL FORMING /CUTTING EQUIPMENT	
1	TUBE EXPANDING M/C PNEUMATIC 60-100 MM	630
2	ELECTRO HYDRAULIC PIPE BENDING M/C 4"	1630
3	BOLTING MACHINE (ALCOA/AVLOCK/ HUCK)	1800
4	-do- Gun with nose Assembly only	540
V	TESTING/INSPECTION EQUIPMENT	
1	DATA LOGGER for PG TESTING	36980
2	MOTORISED HYDRAULIC TEST PUMP 250kg/cmsq	800
3	MOTORISED HYDRAULIC TEST PUMP 400-450kg/cmsq	1090
4	MOTORISED HYDRAULIC TEST PUMP 600 KG/CMSQ	1270
5	HYDRAULIC TEST PUMP 800 KG/CMSQ	1330
6	HYDRAULIC TEST PUMP 1000 KG/CMSQ	2230
7	BOLT STRETCHING DEVICE	910
8	BOROSCOPE/FIBROSCOPE FLEXIBLE TYPE (FLEXUX) IMPORTED	3640
9	ULTRASONIC FLAW DETECTOR	2730
10	MPI TEST KIT	360
11	GAS LEAK DETECTOR	270
12	VIBRATION/SOUND LEVEL METER IRD-306	360
13	VIBRATION/SOUND LEVEL METER IRD-308	360
14	VIBRATION ANALYSER/DYNAMIC BALANCING M/C IRD 350	1450
15	VIBRATION ANALYSER/DYNAMIC BALANCING M/C IRD 360	2540
16	SHOCK PULSE METER	630
17	HV.DC TEST KIT UPTO 50 KV	540
18	HV.DC TEST KIT ABOVE 50 KV	1000
19	HV.AC TEST KIT UPTO 50KV	810
20	HV.AC TEST KIT ABOVE 50KV	2910
21	MOTORISED MEGGER 2.5KV	400
22	MOTORISED MEGGAR 5KV	450
23	OSCILLOSCOPE-DUAL BEAM INDIGENOUS	450
24	OSCILLOSCOPE-DUAL BEAM IMPORTED	1090
25	WAVEFORM ANALYSER	910
26	OSCILLOGRAPH/UV RECORDER 24 CHANNEL	1630
27	OSCILLOGRAPH/UV RECORDER 12 CHANNEL	1090
28	OSCILLOGRAPH/UV RECORDER 6 CHANNEL	910

**RATES OF T&P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILERS ETC. FOR
SUB-CONTRACTORS WORKING FOR BHEL FOR DOING BHEL JOBS**

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/09/2021 to 31/8/2023
29	DIGITAL LOW RESISTANCE METER	630
30	DC POTENTIOMETER	180
31	PRECISION DEAD WEIGHT TESTER	1000
32	OPTICAL ALIGNMENT KIT	1360
33	BOROSCOPE/FIBROSCOPE(NON FLEXIBLE)	1200
34	VERNIER THEODOLITE,PRECISION	1200
35	VERNIER THEODOLITE,ORDINARY	200
36	ENGINEERS PRECISION LEVEL/DUMPY LEVEL	120
37	ISKAMATIC 'A'	3200
38	CALIBRATOR '03'	1000
39	48 POLE EXTENDER CARD	200
40	MULTIJET NPM	400
41	OSCILLOMETER	10190
42	VOC EQUIPMENT	1400
43	BINARY SIGNAL GENERATOR	290
44	ELECTRIC COUNTER	690
45	FREQUENCY GENERATOR	1000
46	DBF 3 VIBRATION RECORDER/ANALYSER	3270
47	L&T GOULD OSCILLOGRAPH 2-CHANNEL	490
48	L&T GOULD OSCILLOGRAPH 6-CHANNEL	1180
49	VIBROPORT 41/FFT ANALYSER	5460
50	ELCID kit	10010
51	UNIVERSAL CALIBRATION SYSTEM	2730
52	NATURAL FREQUENCY TESTER	2910
53	DIGITAL HARDNESS TESTER	360
54	ADRE 208 VIBRATION ANALYSER	7280
55	PCB DIAGNOSTIC REPAIR KIT	2000
56	SECONDARY INJECTION RELAY TEST KIT	5270
57	MICRO OHM METER	1450
58	DIGITAL MICRO OHM METER MEASURING RANGE: 200 $\mu\Omega$ TO 20K Ω	3230
59	PMI Machine OLYMPUS make	3350
60	Mobile Lighting Mast - 9 metres (4X400 W)	860
61	10KVA RESISTANCE BRAZING MACHINE	140
62	RECURRENT SURGE OSCILLOGRAPH (RSO) TEST KIT WITH PORTABLE HANDHELD OSCILLOSCOPE.	460
63	HYDROGEN GAS LEAK DETECTOR	50
64	STATOR WEDGE ANALYZER KIT WITH COMPLETE ACCESSORIES	4980
65	WEDGE DEFLECTION KIT	80
66	TILE PRESSING MACHINE FOR GAS TURBINE	270
67	INDUCTION BRAZING MACHINE	4870
68	MAGNETIC COHESIVE FORCE (MCF) EQUIPMENT	3640
69	ULTRASONIC FLOW METER	180
70	PORTABLE VIBRATION ANALYSER (MODEL 811T)	40
71	CENTRIFUGAL PUMP SET FOR ACID CLEANING (WITH MOTOR AND PANEL) : PRESSURE -14KG/SQ CM. ; FLOW 60 M3/HR	470
72	CENTRIFUGAL PUMP SET FOR ACID CLEANING (WITH MOTOR AND PANEL) : PRESSURE -30KG/SQ CM. ; FLOW 15 M3/HR	430

**RATES OF T&P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILERS ETC. FOR
SUB-CONTRACTORS WORKING FOR BHEL FOR DOING BHEL JOBS**

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/09/2021 to 31/8/2023
73	HI SPEED MEMORY RECORDER, MAKE -YOKOGAWA, MODEL DL850E-Q-HE/B5/HD1	1810
74	TROLLEY MOUNTED HYDRAULIC JACK (100 MT)	1260
75	5KV Insulation Tester	450
76	4 Channel Digital Oscilloscope /Fast Recorder	1710
77	4 Channel Oscillographic Recorder	580
78	Sound Level Meter	230
79	Thermal Imaging Camera	770
80	Videoscope (Video Boroscope)	1510
81	DO (Dissolve Oxygen) Meter (0 to 1500 ppb)	1310
82	Conductivity Meter	80
83	Core Flux Test Kit	7280
84	Primary Current Injection Kit (2000A)	870
85	3 Phase Secondary Injection Kit (Relay Test)	3760
86	FRF Filtration Kit	1330
87	FFT Analyser	2290
88	Flue Gas Analyser	1030
89	Oil Test Kit (Mineral Oil)-Transformer	1010
90	Winding Resistance kit (R L C Load)	880
91	SFRA test Kit	1190
92	Tan Delta test Kit	4060
93	PF Meter	330
94	Ultrasonic Flow Meter	830
95	Oil Particle Counter	360
96	Plasma Cutting Machine (With complete accessories)	310
97	JCB make DG Set 80 KVA	670
98	Diesel Generating Set 82.5 KVA	610
99	Portable Jacking Oil Pump	1080
100	Alloy Analyser	1770

RATES OF T & P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILLERS ETC. FOR OUTSIDE AGENCIES

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/09/2021 to 31/8/2023
I	LIFTING EQUIPMENTS	
1	Strand Jack System for Boiler Drum Lifting	23250
2	MULTI SHEAVE PULLEY BLOCK 40/50T/60T	350
3	MULTI SHEAVE PULLEY BLOCK 100T	700
4	MULTI SHEAVE PULLEY BLOCK 150T	1400
5	ELECTRIC WINCH 5T	1410
6	ELECTRIC WINCH 10T	2620
7	ELECTRIC WINCH 15 T	2390
8	PASSENGER CUM GOODS HOIST 1T	2520
9	FURNACE MAINTENANCE PLATFORM	5600
10	Gang Operated Hydraulic Jack (Set of 4 Jacks - 175 MT each)	2330
II	WELDING & HEAT TREATMENT EQUIPMENT	
1	125KW, 3KHZ, AIR-COOLED INDUCTION HEATING EQUIPMENT	18190
2	75KW, 10 KHZ, COMPACT INDUCTION HEATING EQUIPMENT	9090
3	WELDING GENERATOR 320/300 A	330
4	WELDING RECTIFIER 400A/300A	330
5	WELDING RECTIFIER 600A	440
6	DIESEL WELDING GENERATOR 400A/300A	440
7	TRANSFORMER,600A	330
8	TRANSFORMER 300/400A	220
III	SERVICE PLANTS & ALLIED EQUIPT.	
1	500KVA DIESEL GENERATOR	4220
2	TRANSFORMER OIL FILTRATION EQUIPMENT 6000LPH CAPACITY WITHOUT STORAGE TANK	7070
3	-DO-, WITH STORAGE TANK	8080
4	OIL FILTRATION M/C, 250/500 LPH (OTHER THAN SILICON OIL)	1010
5	OIL FILTRATION M/C, 250GPH/1000LPH (OTHER THAN SILICON OIL)	1510
6	OIL FILTRATION M/C, 500GPH/2500LPH (OTHER THAN SILICON OIL)	2020
7	OIL FILTRATION M/C, 1000GPH/5000LPH (OTHER THAN SILICON OIL)	4040
8	Portable Lube Oil Purification Unit (Centrifuge M/c) Capacity: 750 LPH	1410
9	Low Vacuum de-hydration unit	700
10	DIESEL GENERATING SET,250 KVA	1970
11	DIESEL GENERATING SET,25 KVA	560
12	VACUUM PUMP(ABSOLUTE V.C.)	600
13	ACID CIRCULATING PUMP WITH MOTOR 120M HEAD, 150T/HR	1210
14	ACID TRANSFER PUMP 20/50 T/HR	600
15	DEWATERING PUMP (Kirloskar make,11KW/15HP)	90
16	HP Air compressor (32 Kg/Sq. Cm, 150 CFM)	4710
17	AIR COMPRESSORS 250/300/330/360/350 CFM	3030
18	AIR COMPRESSORS 140/150/190/210 CFM	1010

RATES OF T & P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILLERS ETC. FOR OUTSIDE AGENCIES

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/09/2021 to 31/8/2023
19	ACID CIRCULATING PUMP WITH MOTOR & STARTER, 200T/HR, 150M, 220 HP	2020
20	Industrial Blower 2000CFM	1410
21	Air Leak Test Blower (Flow: 40000 m³/Hr)	1290
22	Air Blower (Flow: 20000 m³/Hr)	1040
IV	METAL FORMING /CUTTING EQUIPMENT	
1	TUBE EXPANDING M/C PNEUMATIC 60-100 MM	700
2	ELECTRO HYDRAULIC PIPE BENDING M/C 4"	1810
3	BOLTING MACHINE (ALCOA/AVLOCK/ HUCK)	2000
4	-do- Gun with nose Assembly only	600
V	TESTING/INSPECTION EQUIPMENT	
1	DATA LOGGER for PG TESTING	41090
2	MOTORISED HYDRAULIC TEST PUMP 250kg/cmsq	880
3	MOTORISED HYDRAULIC TEST PUMP 400-450kg/cmsq	1210
4	MOTORISED HYDRAULIC TEST PUMP 600 KG/CMSQ	1410
5	HYDRAULIC TEST PUMP 800 KG/CMSQ	1480
6	HYDRAULIC TEST PUMP 1000 KG/CMSQ	2480
7	BOLT STRETCHING DEVICE	1010
8	BOROSCOPE/FIBROSCOPE FLEXIBLE TYPE (FLEXUX) IMPORTED	4040
9	ULTRASONIC FLAW DETECTOR	3030
10	MPI TEST KIT	400
11	GAS LEAK DETECTOR	300
12	VIBRATION/SOUND LEVEL METER IRD-306	400
13	VIBRATION/SOUND LEVEL METER IRD-308	400
14	VIBRATION ANALYSER/DYNAMIC BALANCING M/C IRD 350	1610
15	VIBRATION ANALYSER/DYNAMIC BALANCING M/C IRD 360	2830
16	SHOCK PULSE METER	700
17	HV.DC TEST KIT UPTO 50 KV	600
18	HV.DC TEST KIT ABOVE 50 KV	1110
19	HV.AC TEST KIT UPTO 50KV	900
20	HV.AC TEST KIT ABOVE 50KV	3230
21	MOTORISED MEGGER 2.5KV	440
22	MOTORISED MEGGAR 5KV	500
23	OSCILLOSCOPE-DUAL BEAM INDIGENOUS	500
24	OSCILLOSCOPE-DUAL BEAM IMPORTED	1210
25	WAVEFORM ANALYSER	1010
26	OSCILLOGRAPH/UV RECORDER 24 CHANNEL	1810
27	OSCILLOGRAPH/UV RECORDER 12 CHANNEL	1210
28	OSCILLOGRAPH/UV RECORDER 6 CHANNEL	1010
29	DIGITAL LOW RESISTANCE METER	700
30	DC POTENTIOMETER	200
31	PRECISION DEAD WEIGHT TESTER	1110
32	OPTICAL ALIGNMENT KIT	1510
33	BOROSCOPE/FIBROSCOPE(NON FLEXIBLE)	1330
34	VERNIER THEODOLITE,PRECISION	1330
35	VERNIER THEODOLITE,ORDINARY	220

**RATES OF T & P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILLERS
ETC. FOR OUTSIDE AGENCIES**

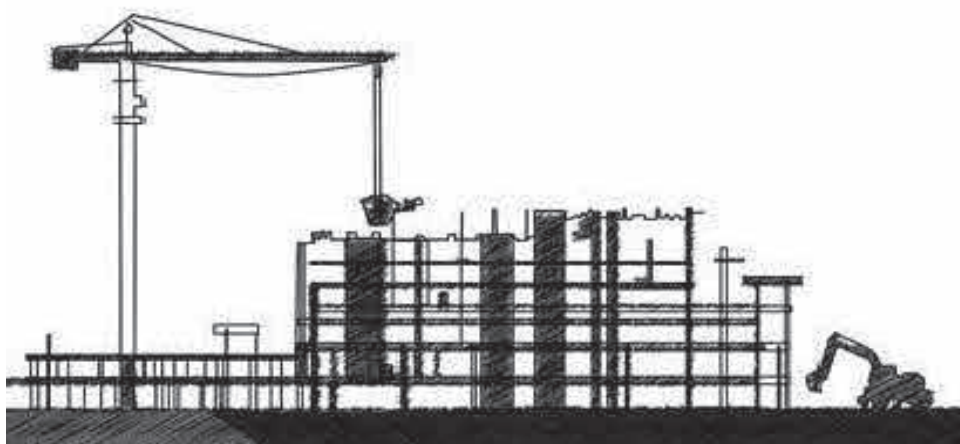
SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/09/2021 to 31/8/2023
36	ENGINEERS PRECISION LEVEL/DUMPY LEVEL	130
37	ISKAMATIC 'A'	3550
38	CALIBRATOR '03'	1110
39	48 POLE EXTENDER CARD	220
40	MULTIJET NPM	440
41	OSCILLOMETER	11320
42	VOC EQUIPMENT	1550
43	BINARY SIGNAL GENERATOR	320
44	ELECTRIC COUNTER	760
45	FREQUENCY GENERATOR	1110
46	DBF 3 VIBRATION RECORDER/ANALYSER	3630
47	L&T GOULD OSCILLOGRAPH 2-CHANNEL	540
48	L&T GOULD OSCILLOGRAPH 6-CHANNEL	1310
49	VIBROPORT 41/FFT ANALYSER	6060
50	ELCID kit	11120
51	UNIVERSAL CALIBRATION SYSTEM	3030
52	NATURAL FREQUENCY TESTER	3230
53	DIGITAL HARDNESS TESTER	400
54	ADRE 208 VIBRATION ANALYSER	8080
55	PCB DIAGNOSTIC REPAIR KIT	2220
56	SECONDARY INJECTION RELAY TEST KIT	5860
57	MICRO OHM METER	1610
58	DIGITAL MICRO OHM METER MEASURING RANGE: 200 $\mu\Omega$ TO 20K Ω	3590
59	PMI Machine OLYMPUS make	3730
60	Mobile Lighting Mast - 9 metres (4X400 W)	960
61	10KVA RESISTANCE BRAZING MACHINE	160
62	RECURRENT SURGE OSCILLOGRAPH (RSO) TEST KIT WITH PORTABLE HANDHELD OSCILLOSCOPE.	510
63	HYDROGEN GAS LEAK DETECTOR	60
64	STATOR WEDGE ANALYZER KIT WITH COMPLETE ACCESSORIES	5530
65	WEDGE DEFLECTION KIT	90
66	TILE PRESSING MACHINE FOR GAS TURBINE	300
67	INDUCTION BRAZING MACHINE	5410
68	MAGNETIC COHESIVE FORCE (MCF) EQUIPMENT	4040
69	ULTRASONIC FLOW METER	200
70	PORTABLE VIBRATION ANALYSER (MODEL 811T)	50
71	CENTRIFUGAL PUMP SET FOR ACID CLEANING (WITH MOTOR AND PANEL) : PRESSURE -14KG/SQ CM. ; FLOW 60 M3/HR	520
72	CENTRIFUGAL PUMP SET FOR ACID CLEANING (WITH MOTOR AND PANEL) : PRESSURE -30KG/SQ CM. ; FLOW 15 M3/HR	480
73	HI SPEED MEMORY RECORDER, MAKE -YOKOGAWA, MODEL DL850E-Q-HE/B5/HD1	2010
74	TROLLEY MOUNTED HYDRAULIC JACK (100 MT)	1400
75	5KV Insulation Tester	500

**RATES OF T & P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILLERS
ETC. FOR OUTSIDE AGENCIES**

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/09/2021 to 31/8/2023
76	4 Channel Digital Oscilloscope /Fast Recorder	1900
77	4 Channel Oscillographic Recorder	650
78	Sound Level Meter	260
79	Thermal Imaging Camera	860
80	Videoscope (Video Boroscope)	1680
81	DO (Dissolve Oxygen) Meter (0 to 1500 ppb)	1460
82	Conductivity Meter	90
83	Core Flux Test Kit	8090
84	Primary Current Injection Kit (2000A)	960
85	3 Phase Secondary Injection Kit (Relay Test)	4180
86	FRF Filtration Kit	1480
87	FFT Analyser	2550
88	Flue Gas Analyser	1140
89	Oil Test Kit (Mineral Oil)-Transformer	1120
90	Winding Resistance kit (R L C Load)	970
91	SFRA test Kit	1320
92	Tan Delta test Kit	4510
93	PF Meter	360
94	Ultrasonic Flow Meter	920
95	Oil Particle Counter	400
96	Plasma Cutting Machine (With complete accessories)	340
97	JCB make DG Set 80 KVA	740
98	Diesel Generating Set 82.5 KVA	680
99	Portable Jacking Oil Pump	1200
100	Alloy Analyser	1970

**HSEP14**

Health, Safety & Environment Plan for Site Operations by Subcontractors



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SECTION A

CRITICAL RESOURCES FOR HSE IMPLEMENTATION

1. SHARING OF OPERATING COSTS OF FACILITIES

TABLE A.1

SN	FACILITY
1	Ambulance with 24 hr. First Aid Trained Driver (Specs in Annexure A)
2	Operation of Medical center, Nurses, Medical Consumables etc. (Specs in Annexure A)
3	Training Center Consumables
4	Water sprinkling for dust suppression
	(Others:)

Note:

- Responsibility of operation of above facilities shall rest with BHEL
- Operating cost of the above shall be deducted from subcontractors on 'proportional to contract' value basis. Sample deduction table enclosed as Annexure A.1
- "Contract value" defined above & subsequently in the document shall be considered as "Awarded contract value".
- No overhead cost/ enabling cost of BHEL shall be levied on the contractors for common facilities.
- These running costs shall be recovered from all the available subcontractors at site for the complete operational duration of the site
- No overheads shall be charged on shared operating costs

2. RESOURCES TO BE PROVIDED SOLELY BY THE SUBCONTRACTOR

TABLE A.2

SN	ITEM	SPECIFICATIONS
1.	HSE DISPLAYS, Posters and signage	Annexure B
2.	HSE Tools/ Equipment/ Devices	Annexure C
3.	Rest Sheds for Workers	Annexure D
4.	Labor Colony	Annexure E
5.	Toilets (Latrines & Urinals) - in Site and Labor Colony	Annexure F
6.	Fire Extinguishers	Annexure G

Note:

In case subcontractor fails to provide the required resources, same will be procured and deployed by BHEL with applicable overhead on total procurement cost

3. ESTABLISHMENT OF COMMON FACILITIES

In green field projects BHEL shall arrange and provide the following facilities which shall be used by all subcontractors for their employees and workers. These shall be

- Medical Centre
- Safety park with facilities of audio-visual training & vertigo test center.
- No cost shall be deducted from the subcontractors for the structure part only.
- The running cost with basic inputs already mentioned at Point 1 above shall be shared by all contractors.
- The sub-contractors shall be required to ensure participation in trainings, medical checkup and vertigo test as per the guidelines laid in this document and required as per statutory HSE requirements.

- vi. However, in projects where in these facilities are not provided by BHEL, subcontractors shall ensure the training, medical/ vertigo test of all workers at site in consultation and guidance of BHEL HSE team at site in line with provisions of this document.
- vii. The overall onus of compliance to HSE practices pertaining to training, medical checkup including vertigo test shall lie on the subcontractor only.

4. CRITICAL REQUIREMENTS W.R.T. EQUIPMENT & PPES

- i. Conventional Hydra crane with carriage in front shall not be permitted. Pick & carry tyre mounted Front Cabin mobile crane (FX or TRX/ NextGen series of 'ESCORT' or equivalent make) shall only be permitted.
- ii. Any Heavy equipment (cranes, winch machines, etc.) shall be deployed only after pre-safety Inspection by safety dept. Valid AMCs/ Fitness/ other statutory clearances as per local rules shall be required to be submitted before mobilizing the equipment at site.
- iii. All other Hand tools and power tools should not be older than 5 years.
- iv. For Chimney passenger lift, winch to have double drum rope for passenger and double safety devices must be used. Winch should not more than 3 years old and winch rope must be inspected with valid certificate from competent authority within 6 months and should meet the IS standard 9507 provision of OLR and push back button arrangement or dead man switch.
- v. Gate pass for all the lifting T&Ps and construction machinery/ equipment shall be made after obtaining written acceptance (Pre-entry Safety Clearance) from BHEL Site Safety Department after physical verification and checking all requisite documents/ compliance to Safety norms
- vi. All motor vehicles should have valid registration certificate, insurance, Pollution under control (PUC) and fitness certificate as per Motor Vehicle Act 2020. The certificates should be pasted in the glass from inside.
- vii. PPEs shall be from reputed manufactures viz. 3M, Udyogi, Karam, Frontier, Freedom, Honeywell, Liberty, Bata, Nomex, Acme, Unicare, Life Gear or equivalent. In case Subcontractor recommends any other name the same can be approved at site level by the Construction manager & Site HSE
- viii. For height work, where fall could result in death or disability, a secondary means of fall protection (Safety Net, Retractable Fall Arrestor etc.) shall be mandatorily provided by the subcontractor, failing which, a penalty of INR 10000 per case will be imposed. In addition, there should be constant supervision for such critical height work. Any non-erection activities at height eg. Housekeeping etc. shall also fall under the category of height work

ix. Scaffold Tagging

Scaffolds being erected, modified or dismantled must be tagged as suitable for use. Tagging shall be done with standard tag holder. Scaffolding tag should be certified by scaffolding inspector having valid certificate.

- **GREEN** scaffold tag- shall be fixed when scaffold is complete and safe for use, signed and dated by the scaffolding competent person daily.
- **RED** scaffold tag – to be fixed if scaffold is in some way defective and cannot be used or is still under erection.
- **YELLOW** scaffold tag – to be fixed if scaffold is in under construction/ maintenance.



FIG. A.4.1 SAMPLE SCAFFOLD TAGS AND TAG HOLDER

x. **T&P Color Coding:**

- a. Inspections and tests shall be documented by means of color coding which shall verify that inspections or testing are current and that all receptacles, portable Power tools, Lifting Tools & Tackles have been inspected and tested as required. The color codes used on the project shall be:

GREEN	BLUE	YELLOW	PURPLE
January	April	July	October
February	May	August	November
March	June	September	December

TABLE. A.4.2: T&P COLOR CODES

- b. The cycle of colors shall be Quarterly as a minimum or as decided by BHEL. The color code tape / Sticker shall be clearly visible to designate the period for which the inspections and tests were conducted.
- c. Following the initial inspection, the equipment must be color-coded quarterly as per color-coding instructions that will be issued by the subcontractor.
- d. Fire extinguisher with the current month color-coding inspection sticker must be provided and secured in the platform.
- e. All slings shall be regularly inspected in accordance with the requirement of the project for frequent and periodic inspections and discard immediately if they fail to meet the minimum requirements of the project.
- f. The Subcontractor's HSE Officer shall ensure that all PPE is inspected prior to its issue. He is to ensure all subcontractor personnel are using safe and proper PPE equipment.

- inspections on the PPE shall be carried out and personnel not adhering to those inspections shall be removed immediately from the site.
- g. A Ten (10) day interval period shall be given into each monthly color code change. During this Ten (10) day period either color shall be acceptable.
- xi. **T&P Tagging:**
All deployed Wire Rope Slings, Chain Pulley Blocks, Hooks, slings etc. shall be Tagged using aluminum or any other metal tag with punching.

5. HSE PERSONNEL TO BE PROVIDED SOLELY BY THE SUBCONTRACTOR

5.1. NUMBERS OF HSE PERSONNEL (APPLICABLE FOR EACH WORK SHIFT)

Number of HSE Officers and Supervisors shall be in proportion to number of workers as per Table A.6 below

TABLE A.5

No. of Workers	No. of HSE Supervisors	No. of HSE Officers
Up to 100	1	1
101 to 250	2	1
251 to 500	4	1
501 to 1000	6	2
1000 to 2000	6+ One additional supervisor up to every additional 250 workers	3
2000-3000	10+ One additional supervisor up to every additional 250 workers	4
3000-4000	14+ One additional supervisor up to every additional 250 workers	5

5.1.1. DEPLOYMENT PLAN

- Above requirement is for every shift for each unit.
- The dynamic deployment plan of Safety manpower at various locations containing names, areas, time periods, shifts etc. shall be submitted to BHEL for approval by subcontractor
- BHEL may modify the deployment plan based on nature and volume of jobs, Risks and hazards associated etc.
- For less than 20 workers HSE Officer is not mandatory. In case the number of workers exceed 20 for 3 consecutive months, HSE Officer is to be engaged. The HSE Officer shall be deployed for a minimum period of 6 months even if the number of workers fall below 20 in any month subsequent to deployment. If within that 6-month period, the number of workers is more than 20 for at least 3 months, the deployment duration of HSE Officer will extend further 6 months after completion of previous 6-month period.
- For Site Material Management/ Handling (Loading/ Unloading) contracts, 1 no. HSE Officer shall be required irrespective of the total manpower deployed.
- HSE Officers/Supervisors of all the vendors may be required to report directly to BHEL HSE Officer at site & shall comprise as a total team for handling all HSE issues. However, each safety officer/ agency shall be individually responsible for the safe execution of work in their respective areas.

5.2. QUALIFICATION & EXPERIENCE REQUIREMENTS OF HSE PERSONNEL

5.2.1. HSE OFFICER

First HSE Officer to be mandatorily as per Option I as under and shall be designated Senior HSE Officer. In case of non-availability of HSE Officers with Option I configuration, the subsequent HSE Officers can be as per Option II below with recorded reasons and approval of Site Construction Manager of BHEL. All these deviations should be reported to Region HSE and PSHQ HSE.

A. Option I

- i. possesses a recognized degree in any branch of engineering or technology or architecture and had a practical experience of working in a building or other construction work in a supervisory capacity for a period of not less than two years or possesses a recognized diploma in any branch of engineering or technology and has had practical experience of building or other construction work in a supervisory capacity for a period of not less than five years;
- ii. possesses a recognized degree or diploma in industrial safety with at least one paper in construction safety (as an elective subject/ part thereof);
- iii. has adequate knowledge of the language spoken by majority of building workers from the construction site in which he is to be appointed.

B. Option II:

Graduation Degree in Science with Physics & Chemistry and degree or diploma in Industrial Safety (All Degrees/ Diploma from any Indian institutes recognized by AICTE or State Council of Technical Education of any Indian State) with practical experience of working in a building, plant or other construction works (as HSE Officer, in line with Indian Factories Act, 1958 or BOCW Act, 1996) for a period of not less than five years

Note:

- i. HSE Officer as per Option II shall be valid only on availability of Senior HSE Officer as per Option I at site.
- ii. In case of resignation of the Senior HSE Officer, the same has to be replaced within 15 days else all subsequent HSE Officers as per Option II (in case of multiple HSE Officers with a single agency) shall not be considered as valid.
- iii. The penalty shall be deducted considering non-availability of any HSE Officer at site.

5.2.2. HSE SUPERVISOR: EITHER OF X OR Y BELOW

X. Recognized Degree in any branch of Engineering OR Diploma in any branch of engineering with at least one-year construction experience

OR

Y. A recognized graduation Degree in Science (with Physics & Chemistry) or a recognized diploma in Engg. or Tech.

Additional requirements for option (Y) above

Bharat Heavy Electricals Limited, Power Sector

Regd. Office: BHEL House, Siri Fort, New Delhi-110049



- i. Trained in fire-fighting as well as in safety / occupational health related subjects, with:
- ii. Minimum Two years of practical experience in construction work environment or in the field of safety and

Note:

- i. Option a above is by default, b is under special approval from Site HSE & Construction manager
- ii. In both cases the candidate should possess requisite skills to deal with construction & fire safety related day-to-day issues.

5.3. HSE IN-CHARGE

In case there is more than one HSE Officer with any subcontractor, one of them, who is senior most by experience & meets qualification as per option 1 as mentioned in clause 2.1 A above (in HSE discipline), may be designated as HSE In-charge who will be the nodal point of contact on HSE matters.

5.4. SUPPORTING STAFF TO HSE TEAM

- i. Supporting Staff shall include scaffolders, scaffolding inspectors, riggers, skilled and unskilled manpower
- ii. Subcontractor shall provide adequate number of workers as and when required, in order to attend and comply to Safety observations raised by BHEL/ Customer.

5.5. AVAILABILITY AND PENALTY FOR NON-DEPLOYMENT

- i. The subcontractor shall submit the certificates of qualification & experience of HSE manpower before deployment for BHEL to assess suitability as per requirement detailed in this document
- ii. In case of rejection, subcontractor shall arrange additional candidates and submit resume to BHEL. Penalties will be applicable during the period of non-deployment in such cases as well.
- iii. Subcontractor shall ensure physical availability of safety personnel at the place of specific work locations.
- iv. The Subcontractor shall deploy the HSE Officers as per the site's requirement. Non-deployment shall lead to stoppage of the work and final decision shall rest with Site HSE & Construction manager.
- v. The Subcontractor shall prepare an organization chart identifying the areas of operations, responsibilities and reporting structure of all safety personnel for each shift and submit the same to BHEL.
- vi. The subcontractor shall deploy sufficient HSE Officers, supervisors, as per numbers & qualifications mandated in this Section since mobilization of first batch of manpower and add more in proportion to the added strength in work force. Any delay in deployment will attract a penalty at following rates:

Non-deployment of HSE Officer –	Rs. 75,000 per man-month
Non-deployment of HSE Supervisor –	Rs. 50,000 per man-month

- vii. Penalty shall be collected for the period of non-availability of safety personnel after allowing a grace period of 15 days for finding a replacement. The same shall be deducted on pro-rata basis till the required manpower is deployed.
- viii. In case of abnormal delay & frequent rejections of candidates proposed by the subcontractor, BHEL shall exercise the right to deploy the safety manpower & deduct the amount from subcontractor's running bill with applicable overheads. In such cases also, the provision of logistics, transportation, food and other logistical support to the HSE personnel shall be in the scope of subcontractor in addition to the salary. After deployment of manpower by BHEL, the penalty for non-deployment specified above shall not be applicable.

6. COMPETENCY OF OPERATORS/ DRIVERS OF CRANE, WINCH, LIFTING/ CONSTRUCTION EQUIPMENT ETC.

- i. The Operators/ Drivers of crane, winch, construction/ lifting equipment etc. shall be experienced and have valid driving license for the class of vehicle / machinery as applicable (like Crane/ Forklift/ Rig, Construction equipment driving license etc.).
- ii. Minimum HMV driving license is required for all heavy equipment/ heavy vehicle (trailer/ Hyva /dumper /TM) operators at site.
- iii. The subcontractor shall certify competence of these persons in writing as and when they are posted at site.
- iv. Crane, Winch, Construction & lifting equipment operator should have certificate on subject course or experience certificate in employer letterhead.
- v. Where state is providing license for operating crane, tractor and other construction vehicles, same to be ensured.

Note: In case the statutory requirements i.e. State or Central Acts and / or Rules as applicable like the Building and Other Construction Workers' Regulation of Employment and Conditions of Service- Act,1996 or State Rules (wherever notified), the Factories Act, 1948 or Rules (wherever notified), etc. are more stringent than above, the same shall be followed.

- 7. In case of any stringent requirement of BHEL's customer over and above the specifications mentioned in current document, the same shall also be required to be complied at site by subcontractor.

8. REFERENCES

The Safety Rules for Construction & Erection as outlined hereunder, while setting out a broad parameter of safety norms, are not exhaustive. The subcontractor and his agencies are advised to refer to the following statutory provisions as amended from time to time for details and strict compliance therewith.

8.1.FOR GREENFIELD PROJECTS

- a) Building and Other Construction Workers (regulation of employment and conditions of service) Act, 1996 (briefly referred to as BOCW Act),
- b) Building and other construction workers (regulation of employment and conditions of service) Central Rules, 1998 (briefly referred to as BOCW Rules) as adopted by the various State Governments,

8.2. FOR EXPANSION, MODIFICATION, ALTERATION AND, OR CONSTRUCTION ACTIVITY WITHIN AN EXISTING PLANT OPERATING AS PER APPROVED SITE PLAN UNDER THE FACTORIES ACT

- a) Factories Act, 1948,
- b) Factories Rules, as adopted by the various State Governments
- c) BOCW Act
- d) BOCW Rules
- e) In case a new act/ statutory guideline/ modification/ consolidation of acts is implemented the same shall be required to be adhered by the subcontractor.
- f) The latest amendment of the above-mentioned acts/ rules shall be followed at site.

9. BHEL POWER SECTOR HSE MANAGEMENT SYSTEM

The Systems and procedures of BHEL Power Sector HSE Management System shall be implemented by the subcontractor, including:

- HSE PROCEDURE FOR REGISTER OF OHS HAZARDS AND RISKS
- HSE PROCEDURE FOR REGISTER OF ENVIRONMENTAL ASPECTS AND IMPACTS
- HSE PROCEDURE FOR REGISTER OF REGULATIONS
- HSE PROCEDURE FOR TRAINING AND AWARENESS
- HSE PROCEDURE FOR EMERGENCY PREPAREDNESS AND RESPONSE PLAN
- HSE PROCEDURE FOR PERMIT TO WORK
- HSE INSPECTION AND OTHER FORMATS

Note:

- i. BHEL reserves the right to revise/ update these systems and procedure as per requirement to address any changing HSE needs
- ii. BHEL will provide hard / soft copies of applicable HSE Procedures, Work Permits, Operational Control Procedures, Inspection/ Other Formats etc. that are necessary for ensuring safe work to the successful bidder at Site. It is the responsibility of the subcontractor to ensure availability of these documents before commencing work at site.
- iii. The subcontractor can get soft copies of these documents from respective Region SCT/ HSE for reference. The signed hard copies of the same shall not be required to be submitted along with tender document
- iv. Subcontractor shall use the Digital (Web & App-Based) HSE management Software Systems provided by BHEL whenever provided. In case not provided, hard copy systems will continue to be used. All information technology resources (Computers, mobile phones, mobile data, internet access etc.) for the use of such systems shall be ensured by the subcontractor.

10. CLEARANCE OF MONTHLY RUNNING BILLS SUBJECT TO SAFETY COMPLIANCE

- The monthly running Bills of the subcontractor shall be released subject to compliance to HSE requirements as per checklist in Annexure H
- BHEL site HSE Head and Package In-charge shall be authorized to issue the clearance
- Site Construction Manager of BHEL shall be the final authority on the matter.

11. HSE PERFORMANCE EVALUATION

- Subcontractor shall be assessed on monthly basis for HSE Compliance by BHEL Safety In-charge at site.
- The HSE evaluation shall be based on HSE Performance Evaluation System of BHEL covering the contractual, statutory and regulatory requirements of HSE.
- BHEL shall reserve the right to use these performance scores for evaluating bidder's capacity for future tenders
- If safety record of the subcontractor in execution of the awarded job is to the satisfaction of safety department of BHEL, issue of an appropriate certificate to recognize the safety performance of the subcontractor may be considered by BHEL after completion of the job, provided the execution performance is satisfactory.

12. HSE PENALTIES

- Nonconformity of safety rules and safety appliances will be viewed seriously and BHEL has right to impose fines on the subcontractor for every instance of violation noticed.
- As per contractual provision HSE penalties shall be imposed on subcontractors for non-compliance on HSE requirement as per following format.
- Following are the applicable penalties for various Safety violations:

Sub: MEMO for Penalty for non-compliances in Safety

Following lapse (tick marked) was observed and penalty (in Rs.) is imposed as stated at the bottom of this memo. It is requested that such occurrences be please avoided in future.

S. No	Nature of Non - Compliance	Penalty (in INR)	Remarks
A. System Violations			
1	Working without valid Work Permit/ HIRA/ Method Statement / JSA	2000	Per case
2	Controls as per Work Permit/ HIRA/MS/JSA not ensured	2000	Per case
3	Reported Safety Violations Not Closed within Stipulated Time	1000-10000	Per case
4	Absence of required Subcontractor Officials (Site Head, HS Head) in Safety Reviews/Meetings	5000	Per case
5	Not providing required PPEs (Safety Harness, Lifeline, Safety Net, Fall arrestor, Safety Helmet, Gloves, Shoes etc.) for the work by subcontractor	2000	Per case
B. Competency/ Training/ Induction Violations			

1	Incompetent personnel deployed for specialized jobs like height work, hot work, rigging, vehicle operation etc. (without valid license/ certificate etc.)	3000	Per case
2	Work without induction training & medical check	2000	Per case
3	Height Work without Vertigo Test and height work training	2000	Per case
C. PPE Violations – Height Work			
1	Not wearing/ hooking Double Lanyard Safety Harness while working at height (> 1.2 meters) or not anchoring to lifeline	1000	Per case
2	Not Providing Lifeline for height work	3000	
3	Unsafe platforms – without Top, Mid Rails and Toe-Guards for Height Work	3000	
4	Not providing secondary means of fall protection for height work (Safety Nets, Retractable Fall Arrestors etc.)	3000	Per case
D. PPE Violations – General			
1	Not wearing safety helmet	1000	Per case
2	Wearing of helmets without chin straps	1000	Per case
3	Not Wearing safety shoes	500	Per case
4	Not wearing gloves	500	Per case
6	Not using grinding goggles/ face shield during grinding/ cutting	2000	Per case
E. Electrical Safety Violations			
1	Broken/ exposed wires/ cables	2000	Per case per day
2	Electrical plug not used for connection/ hand machines	1000	Per case per day
3	Not using proper ELCBs for electrical equipment	2000	Per case per day
4	Improper earthing of welding & Other electrical machines (Lack of double earthing, improper/ untested earth pit etc.)	2000	Per case per day
5	Not using 24 V supply for lighting in confined spaces	2000	Per case
6	Cables haphazard/ blocking way/ not organized properly	1000	Per case per day
F. Lifting & Rigging Violations			
1	Using Sling/ Chain Pulley Block and other Small T&Ps without proper, traceable Tag and Test Certificate	2000	Per T&P per day
2	Using damaged slings or not slinging properly	2000	Per T&P per day
3	Use of lifting equipment without having valid Test certificate	5000	Per equipment per seven days
4	Lifting hooks used without latches	2000	Per hook per day
5	Not effectively barricading area below lifting activity	5000	Per case
6	Using untrained/ unqualified rigger	5000	Per case
G. Housekeeping			
1	Non-removal of scrap from platforms	5000	Per Event Per location per 7 days
2	Not conducting scheduled housekeeping drives	5000	Per drive
H. Hot Work Safety Violations			
1	Gas cutting without flash back arrestor at both ends	5000	Per machine per incidence
2	Gas cutting at height without fire blanket	2000	Per event

3	Not keeping gas cylinders vertically	2000	Per event
4	Lifting cylinders without cage or rolling of cylinders	2000	Per incidence
5	Leakage in gas cylinder	2000	Per incidence
I. Vehicle Safety/ Operation			
1	Not having valid driving license for the type of vehicle/ T&P	2000	Per driver per incidence
2	Two-wheeler entry in construction area	2000	Per vehicle
3	Using Hydra for material movement at site in unsafe manner	2000	Per case
4	Using Two Hydra in Tandem for material movement without proper precautions as per OCP	2000	Per case
5	Vehicles, Hydras, Cranes, Dumpers and Earth Movers not having automatic back horns linked to gear	2000	Per Equipment per day
6	Not providing proper hard barricades around excavations/ unpermitted areas	5000	Per location per day
7	Not using guide rope while transporting material using Hydra or Cranes	2000	Per event
8	Over speeding	5000	Per case
9	Using Conventional Hydra crane	50000	Per day /crane
J. Accidents/ Incidents/ Near Misses			
1	Non-reporting of Near Miss/ Incident	20000	Per case
2	Major Accident – Worker unable to resume work within 48 hrs	100000	Per incident
3	Fatal Accident	500000	Per incident
K. Miscellaneous			
1.	Not providing the facility (drinking water, rest shed, labor colony etc. as per the specifications/ requirement)	5000	Per month per violation
2.	Not nominating the required number of workers for training as per plan	5000	Per incidence
3.	Lack of proper arrangement for disposal of sewage/ waste water/ effluents etc.	10000	Per incidence

Details (if any) related to non- compliance (Name of persons, Nature of deficiency, etc.):

Penalty Amount:

1. Rate as per above chart
2. No. of Persons/ machine/ event/ labor
3. No. of times the same error is repeated: Repetition factor
4. Total Penalty= 1. X 2. X 3. =

Witnessed by:

(Sub- Subcontractor representative)
representative)

(BHEL

Signature

Name

Bharat Heavy Electricals Limited, Power Sector

Regd. Office: BHEL House, Siri Fort, New Delhi-110049



Distribution: 1 Copy: to Sub- subcontractor Site In-charge,
1 Copy to Site Construction Manager (BHEL)
1 Copy to Site Finance

Note:

- i. In case the amount of penalty imposed by BHEL's Client on BHEL for Safety violation/ incident due to or in the area of the subcontractor is more than those indicated above, same shall be imposed back-to-back on the subcontractor. However, in case such an amount is less than the specified above, penalty amount indicated above shall be imposed on the subcontractor.
- ii. For same violation only one penalty (higher of the two mentioned below) shall be applicable
 - a. Penalty imposed by BHEL's Customer over BHEL.
 - b. Penalty as indicated in current document.
- iii. For repeated violation for the same equipment/ location, the penalty would be double of the previous penalty. Date of "Repeated violation" will be counted from subsequent days.
- iv. For repeated fatal incident in the same Unit incremental penalty shall be imposed: The subcontractor will pay 2 times the previously paid penalty in case there is repeated major/ fatal incident under the same subcontractor for the same package in the same unit.
- v. Any other non-conformity noticed not listed above will also be fined as deemed fit by BHEL. The decision of BHEL engineer is final on the above.
- vi. If principal customer/statutory and regulatory bodies impose some penalty on HSE due to the non-compliance of the subcontractor the same shall be passed on to them.
- vii. The penalty amount shall be recovered by BHEL Finance department from subcontractors from the RA/Final bill.

13. PUNITIVE ACTIONS FOR "CRITICAL SAFETY VIOLATIONS":

"Critical Safety Violations" include:

- i. Not wearing required PPEs when provided and not following safe work procedure
- ii. Taking unnecessary risks especially in height work, hot work, radiation work, lifting activity
- iii. Coming to work under influence of sedatives like alcohol, drugs etc.
- iv. Coming to work without ID Card/ Gate Pass (if provided)
- v. Intimidating/ threatening at work
- vi. Using cell phones during height work, hot work, lifting activity, driving.

In case any worker carries out any of the critical safety violations as above, BHEL reserves the right to enforce punitive action in following manner:

First Offence:	1 Punch on Gate Pass/ Induction Card/ ID Card etc. and 1-hour HSE Training. With one day off from duty
Second Offence:	2 Punches and 2-hours HSE Training with one day off from duty

Third Offence:	3 Punches and the worker will be dismissed. Gate pass to be confiscated

In case any employee of subcontractor carries out any of the critical safety violations as above, subcontractor Site In-charge shall issue warning letter to concerned employee with copy to BHEL

Note:

- i. For above violations, guilt of the worker/ employee has to be established through appropriate evidences and records maintained.
- ii. If worker/ employee has not been given the required PPEs and safety equipment by the agency and/or not facilitated by the agency to follow safety rules, he/ she will not be considered liable but the agency will be penalized as per penalty provision in this document. In such cases, the subcontractor shall not pass the penalty over to the worker/ employee through wage deduction etc.
- iii. These critical safety violations and their consequences shall be shared with all workers and employees during induction and other training programs/ meetings, toolbox talks etc.
- iv. Gate Pass shall have provision of Tagging as indicated above
- v. The appellate authority (only for final dismissal) in this case shall be the BHEL Site In-charge whose decision shall be final on the matter and binding on all parties.

14. LEGAL IMPLICATIONS

Any legal Costs incurred by BHEL, on account of accidents taking place in the activities of the subcontractor, shall be debited to the subcontractor on actual cost basis.

For any accident occurring at site to any worker/ employee of the subcontractor leading to legal implications to BHEL Employee/ Management shall be safeguarded by BHEL legal department. All legal expenses incurred by BHEL on this account shall be recovered from the subcontractor. The accident also includes fire, loss of property or life at site.

15. HSE REVIEW MEETING

- i. Subcontractor Site In-charge and HSE In-charge shall attend the HSE Review Meeting as and when called by BHEL.

The indicative agenda points are given below:

- a) Implementation of earlier MOM points
- b) Compliance Status of HSE Observations
- c) Incidents & Near Misses, their Root Causes and Actions Taken
- d) HSE performance review
- e) HSE inspection findings
- f) HSE audit and CAPA
- g) HSE training
- h) Health check-up camp
- i) HSE planning for the erection and commissioning and installation activities in the coming month

- j) HSE reward and promotional activities
- ii. MOM on the discussion along with HSE observations will be circulated to the subcontractor for action.
- iii. The subcontractor shall close the observations to the satisfaction of BHEL within stipulated time frame

16. OTHER REQUIREMENTS

- i. If the subcontractor fails to improve the standards of safety in its operation to the satisfaction of BHEL after being given reasonable opportunity to do so and/or if the subcontractor fails to take appropriate safety precautions or to provide necessary safety devices and equipment or to carry out instruction regarding safety issued by BHEL, BHEL shall have the right to take corrective steps and the cost shall be debited to the subcontractor with applicable overheads.
- ii. If the subcontractor succeeds in carrying out its job in time without any fatal or disabling injury incident and without any damage to property BHEL may, at its sole discretion, favorably consider to reward the subcontractor suitably for the performance.
- iii. In case of any damage to property due to lapses by the subcontractor, BHEL shall have the right to recover the cost of such damages from the subcontractor after holding an appropriate enquiry.
- iv. The subcontractor shall take all measures at the sites of the work to protect all persons from incidents and shall be bound to bear the expenses of defense of every suit, action or other proceeding of law that may be brought by any persons for injury sustained or death owing to neglect of the above precautions and to pay any such persons such compensation or which may with the consent of the subcontractor be paid to compromise any claim by any such person, should such claim proceeding be filed against BHEL, the subcontractor hereby agrees to indemnify BHEL against the same.
- v. The subcontractor shall not employ men below the age of 18 years and women on the work of painting with products containing lead in any form. Wherever men above the age of 18 are employed on the work of lead painting, overalls shall be supplied by the subcontractor to the workmen and adequate facilities shall be provided to enable the working painters to wash during the cessation of work.
- vi. The subcontractor shall notify BHEL of his intention to bring to site any equipment or material which may create hazard.
- vii. BHEL shall have the right to prescribe the conditions under which such equipment or materials may be handled and the subcontractor shall adhere to such instructions.
- viii. BHEL may prohibit the use of any construction machinery, which according to the organization is unsafe. No claim for compensation due to such prohibition will be entertained by BHEL.

17. MEMORANDUM OF UNDERSTANDING:

After award of work, subcontractors are required to enter into a memorandum of understanding as given below:

Memorandum of Understanding

BHEL, Power Sector Region is committed to Health, Safety and Environment Policy (HSE Policy).

M/s.....do hereby also commit to comply with the same HSE Policy while executing the Contract Number _____

M/s.....have gone through and understood all the HSE requirements of the contract including HSE manpower, tools & equipment, systems & procedures, and agree to fulfill the same as a minimum. Any additional resources and support required for ensuring fulfillment of HSE Objectives shall be provided by subcontractor at no extra cost.

M/s..... agree that in case they fail to comply to the HSE requirements as stipulated in the contract, BHEL shall have the right to implement the same and the cost shall be recovered from the subcontractor with applicable overheads.

M/s..... shall ensure that safe work practices as per the HSE plan. Spirit and content therein shall be imbibed in all workers and supervisors for compliance.

In addition to this, M/s.....shall comply to all applicable statutory and regulatory requirements which are in force in the place of project and any special requirement specified in the contract document of the principal customer.

M/s.....shall co-operate in HSE audits/inspections conducted by BHEL /customer/ third party and ensure to close any non-conformity observed/reported within prescribed time limit.

M/s..... agree that the subcontractor shall seek HSE clearance as per BHEL format before each RA bill as mentioned in clause no. 9. The penalty amounts for not providing Safety manpower and various Safety violations have also been reviewed and agreed.

M/s..... agree to share the HSE Costs (running costs) of common facilities created by BHEL on proportional to contract value basis as calculated at Site by BHEL.

Signed by authorized representative of M/s -----

Name :

Place & Date:

SECTION B

OPERATIONAL REQUIREMENTS

1. PURPOSE:

- 1.1. The purpose of this HSE Plan is to provide for the systematic identification, evaluation, prevention and control of general workplace hazards, specific job hazards, potential hazards and environmental impacts that may arise from foreseeable conditions during installation and servicing of industrial projects and power plants.
- 1.2. This document shall be followed by BHEL's subcontractors at all installation and servicing sites. In case customer specific documents are to be implemented, this document will be followed in conjunction with customer specific documents in complementary manner.
- 1.3. Although every effort has been made to make the procedures and guidelines in line with statutory requirements, in case of any discrepancy wherein the relevant statutory guidelines supersedes this document, the same shall be followed.
- 1.4. In case there's any specific HSE requirement from BHEL's Client, not explicitly indicated in this document the same shall be required to be fulfilled as per the decision of BHEL Site construction manager.

2. SCOPE:

The document is applicable to BHEL's Subcontractors at all installation / servicing activities of BHEL Power Sector as per the relevant contractual obligations

3. OBJECTIVES AND TARGETS:

- i. To achieve "Zero Incident at Site"
- ii. 100% compliance to all legal/statutory requirements related to EHS.
- iii. 100% Health, Safety and Environmental Induction training attendance for all workers.
- iv. 100% High Risk activities to be carried out only after approved Method Statement, HIRA / Aspect-Impact / JSA / OCP and Permit to Work are implemented.
- v. 100% PPEs compliance in high and medium risk activities.
- vi. 100% incident reporting, recording and reviewing for corrective actions.
- vii. Regular Safety Reviews to assess HSE program compliance and closure of any recognized gaps to improve safety management and incident prevention
- viii. Prevent injury and ill health of all workers at site ('Workers' refers to all personnel including managerial, supervisory, professional, technical, clerical and other workers including contract laborers)
- ix. Prevent pollution to environment
- x. Ensure the Health and Safety of all persons at work site is not adversely affected by the work.
- xi. Ensure protection of environment of the work site.
- xii. Comply at all times with the relevant statutory and contractual HSE requirements.
- xiii. Provide trained, experienced and competent personnel. Ensure medically fit personnel only are engaged at work.
- xiv. Provide and maintain plant, places and systems of work that are safe and without risk to health and the environment.

- xv. Provide all personnel with adequate information, instruction, training and supervision on the safety aspect of their work.
- xvi. Effectively control, co-ordinate and monitor the activities of all personnel on the Project sites including subcontractors in respects of HSE.
- xvii. Establish effective communication on HSE matters with all relevant parties involved in the Project works.
- xviii. Ensure that all work planning considers all persons that may be affected by the work.
- xix. Ensure fitness testing of all T&Ps/Lifting appliances like cranes, chain pulley blocks etc. are to be certified by competent person.
- xx. Ensure timely provision of resources to facilitate effective implementation of HSE requirements.
- xxi. Ensure continual improvements in HSE performance.
- xxii. Ensure conservation of resources and reduction of wastage.
- xxiii. Capture the data of all incidents including near misses, process deviation etc. Investigate and analyze the same to find out the root cause.
- xxiv. Ensure timely implementation of correction, corrective action and preventive action.
The subcontractor shall also comply with HSE Targets stipulated by BHEL from time to time.

4. BHEL HEALTH, SAFETY & ENVIRONMENT POLICY:

In BHEL, Health, Safety and Environment (HSE) responsibilities are driven by our commitment to protect our employees and people we work with, community and environment. BHEL believes in zero tolerance for unsafe work/non-conformance to safety and in minimizing environmental footprint associated with all its business activities. We commit to continually improve our HSE performance by:

- ❖ Developing safety and sustainability culture through active leadership and by ensuring availability of required resources.
- ❖ Ensuring compliance with applicable legislation, regulations and BHEL systems.
- ❖ Taking up activities for conservation of resources and adopting sound waste management by following Reduce/Recycle/Reuse approach.
- ❖ Continually identifying, assessing and managing environmental impacts and Occupational Health & Safety risks of all activities, products and services adopting approach based on elimination/ substitution/reduction/control.
- ❖ Incorporating appropriate Occupational Health, Safety and Environment criteria into business decisions, design of products & systems and for selection of plants, technologies and services.
- ❖ Imparting appropriate structured training to all persons at workplace and promoting awareness amongst customers, subcontractors and suppliers on HSE issues.
- ❖ Reviewing periodically this policy and HSE Management Systems to ensure its relevance, appropriateness and effectiveness.
- ❖ Communicating this policy within BHEL and making it available to interested parties.

Chairman & Managing Director

Bharat Heavy Electricals Limited, Power Sector

Regd. Office: BHEL House, Siri Fort, New Delhi-110049



5. ILLUSTRATIVE RESPONSIBILITIES OF SUBCONTRACTOR EMPLOYEES

5.1 HSE - A LINE RESPONSIBILITY

- i. HSE is a "Line Responsibility".
- ii. The term "Line" includes management, Executives, Supervisors, Foremen, and Workers who are part of the workforce. Line is to be fully involved in HSE Planning & Implementation with the aid and advice of HSE organization.
- iii. "Line", having control of resources and manpower is responsible for overall implementation of HSE Systems and closure of HSE observations.

5.2 SITE IN -CHARGE:

- i. Shall sign Memorandum of Understanding (MoU)
- ii. Shall ensure availability of all necessary resources required for implementation of HSE at Site
- iii. Shall engage qualified HSE Officer(s) and supervisors (s)
- iv. Shall adhere to the rules and regulations mentioned in this code, practice very strictly in area of work in consultation with concerned engineer and the safety coordinator.
- v. Shall screen all workmen for health and competence requirement before engaging for the job and periodically thereafter as required.
- vi. Shall not engage any employee below 18 years.
- vii. Shall arrange for all necessary PPEs like safety helmets, belts, full body harness, shoes, face shield, hand gloves etc. before starting the job.
- viii. Shall ensure that all T&Ps engaged are tested for fitness and have valid certificates from competent person.
- ix. Shall ensure closure of all HSE non-conformities reported by BHEL or observed during internal inspection by providing appropriate resources in a timely manner.
- x. Shall ensure the implementation of provisions of applicable acts and rules pertaining to HSE.
- xi. Shall ensure availability of updated (Hazard Identification and Risk Assessment) Register for the area of activity
- xii. Shall ensure availability of Method Statements & Job Safety Analysis for all hazardous activities
- xiii. Shall ensure necessary controls to minimize risk in all applicable hazardous activities including Height Work, Hot Work, Lifting & Rigging, Confined Space, Maintenance, excavation, Radiography, Loading/ Unloading, Drilling/ Blasting etc.
- xiv. Shall ensure implementation of HSE requirements mentioned in this document and as specified in the BHEL HSE management System including training, inspection, awareness, reporting etc.
- xv. Shall ensure that person working above 2.0 meter should use Safety Harness tied to a life line/stable structure.
- xvi. Shall ensure a secondary means of fall protection (Safety Net, Retractable Fall Arrestor etc.) for preventing fall from height
- xvii. Shall ensure that materials are not thrown from height. Cautions to be exercised to prevent fall of material from height.

- xviii. Shall report all incidents (Fatal/Major/Minor/Near Miss) to the Site engineer /HSE officer of BHEL.
- xix. Shall ensure that Horseplay is strictly forbidden.
- xx. Shall ensure that adequate illumination is arranged during night work.
- xxi. Shall ensure that all personnel working under subcontractor are working safely and do not create any Hazard to self and to others.
- xxii. Shall ensure display of adequate signage/posters on HSE.
- xxiii. Shall ensure that mobile phone is not used by workers while working.
- xxiv. Shall ensure conductance of HSE audit, mock drill, medical camps, induction training and training on HSE at site.
- xxv. Shall ensure full co-operation during HSE audits.
- xxvi. Shall ensure submission of look-ahead plan for procurement of HSE equipment's and PPEs as per work schedule.
- xxvii. Shall ensure good housekeeping.
- xxviii. Shall ensure adequate valid fire extinguishers are provided at the work site.
- xxix. Shall ensure availability of sufficient number of toilets (preferably bio-toilets) /restrooms and adequate drinking water at work site and labor colony.
- xxx. Shall ensure adequate emergency preparedness.
- xxxi. Shall be member of site HSE committee and attend all meetings of the committee
- xxxii. Power source for hand lamps shall be maximum of 24 v.
- xxxiii. Temporary fencing should be done for open edges if Hand – railings and Toe-guards are not available
- xxxiv. To record all incidents including near miss and report to BHEL and to ensure analysis & corrective actions for the same
- xxxv. Shall conduct weekly Safety Walks in the work area and record the findings.
- xxxvi. Construction of Canteen at Site, Office Infrastructure: Printer, PC, Fire Extinguishers etc.
- xxxvii. Shall analysis HSE Performance regularly in work area and take steps to improve the same
- xxxviii. Shall ensure stoppage of work in case of unacceptable Safety hazards

5.3 HSE OFFICER:

- i. Carry out safety inspection of Work Area, Work Method, Men, Machine & Material, P&M and other tools and tackles.
- ii. Facilitate inclusion of safety elements into Work Method Statement and creation of Job Safety Analysis (JSA)
- iii. (HSE Head) To prepare deployment plan of HSE personnel for all shifts, so as to ensure constant supervision of all areas. The plan to be submitted to BHEL
- iv. Highlight the requirements of safety through Tool-box / other meetings.
- v. Help concerned HOS to prepare Job Specific instructions/ JSA for critical jobs.
- vi. Conduct investigation of all incident/dangerous occurrences & recommend appropriate safety measures.
- vii. Advice & co-ordinate for implementation of HSE Systems & Procedures.
- viii. To stop work in case of any critical safety violation until the violation is cleared
- ix. Convene HSE meeting & minute the proceeding for circulation & follow-up acti

- x. Plan procurement of PPE & Safety devices and inspect their healthiness.
- xi. Report to BHEL on all matters pertaining to status of safety and promotional program at site level.
- xii. Facilitate administration of First Aid
- xiii. Facilitate screening of workmen and safety induction.
- xiv. Conduct fire Drill and facilitate emergency preparedness
- xv. Design campaigns, competitions & other special emphasis programs to promote safety in the workplace.
- xvi. Apprise BHEL on safety related problems.
- xvii. Notify site personnel non-conformance to safety norms observed during site visits / site inspections.
- xviii. Recommend to Site In charge, immediate discontinuance of work until rectification, of such situations warranting immediate action in view of imminent danger to life or property or environment.
- xix. To decline acceptance of such PPE / safety equipment that do not conform to specified requirements.
- xx. Encourage raising Near Miss Report on safety along with, improvement initiatives on safety.
- xxi. Shall work as interface between various agencies such customer, package-in-charges, subcontractors on HSE matters.

5.4 HSE SUPERVISOR:

- i. All requirements as per 5.1
- ii. To monitor allotted area for Safety violations, take required action and inform the concerned Safety Supervisor / Officer
- iii. To assist HSE Officer

5.5 PACKAGE IN-CHARGES, ENGINEERS & ALL EMPLOYEES:

- i. To be aware of, get involved in and ensure implementation of all HSE related Systems and Procedures including but not limited to:
 - a. BHEL HSE Management System including HSE Procedures and OCPs, HIRA, JSA etc.
 - b. Work Permit System
 - c. Emergency Preparedness Response Plans
 - d. Contractual HSE requirements
 - e. Legal Requirements
 - f. Penalty System
 - g. Training requirements
- ii. To ensure that the persons engaged in respective area follow the safety rules like using appropriate PPEs.
- iii. To develop Method Statements and ensure availability of Job Safety Analysis for all activities in scope
- iv. To ensure that the reported HSE non-conformities in the work area are resolved immediately before resuming work
- v. To record all incidents including near miss and report to BHEL.

- vi. To adopt safe working practices at all times and act as role model for Safety
- vii. To take immediate corrective action actions in case any non-conformity is observed on product / process / system with respect to Occupational Health, Safety and Environment.
- viii. In case any particular activity / work has extremely high consequential risk or high environmental impact, same shall be brought to the notice of BHEL Package In-charge before starting the work.
- ix. To interfere/ stop work as & when identified unsafe.
- x. To maintain & promote improved level of house-keeping all the time at site.
- xi. To support/co-operate with audit team members as & when safety audits are carried out.
- xii. To involve in investigation, if any incident occurs in his work area.
- xiii. To participate in safety promotional programs
- xiv. To attend the safety committee meeting, if member/invitee
- xv. To ensure that only fit T&Ps and qualified persons are engaged for all activities.
- xvi. Shall ensure that person working above 2.0 meter should use Safety Harness tied to a life line/stable structure.
- xvii. Shall ensure that materials are not thrown from height. Cautions to be exercised to prevent fall of material from height.
- xviii. Shall ensure that all T&Ps engaged are tested for fitness and have valid certificates from competent authorities.

6. HSE PLANNING BY SUBCONTRACTOR:

6.1 HAZARD ANALYSIS & RISK ASSESSMENT (HIRA), METHOD STATEMENT (MS) & JOB SAFETY ANALYSIS (JSA):

- i. Subcontractor shall identify all OHS Hazards and Risks applicable to all activities in scope and plan & implement the required control measures. HIRA Register shall be maintained.
- ii. Subcontractor shall develop Method Statements & Job Safety Analysis documents for all hazardous activities in scope and ensure the required control measures. Job Safety Analysis is to be attached along with any Work Permit request

6.2 REGISTER OF REGULATIONS:

Subcontractor shall prepare a register of applicable rules and regulations in the scope and plan to ensure compliance.

HIRA Register, Method Statements, Job Safety Analysis and Register of Regulations are dynamic documents and shall be revised (as applicable):

- i. At fixed frequency of 3 months
- ii. Addition/ deletion/ modification of a process/ activity
- iii. After an accident/ incident
- iv. After any change in applicable rules/ regulations/ laws.

6.3 MONTHLY HSE PLAN COVERING THE FOLLOWING AS A MINIMUM SHALL BE PREPARED AND SUBMITTED TO BHEL FOR APPROVAL:

- i. HSE Trainings covering all activities/ hazards/ workers
- ii. HSE Inspection Plan covering all areas/ activities/ equipment/ hazards
- iii. HSE Activities: Safety walks, Awards, housekeeping, reviews etc.

Note: Online/ App-based system shall be used for HSE Planning and Implementation/ Update whenever provided by BHEL otherwise Hard-copy based system shall continue

6.4 MONTHLY HSE PLANNING & REVIEW OF HSE ACTIVITIES ALONG WITH BHEL:

Monthly planning and review of HSE activities shall be carried out by subcontractor as per provided **format** jointly along with BHEL

7. MOBILIZATION OF MACHINERY/EQUIPMENT/TOOLS BY SUBCONTRACTOR:

- i. Subcontractor shall notify the engineer, of his intention to bring on to site any equipment or any container, with liquid or gaseous fuel or other substance which may create a hazard. The Engineer shall have the right to prescribe the condition under which such equipment or container may be handled and used during the performance of the works and the subcontractor shall strictly adhere to such instructions. The Engineer shall have the right to inspect any construction tool and to forbid its use, if in his opinion it is unsafe. No claim due to such prohibition will be entertained.
- ii. As a measure to ensure that machinery, equipment and tools being mobilized to the construction site are fit for purpose and are maintained in safe operating condition and complies with legislative and owner requirement, inspection shall be arranged by in-house competent authority for acceptance as applicable. Inspection by Third Party competent person shall be arranged:
 - a. Before first time use at site
 - b. After carrying out any modification
 - c. After repairs subsequent to involvement in any accident/ incident
- iii. As a further measure to ensure that machinery, equipment and tools being mobilized to the construction site are fit for purpose and are maintained in safe operating condition and comply with legislative and owner requirement, inspection as per provided format shall be arranged by in-house expert / competent authority (preferable) for acceptance. The equipment considered for this purpose shall include all those in the T&P list in the tender document.

8. MOBILIZATION OF MANPOWER BY SUBCONTRACTOR:

- i. As a measure to ensure that manpower being mobilized to the construction site is fit and competent for safe working, screening arrangement shall be made by the sub-subcontractor to ensure competency and fitness through following measures:
 - a) **Medical Checkup:** Examination of medical fitness shall be conducted through qualified medical professional for all workers to be deployed as per provided **format**. For height workers, vertigo (height phobia) test to be carried out as qualification criteria as per Annexure K and recorded in provided **format**.

- b) **Induction Training:** Induction training of all workers to be ensured as per **provided procedure and format**. Training evaluation to be carried out and training to be repeated if not passed
- c) Only on successfully meeting above criteria, permanent gate passes to be issued
- ii. The subcontractor shall arrange induction and regular health check of their employees as per schedule VII of BOCW rules by a registered medical practitioner.
- iii. The subcontractor shall take special care of the employees affected with occupational diseases under rule 230 and schedule II of BOCW Rules. The employees not meeting the fitness requirement should not be engaged for such job.
- iv. Ensure that the regulatory requirements of excessive weight limit (to carry/lift/ move weights beyond prescribed limits) for male and female workers are complied with.
- v. Appropriate accommodation to be arranged for all workmen in hygienic condition.
- vi. Cost of contractual, statutory and regulatory requirements like Training, medical checks, PPEs etc. shall not be transferred to the workers and such activities shall be considered as part of the job.

9. PROVISION OF PERSONAL PROTECTIVE EQUIPMENT (PPEs):

- i. Personnel Protective Equipment (PPEs), shall be provided by the subcontractor to all workers as per requirement of the job.
- ii. The choice of PPEs to ensure multiple (at least more than 1) means of protection against any hazard. All applicable safety precautions for a job shall be ensured notwithstanding the duration or perceived importance of the task.
- iii. The applicability of PPEs shall be as per the concept of Hierarchy of controls, i.e.:
- iv. Elimination->Substitution->EngineeringControls->AdministrativeControls-PPEs
- v. Relying solely on PPEs without ensuring necessary controls to be strictly avoided.
- vi. The following matrix recommends usage of minimum PPEs against the respective job.

Activity	Type of Protection						Remarks, if any
	Hand	Eye	Ear	Body	Respiratory	Others	
Gas Welding & Cutting	LG	WG	-	LA	*SCBA/ OLBA	-	* for confined space
Electric Arc Welding	LG	HMWS	-	LA	*SCBA/ OLBA	-	* for confined space
Rigging	CG	SG	-				--
Working at Height	-	SG	-	DLCBH	-	*FAS	* for vertical columns
Grinding & Chipping	CG	FS / SG	-	LA	-	-	--
Working in High Noise	-	-	EP / EM	-	-	-	--
Handling of Cement Concrete	RG	SG	-	-	DM	-	

Blasting	CG	SG	EP*	-	-	-	* at noise area
Excavation	CG	SG	-	-	DM	-	*Gum boot in place of Safety shoe for foot
Chemical Handling	PVCG	CSG	-	PVCA	-	-	*Full body rubber suit with hood
Electrical and C&I	ERG*	SG	-	-	-	-	*For high voltages
Sand/shot blasting	CG	-	EP/EM	CA	SAMH	-	

ABBREVIATIONS: FS: Face Shield, CSG: Chemical splash goggles, HMWS: Helmet mounted welder's shield, GB: gum boot, DLFBH: Double lanyard full body harness, SG: Safety goggles, DM: Dust mask, SAMH L Supplied air mask/hood, EP/EM: Ear plug/Ear Muff, CG: Cotton hand gloves, LG: Leather hand gloves, LA: Leather apron, RG: Rubber gloves, PVCG: PVC Gloves, PVCA: PVC Apron, SCBA: Self-contained breathing apparatus, WG: Welding goggles, ERG: Electrical Rubber Gloves. OLBA: Online breathing apparatus

The list is not exhaustive. Additional PPEs to ensure Safe Work may need to be deployed as per the requirement of the task at no additional cost.

- vii. The PPEs shall conform to the relevant standards as below (illustrative list) and bear ISI mark.

RELEVANT IS-CODES FOR PERSONAL PROTECTION

PPEs	IS Codes
Industrial Safety Helmets.	IS: 2925 – 1984
Rubber gloves for electrical purposes.	IS: 4770 – 1968
Industrial Safety Gloves (Leather & Cotton Gloves).	IS: 6994 – 1973 (Part-I)
Leather safety boots and shoes.	IS: 1989 – 1986 (Part-I-II)
Industrial and Safety rubber knee boots.	IS: 5557 – 1969
Code of practice for selections care and repair of Safety footwear.	IS: 6519 – 1971
Leather Safety footwear having direct molding sole.	IS: 11226 – 1985
Eye protectors.	IS: 5983 – 1978
Ear protectors.	IS: 9167 – 1979
Eye & Face protection during welding	IS: 1179-1967
Industrial Safety Belts and Harness	IS: 3521 – 1983
Guide for selection of industrial Safety equipment for body protection	IS: 8519 -1977
Respiratory Protective Devices	IS: 9473-2002, 14166-1994, 14746-1999

- viii. Where workers are employed in sewers and manholes, which are in use, the subcontractor shall ensure that the manhole covers are opened and ventilated at least for an hour before the workers are allowed to get into manhole, and the manholes so opened shall be cordoned off with suitable railing and provided with warning signals or boards to prevent incident to the public

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- ix. All the personnel and visitors shall mandatorily use safety helmet (with company logo), safety shoe and reflective vests, in addition to any other PPEs as deemed appropriate for the area of work/ visit.
- x. Following Color scheme for Helmets shall be followed:
 - a. Workmen: Yellow
 - b. Safety staff: Green or white with green band
 - c. Electrician: Red
 - d. Others including visitors: White
 - e. For height workers, special marking on helmets besides indication on Gate Pass/ ID Card
- xi. The subcontractor shall maintain register for issue and receipt of PPEs.
- xii. All the PPEs shall be checked for quality before issue and the same shall be periodically re-checked. The users shall be advised to check the PPEs themselves for any defect before putting on. The defective ones shall be replaced.
- xiii. The Helmets shall have logo or name (abbreviation of agency name permitted) affixed or printed on the front.
- xiv. The body harnesses shall be serial numbered.

10. ARRANGEMENT OF INFRASTRUCTURE:

10.1 DRINKING WATER:

- i. Drinking water shall be provided and maintained at suitable places at different elevations such that minimum quantity of 5 liters is available for each worker during the day.
- ii. Drinking water tank shall be so installed so as to be available within 200 meters of each working area
- iii. Container should be labeled as “Drinking Water” in languages understood by the workers
- iv. Cleaning of the container shall be ensured at least once in a week. Mild cleaning detergents as used for cleaning vessels shall be applied and scrubbers (3M or equivalent) shall be used for removing scales and deposits on the inside surface. The tank shall be thoroughly cleaned with potable water only before it is refilled (also applicable to labor colony).
- v. Suitability of water source for drinking to be tested as per IS10500 at least once in six months.

10.2 WASHING FACILITIES:

- i. In every workplace, adequate and suitable facilities for washing shall be provided and maintained.
- ii. Separate and adequate cleaning facilities shall be provided for the use of male and female workers. Such facilities shall be conveniently accessible and shall be kept in clean and hygienic condition and dully illuminated for night use.
- iii. Water suitable for washing and not for drinking shall be clearly indicated as “Not for Drinking” in language understood by workers.
- iv. Overalls shall be supplied by the subcontractor to the workmen and adequate facilities shall be provided to enable the painters and other workers to wash during the cessation of work.

10.3 LATRINES AND URINALS:

- i. Latrines and urinals shall be provided in every work place as indicated in Section A
- ii. Urinals shall also be provided at different elevations.
- iii. They shall be adequately lighted and shall be maintained in a clean and sanitary condition at all times, by appointing designated person.
- iv. Separate facilities shall be provided for the use of male and female worker if any.

10.4 PROVISION OF REST SHEDS FOR WORKERS DURING REST PERIOD:

Proper Rest Shed (s) with shelter shall be provided for rest during break so as to accommodate all workers as indicated in Section A

10.5 MEDICAL FACILITIES:

10.5.1 GENERAL

- i. Provision of Medical Center, Ambulance etc. shall be as per Section A of this document
- ii. Medical waste shall be disposed as per prevailing legislation (Bio-Medical Waste – Management and Handling Rules, 1998)
- iii. Every injury shall be treated, recorded and reported.
- iv. All First Aid injuries shall be recorded as per provided Format
- v. List of qualified first aiders and their contact numbers to be displayed at conspicuous places.

10.5.2 FIRST AIDER/ FIRST AID BOX

- i. The first aider along with facilities should be available at a point nearest to the work location wherein majority of the workers are working.
- ii. The subcontractor shall provide necessary first aid facilities as per schedule III of BOCW. At every work place first aid facilities shall be provided and maintained.
- iii. The first aid box shall be kept by first aider who shall always be readily available during the working hours of the work place. His name and contact no to be displayed on the box.
- iv. The first aid boxes should be placed at various elevations so as to make them available within the reach and at the quickest possible time.
- v. The first aid box shall be distinctly marked with a Green Cross on white background.
- vi. Details of contents of first aid box is given in Annexure J
- vii. A slip of contents shall be pasted on the First Aid Box with following details
- viii. Monthly inspection of First Aid Box shall be carried out by the owner as per provided format
- ix. The subcontractor should conduct periodical first –aid classes to keep his supervisor and Engineers properly trained for attending to any emergency.

10.5.3 HEALTH CHECK UP

The persons engaged at the site shall undergo health check-up as per provided format before induction. In addition, the persons engaged in the following works shall undergo health check-up at least once in a year:

- i. Height workers
- ii. Drivers/crane operators/riggers
- iii. Confined space workers
- iv. Shot/sand blaster
- v. Welding and NDE personnel

10.5.4 HEIGHT PHOBIA/ VERTIGO TEST:

- i. The persons engaged in working at heights (above 2 meters) to be assessed for Vertigo and associated conditions and recorded as per provided format. Suggested Vertigo Test Procedure is given in Annexure K
- ii. Such workers are to be allowed only on successful completion of test, otherwise shall be allocated ground-based jobs.
- iii. IDs / Height passes shall be issued to such workers, besides special markings on helmets for easy identification.

10.5.5 PROVISION OF CANTEEN FACILITY:

- i. Canteen facilities shall be provided for the workmen of the project inside the project site where worker strength is 250 or more.
- ii. Proper cleaning and hygienic condition shall be maintained.
- iii. Proper care should be taken to prevent biological contamination.
- iv. Adequate drinking water should be available at canteen.
- v. Fire extinguisher shall be provided inside canteen.
- vi. Regular health check-up and medication to the canteen workers shall be ensured as per applicable regulations.
- vii. Canteen waste to be disposed of in hygienic manner

10.6 PROVISION OF ACCOMMODATION/LABOR COLONY FOR WORKFORCE:

- i. Proper accommodation for workforce to be provided in line with minimum requirements indicated in Section A
- ii. Labor colony shall be inspected each week by HSE Officer and report submitted to BHEL as per provided format

10.7 PEST CONTROL:

Regular pest control should be carried out at all offices, mainly laboratories, canteen, labor colony and stores.

10.8 SCRAPYARD:

- i. In consultation with customer, scrapyard shall be developed to store metal scrap, wooden scrap, waste, hazardous waste.
- ii. Scrap/Waste shall be segregated as Bio-degradable and non-bio-degradable and stored separately.

10.9 ILLUMINATION:

- i. The subcontractor shall arrange at his cost adequate lighting facilities e.g. flood lighting, hand lamps, area lighting etc. at various levels for safe and proper working operations at dark places and during night hours at the work spot as well as at the pre-assembly area.
- ii. Lamp (hand held) shall not be powered by mains supply but either by 24V or dry cells.
- iii. Lamps shall be protected by suitable guards where necessary to prevent danger, in case of breakage of lamp.
- iv. Emergency lighting provision for night work shall be made to minimize danger in case of main supply failure.
- v. Adequate and suitable light shall be provided at all work places & their approaches including passage ways as per IS: 3646 (Part-II).

SUITABLE ILLUMINATION LEVELS FOR VARIOUS AREAS SHALL BE DECIDED BASED ON BROAD GUIDELINES INDICATED BELOW:

S. No.	Location	Lux Level (lumens/sqm)
A.	Construction Site	
1	Outdoor areas like store yards, entrance and exit roads	20
2	Platforms	50
3	Entrances, corridors and stairs	100
4	General illumination of work area	150
5	Rough work like fabrication, assembly of major items	150
6	Medium work like assembly of small machined parts	300
7	Fine work like precision assembly, precision measurements etc.	700
8	Sheet metal works	200
9	Electrical and instrument labs	450
B.	Office	
1	Outdoor area like entrance and exit roads	20
2	Entrance halls	150
3	Corridors and lift cars	70
4	Lift landing	150
5	Stairs	100
6	Office rooms, conference rooms, library reading tables	300
7	Drawing table	450
8	Manual telephone exchange	200

- vi. Illuminations shall be inspected on weekly basis as per provided **format** using a calibrated lux meter.

11. HSE TRAINING & AWARENESS:

11.1 TRAINING PLAN:

- i. All training programs to be carried out in a planned manner. Monthly/ Annual Training Calendar to be submitted to BHEL for approval and shall cover HSE Training requirements of all activities, workers, hazards applicable to the area(s) of work.
- ii. Subcontractor shall nominate workers as per the schedule of specific training plan, failing which, penalty shall be imposed.
- iii. Training records of all workers along with attendance, signatures, faculty details etc. shall be maintained in soft/ hard copy as per provided **formats**.
- iv. Each labor should undergo at least 0.5% of total man-hours worked in HSE training.

11.2 HSE INDUCTION TRAINING

- i. All persons entering into project site shall be given HSE induction training by the HSE officer of BHEL /subcontractor before being assigned to work.
- ii. The induction training shall be imparted through audio-visual medium (Classroom specialized training), and shall be minimum of 1 Complete Day.
- iii. Evaluation to be carried out after training and training shall be repeated in case of failure.
- iv. Safety Induction Card shall be printed by Subcontractor and provided to all trained workers. A Safety induction book shall also be printed and issued to each worker after induction training (Format for the same may be provided by BHEL).
- v. Induction training subjects shall include but not limited to:
 - a. Briefing of the Project details.
 - b. Safety objectives and targets.
 - c. Site HSE rules.
 - d. Critical Safety Violations and consequences
 - e. Site HSE hazards and aspects.
 - f. First aid facility.
 - g. Emergency Contact No.
 - h. Incident & Near Miss reporting.
 - i. Fire prevention and emergency response.
 - j. Rules to be followed in the labor colony (if applicable)
 - k. Accident case studies
- vi. General:
 - a. Proper safety wear & gear must be issued to all the workers being registered for the induction (i.e., Shoes/Helmets/Goggles/Leg guard/Apron etc.)
 - b. They must arrive fully dressed in safety wear & gear to attend the induction.
 - c. Any one failing to conform to this safety wear& gear requirement shall not qualify to attend.

- d. On completing attending subcontractor's in-house HSE induction, each employee shall sign an induction training form to declare that he had understood the content and shall abide to follow and comply with safe work practices.
- e. They may only then be qualified to be issued with a personal I.D. card, for access to the work site subject to clearing the medical fitness test.

SAFETY INDUCTED	
Name :	
Date :	
Sign By Trainer :	

ABOVE STICKER SHALL BE PASTED ON HELMET OF WORKERS AFTER SAFETY INDUCTION TRAINING

11.3 JOB-SPECIFIC SKILL BASED HSE TRAINING

The contracting agency shall also impart job specific skill-based safety training to all its employees (Minimum one day) on various related safety topics using internal/external safety professionals/consultants as per the matrix given below. Record of such trainings and attendance particulars shall be maintained in a register for ready reference to statutory authorities/engineer-in charge as per provided format.

TRAINING MATRIX

Name of topic	Executives	Supervisors	Skilled Workmen	Other Workers
Safety Induction	Y	Y	Y	Y
Accident_ Causes, factors, cost	Y	Y	Y	-
Industrial hazards & Accident Prevention	Y	Y	Y	-
Investigating, reporting, records	Y	Y	-	-
Personal Protective Equipment	-	Y	Y	Y
Construction Safety & Role of Supervisory personnel	-	Y	-	-
Permit to Work (PTW)	-	Y	Y	y
Statutory Provisions (BOCW Act/Rules, Factories Act 1948 etc.)	Y	Y	y	y
Material handling	-	y	Y	Y
Emergency Management	Y	Y	Y	-
Electrical Safety	-	Y	Y	-
Fire safety	Y	Y	Y	Y
First Aid & CPR (cardio pulmonary resuscitation)	-	Y	Y	Y (Selected)
Safety in Welding & Cutting	-	-	Y	-
Safety Audit	Y	Y	-	-
Safety in Lifting Tools & Tackles	-	Y	Y	y

Safety in Working at height	-	Y	Y	Y
Safety in Confined space work	-	Y	Y	Y
Defensive Driving	-	Y*	Y*	Y*

*for construction vehicle operators, helpers & crane operators

Y=YES

Note:

- Subcontractor shall prepare a training plan/ matrix covering all hazards and implement the same after approval of BHEL.
- It is to be ensured that every worker undergoes Job-Specific training once every 3 months.
- Records of training programmes along with attendance shall be maintained by the subcontractor
- Each worker to be issued a Card indicating the types of trainings undergone.

11.4 HSE TOOL-BOX TALK:

- HSE tool Box talk shall be conducted by frontline foreman/supervisor of subcontractor to specific work groups prior to the start of work and shall be randomly attended by subcontractor engineers/ officials. The agenda shall consist of the following:
 - Details of the job being intended for immediate execution.
 - The relevant hazards and risks involved in executing the job and their control and mitigating measures.
 - Specific site condition to be considered while executing the job like high temperature, humidity, unfavorable weather etc.
 - Recent non-compliances observed.
 - Appreciation of good work done by any person.
 - Any doubt clearing session at the end.
- Tool box talk to be conducted before start of work in every shift.
- During toolbox talk, visual check-up of workers regarding health, any signs of fatigue, intoxication etc. shall be conducted and any suspected workers to be acted upon.
- Record of Tool box talk shall be maintained as per provided **format**

11.5 TRAINING ON HEIGHT WORK:

- Training on height work shall be imparted to all workers working at height by in-house/external faculty at least once every 3 months.
- For Height Workers Separate pass shall be provided by the subcontractor.
- The training shall be of minimum 2-hour duration, through audio-visual medium and followed by evaluation. In case of poor scoring, training shall be repeated.
- The training shall include following topics:
 - Proper use of PPEs – safety harness, lanyard, fall arrester, retractable fall arrester, life line, safety nets etc.
 - Provision of secondary means of fall protection

- c. Safe climbing through monkey ladders.
- d. Inspection of PPEs.
- e. Medical fitness requirements.
- f. Mock drill on rescue at height.
- g. Dos & Don'ts during height work.
- h. Accident case Studies

11.6 RE-INDUCTION TRAINING

The induction training shall be repeated for every worker after at least 1 year and shall be a pre-requisite for renewal of Gate Pass/ ID card.

11.7 PENALTY TRAINING

The personnel involved in Safety Violations/ Incidents shall mandatorily undertake penalty training pertaining to the violation/ incident. Penalty training shall be at least half-day duration.

11.8 HSE PROMOTION-SIGNAGE, POSTERS, COMPETITION, AWARDS ETC.:

- i. HSE Displays shall be installed as indicated in Section A
- ii. Contracting agencies shall arrange for display of safety hoardings depicting suitable safety cartoons/messages/ cautionary notices at appropriate places of project site to remind the workers to perform their duties safely.
- iii. Apart from safety hoardings, each agency should maintain a safety bulletin board at all their work locations. Such safety bulletin boards should depict the activities being planned for the day, good practices, permit details etc.
- iv. Safety suggestion boxes shall be kept at each subcontractor's office at site for obtaining safety suggestions from the workers. Best suggestions should be implemented and may be rewarded suitably to encourage the workers for safety.
- v. Safety awareness campaigns, competitions, plays, movie shows, songs etc. to be organized for workers at Site and Labor colony from time to time to enhance Safety Awareness

11.9 HSE REWARDS & INCENTIVE SCHEME

Subcontractor shall implement a reward & incentive scheme for workers & supervisors displaying adherence to safety principles. Such workers shall be felicitated in a monthly function, attended by Subcontractor top management and BHEL representatives. Suitable gift shall be given to such workers for encouragement.

11.10 HSE AWARENESS PROGRAM FOR OFFICIALS:

Subcontractor shall arrange monthly HSE awareness program on different topics including medical awareness for all engineers/ supervisors / officials working at site. This program can be part of progress/ safety review meetings.

12. HSE COMMUNICATION AND PARTICIPATION:

12.1 HSE INCIDENT REPORTING, INVESTIGATION & CORRECTIVE ACTION:

- i. All incidents (near misses, property damage, first-aid cases, minor, major and fatal incidents) shall be reported to BHEL as they happen immediately through SMS and Hard/Soft copy as per provided format
- ii. All incidents including near miss, minor, major and fatal incidents shall be recorded
- iii. All incidents shall be investigated for Root Causes and corrective actions ensured to prevent recurrence shall be implemented.
- iv. Work shall be put on hold in the area till corrective actions are verified by BHEL
- v. The Root Cause Analyses and Corrective actions taken shall be recorded

12.2 HSE EVENT REPORTING:

- i. Important HSE events like HSE training, Medical camp etc. organized at site shall be reported to BHEL site management in detail with photographs for publication in different in-house magazines
- ii. Celebration of important days like National Safety Day, World Environment Day etc. shall also be reported as mentioned above.

12.3 MONTHLY HSE REPORTING:

- i. All routine and non-routine HSE activities shall be reported to BHEL on monthly basis by the subcontractor as per provided format. The reporting medium can be hard/soft as per BHEL requirement.
- ii. The period of reporting shall be 25th of the preceding month to 24th of the present month and shall be submitted by the end of the calendar month.
- iii. Report shall include good quality images of HSE Activities

12.4 DAILY HSE ACTIVITY REPORTING:

Daily HSE activities shall be reported by subcontractor to BHEL as per provided format

12.5 HSE SUGGESTIONS:

All workers and employees shall be encouraged to provide suggestions for improvement in Health, Safety & Environment performance at site. The suggestions shall be recorded in a "Suggestions Register" as per provided format. Suggestions found suitable for implementation shall be implemented and recognition / reward to be given to the submitter.

Suggestion Register to be placed at Site and Labor Colony and shall be reviewed on periodic basis

12.6 CLIENT COMMUNICATION:

All HSE related communication from BHEL, customer / external statutory and regulatory agencies to be handled on priority. Same to be recorded and issues to be resolved in expeditious manner

13. SAFETY DURING WORK EXECUTION:

Safety during work execution shall be ensured by following appropriate Safety Rules, providing adequate resources, deploying competent and trained manpower, regular training & inspection and non-conformity resolution. Main aspects are indicated as under:

13.1 OPERATIONAL CONTROL PROCEDURES:

In order to reduce the risk associated with hazardous activities, applicable OCPs (Operational control procedures) will be followed by subcontractor as per BHEL instructions, outcomes of Hazard Analysis & other requirements. This will be done as part of normal scope of work. Illustrative list of reference OCPs is given below.

TABLE 13.1 ILLUSTRATIVE LIST OF REFERENCE OCPs

No.	Topic	No.	Topic	No.	Topic
0	General Safety	22	Steam blowing	44	Material preservation
1	Handling of chemicals	23	Working in confined area	45	Electro-resistance heating
2	Electrical safety	24	Operation of passenger lift, material hoists & cages	46	Blasting
3	Energy conservation	25	Vehicle/ Crane maintenance	47	Transformer charging
4	Welding and gas cutting operation	26	Radiography	48	Handling of battery system
5	Fire safety	27	Waste disposal	49	DG set
6	Use of hand tools	28	Handling & storage of mineral wool	50	Sanitary maintenance
7	First aid	29	Working at night	51	Piling rig operation
8	Food safety at canteen	30	Computer operation	52	Passivation
9	Use of cranes	31	Storage in open yard	53	EDTA Cleaning
10	Storage and handling of gas cylinders	32	Drilling, reaming and grinding(machining)	54	Chemical cleaning of Pre boiler system
11	Manual arc welding	33	Stress relieving	55	Boiler Light up
12	Use of helmets	34	Hydraulic test	56	Rolling and Synchronization
13	Good house keeping	35	Trial run of rotary equipment	57	Loading of Unit

14	Safe excavation	36	Batching	58	Air compressor
15	Working at height	37	Cable laying/tray work	59	Hydra Operation
16	Filling of hydrogen in cylinder	38	Spray insulation	60	Duct Pre-assembly
17	Illumination	39	Compressor operation	61	Resumption of construction activities after lockdown and prevention of coronavirus infection during site operations
18	Handling and erection of heavy metals	40	Gas distribution test		
19	Acid cleaning	41	Cleaning of Hot well / Deaerator		
20	Oil flushing	42	Electrical maintenance	61A	Prevention of Covid-19 infection in labour colony
21	Alkali boil out	43	O&M of control of AC plant & system	62	Truss/ Structure fit-up and alignment

- The reference OCPs shall be suitably modified by subcontractor as per specific requirements to control the hazards.
- In case any other OCP is found to be applicable during the execution of work at site, then subcontractor will prepare and follow those as well.

13.2 WORK PERMIT SYSTEM:

- The following activities shall be carried out by the subcontractor strictly after obtaining Permit to Work from BHEL
 - Height working
 - Hot working
 - Confined space Work
 - Excavation more than 2-meter depth
 - Radiography
 - Heavy / Complex / Critical Lifting Activity
 - Night / Holiday Work
 - Material Loading / Unloading
 - Grating, Safety Net, Safety Facility Removal
 - Live Electrical Maintenance etc. - Lockout / Tagout
 - Beam / truss/ duct/ structure alignment
- The Work Permit Formats shall be provided by BHEL at Site. It is the responsibility of the subcontractor to ensure their availability
- The above list is not exhaustive. BHEL reserves right to introduce additional Permits or modify requirements for usage of existing Permits. The conditions for using the Permit are specified in the Format (General Requirements).
- Where customer is having separate Work Permit System the same shall be followed in conjunction / merged to ensure all activities and checks are covered in all systems.
- Details of working Group to be attached along with work permit request.

- vi. All the Permits along with JSA/HIRA must be initiated by Agency Execution Team
- vii. Permit applicant shall apply for work permit of particular work activity at particular location before starting of the work with Job Hazard Analysis.
- viii. All Permit signatories (including subcontractor's package in-charge and HSE Officer) shall physically visit the work area and check that all the safety control measures necessary for the activity are in place. Only then the permit shall be issued.
- ix. Signatory shall physically visit the area of work and ensure all required safeguards before signing the Permit
- x. Signatory shall periodically visit the area to confirm the availability of required safeguards throughout the currency of the permit
- xi. In case any Permit requirement is not available, work will be stopped till it is made available
- xii. Permit holder shall implement and maintain all control measures during the period of permit. The permit will be closed after completion of the work.
- xiii. Online Work Permit System shall be used whenever provided by BHEL, otherwise hard copy shall be used

13.3 ACTIVITY-SPECIFIC PRECAUTIONS/ CONTROLS

Detailed HSE precautions for various activities undertaken at Site by the subcontractors are specified in **Annexure I**. Same are to be ensured by the Sub-subcontractor while carrying out respective activities at Site

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14. ENVIRONMENTAL CONTROL & SOCIAL RESPONSIBILITY

- i. Environment protection has always been given prime importance by BHEL. Environmental damage is a major concern of the principal subcontractor and every effort shall be made, to have effective control measures in place to avoid pollution of Air, Water and Land and associated life. Banned substances like asbestos and Chlorofluorocarbons such as carbon tetrachloride and trichloroethylene shall not be used. Waste disposal shall be done in accordance with the guidelines laid down in the project specification.
- ii. Any chemical including solvents and paints, required for construction shall be stored in designated bonded areas around the site as per Material Safety Data Sheet (MSDS).
- iii. In the event of any spillage, the principle is to recover as much material as possible before it enters drainage system and to take all possible action to prevent spilled materials from running off the site. The subcontractor shall use appropriate MSDS for clean-up technique
- iv. All subcontractors shall be responsible for the cleanliness of their own areas
- v. Regular dust suppression using sprinklers shall be carried out in respective area
- vi. The subcontractors shall ensure that noise levels generated by plant or machinery are as low as reasonably practicable. Where the subcontractor anticipates the generation of excessive noise levels from his operations the subcontractor shall inform to Construction Manager of BHEL accordingly so that reasonable & practicable precautions can be taken to protect other persons who may be affected.
- vii. It is imperative on the part of the subcontractor to join and effectively contribute in joint measures such as tree plantation, environment protection, contributing towards social upliftment, conversion of packing woods to school furniture, enhancing good relation with local populace etc.
- viii. The subcontractor shall carry out periodic air and water quality check and illumination level checking in his area of work place and take suitable control measure.

15. HOUSEKEEPING

- i. Keeping the work area and access roads clean/ free from debris, removed scaffoldings, scraps, insulation/sheeting wastage /cut pieces, temporary structures, packing woods etc. will be in the scope of the subcontractor. Such cleanings have to be done by subcontractor within quoted rate, on daily basis.
- ii. If such activity is not carried out by subcontractor / BHEL is not satisfied, then BHEL may get it done by other agency and actual cost along with BHEL overheads will be deducted from subcontractor's bill. Such decisions of BHEL shall be binding on the subcontractor
- iii. Dedicated Housekeeping gangs shall be deployed, who shall be provided all required PPEs and safety training
- iv. Mass housekeeping shall be carried out for half a day in a week
- v. Proper housekeeping to be maintained at work place and the following are to be taken care of on daily basis.
- vi. All surplus earth and debris are removed/disposed off from the working areas to identified locations.
- vii. Unused/Surplus cables, steel items and steel scrap lying scattered at different places/elevation within the working areas are removed to identified locations.
- viii. All wooden scrap, empty wooden cable drums and other combustible packing materials, shall be removed from workplace to identified locations.
- ix. Sufficient waste bins shall be provided at different work places for easy collection of scrap/waste. Scrap chute shall be installed to remove scrap from high locations.
- x. Access and egress (stair case, gangways, ladders etc.) path should be free from all scrap and other hindrances.
- xi. Workmen shall be educated through tool box talk about the importance of housekeeping and encourage not to litter.
- xii. Labor camp area shall be kept clear and materials like pipes, steel, sand, concrete, chips and bricks, etc. shall not be allowed in the camp to obstruct free movement of men and machineries.
- xiii. Fabricated steel structures, pipes & piping materials shall be stacked properly.
- xiv. No parking of trucks/trolleys, cranes and trailers etc. shall be allowed in the camp, which may obstruct the traffic movement as well as below LT/HT power line.
- xv. Utmost care shall be taken to ensure over all cleanliness and proper upkeep of the working areas.

16. WASTE MANAGEMENT

- i. Take suitable measures for waste management and environment related laws/legislation as a part of normal construction activities. Compliance with the legal requirements on storage/ disposal of paint drums (including the empty ones), Lubricant containers, Chemical Containers, and transportation and storage of hazardous chemicals will be strictly maintained.
- ii. Details of E-Waste, Hazardous Waste, biomedical waste etc. and their disposal plan, shall be submitted to BHEL every 6 months as per provided **formats**.

16.1 BINS AT WORK PLACE

- i. Sufficient rubbish bins shall be provided close to workplaces.
- ii. Bins should be painted yellow and numbered.
- iii. Sufficient nos. of drip trays shall be provided to collect oil and grease.
- iv. Sufficient qty. of broomsticks with handle shall be provided.
- v. Adequate strength of employees should be deployed to ensure daily monitoring and service for waste management.

16.2 STORAGE AND COLLECTION

- i. Different types of rubbish/waste should be collected and stored separately.
- ii. Paper, oily rags, smoking material, flammable, metal pieces should be collected in separate bins with close fitting lids.
- iii. Rubbish should not be left or allowed to accumulate on construction and other work places.
- iv. Do not burn construction rubbish near working site.

16.3 SEGREGATION

- i. Earmark the scrap area for different types of waste.
- ii. Store wastes away from building.
- iii. Oil spill absorbed by non-combustible absorbent should be kept in separate bin.
- iv. Clinical and first aid waste stored and incinerated separately.

16.4 DISPOSAL

- i. Sufficient containers and scrap disposal area should be allocated.
- ii. All scrap bin and containers should be conveniently located.
- iii. Provide self-closing containers for flammable/spontaneously combustible material.
- iv. Keep drainage channels free from choking.
- v. Make schedule for collection and disposal of waste.

16.5 WARNING AND SIGNS

- i. Appropriate sign to be displayed at scrap storage area
- ii. No toxic, corrosive or flammable substance to be discarded into public sewage system.
- iii. Waste disposal shall be in accordance with best practice.
- iv. Comply with all the requirements of Pollution Control Board (PCB) for storage and disposal of hazardous waste.

17. TRAFFIC MANAGEMENT SYSTEM

17.1 SAFE WORKPLACE TRANSPORT SYSTEM

- i. Traffic routes in a work place shall be suitable for the persons or vehicles using them. This shall be sufficient in number and of sufficient size. This shall reflect the suitability of traffic routes for vehicles and pedestrians.

- ii. Where vehicles and pedestrians use the same traffic routes there shall be sufficient space between them. Where necessary all traffic routes must be suitably indicated. Pedestrians or vehicles must be able to use traffic routes without endangering those at work. There must be sufficient separation of traffic routes from doors, gates and pedestrian traffic routes.
- iii. For internal traffic, lines marked on roads / access routes and between buildings shall clearly indicate where vehicles are to pass.
- iv. Temporary obstacles shall be brought to the attention of drivers by warning signs or hazard cones.
- v. Speed limits shall be clearly displayed for each kind of vehicle.
- vi. Speed ramps preceded by a warning signs or marker are necessary.
- vii. The traffic route should be wide enough to allow vehicles to pass and re-pass oncoming or parked traffic and it may be advisable to introduce on-way system or parking restrictions.
- viii. Safest route shall be provided between places where vehicles have to call or deliver.
- ix. Avoid vulnerable areas/items such as fuel or chemicals tanks or pipes, open or unprotected edges and structures likely to collapse
- x. Safe areas shall be provided for loading and unloading.
- xi. Avoid sharp or blind bends. If this is not possible hazards should be indicated e.g. blind corner.
- xii. Ensure road crossings are minimum and clearly signed.
- xiii. Entrance and gateways shall be wide enough to accommodate a second vehicle without causing obstruction.
- xiv. Set sensible speed limits which are clearly sign posted.
- xv. Where necessary ramps should be used to retard speed. This shall be preceded by a warning sign or mark on the road.
- xvi. Forklift trucks shall not pass over road hump unless of a type capable of doing so.
- xvii. Overhead electric cable, pipes containing flammable hazardous chemical shall be shielded by using goal posts height gauge posts or barriers.
- xviii. Road traffic signs shall be provided on prominent locations for prevention of incidents and hazards and for quick guidance and warning to employees and public. Safety signs shall be displayed as per the project working requirement and guideline of the state in which project is done. Vehicles hired or used shall not be parked within the 15m radius of any working area. Any vehicle, that is required to be at the immediate/near the vicinity, shall be approved by the person in-charge of the site.

17.2 TRAFFIC ROUTE FOR PEDESTRIANS

- i. Where traffic routes are used by both pedestrians and vehicles road shall be wide enough to allow vehicles and pedestrians safely.
- ii. Separate routes shall be provided for pedestrians to keep them away from vehicles. Provide suitable barriers/guard at entrances/exit and the corners or buildings.
- iii. Where pedestrian and vehicle routes cross, appropriate crossing shall be provided.

- iv. Where crowd is likely to use roadway e.g. at the end of shift, stop vehicles from using them at such times.
- v. Provide high visibility clothing for people permitted in delivery area.

17.3 WORK VEHICLE

Work vehicle shall be as safe stable efficient and roadworthy as private vehicles on public roads. Site management shall ensure that drivers are suitably trained. All vehicle e.g. heavy motor vehicle forklift trucks dump trucks mobile cranes shall ensure that the work equipment conforms to the following:

- i. A high level of stability.
- ii. A safe means of access/egress.
- iii. Suitable and effective service and parking brakes.
- iv. Windscreens with wipers and external mirrors giving optimum all round visibility.
- v. Provision of horn, vehicle lights, reflectors, reversing lights, reversing alarms.
- vi. Provision of seat belts.
- vii. Guards on dangerous parts.
- viii. Driver protection - to prevent injury from overturning and from falling objects/materials.
- ix. Driver protection from adverse weather.
- x. No vehicle shall be parked below HT/LT power lines.
- xi. Valid Pollution Under Control certification for all vehicles
- xii. Wheel stopper shall be use during the parking of vehicle
- xiii. Helper to be deployed in each vehicle as per site requirement.

17.4 DAILY CHECK BY DRIVER

1. There should also be daily safety checks containing below mentioned points by the driver before the vehicle is used.

Brakes	Mirrors	Warning signals
Tires	Windscreen waters	Specific safety systems i.e. controls & interlocks
Steering	Wipers	

2. Management should ensure that drivers carry out these checks.

17.5 TRANSPORTATION OF PERSONNEL AND MATERIALS BY VEHICLES

- i. All drivers shall hold a valid driving License for the class of vehicle to be driven and be registered as an authorized BHEL driver with the Administration Department.
- ii. Securing of the load shall be by established and approved methods, i.e. chains with patented tightening equipment for steel/heavy loads. Sharp corners on loads shall be avoided when employing ropes for securing.
- iii. All overhangs shall be made clearly visible and restricted to acceptable limits
- iv. Load shall be checked before moving off and after traveling a suitable distance.
- v. On no account is construction site to be blocked by parked vehicles Drivers of vehicles shall only stop or park in the areas designate by the stringing foreman.

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- vi. Warning signs shall be displayed during transportation of material.
- vii. All vehicles used by BHEL shall be in worthy condition and in conformance to the Land Transport requirement.
- viii. Wheel stopper shall be use during the parking of vehicle
- ix. Helper to be deployed in each vehicle as per site requirement.

17.6 MAINTENANCE

All Vehicles used for transportation of man and material shall undergo scheduled inspections on frequent intervals to secure safe operation. Such inspections shall be conducted in particular for steering, brakes, lights, horn, doors etc. Site management shall ensure that work equipment is maintained in an efficient, working order and in good repair. Inspections and services carried out at regular intervals of time and or mileage. No maintenance shall be carried below HT/LT power lines.

18. EMERGENCY PREPAREDNESS AND RESPONSE

- i. Emergency preparedness and response capability of site shall be developed as per Emergency Preparedness and Response plan issued by BHEL
- ii. Availability of adequate number of first aiders and fire warden shall be ensured with BHEL and its subcontractors
- iii. All the subcontractor's supervisory personnel and sufficient number of workers shall be trained for fire protection systems. Enough number of such trained personnel must be available during the tenure of contract. Subcontractor should nominate his supervisor to coordinate and implement the safety measures.
- iv. Assembly point shall be earmarked and access to the same from different location shall be shown
- v. Fire exit shall be identified and pathway shall be clear for emergency escape.
- vi. Appropriate type and number of fire extinguisher shall be deployed as per Fire extinguisher deployment plan and validity shall be ensured periodically through inspection
- vii. Adequate number of first aid boxes shall be strategically placed at different work places to cater emergency need. Holder of the first aid box shall be identified on the box itself who will have the responsibility to maintain the same.
- viii. First aid center shall be developed at site with trained medical personnel and ambulance
- ix. Emergency contact numbers (format given in EPRP) of the site shall be displayed at prominent locations.
- x. Tie up with fire brigade shall be done in case customer is not having fire station.
- xi. Tie up with hospital shall be done in case customer is not having hospital.
- xii. Disaster Management group shall be formed at site
- xiii. Mock drill shall be arranged at regular intervals. Monthly report of the above to be given to BHEL HSE Officer as per prescribed BHEL formats
- xiv. Mock drill shall be conducted on different emergencies periodically to find out gaps in emergency preparedness and taking necessary corrective action

19. HSE INSPECTION

Inspection on HSE for different activities being carried out at site shall be done to ensure compliance to HSE requirements. The subcontractor shall maintain and ensure necessary safety measures as required for inspection and tests HV test, Pneumatic test, Hydraulic test, Spring test, Bend test as applicable, to enable inspection agency for performing Inspection. If any test equipment is found not complying with proper safety requirements then the Inspection Agency may withhold inspection, till such time the desired safety requirements are met.

Online/ App-based HSE Inspection system shall be used for inspection whenever provided by BHEL otherwise Hard-copy based system shall continue

 ☐ OK ☐ NOT OK	
Contractor Name:	
Equipment Identification No :	
Inspection Date :	
Next Inspection Date :	
Inspected By :	

Every Inspected Equipment shall display above sticker

19.1 INSPECTION PLAN

Subcontractor shall prepare an inspection plan covering all areas/ activities/ equipment/ hazards and implement the same after getting approval of BHEL. Responsibility to ensure coverage of all areas/ activities rests with the subcontractor.

All Inspections shall be witnessed by BHEL – only then they shall be considered as valid

19.2 INSPECTION REPORTS

Monthly inspection reports as per plan shall be submitted to BHEL HSE Head

19.3 NON-CONFORMANCES

Any non-conformances identified during inspection observed shall be addressed on priority.

The responsibility of resolution shall rest with the Subcontractor Site In-charge

In case immediate closure of non-conformities is not possible:

- work to be halted in the area
- non-conformance to be generated and submitted to responsible person and BHEL
- non-conformance to be resolved through responsible agency / person

Only after closure of non-conformances, work to be allowed to resume

19.4 DAILY HSE CHECKS

Both the Site Supervisors and HSE Officer of Subcontractor are to conduct daily site Safety inspection around work activities and premises to ensure that work methods and the sites

are maintained to an acceptable standard. The following are to form the common subjects of a daily safety inspection:

- i. Personal Safety wears & gear compliance.
- ii. Complying with site safety rules and permit-to-work (PTW).
- iii. Positions and postures of workers.
- iv. Use of tools and equipment etc. by the workers.

The inspection should be carried out just when work starts in beginning of the day, during peak activities period of the day and just before the day's work ends.

19.5 INDICATIVE LIST OF INSPECTIONS AND PERIODICITIES

Indicative list & periodicity of Inspections is given as under. It is the responsibility of the subcontractor to develop an inspection plan covering all areas & activities in the scope.

SL. No.	Format Name	Frequency of check (if applicable)
01	Inspection of First Aid Box	Weekly
02	Inspection of PPE	Weekly
03	Inspection of T&Ps	Monthly
04	Inspection of Cranes	Monthly
05	Inspection of Winches	Monthly
06	Inspection on Height Working	Weekly
07	Inspection on Welding & Gas Cutting	Monthly
08	Inspection on Electrical Installation	Monthly
09	Inspection on Elevator	Weekly
10	Inspection of Excavation	Weekly
11	Inspection of Labor Colony	Monthly
12	Inspection of Illumination Levels	Weekly

The checklists shall be provided by BHEL at Site. It is the responsibility of the subcontractor to ensure their availability before start of work

19.5.1 INSPECTION OF PPE

- i. PPEs shall be inspected by HSE officer at random once in a week as per provided **format** for its compliance to standard and compliance to use and any adverse observation shall be recorded in the PPE register.
- ii. The applicable PPEs for carrying out particular activities are listed below.

19.5.2 INSPECTION OF TOOLS & PLANTS (T&Ps)

- i. A master list of T&Ps shall be maintained by each subcontractor in provided **format**.
- ii. All T&Ps being used at site shall be inspected by HSE officer once in a month as per provided **format** for its healthiness and maintenance.
- iii. The T&Ps which require third party inspection shall be checked for its validity during inspection. The third-party test certificate should be accompanied with a copy of the concerned competent person's valid qualification record.

- iv. BHEL shall be given advance intimation of Third-Party Inspection. BHEL shall associate with Inspection as per discretion.
- v. The validity of T&P shall be monitored as per provided **format**

19.5.3 INSPECTION OF CRANES AND WINCHES

- i. Cranes and winches shall be inspected by the operator through a daily checklist for its safe condition (as provided by the equipment manufacturer) before first use of the day.
- ii. Cranes and Winches shall be inspected by HSE officer once in a month as per provided **format** for healthiness, maintenance and validity of third-party inspection.
- iii. The date of third-party inspection and next due date shall be painted on cranes and winches.
- iv. The operators/drivers shall be authorized by sub-subcontractor based on their competency and experience and shall carry the I-card.
- v. The operator should be above 18 years of age and should be in possession of driving license of HMV man & goods), vision test certificate and should have minimum qualification so that he can read the instructions and check list.

19.5.4 INSPECTION OF HEIGHT WORKING

- i. Any activity carried out at more than 2 m height is classified as height work.
- ii. Inspection of height working shall be conducted daily by Supervisors before start of work to ensure safe working condition including provision of
 - a. Fall arrestor
 - b. Lifelines – connected to rigid & independent structure
 - c. Safety nets deployed below all height work activities
 - d. Fencing and barricading
 - e. Warning signage
 - f. Covering of opening
 - g. Proper scaffolding with access and egress.
 - h. Illumination
- iii. For full duration of height work, constant supervision to be maintained by dedicated HSE personnel
- iv. Inspection on height working shall be conducted once in a week by HSE officer as per provided **format**.
- v. Medical fitness of height worker shall be ensured.
- vi. Height working shall not be allowed during adverse weather.

19.5.5 INSPECTION OF WELDING AND GAS CUTTING OPERATION

- i. Supervisor shall ensure that no flammable items are available in near vicinity during welding and gas cutting activity.
- ii. Gas cylinders shall be kept upright.
- iii. Use of Flash back arrestor shall be ensured at both ends.

- iv. Inspection during welding and gas cutting operations shall be carried out by HSE officer once a month as per provided **format**.
- v. Use of fire blanket to be ensured to avoid falling of splatters during welding or gas cutting operation at height.
- vi. Availability of fire extinguisher at vicinity shall be ensured.

19.5.6 INSPECTION OF ELECTRICAL INSTALLATION / APPLIANCES

- i. Ensure proper earthing in electrical installation
- ii. Use ELCB at electrical booth
- iii. Electrical installation shall be properly covered at top where required
- iv. Use appropriate PPEs while working
- v. Use portable electrical light < 24 V in confined space and potentially wet area.
- vi. Inspection shall be carried out as per provided **format**.

19.5.7 INSPECTION OF ELEVATOR

- i. Elevators shall be inspected by concerned supervisors once in a week as per provided **format**
- ii. All elevators shall be inspected by competent person and validity shall be ensured.
- iii. The date of third-party inspection and next due date shall be painted on elevator.

19.5.8 INSPECTION OF EXCAVATION

Excavation activities shall be inspected as per provided **format**

19.5.9 INTERNAL/ EXTERNAL HSE AUDITS/INSPECTIONS

- i. All non-conformities and observations on HSE identified during internal or external HSE audit shall be disposed of by site in a time bound manner and reported back the implementation status.
- ii. Corrective action and Preventive action on HSE issues raised by certification body issued by BHEL shall be implemented by site and reported to Site management.

20. TERMS AND DEFINITIONS:

1. Incident

Work- related or natural event(s) in which an injury, or ill health (regardless of severity), damage to property or fatality occurred, or could have occurred.

2. Near Miss:

An incident where no ill health, injury, damage or other loss occurs, but it had a potential to cause, is referred to as "Near-Miss".

3. Man-Hours Worked:

The total number of man hours worked by all employees including subcontractors working in the premises. It includes managerial, supervisory, professional, technical, clerical and other workers including contract labors. Man-hours worked shall be calculated from the payroll or time clock recorded including overtime. When this is not feasible, the same shall be estimated by multiplying the total man-days worked

period covered by the number of hours worked per day. The total number of workdays for a period is the sum of the number of men at work on each day of period. If the daily hours vary from department to department separate estimate shall be made for each department and the result added together.

4. First Aid Cases:

First aids are not essentially all reportable cases, where the injured person is given medical treatment and discharged immediately for reporting on duty, without counting any lost time.

5. Lost Time Injury:

Any work injury which renders the injured person unable to perform his regular job or an alternative restricted work assignment on the next scheduled work day after the day on which the injury occurred.

6. Medical Cases:

Medical cases come under non-reportable cases, where owing to illness or other reason the employee was absent from work and seeks Medical treatment.

7. Type of Incidents & Their Reporting:

The three categories of Incident are as follows:

8. Non-Reportable Cases:

An incident, where the injured person is given medical help and discharged for work without counting any lost time.

9. Reportable Cases:

In this case the injured person is disable for 48 hours or more and is not able to perform his duty.

10. Injury Cases:

These are covered under the heading of non-reportable cases. In these cases, the incident caused injury to the person, but he still continues his duty.

11. Total Reportable Frequency Rate

Frequency rate is the number of Reportable Lost Time Injury (LTI) per one Million Man hours worked. Mathematically, the formula read as:

Number of Reportable LTI x 1,000,000/ Total Man Hours Worked

12. Severity Rate:

Severity rate is the Number of days lost due to Lost Time Injury (LTI) per one Million Man hours worked. Mathematically, the formula reads as:

Days lost due to LTI x 1,000,000/ Total Man Hours Worked

13. Incidence Rate:

Incidence Rate is the Number of LTI per one thousand manpower deployed. Mathematically, the formula reads as:

Number of LTIx1000/Average number of manpower deployed

14. HIRA:

Hazard Identification and Risk Assessment (HIRA) is a process of identifying Hazards in work area and then assessing them properly

15. Method Statement:

A method statement is prepared by the Execution/ Engineering Department detailing the steps, equipment, competencies and safety precautions required for carrying out any activity

16. Job Safety Analysis:

A job safety analysis (JSA) is a procedure which helps integrate accepted safety and health principles and practices into a particular task or job operation. In a JSA, each basic step of the job is to identify potential hazards and to recommend the safest way to do the job. Other terms used to describe this procedure are job hazard analysis (JHA) and job hazard breakdown.

17. Safety Walk:

It's conducted periodically by an official - it's a walk through a portion or whole of a site as a HSE officer who notes down HSE observations, speak to concerned workmen and supervisor on observation, get the same corrected with personal follow up- this sends out a strong message on Management's commitment to safety.

18. Heavy & Complex Lifting:

A heavy and complex lifting activity includes:

1. Lifting above 20 Tons
2. Tandem Lifting using multiple cranes
Total load exceeding 75% of capacity of crane. Depending up the condition of cranes, hydra cranes, winch machines & other lifting accessories
3. Lift of unusual difficulty or geometry or rigging
4. Lift over operating units
5. Any other lift as decided by site HSE / Erection

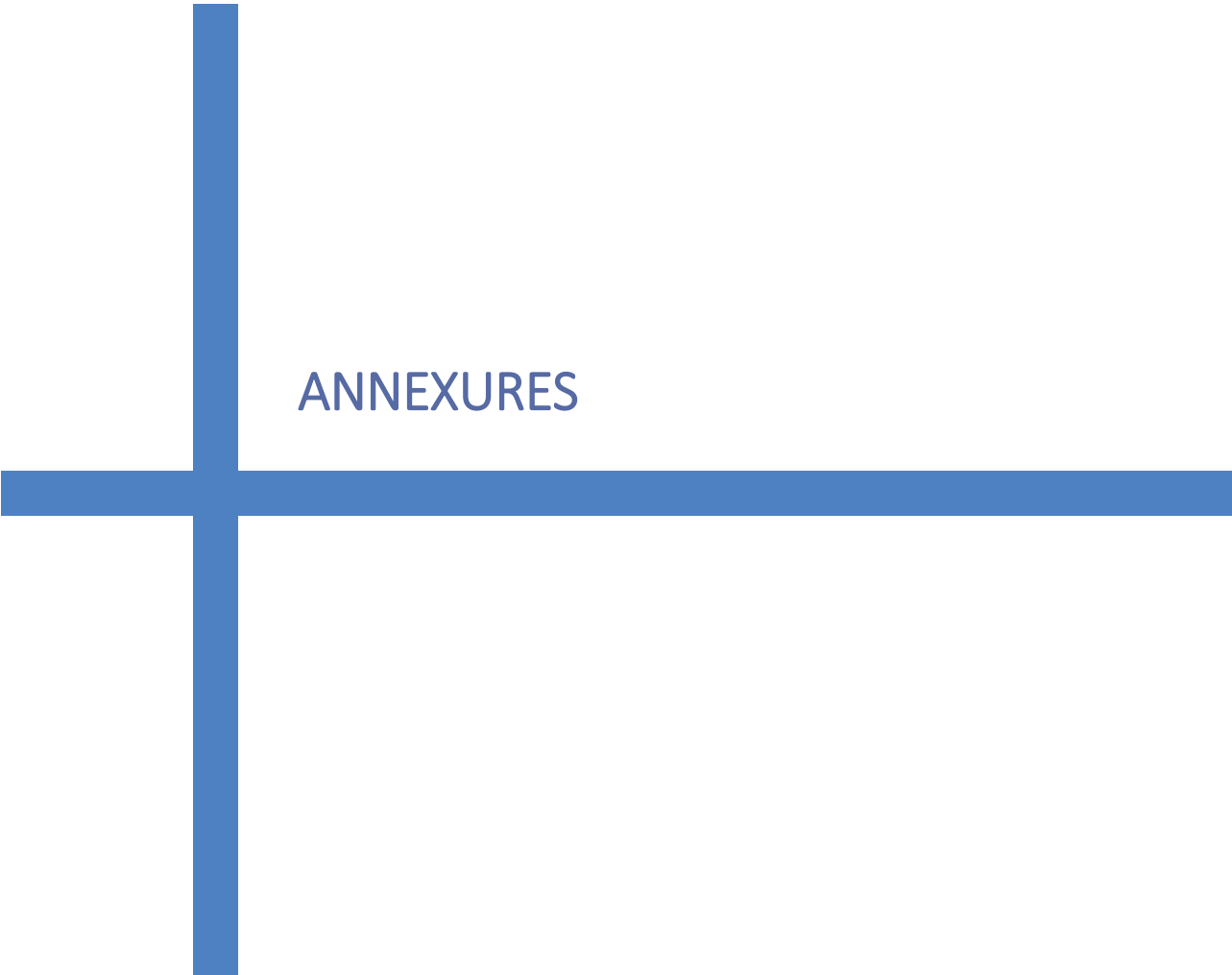
19. Safety Committee:

As per the BOCW, Safety Committee shall be constituted if there are more than five hundred or more construction workers are employed at any site. As per the Factories Act, 1948 it is for 250 workers. It shall be represented by equal number of representatives of employer and construction workers.

20. Night Work:

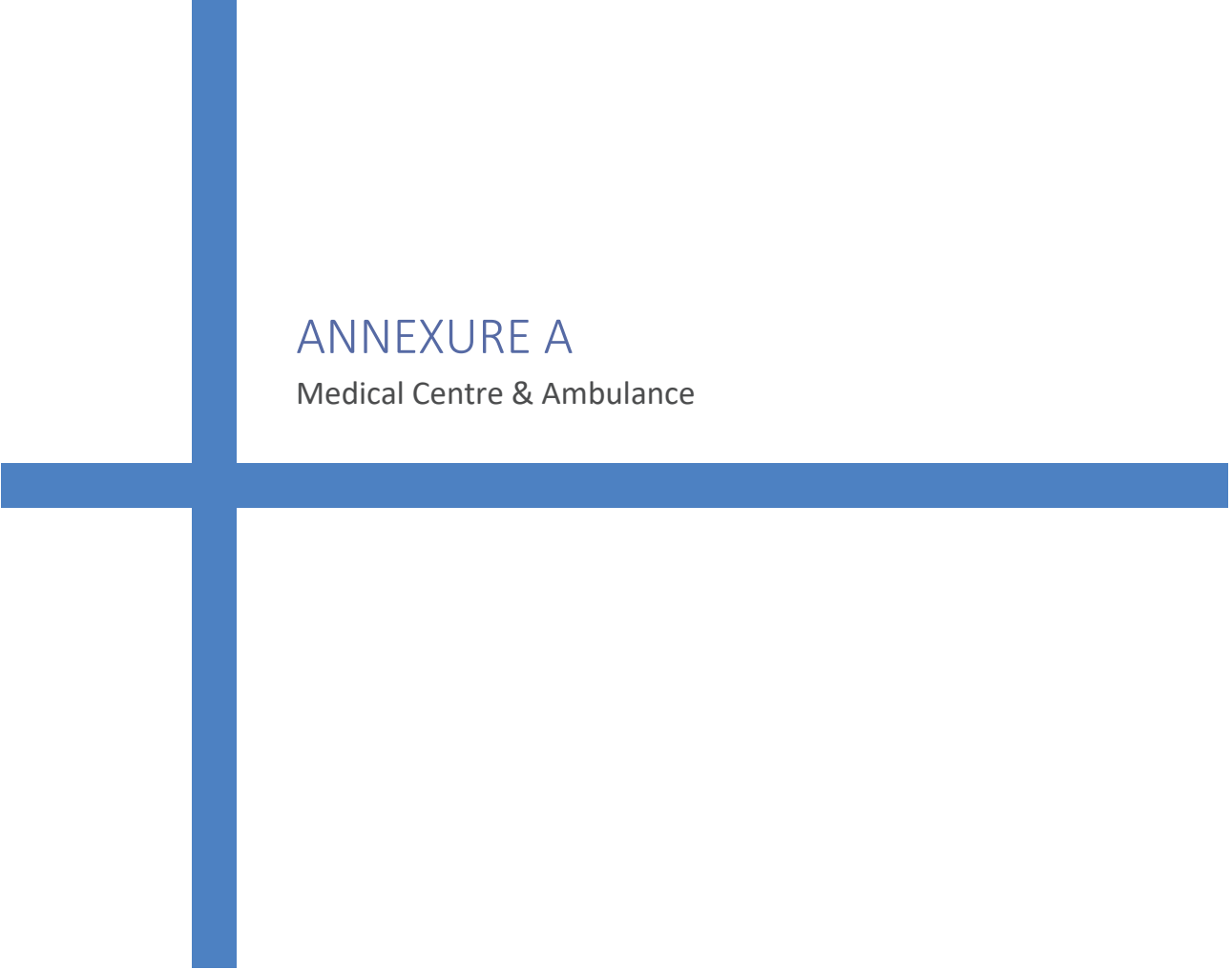
Work conducted after sunset when only a fraction of total manpower is available





ANNEXURES

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ANNEXURE A

Medical Centre & Ambulance

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A. Medical Centre

1. Paramedical staff
 - a. When < 500 workers, 1 Trained Male Nurse (round the clock deployment)
 - b. When >=500 workers*:
 - i. Registered Medical Practitioner (Qualified MBBS) to be deployed for at least 8 hours in a day, 5 days per week
 - ii. 2 Trained Male Nurses (round the clock deployment)
 2. All articles as per Schedule IV of BOCW Central Rules, 1998 to be made available in the Medical Centre (given under for convenience)
 3. Basic Facilities/ Requirements to be provided as per location eg. Refrigerator, Air Conditioner, Anti Venom Serums etc.
 4. Tie-ups with speciality hospitals to be ensured for referring serious patients
- * In case the number of workers is envisaged to exceed 500, a medical practitioner is to be engaged.

SCHEDULE IV (BOCW CENTRAL RULES, 1998) ARTICLES FOR AMBULANCE ROOM [SEE RULE 226 (C)]

- i. A glazed sink with hot and cold water always available.
- ii. A table with a smooth top at least 180 cm x 105 cm.
- iii. Means for sterilising instruments.
- iv. A couch.
- v. Two stretchers.
- vi. Two buckets or containers with close fitting lids.
- vii. Two rubber hot water bags
- viii. A kettle and spirit stove or other suitable means of boiling water.
- ix. Twelve plain wooden splints 900 cm x 100 cm x 6 cm.
- x. Twelve plain wooden splints 350 cm x 75 cm x 6 cm.
- xi. Six plain wooden splints 250 cm x 50 cm x 12 cm.
- xii. Six woollen blankets.
- xiii. Three pairs of artery forceps.
- xiv. One bottle of spiritus annemia aremations (120 ml).
- xv. Smelling salt (60 gm).
- xvi. Two medium size sponges.
- xvii. Six hand towels.
- xviii. Four kidney trays.
- xix. Four cakes of toilet, preferably antiseptic soap.
- xx. Two glass tumblers and tow wine glasses.
- xxi. Two clinical thermometers.
- xxii. Two tea spoons.
- xxiii. Two graduated (120 ml) measuring glasses.
- xxiv. Two minimum measuring glasses.
- xxv. One wash bottle (1000 cc) for washing eyes.
- xxvi. one bottle (one litre) carbolic lotion 1 to 20.
- xxvii. Three chairs.
- xxviii. One screen.
- xxix. One electric hand torch.
- xxx. Four first-aid boxes or cupboards stocked to the standards prescribed in
- xxxi. An adequate supply of tetanus toxide.
- xxxii. Injections—morphia, pethidine, atrophine, adrenaline, coramine, novocaine (6 each).
- xxxiii. Cramine liquid (60 ml).
- xxxiv. Tablets—antihistaminic antispasmodic (25 each).
- xxxv. Syringes with needles—2 cc, 5 cc, 10 cc and 500 cc.

- xxxvi. Three surgical scissors.
- xxxvii. Two needle holders, big and small.
- xxxviii. Suturing needles and materials.
- xxxix. Three dissecting forceps
- xl. Three dressing forceps
- xli. Three scalpels.
- xlii. One stethoscope and a B. P. apparatus.
- xlili. Rubber bandage—pressure bandage.
- xliv. Oxygen cylinder with necessary attachments.
- xlvi. Atropine eye ointments.
- xlvi. I. V. Fluids and sets 10 nos.
- xlvi. Suitable, foot operated, covered, refuse containers.
- xlvi. Adequate number of sterilised, paired, latex hand gloves.

B. Ambulance

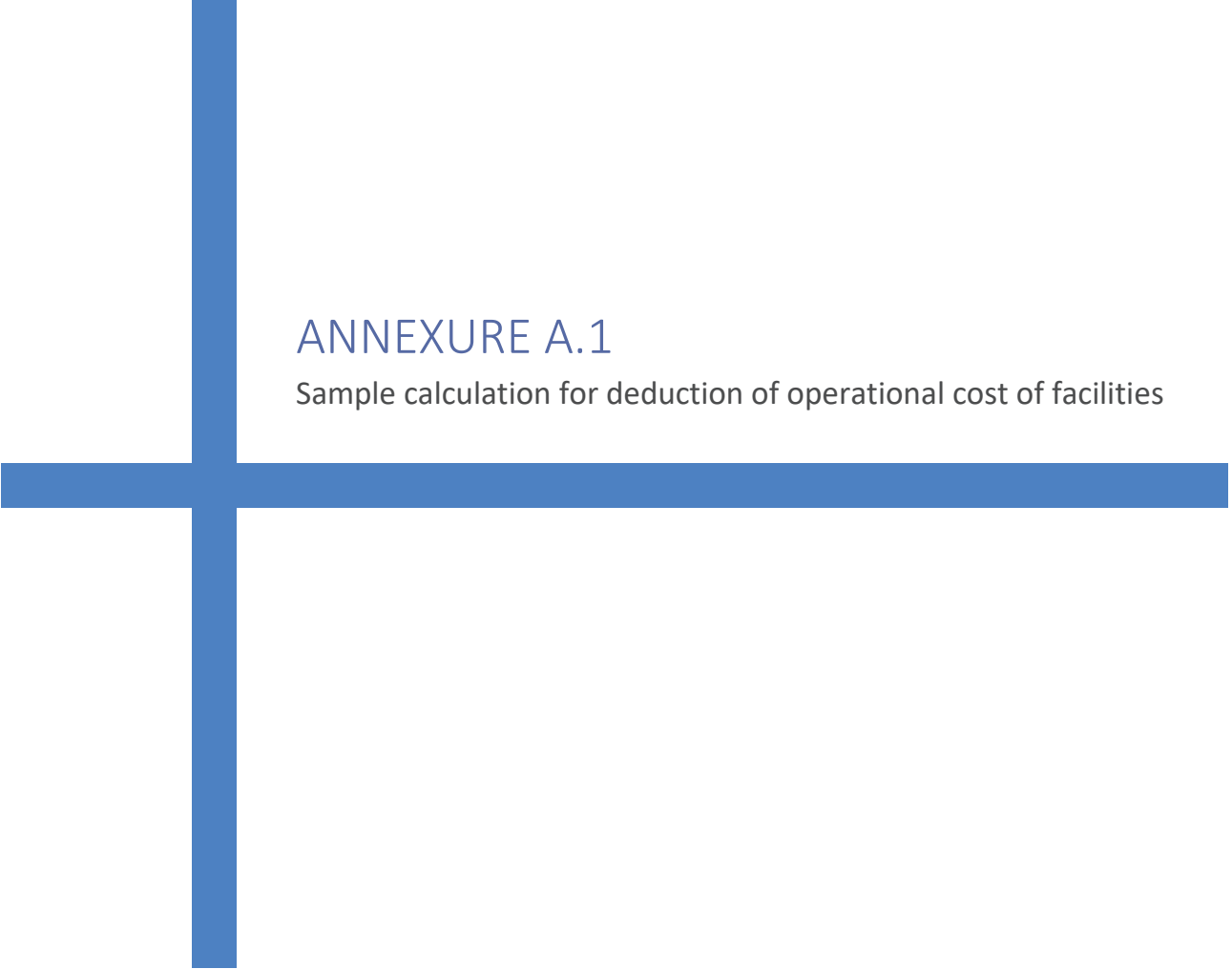
1. When number of workers is <500:
If the distance to a major hospital capable of handling critical injuries expected at Site is ≤ 50 KM from Site, then 1 BLS (Basic Life Support)/ Type B Ambulance otherwise ALS* (Advanced Life Support)/ Type D Ambulance
2. If no. of workers increases to >2000 workers one additional BLS Ambulance to be deployed
3. Minimum Articles as per Schedule V of BOCW Central Rules to be ensured in each Ambulance. (given under for convenience)

*Final call to be taken at Site in consultation with all the contractors

SCHEDULE V (BOCW CENTRAL RULES, 1998) CONTENTS OF AMBULANCE VAN OR CARRIAGE [SEE RULE 227]

The Ambulance Van shall have equipment prescribed as under:

- a) General—a portable stretcher with folding and adjusting devices with the Head of the stretcher capable of being tilted upward. Fixed suction unit with equipment. Fixed oxygen supply with equipment. Pillow with case, sheets, blankets, towels, emergency bag, bed pan, urinal glass.
- b) Safety Equipment—Flaros with life of three thousand minutes, floor lights, flash lights, fire extinguishers (dry power type), insulated guntlets.
- c) Emergency Care Equipment—
 - i. **Resuscitation**—Portable suction unit, portable oxygen unit, bag valve mask, hand operated artificial ventilation unit, airways, mouth gag tracheostomy adapters, short spine board, I.V. FLUIDS with administration unit, B. P. manometer cuff stethoscope.
 - ii. **Immobilisation**—Long and short padded boards, wire ladder splints, triangular bandage—long and short spine boards.
 - iii. **Dressing**—Gauze pads—100 mm x 100 mm universal dressing 250 x 1000 mm, roll of aluminium foils—soft roller bandages 150 mm x 5 mm yards adhesive tape in 75 mm roll safety pins, bandage sheets, burn sheets.
 - iv. **Poisoning**—Syrup of Ipecac, activated charcoal pre packeted dose, snake bit kit, drinking water.
 - v. **Emergency Medicines**—As per requirement (under the advice of construction Medical Officer).



ANNEXURE A.1

Sample calculation for deduction of operational cost of facilities

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Annexure A.1

Cost Calculation Methodology of Operation of Facilities (Data is indicative only)

(Period of 48 months is considered - shall be on actual basis)

A. Project Info:

Total time of Project	48 months
Project cost	1000 Crore
No. of packages	10 (A1-A10)

B. Item-wise Calculation:

Item	Nos.	Rate	Unit	Amount
Ambulance with Driver	2		Monthly/Unit	170000
Nurse/First aider	2 X 2 shifts	15000	Per month	30000
Training center one time cost	1	100000	Once	100000
Medical center one time cost	1	200000	Once	200000
Medicines at medical center	1	10000	Monthly	10000
Dust suppression water tank	2	2000	Monthly	4000
Doctor	1	70000	Monthly	70000
Cleaning staff	1	12000	Monthly	12000
		Recurring monthly expenditure		296000
		Total one-time expenditure		300000

C. Package-wise Deduction Plan for a period of 48 months

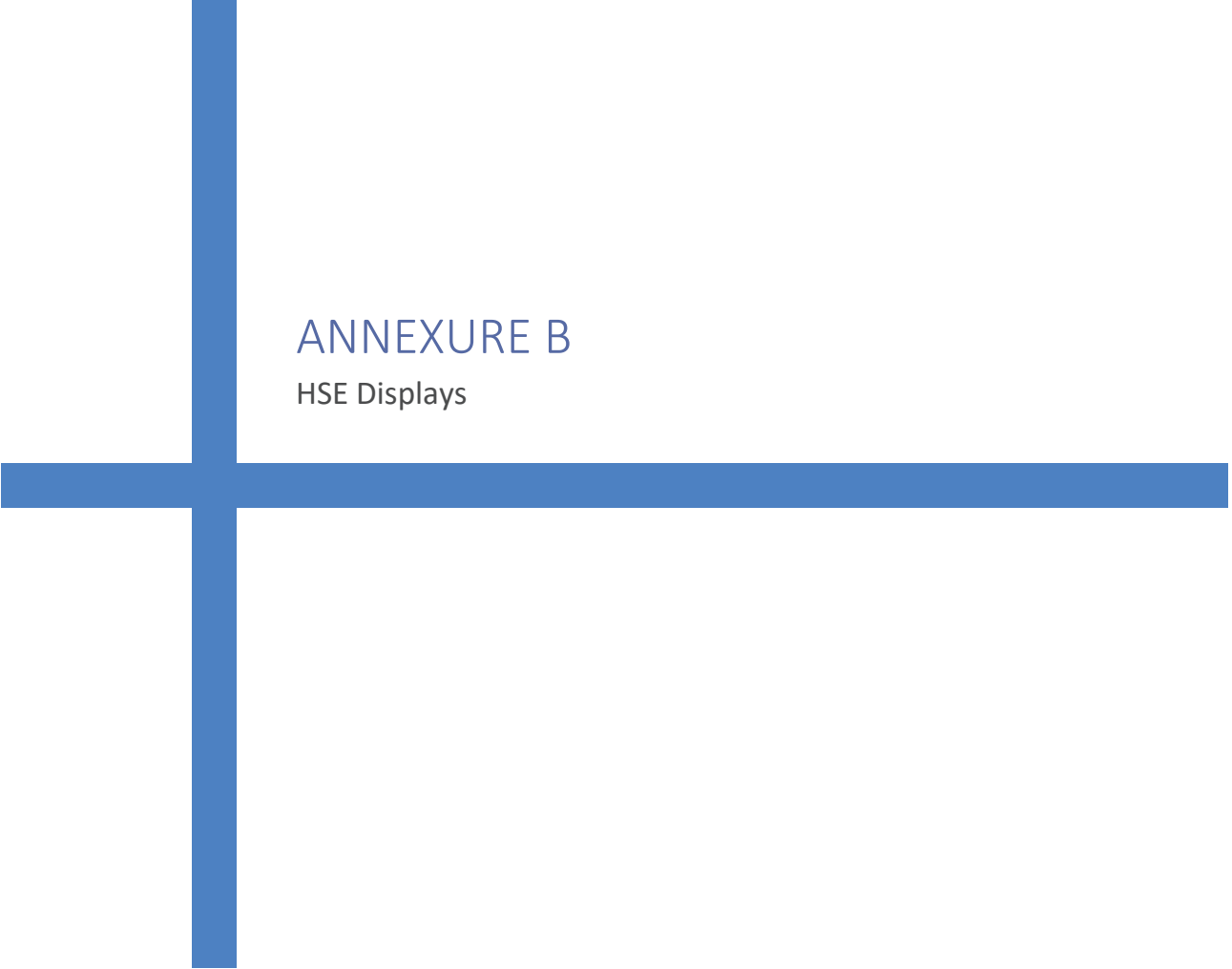
Period (In Months)	6	36	6
	For 1-6 months	For 7-42 months	For 43-48 months
Cost to be incurred from contractors	7%	81%	12%
	1.17% per month	2.25% per month	2.00% per month

D. Calculation For One-Time Running Cost

Packages/ Contracts	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10				
Contract Values (in Thousands)	100000	250000	2000000	200000	500000	1500000	1000000	1000000	250000	200000	7000000			
Share of common facilities one time running cost (in Thousands)	4	11	86	9	21	64	43	43	11	9	Individual Pkg value X Total one time running cost / All Pkg award values			
Timeline of work	1-6	1-8	2-48	6-36	7-15	10-48	6-48	7-40	40-48	41-48				
Month Count of work	6	8	47	31	9	39	43	34	9	8				
Deduction per month (in Thousands)	1	1	2	0	2	2	1	1	1	1	Total of One time Running cost (in thousands)	% deduction share of one time running cost per month	Nos. of active packages in month	
Month No.														
1	1	1									2	1%	2	
2	1	1	2								4	1%	3	
3	1	1	2								4	1%	3	
4	1	1	2								4	1%	3	
5	1	1	2								4	1%	3	
6	1	1	2	0			1				5	2%	5	
7		1	2	0	2		1	1			8	3%	6	
8		1	2	0	2		1	1			8	3%	6	
9			2	0	2		1	1			7	2%	5	
10			2	0	2	2	1	1			8	3%	6	
11			2	0	2	2	1	1			8	3%	6	
12			2	0	2	2	1	1			8	3%	6	
13			2	0	2	2	1	1			8	3%	6	
14			2	0	2	2	1	1			8	3%	6	
15			2	0	2	2	1	1			8	3%	6	
16			2	0		2	1	1			6	2%	5	
17			2	0		2	1	1			6	2%	5	
18			2	0		2	1	1			6	2%	5	
19			2	0		2	1	1			6	2%	5	
20			2	0		2	1	1			6	2%	5	
21			2	0		2	1	1			6	2%	5	
22			2	0		2	1	1			6	2%	5	
23			2	0		2	1	1			6	2%	5	
24			2	0		2	1	1			6	2%	5	
25			2	0		2	1	1			6	2%	5	
26			2	0		2	1	1			6	2%	5	
27			2	0		2	1	1			6	2%	5	
28			2	0		2	1	1			6	2%	5	
29			2	0		2	1	1			6	2%	5	
30			2	0		2	1	1			6	2%	5	
31			2	0		2	1	1			6	2%	5	
32			2	0		2	1	1			6	2%	5	
33			2	0		2	1	1			6	2%	5	
34			2	0		2	1	1			6	2%	5	
35			2	0		2	1	1			6	2%	5	
36			2	0		2	1	1			6	2%	5	
37			2			2	1	1			6	2%	4	
38			2			2	1	1			6	2%	4	
39			2			2	1	1			6	2%	4	
40			2			2	1	1	1		7	2%	5	
41			2			2	1		1	1	7	2%	5	
42			2			2	1		1	1	7	2%	5	
43			2			2	1		1	1	7	2%	5	
44			2			2	1		1	1	7	2%	5	
45			2			2	1		1	1	7	2%	5	
46			2			2	1		1	1	7	2%	5	
47			2			2	1		1	1	7	2%	5	
48			2			2	1		1	1	7	2%	5	
Total	4	11	86	9	21	64	43	43	11	9	300	100%		

D. Calculation For Recurring Running Cost

Packages/ Contracts	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10		
Contract Values (in Thousands)	100000	250000	2000000	200000	500000	1500000	1000000	1000000	250000	200000	7000000	
Timeline of work	1-6	1-8	2-48	6-36	7-15	10-48	6-48	7-40	40-48	41-48	Total of Recurring cost (in thousands)	Nos. of active packages in month
Month No.	6	8	47	31	9	39	43	34	9	8		
1	85	211									296	2
2	13	31	252								296	3
3	13	31	252								296	3
4	13	31	252								296	3
5	13	31	252								296	3
6	8	21	167	17			83				296	5
7		15	120	12	30		60	60			296	6
8		15	120	12	30		60	60			296	6
9			126	13	31		63	63			296	5
10			95	10	24	72	48	48			296	6
11			95	10	24	72	48	48			296	6
12			95	10	24	72	48	48			296	6
13			95	10	24	72	48	48			296	6
14			95	10	24	72	48	48			296	6
15			95	10	24	72	48	48			296	6
16			104	10		78	52	52			296	5
17			104	10		78	52	52			296	5
18			104	10		78	52	52			296	5
19			104	10		78	52	52			296	5
20			104	10		78	52	52			296	5
21			104	10		78	52	52			296	5
22			104	10		78	52	52			296	5
23			104	10		78	52	52			296	5
24			104	10		78	52	52			296	5
25			104	10		78	52	52			296	5
26			104	10		78	52	52			296	5
27			104	10		78	52	52			296	5
28			104	10		78	52	52			296	5
29			104	10		78	52	52			296	5
30			104	10		78	52	52			296	5
31			104	10		78	52	52			296	5
32			104	10		78	52	52			296	5
33			104	10		78	52	52			296	5
34			104	10		78	52	52			296	5
35			104	10		78	52	52			296	5
36			104	10		78	52	52			296	5
37			108			81	54	54			296	4
38			108			81	54	54			296	4
39			108			81	54	54			296	4
40			103			77	51	51	13		296	5
41			120			90	60		15	12	296	5
42			120			90	60		15	12	296	5
43			120			90	60		15	12	296	5
44			120			90	60		15	12	296	5
45			120			90	60		15	12	296	5
46			120			90	60		15	12	296	5
47			120			90	60		15	12	296	5
48			120			90	60		15	12	296	5
Total	143	388	5676	329	235	3102	2334	1772	132	96	14208	



ANNEXURE B

HSE Displays

Rk

A. Types of Displays**1. Based on Content**

SN	Type
1.	HSE Hazards & Precautions Height Work, Housekeeping, Fire Safety, PPEs, Hot Work, Lifting & Rigging Activity, Site-specific Hazards – eg. for Refineries, Nuclear plants etc.; COVID Precautions; Environment Protection etc.
2.	Other Displays, Signage etc. HSE Policy, ISO Certificate, Safety Statistics, Assembly Area Location/ Route, Emergency Contact Numbers, Site Safety Rules & Regulations, Speed Limit, Work in Progress, Lock-Out Tag-Out (LOTO) Boards etc.

2. Based on Mounting

[Type 1]	[Type 2]	[Type 3]
Flex Sign Boards of Wooden Frame – directly mounted on Structures (walls, stairs, railings etc.)	Flex Sign Boards with Wooden Frame – mounted on metallic/ wooden legs – preferably double-sided	Coloured weather-proof Paintings on Walls (after due concurrence of BHEL/ Customer – Type 1 in case of no concurrence/ space)

B. General Requirements:

- Displays should be weather-proof as per installation location, i.e. rain-proof, wind-proof and sun-proof.
- Installation location and size to ensure visibility for the intended viewers (workers and moving personnel)
- Displays to have at least 50% graphical elements preferably (as applicable). Language should be understandable by majority of the workers
- Displays to be relevant to the hazards in the area
- Proper installation to ensure boards don't obstruct activities and should not be prone to fall so as to pose danger
- In case of multiple elevations (eg. Boiler, Power-house etc.), each elevation to have displays for applicable hazards including Height-Work, Housekeeping
- For temporary work locations, posters/ boards may be erected and shifted after task is over
- Minimum size of displays should be A1 unless otherwise specified
- In case of damage, displays shall be reviewed and repaired/ replaced
- In areas where night work is envisaged, fluorescent displays shall be installed and these should comprise of at least 20-30% of total displays
- Total Number of displays to be not less than 1 per 10 workers and are to be dynamically updated based on number of workers

C. Area-wise Displays

Below is list of Area-wise displays that are to be installed at Sites (Numbers, locations may be adjusted for specific requirements)

SN	Area	Suggested Subjects	Minimum Size	Minimum Quantity	Locations
1	Walls/ Foundations/ Cement Structures etc. belonging to the package area	Safety Hazards Prevention and other HSE Awareness content	[Type 3]	As per BHEL assessment from time to time	
2	Site Interior Roads belonging to the package area	At least every 20 meters: 1. Speed Limit Indication, Safe Driving board 2. Boards for hazard awareness	1.As needed [Type 2] 2. A1 or equivalent each [Type 2]	As indicated	Sides of Roads; Height to ensure good visibility
3	Specific Package Areas	A. Common At entry to respective Package/ Work Area, each contractor to put up daily updated board with following for each shift: 1. Scope of work and start date 2. Emergency Contact Numbers 3. Emergency Assembly Location, Escape Plan 4. Locations and supervisors of various gangs in the area, 5. Current Work permit Details 6. Safety Supervisor Location assignments - Names, Mobile Nos., Assigned Locations 7. Details (Name, Contact No. etc.) of Package In-charge - Contractor & BHEL 8. Details (Name, Contact No. etc.) of Safety In-charge - Contractor & BHEL 9. LTI Free Man-days & details of last LTI also to be indicated In addition, Area-Specific Displays as indicated in Table 1	A0 [Type 2]	1 per Package Area	Entry/ Ground Level

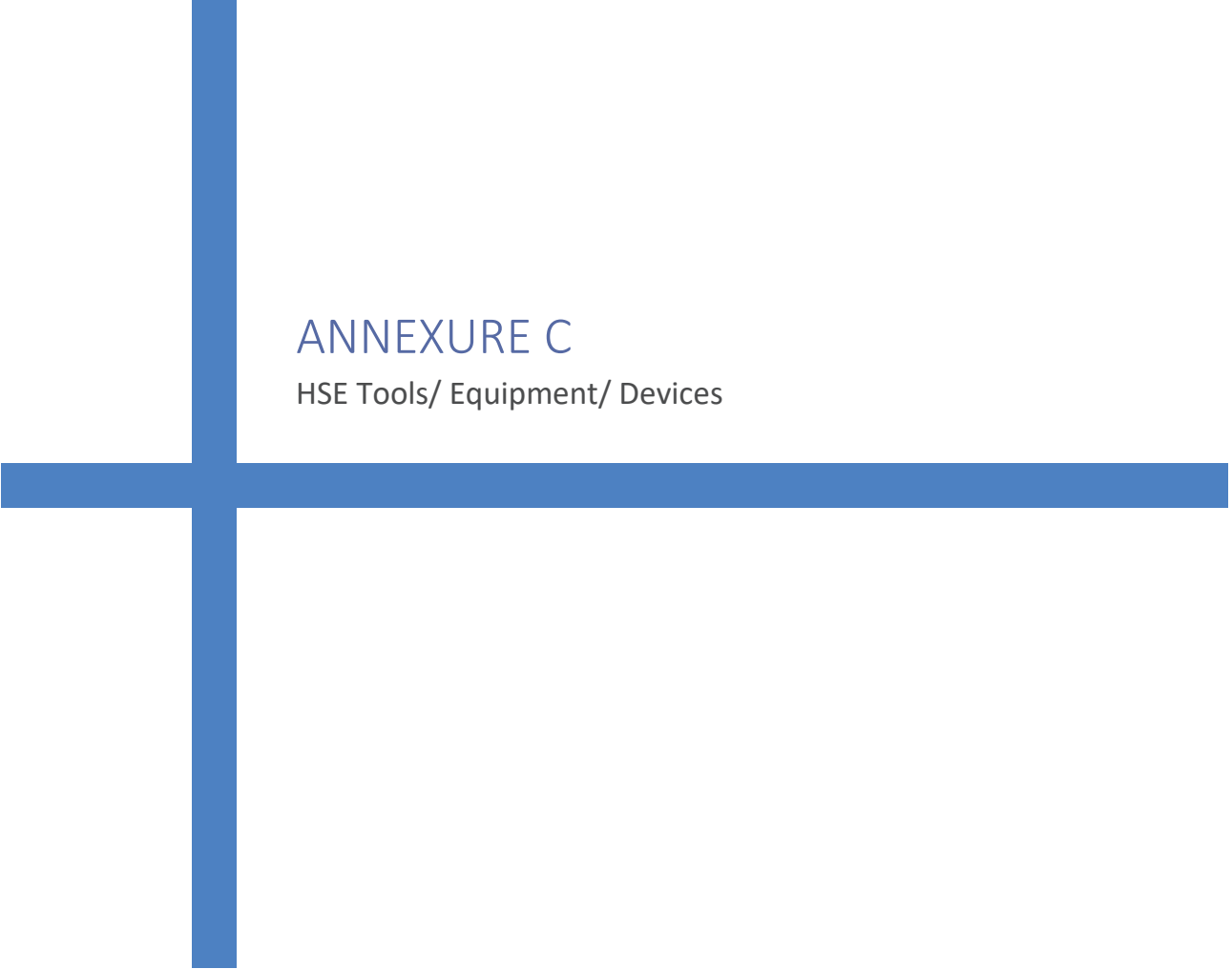
Table 1
(Area/ Package-wise HSE Display Plan – As applicable)

Prepared By (Subcontractor)				
S. No.	Area	Suggested Minimum No. of Displays & Types	Type	Numbers Installed
1	Boiler	3 per working elevation	[Type 1]	
2	Powerhouse	5 per elevation	[Type 1]	
3	ESP	5 Per Pass	[Type 1]	
4	Buildings	5 per elevation	[Type 1]	
5	Cooling Tower (NDCT/ IDCT/ ACC)	20 per Structure	[Type 1]	
6	Chimney	20 per Structure	[Type 1]	
7	Fabrication Yard	10 per Yard	[Type 2]	
8	Batching Plant	5 per Plant	[Type 1]	
9	Material Storage Yard – Open	20 per Yard	[Type 2]	
10	Material Storage Shed – Semi-Closed/ Closed	10 per Shed	[Type 1]	
11	Electrical Booths	2 per booth + Line diagram, Emergency contact details	[Type 1]	
12	Medical & First Aid Centre	2 per Centre	[Type 1]	
13	Rest Shed	2 per Shed	[Type 1]	
14	Canteen	2 per Canteen	[Type 1]	
15	Drinking Water Area	1 Per Outlet	[Type 1]	
16	Washing Water Area	1 Per Outlet	[Type 1]	
17	Training Centre	10 per room	[Type 1/2]	
18	Assembly Area	5	[Type 1/2]	
19	Stairs	1 per landing elevation	[Type 1]	
20	Cylinder Storage Area	5 + Signage: Type of Gas, Empty, Filled etc.	[Type 1/2]	
21	Labor Colony	Electrical Safety with Distribution Plan/ Line Diagram - 1 COVID Precautions Posters – 5 Safety Awareness Posters – 10 Hygiene awareness posters - 2	[Type 1]	
22	Others	As per requirement	[Type 1/2]	

Date:

Sign (Contractor)

Sign (BHEL)



ANNEXURE C

HSE Tools/ Equipment/ Devices

Rk

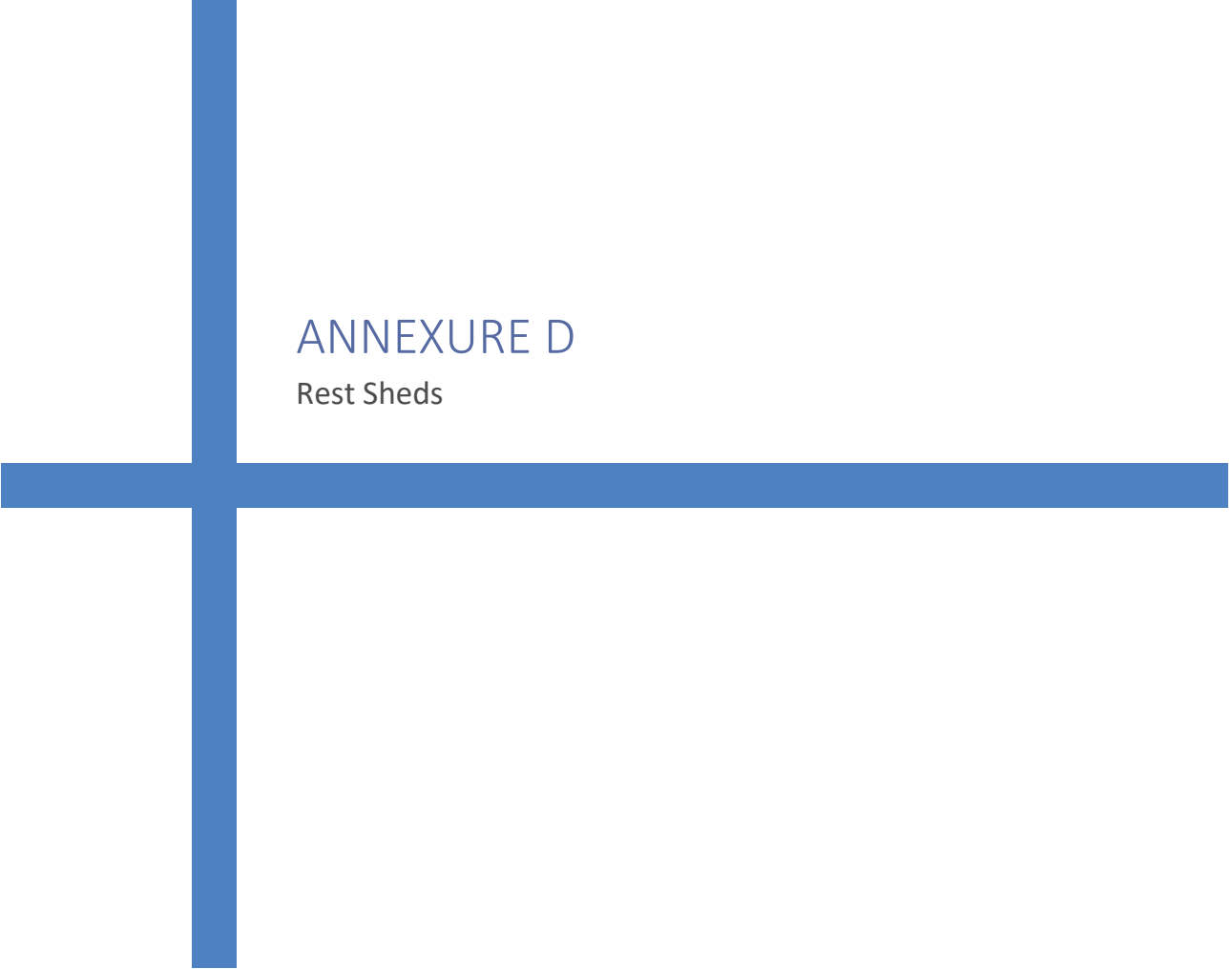
Following equipment conforming to relevant IS/ISO/BS Codes/ Standards in indicated quantities shall be ensured by subcontractor. This list is tentative, not exhaustive. Quantity and date/ period of deployment shall be as per site requirement.

A. HSE Tools/ Equipment/ Devices

SN	Item
1	Lifelines
2	Retractable Fall Arrestors
3	Safety Nets (10m X 5m) fire proof double mesh
4	Sky Climbers
5	Fire Blanket
6	Honey Bee Removal Suit & Kit
7	Scaffolding Pipes
8	Flashback Arrestors
9	Barricading Tape
10	Binoculars
11	Walkie-Talkies
12	LOTO kit
13	24-Volt light
14	Sand Buckets
15	Hard barricading Pipes
16	Standby Fire kits
17	Hand-held Megaphone
18	Small Public Address System
19	Foldable Stretcher
20	Height Rescue Kit (Non-Motorized)
	(Others:)

B. Test & Measurement Devices

SN	Device
1	ELCB Tester
2	Multi meter (Light cables)
3	Earth Resistance Meter
4	Lux Meter
5	Sound Meter
6	Anemometer
7	Breath Analyzer (Alcohol)
8	Multi-gas dozi-meter/ detector
9	Gas leakage detector / alarm
10	Gas monitor (confined space)
11	Radiation meter & Badges
12	Blood Pressure Monitor
13	Fire detectors
14	Hand held signaling light
	(Others:)



ANNEXURE D

Rest Sheds

Rk

1. Determining the Number, Sizes and Locations of Rest Shelters

i. **Numbers:**

The number of rest shelters shall be determined based on maximum number of workers at any one time (across all shifts). Formula is:

W_{max} = Maximum number of workers at any time in the Site

Space per worker = 1.1 sq meter

Total space required, $T_{space} = W_{max} \times 1.1$

Based on total space requirement calculated above, the number of rest sheds can be decided according to availability of locations and concentration of workers – so as to ensure the required space.

ii. **Locations:**

The rest sheds should be so located so as to minimize the distance to be travelled by the workers from their locations of work considering all the practical constraints

iii. **Other:**

The Rest shelter should be fenced so that it cannot be used as parking area.

2. Design & Construction of Rest Sheds

a. **Permanent/ Long duration Rest Sheds**

- i. For locations where, permanent rest sheds can be constructed without possibility of removal for relatively long period of time, a semi-closed shed can be constructed covered with tin roof and supported with well-grouted beams. The floor of the shed to be preferably cemented/ solidified.
- ii. Adequate structural requirements suitable to the local weather (wind/ rain etc.) to be ensured.
- iii. The design of the rest shed to be approved by Civil Engineering Department of BHEL Site before commencing work

b. **Temporary/ Movable/ Portable Rest Sheds**

- i. For locations where, permanent rest sheds cannot be constructed either due to non-availability of permanent location or other reasons, temporary rest shed shall be constructed.
- ii. Temporary rest sheds shall comprise of Tent arrangement carried out by professional agencies

3. Amenities in Rest Sheds

a. **Essential Amenities**

Following amenities shall be essentially ensured in a rest shed:

- i. Hygienic environment with regular cleaning and housekeeping (with records)
- ii. Adequate illumination
- iii. Adequate ventilation/ heating as per weather conditions
- iv. Clean Drinking water source
- v. Hand Washing area
- vi. Toilets & Urinals
- vii. Benches/ mats for sitting/ lying
- viii. Any other essential requirement deemed necessary by the Site
- ix. Dust bins of sufficient quantity/ size that are vacated each day/ as per requirement

b. **Additional/ Optional Amenities**

Following amenities are optional but are recommended to enhance the level of satisfaction of work force:

- i. Hot/ Cold drinks (Tea, Coffee, Glucose etc.) as per requirement
- ii. Snacks
- iii. Fans/ Coolers/ Heating arrangements as per requirement and weather conditions
- iv. A nice, welcoming interior design, music etc.
- v. Water cooler

4. Health & Safety Requirements of Rest Sheds

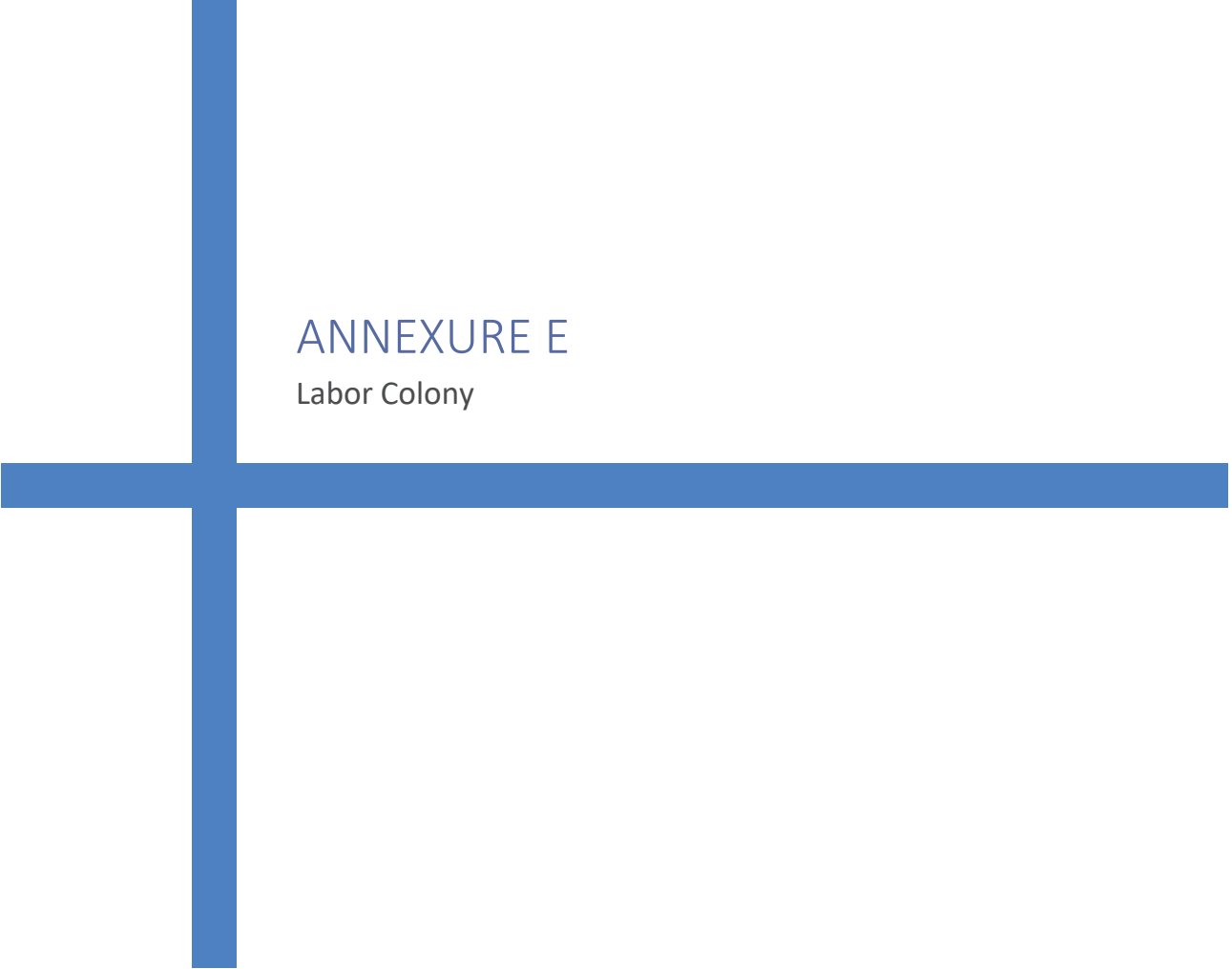
Use of asbestos in construction is banned and shall not be used.

In addition, following essential Safety features shall be ensured in Rest sheds:

- i. Availability of Fire extinguishers (preferably CO2 type)
- ii. Display of Safety Posters
- iii. Pest/ reptile protection
- iv. Mosquito prevention measures

5. Note:

Any suitable closed spaces/ newly constructed buildings etc. available at project may also be used for the purpose of rest shed with due concurrence of BHEL



ANNEXURE E

Labor Colony

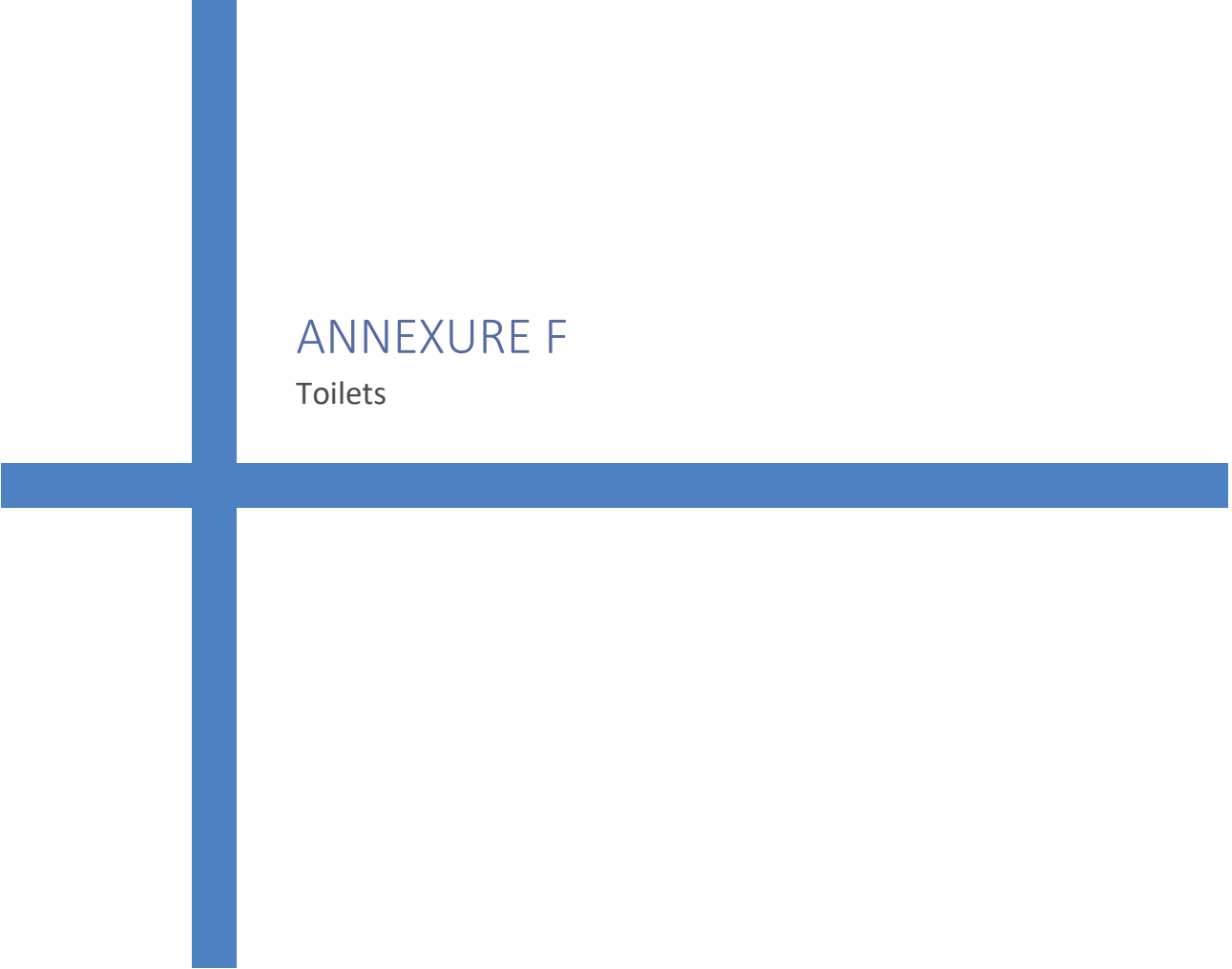
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1. These Guidelines suggest minimum requirements. However, additional requirements based on feasibility and circumstances, while adhering to directions of GOI/District Administration/Local Authority guidelines to be considered
2. Norms for social distancing, training/ awareness, face masks, disinfection, sanitization, gate entry, quarantine, medical, action in case of suspect cases of COVID and other communicable diseases etc. to be followed as per Govt. and BHEL guidelines issued from time to time
3. Labor colony to be developed as close to the Site as possible to avoid lengthy commute
4. A "Suggestion Register" shall be made available at the labor colony for residents. The feedback shall be reviewed on weekly basis and acted upon by concerned Contractor. Same shall be reviewed periodically by authorized BHEL Site Official.
5. **Canteens, Latrines & Urinals, Washing Facilities, Creches, Residential Accommodation and other infrastructure/ facilities:**
Numbers/ Quantities and Features of these facilities shall be in line with the following as applicable:
 - a. BOCW Act & State Rules
 - b. The Inter-State Migrant Workmen (Regulation of Employment and Conditions of Service) Act & State Rules
 - c. Factories Act & State Rules
 - d. Other Relevant Acts & Rules
6. **Cleanliness & Hygiene/ Housekeeping:**
 - a. Regular cleaning of the labor colony to be ensured.
 - b. Daily cleaning of Sanitary facilities.
 - c. Proper drainage system to prevent water-logging
 - d. Regular fogging to prevent spread of mosquitoes
 - e. Prevention of foul smell through necessary interventions
 - f. Dust suppression as per requirement
 - g. Cutting of Grass at regular intervals and other necessary measures to prevent pests & reptiles
 - h. Stray animals to be banned from labor colony.
 - i. Outside every common facility, eg. Toilet, washroom, food hall/ canteen etc., provision of washbasin with flowing water and soap (preferably liquid soap) to be ensured
7. **Power Supply Layout:**
Electrical supply Layout of Labor Colony shall have the provision of Safety devices like MCBs, ELCBs etc. and to be clearly displayed
8. **Washing & Drinking Water Availability**
 - a. Adequate water to be provided in line with: "Estimation of Water Requirements for Drinking and Domestic Use (Source: National Building Code 2016, BIS)"
 - b. Drinking water tank to be cleaned every week and sticker for the same pasted on the tank
 - c. Drinking water source should be tested as per IS 10500
9. **Waste Disposal:** Separate bins for dry, wet and biomedical waste to be installed. These bins to be evacuated regularly
10. **Training & Awareness/ Displays**
 - a. **HSE Awareness Displays:** Posters/ banners/ boards to be displayed in labor colony. Subjects of displays shall be precautions for applicable hazards at work site.
 - b. **Emergency Contact Numbers** including that of Doctor, Hospital, Labor Colony Supervisor, HSE Officials to be displayed prominently

11. Doctor Visits:

Regular and need-based visits by Doctors to be ensured through tie-ups etc.

12. Inspection & Review: Regular inspection of labor accommodation to be carried out by the Contractor as per prescribed format. Last inspection date, inspector and next due date to be prominently indicated near main gate**13.** Provision of a Fair Price shop in the premises to be ensured as per requirement**14.** Adequate arrangements to be ensured in case of children/ families



ANNEXURE F

Toilets

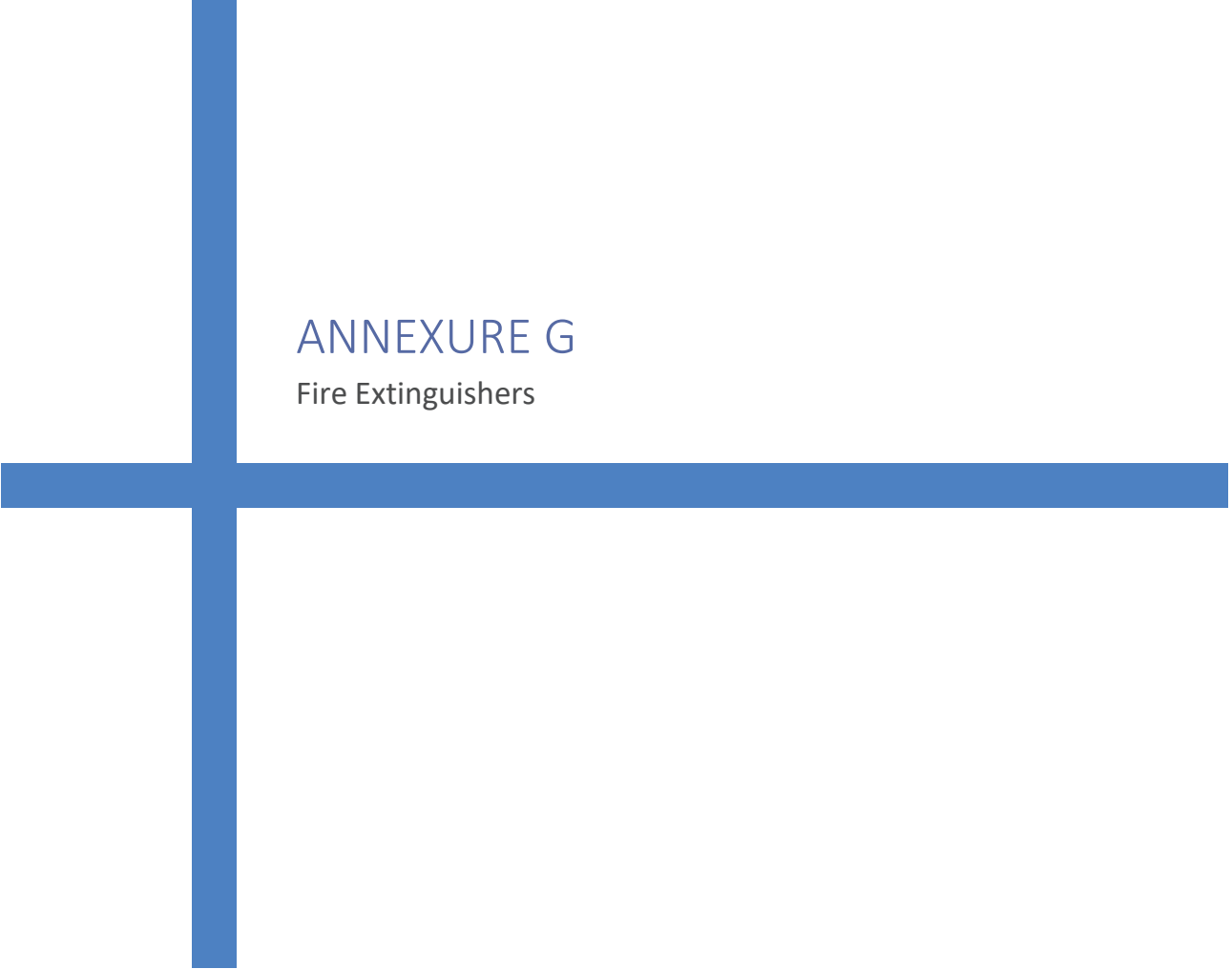
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Toilets (Latrines and urinals shall be ensured at Site and Labor Colony in accordance with the Inter-State Migrant Workmen Act, 1979 as given below:

LATRINES	URINALS
1. Latrines shall be provided in every establishment on the following scale, namely: - a. Where females are employed, there shall be at least one latrine for every 25 females; b. Where males are employed, there shall be at least one latrine for every 25 males: Provided that where the number of males or females exceeds 190, it shall be sufficient if there is one latrine for 25 males or females, as the case may be, up to the first 100, and one for every 30 thereafter 2. Every latrine shall be under cover and so partitioned off as to secure privacy, and shall have a proper door and fastenings.	1. There shall be at least one urinal for male workers up to fifty and one for female up to fifty employed at a time: Provided that where the number of male or female workmen, as the case may be, exceeds 500 it shall be sufficient if there is one urinal for every fifty females up to the first 500 and one for every 100 or part thereof thereafter. 2. The urinals shall be designed and located so as to ensure privacy.

Important:

- Where workers of both sexes are employed there shall be displayed outside each block of latrine and urinal a notice in the language understood by the majority of the workers '**For Men Only**', or '**For Women Only**', as the case may be.
- The notice shall also bear the figure of a man or of a woman, as the case may be.
- The latrines and urinals shall be conveniently situated and accessible to workers at all times at the establishment.
- The latrines and urinals shall be adequately lighted and shall be maintained in a clean and sanitary condition at all times.
- Latrines and urinals other than those connected with a flush sewage system shall comply with the requirements of the public health authorities.
- Water shall be provided by the means of tap or otherwise so as to be conveniently accessible in or near the latrines and urinals.
- At Site, on ground, **Modular Bio-toilets** as per industry standard specifications and regular professional cleaning shall be ensured. The toilets should be sufficient in number and easily accessible to workers from every work area
- At Site, in various elevations, suitable urinals with proper drainage to be ensured at each elevation in line with IS 2064 (1993). Same to be cleaned regularly



ANNEXURE G

Fire Extinguishers

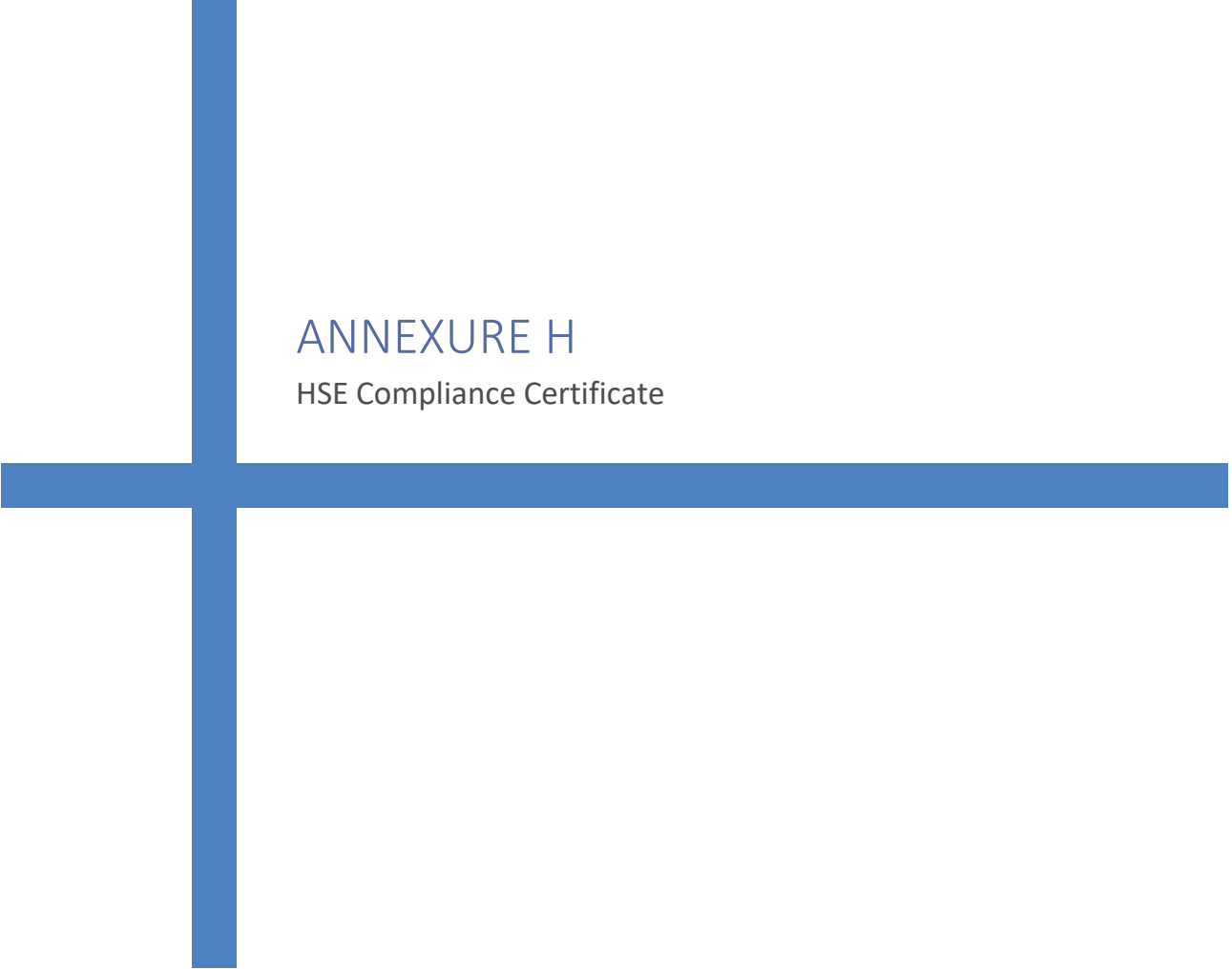
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SN	Type of Fire Risk (Class of Fire)	Extinguishing Medium & Relevant INDIAN STANDARD	Scale of Equipment (Minimum recommended)
1.	CLASS 'A' Fires involving ordinary combustible materials like wood, paper, textiles, rubber etc. (Ordinary hazard or low fire load)	WATER Soda acid type, water type (gas pressure) and water type (constant air pressure) IS: 934 -1976; IS: 940 -1976; IS: 6234 -1971	For every 600 square meter floor area or part, one 9-litre capacity. Minimum 4 numbers per floor or room; should not be required to travel more than 15 meter to reach any extinguisher.
2.	CLASS 'A' (Extra hazard & high fire load)	-do	-do – (Also, consult local fire authority).
3.	CLASS 'A' (Special hazards)	-do	-do – Extra provision For every 100 square meter floor area or part, one 4.5 Kg. CO ₂ ; minimum 2 numbers per room; should not be required to travel more than 10 meter to reach any extinguisher.
4.	CLASS 'B' (Fires in flammable liquids like oils, solvents, petroleum, products, varnishes, paints, etc. where blanketing effect is essential) (Storage and handling in small quantities)	FOAM / CARBON DIOXIDE / DRY CHEMICAL POWDER IS: 933 -1976; IS: 2878 1976; IS: 2171 1976; IS: 4308 -1982	For every 50 square meter floor area or part, 2 numbers 9 -liters foam or 5 kg dry powder; should not be required to travel more than 10 m in the area of storage to reach any extinguisher.
5.	CLASS 'B' (Bulk storage other than in tank form))	-do -	-do- (but minimum 3 numbers per room)
6.	CLASS 'C' (Fires involving gaseous substances under pressure where it is necessary to dilute the burning gas at a very fast rate with an inert gas or powder) (storage and handling of gas cylinders)	CARBON DIOXIDE / DRY CHEM. POWDER. The best way to extinguish such fire is by stopping the flow of fuel gas to the fire. Container is kept cool with water spray. IS: 2878 1976; IS: 2171 -1976; IS: 4308 -1982	For every 100 square meter floor area or part; 2 numbers, 10 kg powder extinguisher or 6 kg CO ₂ ; minimum 3 nos. per room; should not be required to travel more than 10 meter to reach any extinguisher.
7.	CLASS 'D' Fires involving metals like magnesium, aluminum, zinc, potassium etc. where the burning metal is reactive to water and which require special extinguishing media or technique	SPECIAL DRY POWDER IS: 2171 -1976 IS: 4861 -1968	For every 50 square meter floor area or part, 2 nos. 5 kg special dry powder; minimum 3 nos. per room; should not be required to travel more than 10 meter to reach any extinguisher.
8.	MIXED OCCUPANCY (electrical); Generators; Transformers; etc.	CARBON DIOXIDE DRY POWDER, IS: 2878 1976; IS: 2171 -1976	For every 100 square meter floor area or part one 10 kg CO ₂ . Minimum 2 numbers for every location should not be required to travel more than 10 meter to reach an extinguisher.

Note: Due to peculiarities of the power plant construction sites, there would be locations in the construction areas of Boiler, Turbine, Generator, Transformer, etc. where different types of fire risk (classes of fire) may co-exist. Special care shall be taken while selecting and installing portable fire extinguishers for such locations so that all types of fire risk that may co-exist, are adequately covered. Similar special care shall be taken for storage areas.

a. All Electrical welding booths shall be equipped with appropriate Fire Extinguisher

- b. Appropriate Fire Extinguishers shall be made within easy reach of all welding operations
- c. Fire extinguishers shall be regularly tested and last checked date to be indicated on each. Master list shall be prepared with location and details
- d. Providing appropriate fire-fighting equipment at designated work place and nominate a fire officer/warden adequately trained for his job.
- e. Subcontractor shall provide enough fire protecting equipment of the types and numbers at his office, stores, temporary structure in labour colony etc. Such fire protection equipment shall be easy and kept open at all times.
- f. The fire extinguishers shall be properly refilled and kept ready which should be certified at periodic intervals. The date of changing should be marked on the Cylinders.
- g. All other fire safety measures as laid down in the "codes for fire safety at construction site" issued by safety coordinator of BHEL shall be followed.
- h. Non-compliance of the above requirement under fire protection shall in no way relieve the subcontractor of any of his responsibility and liabilities to fire incident occurring either to his materials or equipment or those of others.
- i. Emergency contacts nos. must be displayed at prominent locations
- j. Tarpaulin being inflammable should not be used (instead, only non-infusible covering materials shall be used) as protective cover while preheating, welding, stress relieving etc. at site.



ANNEXURE H

HSE Compliance Certificate

Rk

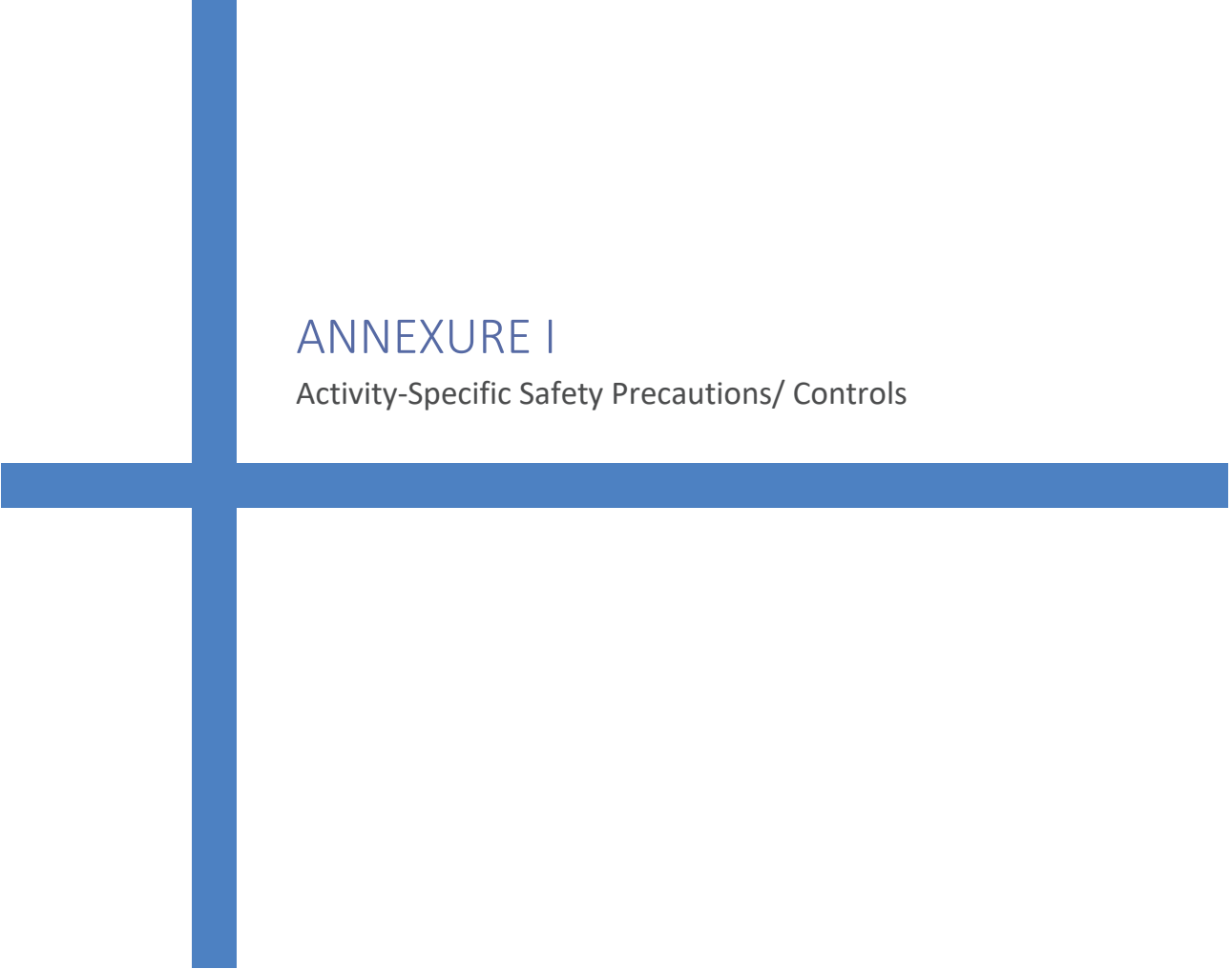
Bill Ref no: _____ Date: _____

NAME OF THE AGENCY: _____ Work-Area/Package: _____

Sl. No.	Description	Remarks
1	<u>HOUSE KEEPING:</u>	
1.1	All working areas at site (specific to the agency) are free from garbage's, scraps & any other undesired non-plant materials. There is no encroachment in safe passage of man, material & T&P to carry out activities safely	
1.2	All the plant materials under the custody of the agency are stacked & stored properly.	
2	<u>GENERAL ILLUMINATION:</u>	
2.1	ALL the working areas at site & office of the agency including passages are having proper & sufficient illumination.	
3	<u>STATUTORY & REGULATORY REQUIREMENT:</u>	
3.1	Sufficient water for drinking & other purposes and sanitation in work area and labour colony are available.	
3.2	Periodical Medical check-up of workers & staff done regularly & report submitted to BHEL	
3.3	Regular EYE testing is done for Crane operators/Welders and data's are available with agency	
3.4	All the T&P, Cranes etc used by the agency are having proper T.Cs & Fitness certificate available from competent authority.	
4	<u>SAFETY COMPLIANCE:</u>	
4.1	Number of Tool box meetings between Safety officers, erection staff & workers of the agency held in this month with location mentioned	
4.2	All precautions & Safety measures including PPE compliances are taken before working at HEIGHT	
4.3	Permit for working at Height is taken & complied accordingly	
4.4	ELCB is used in Construction Power Supply source by the agency & Proper Distribution board and electrical cabling has been used by the agency and regularly checked by electrician & safety officer of the agency	
4.5	Unsafe areas barricaded properly & unsafe opening closed properly	
4.6	Proper Platforms & Hand-rails used In areas earmarked earlier	
4.7	Proper safety signage's, Slogans & Emergency contact phone numbers including FIRE contact nos. are made available by the agency in locations mentioned	
5	Whether any penalty imposed by BHEL towards non-compliance of above points.	

<u>VENDOR'S SIGNATURE</u>	
Erection Engineer	
HSE Officer	
Site-in-Charge	

<u>BHEL'S SIGNATURE</u>	
Erection Engineer	
HSE Officer	
Package-in-Charge	



ANNEXURE I

Activity-Specific Safety Precautions/ Controls

Rk

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General

The philosophy of hierarchy of controls as below shall be followed



Fig. 1.1

It shall be ensured that there are multiple protections against any accident/ incident. For example, for height work there shall be safe platforms and walkways, Safety Nets and Lifelines for hooking double lanyard Safety harness by workers.

Monitoring and modifying worker behavior shall be part of ensuring safety. All personnel should be competent and trained for the job

Brief Safety guidelines for various hazardous activities are indicated below, besides the mandatory requirements based on Hazard Identification studies, HSE Procedures, Operational Control Procedures, Work Permits, applicable Indian Standard Codes and other provisions detailed in this document. Constant supervision at all times to be maintained by Execution & Safety Team to ensure implementation of these provisions.

1. WORK AT HEIGHT:

- a. All work at height above 2 meter above ground level without complete platforms, handrails and other related fall protection shall require a work permit in the prescribed form. This shall require approval by the competent authority. The HSE officer of sub-contractors shall follow the checklist religiously by physically verifying the condition of the work area before recommending for approval.
- b. Prior to the start of work at elevation, the HSE Officer involved with the work must meet the work supervisor to review the scope of work, and must review all the possible fall hazards and effective safety responses. The evaluation / analysis must be documented and kept on file and on site by the HSE Officer.
- c. Whenever a fall hazard or other exposure exists for working at heights more than 2.0m/6ft, the nature and scope of work will be evaluated for conditions and environmental factors before selecting the appropriate fall protection system (active, passive or a combination of measures, as appropriate).
- d. All Engineering and Administrative Controls including barricading, safe platform, Safety Nets etc. shall be made available at work location. Under no circumstances, there shall be total reliance on PPEs only
- e. **Safety Nets**
 - i. Contractor shall maintain sufficient stock of Safety Nets for deployment
 - ii. Safety Nets as per IS: 11057:1984 should be used extensively for prevention / arrest men and materials falling from height.
 - iii. The safety nets shall be fire resistant, duly tested and shall be of ISI marked.

- iv. Safety Nets shall be deployed below all platforms where height work is envisaged. Duration of work, delay shall be no excuses for non-installation of Safety Net
- f. Reaching beyond barricaded area without lifeline support, moving with support of bracings, walking on beams without support, jumping from one level to another, throwing objects and taking shortcut must be discouraged.
- g. Monkey Ladder shall be fitted with cages. Rope ladder should be discouraged.
- h. In case of pipe-rack, persons should not walk on pipes and walk on platforms only.
- i. In case of roof work, walking ladder/ platform should be provided along with lifeline and/ or fall arrestor.
- j. For chimney or structure painting, both hanging platform and men should be anchored separately to a firm structure along with separate fall arrestor.
- k. The procedures for the safety response to identified fall hazards developed and rescue plans must be reviewed with all individuals exposed to the hazards.
- l. The HSE Officer must establish an inspection process of fall protection systems. Some equipment requires documented inspections by its manufacture on a regular schedule. Such equipment must have evidence of the inspection and re-certification process on it. This information must be reviewed before the equipment is actually used. Individuals must visually inspect the fall protection equipment before each use. Failure to complete this inspection process could result in serious injury or death.
- m. Immediately remove from service any fall protection equipment that is identified as defective, damaged, or has been subjected to an impact. Damaged fall protective equipment must be destroyed to prevent re-use and not be discarded into trash containers, as the worn or damaged equipment could be unintentionally re-used.
- n. Aerial lifting devices, excluding scissor lifts require the use of full body harnesses and lanyards in any elevated position.
- o. Where Height related works are applicable then rescue team (consist of 5- 10 person) shall be identified and trained for potential rescue.

1.1 Personnel fall protection system must include:

a. Safety Harness

All height workers must use Full Body Safety harness with double lanyards with shock absorber (only). The primary lanyard is never unhooked until the secondary lanyard is secure. The design of the working platform should be such that under no circumstances, worker should have both lanyards unhooked while at height.

b. Lanyard

- i. The type of work and the environment conditions determine lanyard and lifeline selection. If welding, chemical cleaning that may damage lanyards, connectors or lifelines, sandblasting, etc., either protect the components or use more appropriate type of system.
- ii. Lanyards and lifelines must incorporate, or be used with, an appropriate deceleration (shock absorbing) device. Deceleration devices include rope grabs, rip-stitch lanyards, specially woven lanyards, tearing, or deforming lanyards, automatic self-retracting lifelines and lanyards which dissipate or limit the energy imposed on the employee during fall arrest.
- iii. Once in use, the system's effectiveness is to be monitored. In some cases, a program for cleaning and maintaining the system may be necessary. Lanyard and lifelines must use locking snap hooks only and under

no circumstances must two lanyard snap hooks be connected.

c. Lifeline

All lifelines in general are to be made of min 12mm dia. steel rope (plastic coated) and tied to columns with 3 clamps at each end. Wherever columns are not available to tie the lifelines, the vertical posts as per the design below are to be provided after carrying out drop load test initially. A load of 240kg to be dropped off the mid-point of lifeline in this test.

d. Lifeline Post

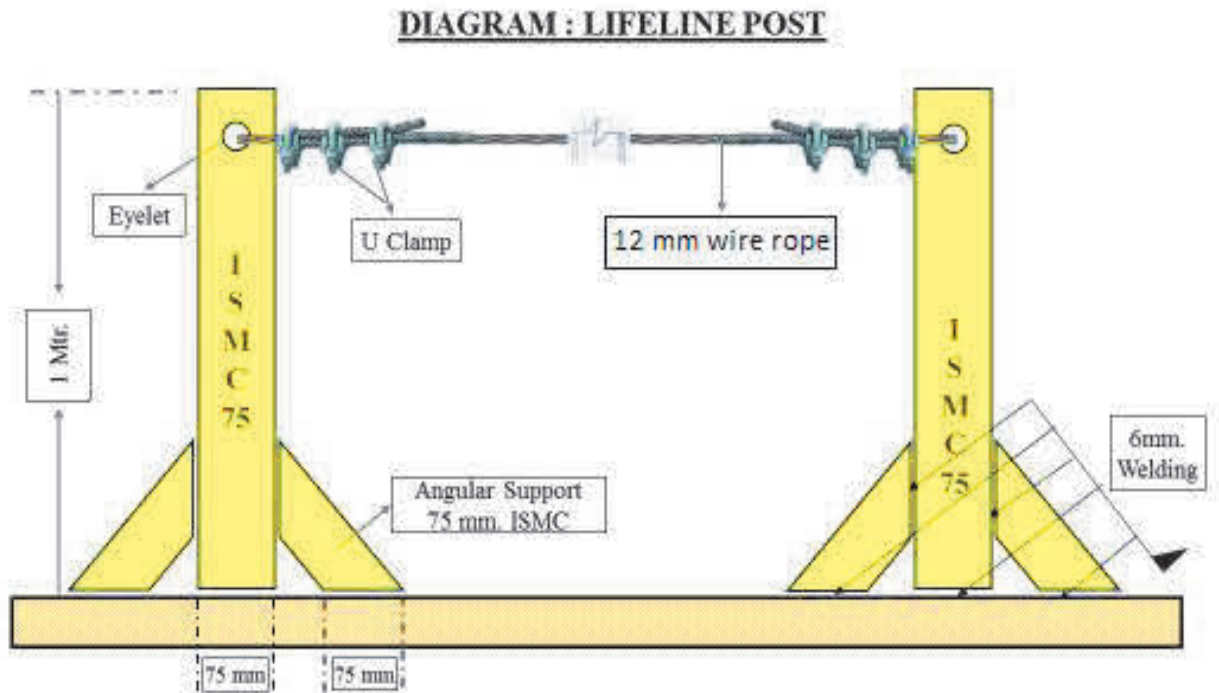


Fig. 2.1 Lifeline Post

- i. The support at vertical post shall be fixed at end-to-end (welded/ bolted). The maximum length of one end to another end shall be 6 meters
- ii. If the length of a lifeline is more than 6 meters, then intermediate vertical post(s) are to be used. Such intermediate post(s) will act as supports and the lifeline rope should simply pass through the eyelets (holes) of such supports without being anchored
- iii. The lifeline need not be wrapped / clamped to any intermediate post
- iv. Such intermediate posts must be used at an interval of every 6 meters
- v. The post(s) in which the original lifeline is to be installed should be capable of sustaining a tensile stress of 2268 Kgs.
- vi. In a horizontal lifeline installation, maximum allowable sagging is 500-600 mm
- vii. For a single spun lifeline, no more than 3(Three Nos.) persons are allowed to work; for more than two workers, another lifeline should be installed
- viii. Horizontal lifeline should be so installed that it does not impede safe movement of workers
- ix. All the installation work must be carried out by competent person with adequate knowledge

1.2 Working Platform

- a. Working platforms, gangways and stairways shall be so constructed that they do not sag unduly or unequally and if the height of the platform gangways provided is more than 3.6 m above ground level or

floor level, they shall be closely boarded and shall have adequate width, which shall not be less than 750 mm and be suitably fenced.

b. Precautions against the fall of Materials, Persons and Collapse of Structures:

- i. Every opening in the floor or a building or in a working platform shall be suitably barricaded to prevent the fall of persons by providing suitable fencing or railing whose minimum height shall be 90 cm.
- ii. Adequate precautions should be taken such as the provision of fencing, or barriers to protect any person who might be injured by the fall of materials, or tools or equipment being raised or lowered. Hard barricading shall be made at such places made of scaffolding pipe & clamps covered with reflective net. Cradle may be used for lifting materials - however this shall be made of MS angles and flats only and duly certified by the HSE officer. Operators may also use designed containers for lifting small tools.
- iii. Guardrails (including scaffolding) erected over/adjacent working areas must have the guardrails screened (opening < 0.5), to prevent material from falling outside the platform/decking.
- iv. Guardrails must be able to withstand a 200-pound force exerted in any one direction.
- v. Where necessary to prevent danger, guys, stays or supports should be used or other effective precautions should be taken to prevent the collapse of structures or parts of structures that are being erected, maintained, repaired, dismantled or demolished.
- vi. All openings through which workers are liable to fall should be kept effectively covered or fenced and indicated in the most appropriate manner.
- vii. Guardrails and toe-board/barricades and sound platform conforming to IS: 4912-1978 and other Indian laws and regulations as depicted below should be provided.

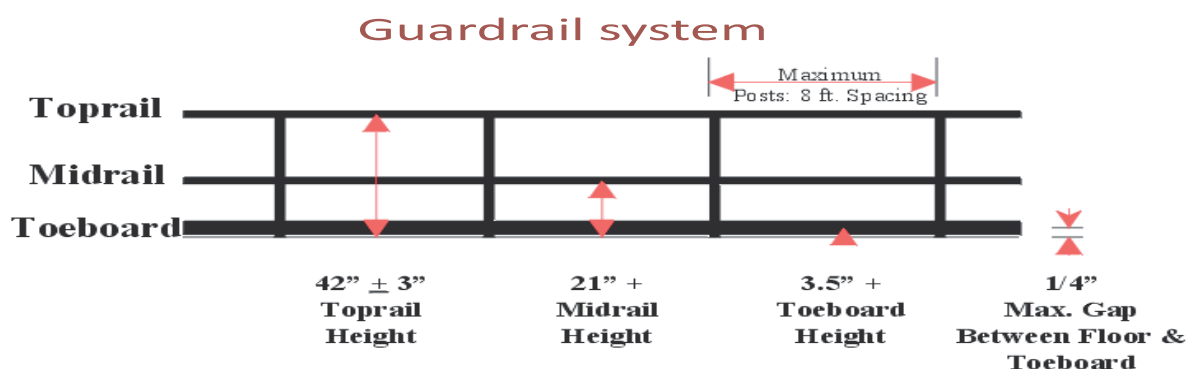


Fig. 2.2 Guard Rail System

- viii. Guardrails shall be provided to protect workers from falling from elevated work places. The rails are generally made of MS pipes of suitable dia. Rebar shall not be used for any handrails, ladder or cover purpose. Wherever the guard-rails and toe-boards cannot be provided:
 - a. adequate safety nets or safety sheets shall be erected and maintained; or
 - b. adequate safety harnesses shall be provided and used and / or
 - c. adequate fall arrestor shall be provided and used.

As mentioned under PPE clause, all these PPEs shall be defect free and regularly inspected for any defect. The full body safety harness shall have double lanyard only with max 1.8m length.

- ix. The monkey ladders shall have sufficient fall arrestors. Adequate lifelines of 8mm steel wire rope shall be provided across the work area.
- x. The HSE officer shall recommend appropriate PPEs after analyzing hazards and risks involved.

1.3 Scaffolding

All scaffolds shall be conformant to the relevant standards including IS 3696 and IS 4014 as applicable. A sketch of the scaffolds proposed to be used shall be prepared and approval of the BHEL Engineer obtained prior to construction / use. Only cup lock type scaffoldings will be allowed in site. Where cup lock type scaffolding arrangement is not feasible by the virtue of the location, in that case only pipe and clamp type scaffolding will be allowed.

- a. The scaffolding work must be carried out by a competent person, who shall train the scaffold users on safety aspects
- b. All scaffolds shall be erected / dismantled by scaffolding crew under direct supervision of competent scaffolding supervisors.
- c. All scaffolds shall be capable of supporting 4 times maximum intended load and erected on sound, rigid footing, capable of carrying the maximum intended load without settling or displacement. Bamboo scaffolding is not permitted for use on site.
- d. Each employee on the scaffold shall use an approved safety harness attached to an independent lifeline. The lifeline is to be securely attached to substantial members of the structure (not the scaffold itself) or to securely rigged lines, which shall safely suspend a worker in event of a fall.
- e. Guard rails and toe boards shall be installed on all open sides and ends of platforms more than (2) meters above ground or floor
- f. Scaffold planks must be at least 5 cm x 25 cm (2" x 10") full thickness lumber scaffold grade or better.
- g. Scaffold planks shall not span distances greater than 2.5 meters (8 feet).
- h. Scaffold planks shall extend over end supports not less than 6 inches nor more than 12 inches and be secured to the scaffold. Scaffolding and accessories with defective parts shall be immediately repaired or replaced.
- i. All scaffolding must be a minimum of two planks wide. No one may work from a single plank.
- j. Scaffold planks must be inspected before use. Planks that have been damaged must be removed from the site.
- k. Access ladders must be provided for each scaffold. Climbing the end frames is prohibited unless the design incorporates an approved ladder.
- l. Adequate mudsills or other rigid footing capable of withstanding the maximum intended load must be provided.
- m. Scaffolds more the 6 meters (20 feet) in height must be tied to the building or structure at intervals which do not exceed 4 meters (13 feet) vertically and 6 meters (20 feet) horizontally.
- n. Do not overload scaffolds. Material should be brought up as needed. Scaffolding must not be loaded in excess of its rated capacity.
- o. Barrels, boxes, kegs, blocks or similar unstable object must never be used as work platforms or to support scaffold.
- p. Where persons must work under or pass under a scaffold then a 18 gauge wire mesh screen must be installed between the toe board and guard rail.
- q. Employees exposed to overhead hazards while working on a scaffold will be protected by 5 cm (2") thick planks.
- r. Wooden/bamboo ladders shall not be allowed at any cost. Ladder's rungs shall be fitted /welded

properly. Before every use the rungs should be checked for safe use.

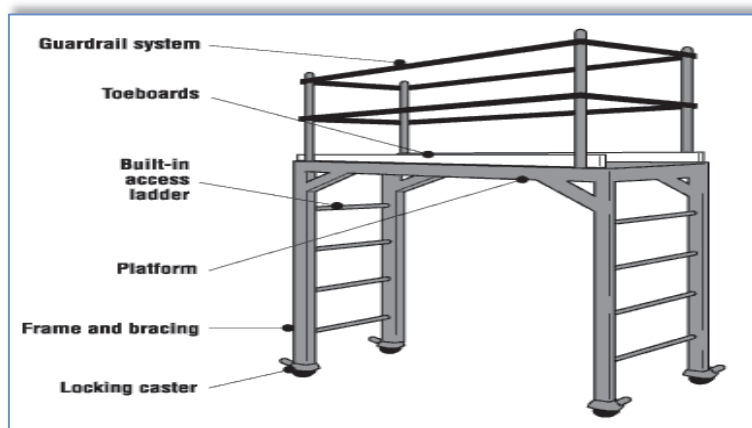
- s. Wooden scaffolds shall not be used in areas where fire / fire products are expected
- t. Ropes made of jute / Plastic and other fire prone material shall not be used to tie up scaffolding components together
- u. The platform should have permanent hand rail and mid rail with Toe board without fail.
- v. All platforms are to be tightly planked for the full width of the scaffold, except as may be necessary for entrance openings. Platforms shall be secured in place.
- w. On suspension scaffolds designed for a working load of 500 pounds, no more than two workers are permitted to work on the scaffold simultaneously. On suspension scaffolds with a working load of 750 pounds, no more than three workers are permitted on the scaffold simultaneously.
- x. **Requirements for different types of Scaffolds:**

A. Suspended Scaffold

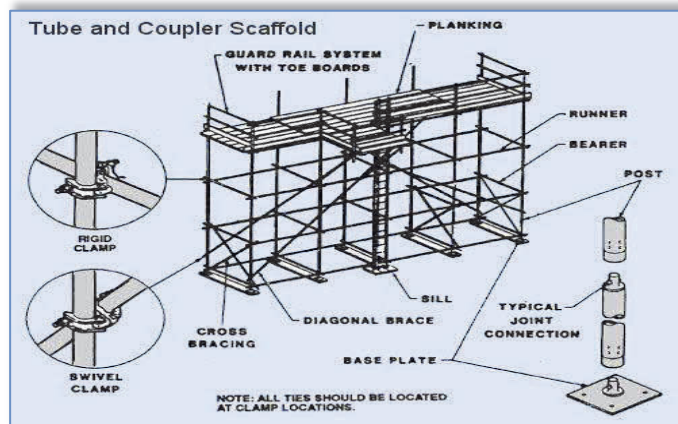
- i. Suspended scaffolds are platforms suspended by ropes, or other non-rigid means, from an overhead structure.
- ii. Requirements for use are to be preapproved by HSE Head, under a specific Permit to Work.

B. Rolling Scaffolds

- i. The height of rolling scaffolds shall not exceed three times the minimum base dimension.
- ii. The minimum base dimension of rolling scaffold will be 1.25 meters (4 feet).
- iii. Adequate help must be provided when moving a rolling scaffold.
- iv. Secure or remove all loose materials, equipment and tools before moving a rolling scaffold.
- v. No one is permitted to ride a rolling scaffold when it is being moved. Castor brakes must be locked-on when the scaffold is not being moved.



Rolling Scaffold



Tube & Coupler Scaffold

Fig. 2.3 Types of Scaffolds

1.4 Ladder Safety

A sketch of the ladders proposed to be used shall be prepared and approval of the BHEL Engineer obtained prior to construction / use

a. Safe Use of Ladders:

- i. Fall protection is required when working on a ladder above 2 meters and when climbing above nearby guardrails.

- ii. Ladders must be inspected prior to use and by a competent person quarterly, with documentation.
- iii. Use portable ladders for height up to 4 M only
- iv. Provide fixed ladders for height above 4 M
- v. Place the ladder at an angle of 75 degrees (approx.) from the horizontal (1:4)
- vi. Extend ladder at least 1 M above the top landing
- vii. Secure top and bottom of the ladder firmly to prevent displacement- anti skid lining at the bottom
- viii. Ensure that the width of the ladder is not less than 300 mm and distance between rungs is not more than 300 mm
- ix. Provide landings of minimum size 600 x 600 mm at intervals not more than 6 M for fixed ladders. Check the ladders daily for any defects
- x. Ensure that the areas around base and top of the ladder are clear. Getting on and off the ladder is more hazardous than using it. Use a mudsill if the ladder is to rest on soft, loose or rough soil
- xi. Do not use ladders of conducting material near power lines, and only use ladders near power line or other energized system with exposed parts if they are confirmed locked-out and de-energized.
- xii. Stand no higher than the fourth rung from the top for carrying out any job standing on a ladder.
- xiii. Never reach out from a ladder to perform work where your belt buckle protrudes past the ladder rung.
- xiv. Always face the ladder while climbing up or down
- xv. Maintain three-point contact while climbing up or down a ladder i.e. two hands and one foot or two feet and one hand on the ladder at all the times.
- xvi. Avoid climbing up or down a ladder while carrying anything in hands. Lift tools, equipment and materials with a rope.
- xvii. Work from portable and extension ladders near guardrail where fall exposure exists over the guardrail regardless of height, and above 2.0 mtr. heights from the working/walking surface will require the use of personal fall arrest equipment

2. EXCAVATION & CIVIL WORKS

All safety precautions shall be taken for foundation and other excavation works as per IS-3764.

2.1 Excavation

The following safety measures are to be ensured before and during excavation:

- a. All Excavation activities more than with depth of 1.22 meter or more shall require an Excavation Work Permit
- b. Check for underground utilities like electrical / telephone cables, sewage, water lines and proper care has to be exercised to protect and prevent damage to it.
- c. Electrical cables and service lines to be identified using cable detector/locator device before carrying out the excavation work
- d. Proper and adequate slope is maintained while excavating
- e. Adequate shoring or sheeting is done wherever required to prevent soil sliding
- f. Safe access through ladder or steps for exit & entry to excavation
- g. No material /excavated soil is kept within one meter from the edge
- h. Safe way is planned and provided for movement of HEM /transport equipment near excavation
- i. Safety helmet and shoes/gum boots are provided and worn by the workmen at excavation works

- j. Dewatering arrangement is made where water seepage is prevailed.
- k. Stop blocks are provided to avoid vehicles reversing into the excavated trenches
- l. Danger signs /Caution boards are displayed at work spot
- m. Hard Barricading is provided at excavated pits. It should be made of scaffolding pipe and clamp with reflective nets.
- n. All Excavated area of depth 3mtr or more is to be hard barricaded with pipe.

Soil Type	Height/Depth ratio	Slope Angle
Stable Rock	Vertical	90 deg.
Type A	¾ : 1	53 deg.
Type B	1 : 1	45 deg.
Type C	1½ : 1	34 deg.

Determining Soil Type		
Type	Description	Examples
A	Cohesive soils with an unconfined compressive strength of 1.5 tons per square foot or greater.	Clay, silty clay, sandy clay, clay loam and in some cases: silty clay loam and sandy clay loam.
B	Cohesive soils with unconfined compressive strength greater than 0.5 tsf but less than 1.5 tsf.	Angular gravel (similar to crushed rock), silt, silt loam, sandy loam and, in some cases silty clay loam and sandy clay loam.
C	Cohesive soils with unconfined compressive strength greater than 0.5 tsf or less.	Granular soils such as gravel, sand and loamy sand; submerged soil or soil from which water is freely seeping; submerged rock that is not stable.

Fig. 3.1 Excavation Reference

2.2 Piling

Ensure the following precautionary measures before starting piling works:

- a. Inspection of piling equipment by responsible person for its condition before initiating piling operation.
- b. Checklist and OCP for piling to be prepared using manufacturer's instructions and used
- c. Testing and its certification wire rope, slings, D-shackles, chain pulley blocks using in the process of piling work by competent person
- d. Adequate support and secured foundation of the piling equipment to avoid toppling
- e. Hoses should be lashed and adequately secured
- f. Proper work platform is to be provided on piling frame
- g. Safe work procedures and close supervision to prevent unsafe acts of operators/any unsafe conditions that may arise
- h. Only experienced and trained operators are engaged for the piling operation
- i. Provision of Personal Protective Equipment (PPE) like safety shoes/gumshoes/safety helmet/safety belt etc. and its use by their workmen.
- j. Special care and precautions If work is near electrical live cables/ electrical equipment
- k. Cordoning of work area to prevent un authorized entry
- l. Guarding of revolving parts
- m. Specific measures to prevent over turning of pile driver/missing of hammer/ hammer movement out of range

2.3 Batching Plant Operation

Following Safety considerations for batching plant are to be ensured:

1. Modern type batching plant should be used in which all the moving parts are protected and emergency

and safety features are incorporated.

2. Installation of external Electric moto-vibrators in the feeding hopper of all batching plants to reduce human intervention.
3. Installation of safety devices like pull-chord on both the sides of conveyor for stopping the conveyor in emergency
4. Workers carrying cement / sand to be given appropriate PPEs like respiratory masks & gloves.
5. Conveyor belt/rotating parts must be guarded properly.
6. Safety awareness shall be inculcated in workmen about the risk involved in rotating parts.
7. The agency shall ensure to erect the batching plant as per drawing including installation of all safety devices as provided by manufacturer and witnessed by BHEL Engineer in charge before starting of machine in future.
8. Safety audit to also focus on Batching plant.
9. The site shall impose penalty on the agency who has violated the safety norms as per contract.

2.4 Mobile Plant

Mobile plant includes tractors, trailers, dumpers, excavators, bulldozers, road rollers etc. for earthmoving purpose and concrete mixers, concrete transit mixtures, concrete pumps etc for concreting purpose. Due to the very nature of their function and movement in difficult terrains, congested areas, working in tandem with manual work and other operations the danger is inherent.

Automatic reverse camera with reverse horn connected with reverse gear is compulsory for all moving machineries.

Following Safety measures to be ensured for Mobile Plant:

- a. Where movement around site is involved, routes should be planned, obstruction free and well maintained
- b. Observe specified speed limits
- c. Operating personnel should be aware of associated risks and its preventive measures
- d. Only experienced, trained and authorized persons with valid license (wherever applicable) should operate the mobile equipment/vehicles
- e. Provide and use Warning lights and reverse horn for cautioning the people around
- f. Operation should be on level and stable ground with adequate working clearance.
- g. Loading of out riggers/stabilizers should be well within safe ground bearing capacity
- h. No person should be on equipment or vehicle during loading and unloading of material
- i. Operators should be protected by warning barriers or switching off power when working in close proximity of overhead power lines
- j. The equipment /vehicles should be well maintained and provided with effective brake system and other safety devices (wherever require)
- k. Rotating parts of equipment should be adequately guarded
- l. Provide necessary personal protective appliances and ensure its use by the operating personnel Ensure effective measures at source to control harmful emissions, dust, fumes contaminating atmosphere and cause health hazards to the operators and people in the vicinity.
- m. No overloading/over stressing of vehicles/plant is allowed
- n. Hoses, pipes, receivers, gauges and valves involved in carrying out hydraulic fluid/ compressed air should be checked for leaks and tested prior to operation.

- o. Adequate safe clearance for swing and movement is to be judged during operation of Concrete mixer
- p. Setting of machines on firm and level ground with wheel locked to prevent movement of machine
- q. Proper instructions and Special precautions are to be ensured to prevent entry in to the danger zone of projectile of bucket while dropping bucket
- r. Operator leaving work spot should ensure that the equipment/vehicle is kept in neutral position and place on firm and level ground.
- s. The hand brake should be kept in position and block road wheels as additional safety measure
- t. Blades/buckets should be kept low while moving
- u. The dozer blades should not be used as brakes except in emergency
- v. The ground should be examined for its bearing capacity and general safety especially when operating road roller at the edges of slopes, embankments.
- w. The roller should not be moved downhill with the engine out of gear
- x. If operating near excavations the following precautionary measures are to be ensured
- y. Barricading, edge protection to prevent fall of persons/vehicles over running while reversing etc.
- z. Suitable support system and adequate allowance to avoid the danger of side collapsing
- aa. Experienced signaler /attendant should be always accompanied with operator/driver for proper direction /signal and also to caution others in the working Zone during operation of mobile plant

2.5 Concrete Vibrators

- a. Revolving parts/belt drives should be adequately guarded and Vibrating unit shall be completely enclosed and have suitable overload relays and effectively earthed
- b. Ensure sufficient length of cable to the Vibrator.
- c. Ensure electric starters and other accessories are firmly fixed adequately supported
- d. Ensure locking of needle load while inserting needle in to the vibrator,
- e. Ensure periodical lubrication and maintenance

2.6 Concrete Mixers

- a. Setting of machines on firm and level ground with wheel locked to prevent movement of machine
- b. Proper instructions and Special precautions are to be ensured to prevent entry in to the danger zone of projectile of bucket while dropping bucket

3. WELDING & GAS CUTTING SAFETY (HOT WORK)

- a. All Hot Work shall require a Hot Work Permit
- b. Inbuilt Voltage Reduction Device (VRD) equipped arc welding machine will only be allowed for work.
- c. There shall be flash-back arrestors conforming to IS-11006 at both cylinder and burner ends. Damaged tube and regulators must be immediately replaced.
- d. All safety precautions shall be taken for welding and cutting operations as per IS-818.
- e. When possible, items to be welded, cut, heated, etc. shall be moved to a safe location free of combustible or flammable material. If this is not possible, then all combustibles/ flammables that can be removed from the area shall be removed within a 35-foot circumference and a positive means of confining arcs and sparks generated by the process shall be ensured and additional person(s) shall be stationed as fire-watch for the area(s) still exposed, along with obtaining the Hot Work Permit as applicable.
- f. Appropriate fire-fighting equipment is to be available in close proximity of any welding and gas cutting operations at all times suitable for the type of Fire.

- g. Drums, tanks, and similar containers that have contained flammable or toxic material shall not be welded, cut, or heated until they have been made safe by water filling, thorough cleansing or similar accepted practices. The container shall also be ventilated during the welding, cutting, or heating process.
- h. Proper ventilation is required for any welding or torch operations performed in a confined space.
- i. Any welding or gas cutting operations performed on metals of toxic compounds or coating such as zinc, stainless steel, lead, cadmium, chromium, and beryllium shall be properly ventilated and/or proper respiratory protection shall be worn by any person that could be exposed to fumes, vapors, and gasses created by the welding and gas cutting processes.
- j. Wherever it is practical, all arc welding operations shall be shielded to prevent direct light rays or sparks from contacting persons in the vicinity or from reaching areas normally used to travel through or into the vicinity. Where this is not practical, persons who shall be in the area are to use proper eye and skin protection. Other persons who are not participating in the welding or gas cutting operations are not to be allowed into the hazard zone.
- k. Welders and other employees who are exposed to arc welding radiation shall wear suitable clothing and protective apparel to prevent burns and other types of ultraviolet radiation damage to the skin.
- l. Arc welding machines shall be shut down when being moved or when they are not in continuous use. Electrode holders left unattended shall have electrodes removed and shall not be left where they might contact employees or conducting objects.
- m. Arc welding power supply cable shall be of proper rating and material, e.g. copper.
- n. Welders shall guard against allowing materials adjacent to or behind them to reflect radiation back toward them or towards others in the area. Reflected radiation can cause skin burns and eye flash burns.
- o. Valve caps shall be in place when cylinders are not in use. Valve caps shall never be used for lifting the cylinder vertically.
- p. Torches shall only be lit by approved strikers; never with matches, cigarette lighters, or hot-work.
- q. **Splatter / Slag Collector:**

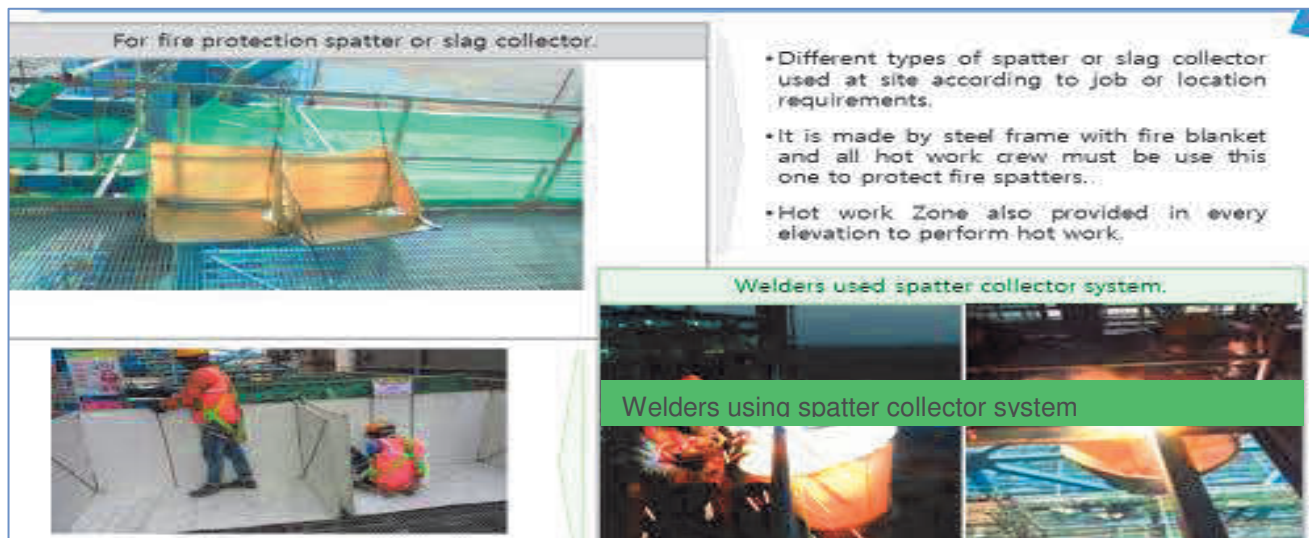


Fig. 4.1 Splatter / Slag Collector

While carrying out job at height, the sparks or molten slag shall be prevented from falling down by putting a fire-resistant (non-asbestos) sheet or patter/ slag collector or even MS Sheet. The passage of falling sparks

or molten slag shall be barricaded till ground floor and any cable/ tubes/ any other objects interfering in the passages shall either be removed or covered with Fire-resistant sheet or MS Sheet.

r. COMPRESSED GAS

- i. All cylinder valves shall be closed when any work is finished and when any Cylinders are empty or being moved. Valve protection caps shall be placed and secured properly before gas cylinders are transported, moved or stored.
- ii. Compressed gas cylinders shall be secured in an upright position with chain or appropriate means during storage & use. However, a trolley shall be used for transportation.
- iii. Compressed gas cylinders shall always be secured from tipping or falling, whether in use, in storage or in transit. The cylinders shall always be secured upright, except during times when actually being hoisted or carried.
- iv. When cylinders are transported by powered vehicle they shall be secured in a vertical position.
- v. Regulators shall be removed when cylinders are not in use or are in transit, unless the cylinder is firmly secured on a special carrier designed for this purpose.
- vi. Gas cylinders are not allowed to be used in man-basket when occupied.
- vii. Cylinders containing oxygen or fuel gasses shall not be taken into confined spaces.
- viii. Oxygen cylinders shall be stored a minimum of 6 meters from fuel gas cylinders or shall have an approved firewall between them.
- ix. All cylinders shall be kept at a safe distance from welding or cutting operations or shielded from arc/sparks / slag.
- x. All cylinders shall be placed where they cannot become part of the electrical circuit.
- xi. Oxygen and acetylene shall not be stored together. Oxygen must be separated from acetylene (or ANY fuel gas) or combustible material by at least 20ft or a barrier with a 30-minute fire resistance rating.
- xii. All Cylinders should be stored upright in a designated area with labels for the type of gas. All applicable precautions to be ensured during storage
- xiii. Oxygen and fuel gas regulators, hoses and associated equipment shall not be altered and shall be in proper working order while in use.
- xiv. Compressed air can be extremely dangerous if allowed to penetrate the skin. As such, the use of compressed air to clean off yourself or other workers shall be strictly prohibited.
- xv. All gas cylinders shall be stored in upright position. Suitable trolley shall be used for cylinder movement, the design of which shall be submitted to BHEL Engineer for approval.
- xvi. No of cylinders shall not exceed the specified quantity as per OCP
- xvii. Cylinders shall be moved by tilting and rolling them on their bottom edges. They shall not be intentionally dragged, struck or permitted to strike each other violently.
- xviii. All cylinder should be kept only in cylinder trolley.
- xix. Cylinder shall be transported in upright vertical position by suitable mean.

4. LIFTING & RIGGING SAFETY

- a. All Heavy / Complex Lifting operations as defined in Clause 6.12 shall require a Lifting Work Permit. A written rigging procedure and plan must be prepared for all individual heavy/ complex lifting operations.

- b. All the cranes and lifting tools & tackles shall be inspected on daily / weekly basis as well as monthly by expert as per applicable formats.
- c. In addition, inspection / certification as mandated by law shall be carried out wherein these shall be tested and certificates of fitness shall be obtained from 3rd party State Govt. approved competent agency before deploying at site and later periodically. BHEL shall be given advance intimation of any such inspections
- d. The last date of Third-Party Inspection and the next Due date shall be conspicuously displayed on all cranes. A copy of certificate shall be pasted on operator's cabin of all the lifting equipment.
- e. Specifically designed heavy steel plates lifting clamps shall be used for lifting heavy metal sheets. Manmade lifting clamp chapa shall not be used for lifting/shifting of plates.
- f. Following requirements shall be mandatorily followed, wherever applicable:
 - i. The manufacturer's instruction for maintenance shall also be followed. All safety measures shall be followed.
 - ii. All tools tackles, lifting appliances; material-handling equipment etc. used by the subcontractor shall be of safe design and construction.
 - iii. The operators, slingers and signalers shall be qualified as per IS 13367 (part-1):2003 "Safe use of cranes- code of practices".
 - iv. There shall be a person responsible for co-ordination among cranes where multiple cranes are used, and lifting over load chart of the crane to be avoided.
 - v. Mobile phone should be banned for crane operator and lifting operation. Only walkie talkie shall be allowed in rigging/Lifting purpose.
- g. Lifts/Movements between 5 Tons and 20 Tons:
 - i. Shall include a rigging plan, detailing schematic representation of the handling/lifting operations that must be included on the Method Statement.
 - ii. When performing similar lifts of identical items, only one rigging plan need be prepared, provided each of the lifts can be performed in accordance with the rigging plan.
- h. Lifts/Movements Less Than 5 Tons:
 - i. An equipment rigging plan is not required for lifts less than 5 tons, safety measures are covered in the JSA. This could change as per BHEL requirement

i. Personnel Lifts (Man-Basket / Jhoola):

The design of personnel man basket shall be submitted to BHEL Engineer for approval before use. Relevant permit (Height work & others as applicable) shall be completed prior to lifting any people, along with a rigging plan.

- i. A separate Lifeline / fall arrestor anchored to a fixed structure outside of Jhoola shall be provided for the workers inside the basket. All occupants of the basket shall have Safety Harnesses equipped with rope grabs, which are to be hooked to the vertical lifeline.
- ii. Man-basket shall be used where access through ladders or scaffolding is not feasible.
- iii. Man-baskets shall be designed and engineered by a manufacturer (job made man-baskets are not allowed, unless designed and tested by a certified engineer), and built robust with MS Angles and flats or plates or channels only.
- iv. Guard rails top and mid, must be in place and screened-in to avoid material from falling out of

basket. The factor of safety shall be 200%.

- v. It shall have a door with double latches and shall open inside. Anchor points shall be identified within the man-basket.
- vi. The man-basket shall be thoroughly inspected and load tested and a trial run performed without personnel before being put to job.
- vii. It shall be treated as a lifting tool (T&P Item) and shall undergo same certification cycle and inspection as other lifting equipment.
- viii. An additional sling of required lifting capacity shall be fixed the man-basket main lifting point and attached to the crane above the ball or block.
- ix. While lifting man-basket, the crane shall maintain a uniform speed of lift without any swing.
- x. Once man-basket reaches the destination, the lift brakes shall be locked as long as the basket
 - a. remains at that point. The same care shall be taken in its descent.
- xi. As for hanging man-basket, the same shall be hung off a rigid structure with help U-shaped handle welded to man-basket. This shall be tested once in a year by a competent person.
- xii. Use of Rebar steel for making and monkey-ladder must be avoided.

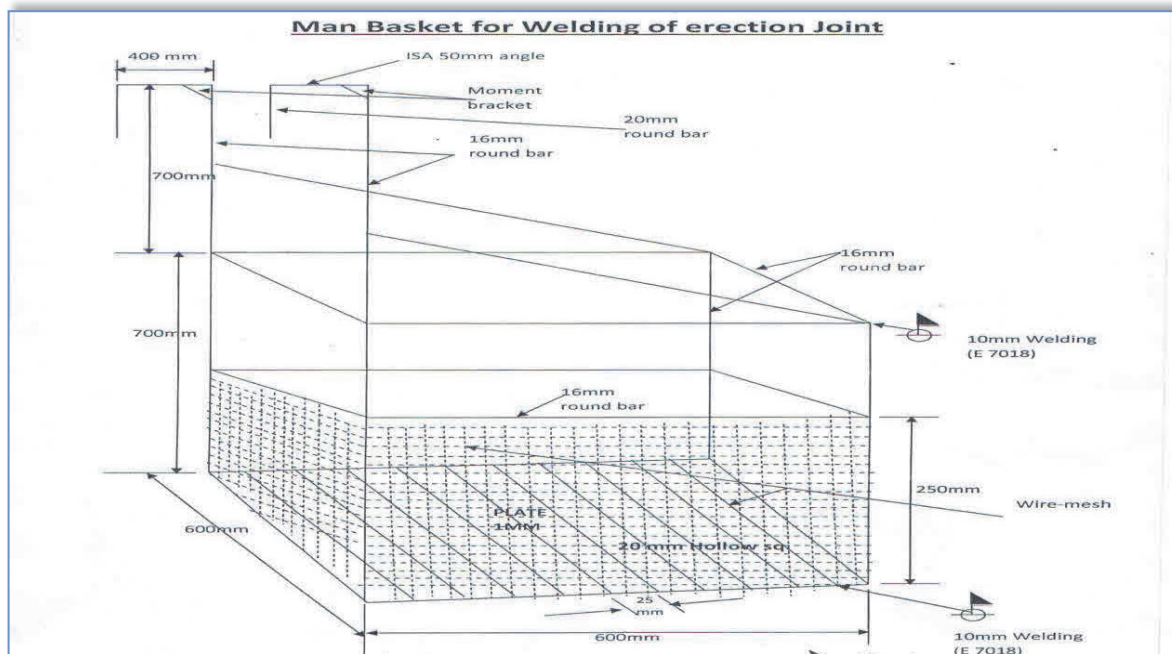


Fig. 5.1 Man Basket for Welding Erection Joint

4.1 Cranes & Hoisting Equipment:

This section provides the guidelines to ensure proper rigging and lifting activities are accomplished safely and in accordance with applicable specifications, codes, and regulations.

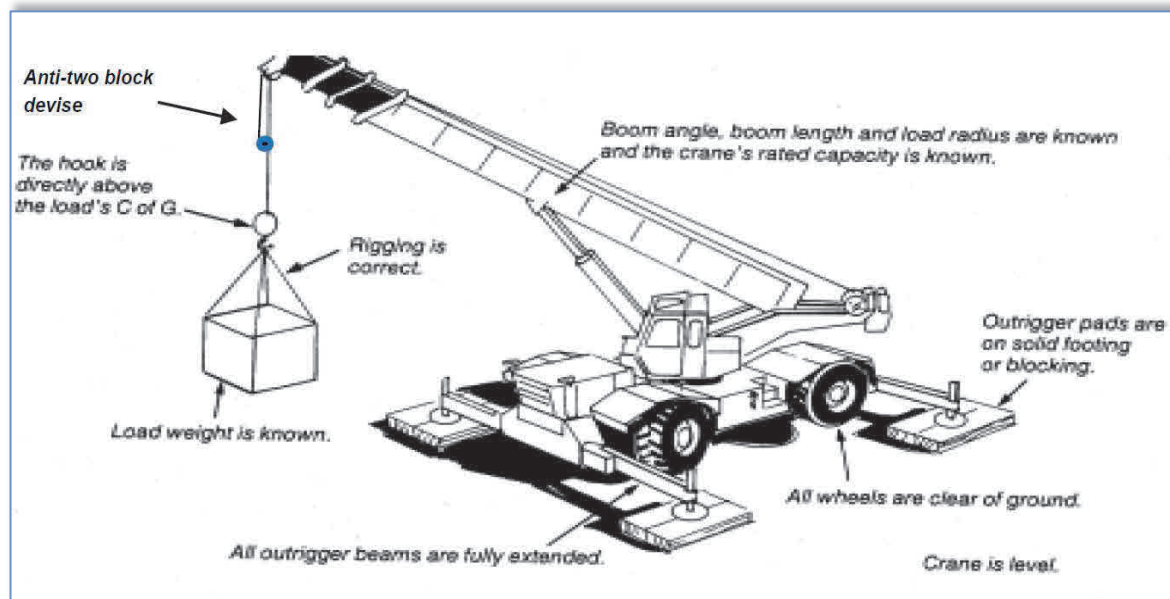


Fig. 5.2 Proper Crane Setup

- a. On every crane or piece of hoisting equipment notices of all rated load capacities, recommended operating speeds, and any hazard warnings or special instructions shall be conspicuously posted. All instructions and warning shall be visible from the equipment operator's station.
- b. Cranes shall have an Anti-Two-block safety device installed
- c. All mobile cranes shall have overload and backup alarms, load angle indicators and limit switches
- d. All areas within swing radius of cranes that are potentially accessible by pedestrian, vehicular, or equipment movement shall be barricaded to prevent anyone or any vehicle or equipment from being struck by the crane or hoisting equipment, or its load(s).
- e. No part of the lifting equipment or its load shall be within the distance as specified in the Indian Electricity Act from an energized power line
- f. Cranes shall have annual certified third-party inspection and be inspected before use by the operator. Any defects shall be corrected before use. Logs of crane inspection shall be kept with the crane.
- g. Make certain that the rigging personnel, material, and equipment have the necessary capabilities for the job and are in safe condition.
- h. Communicate with person(s) directly responsible for accomplishing the work and / or work area to establish requirements/responsibilities and make certain that all preparatory work is complete.
- i. Mats/Pads must be used on all lifting equipment, equipped with out riggers.
- j. Pick and carry must have the load secured to the rig in front.
- k. Only BHEL Approved Plate Lifting Spreader Beam configuration shall be used (Sample in Fig. 11.3.5.3)
- l. Crane operators must follow the following:
 - i. Pass an annual Operator's Physical examination
 - ii. Carry a valid training certification card at all time while operating issued by the Govt. or other recognized institute.

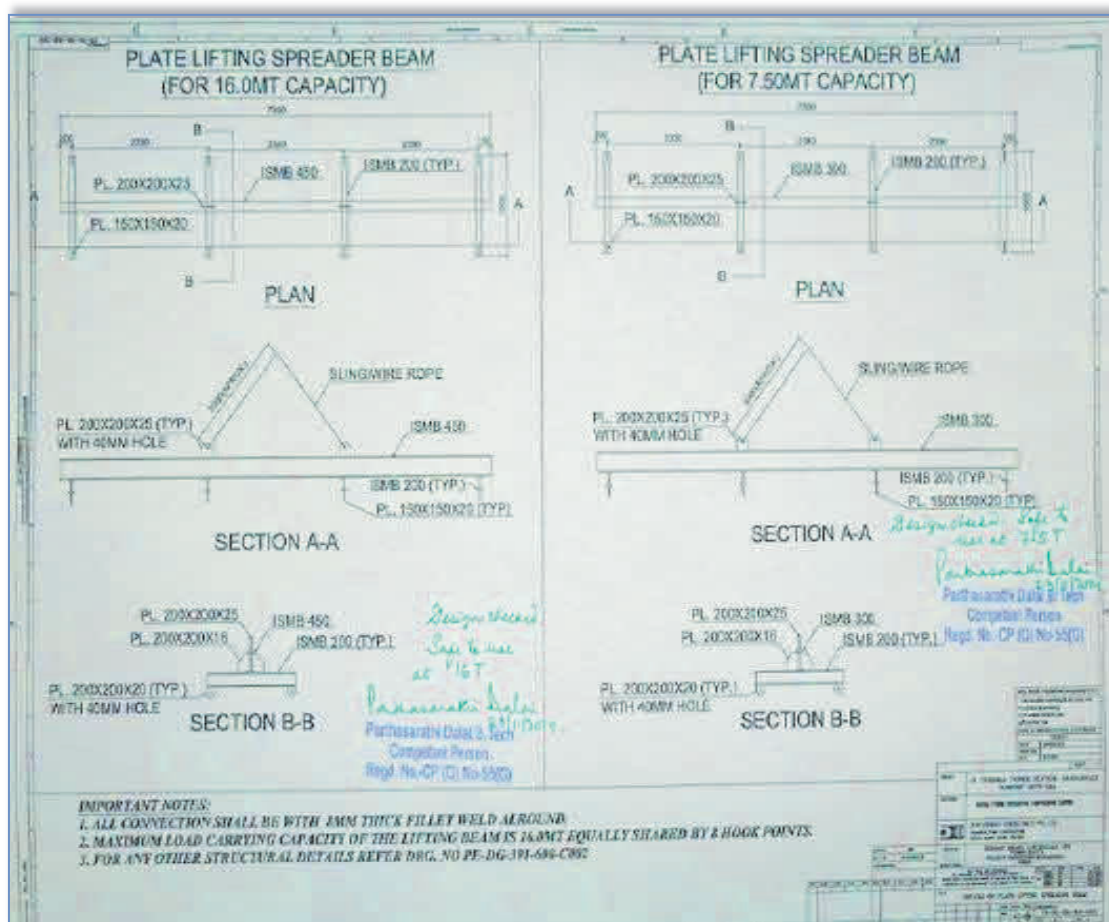


Fig. 5.3 Typical Plate Lifting Spreader Beam Configuration for 7.5 MT and 15 MT Loads

m. Safe Rigging Practices

- Review the planned operation and requirements with the operator and rigging crew.
- Ensure a pre-lift meeting is conducted with crane operator, tagline operator, signal personnel, and Safety Manager.
- Designate a qualified person from the rigging crew to observe clearance of the equipment and give timely warning for all operations where it is difficult for the operator to maintain the desired clearance by visual means.
- Clear the lift area of all unnecessary personnel.
- Hydras shall only be allowed for loading & unloading works & shall not be allowed to move with load

n. Rules for Safe Rigging

- Use loops, thimbles and corner pads to prevent damage to slings when used around corners or on cutting edges.
- Never allow wire rope to lie on the ground for any length of time or on rusty steel or near solvents, chemicals or corrosive substances.
- Slings must not be pulled from between or under loads with load resting on the sling.
- Keep all rope away from flame cutting or welding operations.
- Never use rope as sling material.
- Never wrap a wire rope completely around a hook.

- vii. Do not bend wire rope near any attached fitting.
- viii. The sling must be selected to suite the most heavily loaded leg rather than the total weight when using multi-legged sling to lift loads in which one end is heavier than the other.
- ix. When using 3 and 4-legged sling configurations, any two legs must be capable of supporting the entire load.
- x. Where possible, wire rope choker hitches must include a shackle with the eye around the shackle pin to prevent breaking wires of the choke. The choker hitch must be “snugged down” prior to lifting, not after tension is applied.
- xi. Unless authorized by the hook manufacturer when more than two rope eyes are placed over a hook, install a shackle, pin resting in the hook, and place the rope eyes in the bowl of the shackle.
- xii. Properly rig all loads to prevent dislodgment of any part.
- xiii. Use guide ropes or tag lines to prevent the rotation or uncontrolled motion of the load when necessary.
- xiv. Loads must be safely landed and properly blocked before being unhooked and unslung. Tag lines must not be used in situations that jeopardize the safety of the lift.
- xv. Lifting beams must be plainly marked with their weight and designed working load and must only be used in the manner for which they were designed.
- xvi. The hoist rope or chain must never be wrapped around the load. The load must be attached to the hook by slings or other rigging devices that are adequate for the load being lifted.
- xvii. Multiple part lines must not be twisted around each other.
- xviii. The hook must be brought over the center of gravity of load before the lift is started.
- xix. If there has been a slack rope condition, determine that the rope is properly seated on the drum and in the sheaves prior to lifting.
- xx. Keep hands away from pinch points as the slack is being taken up.
- xxi. Leather gloves are recommended when handling wire rope.
- xxii. Avoid impact loading caused by sudden jerking when lifting or lowering. Lift the load gradually until the slack is eliminated.
- xxiii. Never ride on a load that is suspended.
- xxiv. Avoid allowing the load to be carried over the heads of any personnel.
- xxv. Never work under a suspended load until the load has been adequately supported from the floor and all conditions have been approved by the supervisor in charge of the operation.
- xxvi. Never leave a load suspended unless emergency evacuation is required.
- xxvii. Never make temporary repairs to sling.
- xxviii. The capacity of a sling is determined by its angle, construction, type of hitch and size.
- xxix. Never lift loads with one leg of a multi-leg sling until the unused legs are made secure.
- xxx. Never point load a hook unless it is especially designed and rated for such use.
- xxxi. Make certain that the load is broken free before lifting and that all legs are taking the load.
- xxxii. When using two or more slings on a load make certain all slings are made from the same materials.
- xxxiii. Lower the loads on to adequate blocking to prevent damage to the slings.
- xxxiv. Materials and equipment being hoisted must be loaded and secured to prevent any movement which could create a hazard in transit.

- xxxv. The weight of the hook, load block and any material handling devices must be included when determining crane capacity.
- xxxvi. Calculated weights cannot exceed load chart without written approval.
- xxxvii. Personnel must be completely clear of loads being picked up or set down by crane. Tag lines will be used to control the loads. Loads must not be touched by hand while placing/ moving.

o. Slings

The following are rules for safe use of synthetic slings:

- i. Synthetic slings must be marked to show the rated capacity for each type of hitch and type of web material.
- ii. Nylon web slings must not be used where fumes, vapors, sprays or mists or liquids of acids or phenolic are present. Web slings with aluminum fittings must apply in this category.
- iii. **Synthetic web slings must be removed from service and destroyed if any of the following conditions are present:**
 - a. Acid or caustic burns
 - b. Melting or charring of any part of the sling surface
 - c. Snags, punctures, tears or cuts
 - d. Broken stitches
 - e. Distortion of fittings
 - f. Synthetic web slings of polyester or nylon must not be used at or come in contact with temperatures in excess of 82°C
 - g. Polypropylene web slings must not be used at or come in contact with temperatures in excess of 93°C
 - h. Insulated hooks must be tested yearly to ensure insulation integrity to at least manufacturer's specifications.

p. Wire Rope Slings must be removed from service and destroyed if any of the following conditions are present:

- i. In (10) randomly distributed wires broken in one (1) rope lay, or five (5) broken wires in one (1) strand in one (1) rope lay.
- ii. Wear or scraping of one-third the original diameter of outside wires.
- iii. Kinking, crushing, bird caging or any other damage resulting in distortion of the wire rope structure such as:
- iv. Evidence of heat damage.
- v. End attachments that are cracked, deformed worn.
- vi. Corrosion of the rope or end attachments.

q. Metal mesh slings must be immediately removed from service if any of the following conditions are present:

- i. A broken weld or broken brazed joint along the sling edge.
- ii. Reduction in wire diameter of 25 percent due to abrasion or 15 percent due to corrosion.
- iii. Lack of flexibility due to distortion or corrosion.

r. Requirements of Plate Clamps:

- i. The rated load of the plate clamp must be marked on the main structure.

- ii. Care must be taken to make certain the load is correctly distributed for the plate clamp being used.
- iii. Do not allow load or plate clamp to come into contact with any obstruction.
- iv. The plate clamp must not be used for side pulls or sliding the load.
- v. When lifting stainless steel or special alloys, ensure plate clamp is designed for use on the specific metal.

s. Signaling Practices:

- The "slinger" is responsible for attaching and detaching the load to and from the crane. He shall:
 - have received appropriate training on general safe lifting operations;
 - be capable of selecting lifting gears suitable for the loads;
 - liaise with the operator and direct the movement of the crane safely.
- The "signaller" is responsible for relaying the signal from the slinger to the crane operator. He shall:
 - have received appropriate training on general safe lifting operations;
 - be able to direct the movement of the crane and loads.

Suggested hand signals



Note: During the lifting operation, either the slinger or signaller shall communicate with the operator. Other communication methods (e.g., wireless walkie-talkies, telephones, etc.) may also be used.

Fig. 5.4 Recommended Signaling Practices

5. DEMOLITION WORK

Before any demolition work is commenced and also during the process of the work the following shall be ensured, besides using the Work Permit:

- a. All roads and open areas adjacent to the work site shall either be closed, suitably protected or restricted for movement
- b. No electric cable or apparatus which is liable to be a source of danger nor a cable or an apparatus used by the operator shall remain electrically charged.

- c. All practical steps shall be taken to prevent danger to persons employed from the risks of fire or explosion or flooding. No floor, roof or other part of the building shall be so overloaded with debris or materials as to render them unsafe.

6. T&PS GENERAL

- a. All T&Ps/ MMEs should be of reputed brand/appropriate quality & must have valid test /calibration certificates bearing endorsement from competent authority of BHEL.
- b. Subcontractor to also submit monthly reports of T&Ps deployed and validity test certificates to BHEL safety Officer as per the format/procedure of BHEL.
- c. Tagging and punching in all lifting tool is compulsory with SWL, sr. no. and due date.
- d. All T&Ps shall be inspected by authorized Third Party agency as per applicable frequency. BHEL shall be kept informed of any such scheduled inspection
- e. All T&Ps shall be internally inspected in each quarter and colour coded.

7. CHEMICAL HANDLING

- a. Displaying safe handling procedures & MSDS for all chemicals such as lube oil, acid, alkali, sealing compounds etc. at work place.
- b. Where it is necessary to provide and/or store petroleum products or petroleum mixture & explosives, the subcontractor shall be responsible for carrying out such provision / storage in accordance with the rules & regulations laid down in the relevant petroleum act, explosive act and petroleum and carbide of calcium manual, published by the chief inspector of explosives of India. All such storage shall have prior approval if necessary from the chief inspector of explosives or any other statutory authority. The subcontractor shall be responsible for obtaining the same.
- c. The used containers of chemicals shall be segregated and disposed of suitably
- d. In case the used containers need to be re-used, all traces of the chemical to be removed by thorough cleaning with detergents etc. under trained supervision

8. ELECTRICAL SAFETY

- a. Only electricians licensed by appropriate statutory authority shall be employed by the subcontractor to carry out all types of electrical works. The subcontractor shall maintain adequate number of qualified electricians to maintain his temporary electrical installations.
- b. No PDB or any other distribution board shall be more than 03 (three) years of purchase. Only modern PDB with industrial sockets as shown in layout below to be allowed to use at site.
- c. Power supply to all equipment at site to be routed through MCBs of appropriate rating. A 'Power Supply Distribution Plan' shall be prepared and submitted to BHEL Engineer for approval
- d. All power supplies through cables shall be underground or overhead with height > 3mtrs.
- e. All power distribution boxes shall be locked and the key controlled by site management of concerned subcontractor.
- f. All individual equipment & tools at site shall be powered through Earth Leakage Circuit Breakers of 30 mA sensitivity.
- g. These MCBs and ELCBs shall be regularly tested as per Clause 14
- h. All fuses and fuse wires shall be of standard size and rating.
- i. All electrical appliances used in the work shall be in good working condition and shall be properly double earthed other than armour earthing.

- j. All extension boards shall have separate switches for all sockets / connections.
- k. All portable electric tools used by the subcontractor shall have safe plugging system (industrial top & socket) to source of power and be appropriately earthed.
- l. Providing adequate no. of 24 V sources and ensure that no hand lamps are operating at voltage level above 24 Volts especially in confined spaces like inside water boxes, turbine casings, condensers etc.
- m. Electrical appliance shall have proper earthing and for appliances equal to & more than 415V shall have two separate earthing (as per IS-3043-1987)

n. Portable Electric Lights

- i. Portable electric lights used in wet or potentially wet locations must be either low voltage type (24 volts or less) or protected by a GFI (ground fault interrupter).
- ii. They must be visually checked before each use and periodically while in use to assure their original integrity is maintained.
- iii. Cords with cuts, breaks, deep abrasions, etc. shall be taken out of service immediately.
- iv. Repairs to extension cords shall only be performed by qualified/ licensed electricians.
- v. Must not be allowed to lie in wet or potentially wet areas.

o. Underground Cables:

- i. Every electric line or cable of unknown origin that is discovered or exposed during a digging, drilling, probing, or similar operation is to be considered as energized and life threatening.
 - ii. The senior company employee on the site will ensure that all necessary safety precautions are taken in order to isolate the line from all workers and the public.
 - iii. Such precautions may include halting the operation if appropriate.
 - iv. The senior company employee on the site is to then contact the proper authorities to have the line identified and either confirmed to be abandoned and/or made safe for continuing the work.
 - v. Any and all underground lines that are discovered or become severed must be considered energized on both sides, and be treated accordingly.
- p. Details of earth resource and their test date to be given to BHEL safety officer as per the prescribed formats of BHEL
 - q. The subcontractor shall use only properly insulated and armoured cables and conform to the requirement of Indian Electricity Act and Rules for all wiring, electrical applications at site.
 - r. BHEL reserves the right to replace any unsafe electrical installations, wiring, cabling etc. at the risk & cost of the subcontractor.
 - s. No maintenance work shall be carried out on live equipment
 - t. Adequate precautions shall be taken to prevent danger for electrical equipment. No materials on any of the sites of work shall be so stacked or placed as to cause danger or inconvenience to any person or the public
 - u. The subcontractor shall carefully follow the safety requirement of BHEL/ the purchaser with the regard to voltages used in critical areas.
 - v. Wiring and Branch Circuits Must be protected by a proper amperage over-current device such as a HRC fuse or circuit breaker. Such installations must be located so as to prevent physical damage to the wire conductors & panels.

- w. The sub-contractor shall supply modern power distribution board of different combination (1-phase & 3-phase). All the distribution of power should be through modern PDB. Equipment drawing is mentioned below.

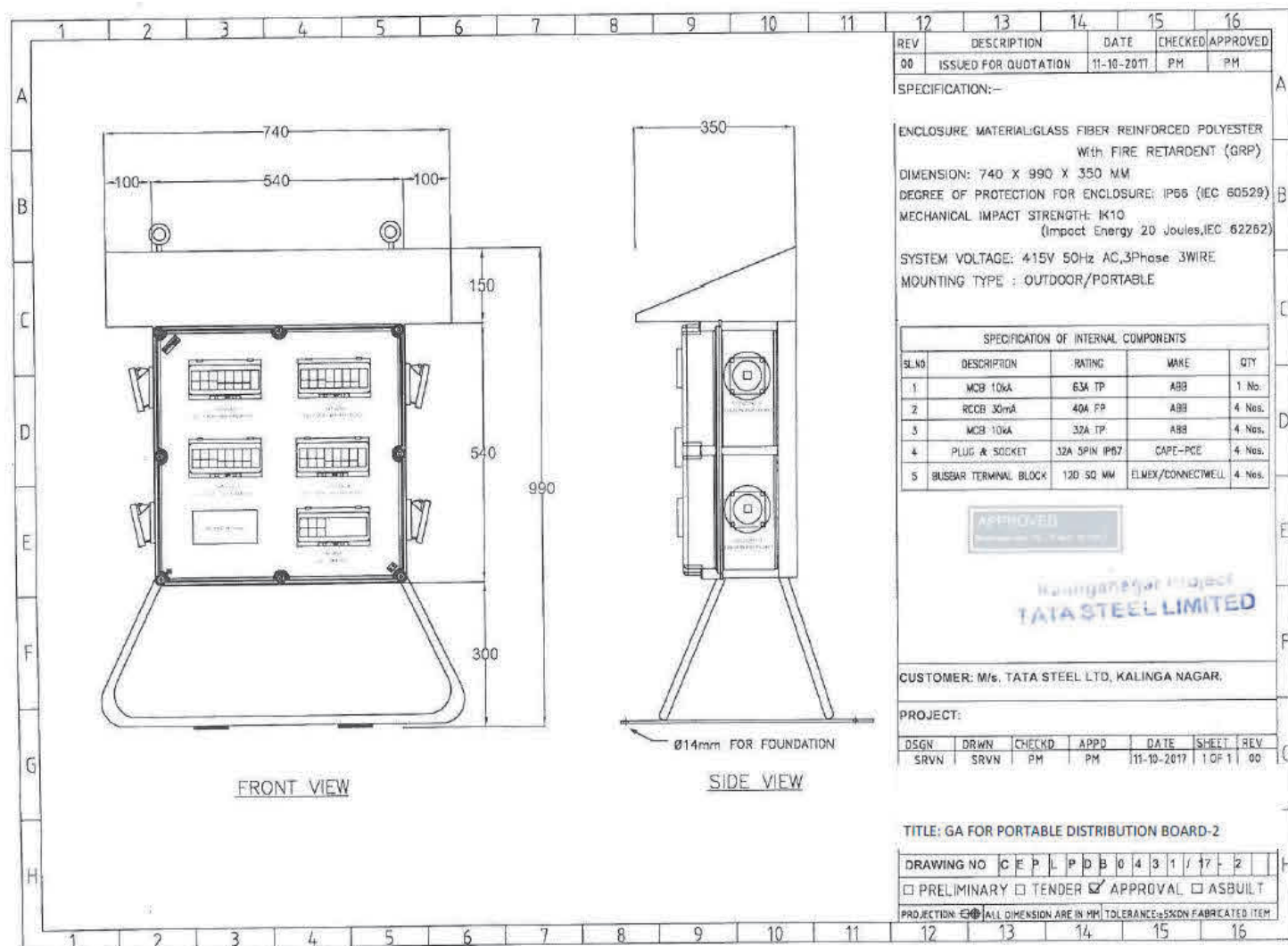


Fig. 9.1 Layout of a modern Power Distribution Board

x. General Electrical Safety

- In general, equipment or machinery being moved or transported must maintain minimum clearances of 25 ft. to all power lines.
- TAG IN/ TAG OUT must be in force in Switch Room and all Distribution Boxes for live power line. The authorized person's name and contact no shall be displayed
- Ensure "double insulated" three - core cables and three pin connectors are used and are properly ground "all insulated" types, all electrical tools and appliances must be manufactured for industrial use.
- All connections shall be electrically and mechanically sound and properly insulated. Taped joints are not permitted. Connections to socket outlets must be made with proper plugs (industrial top and socket).
- Splices in electrical cords are not permitted. Repairs must be made at the socket connection and retain the same mechanical and dielectric condition of the original connection.

- vi. Damaged or defective electric tools, equipment and extension cords, etc. must not be used and shall be tagged out of service, removed from the work area and taken back to stores.
- vii. Only licensed electricians are authorized to repair and work on electrical equipment. Tampering with electric tools or equipment by others could result in termination.
- viii. Temporary electric cabling should be elevated 2.2 meters above the floor/ground or covered for protection. It must be kept clear of walkways and other locations where it may be exposed to damage or create a tripping hazard.
- ix. Energized wiring in junction boxes, circuit breaker panels and similar places must be covered and locked at all times.
- x. Areas with live high voltage wires or terminals must be barricaded against entry and warning signs posted Danger – High Voltage and Authorized Personnel Only.
- xi. Personnel should never work on energized equipment, de-energizing (lockout/tag out) the equipment is always the first requirement.
- xii. The lockout and tag out procedure will be used when testing or working on, or around, energized installation.
- xiii. Working around energized equipment should never be done alone. A second electrician must always be available for assistance.
- xiv. If lockout/tag out of the work is infeasible (must be demonstrated), work on energized electrical circuits must be approved by the Site In-charge. All safety precautions necessary must be taken, PPE use must be evaluated per the exposure and used, i.e high/low voltage gloves, insulated shoes, overcoats/aprons, face shields, and other protective equipment like insulated tools, blankets, mats, etc. must be used.
- xv. The welding machines earth leads shall be properly fixed without loose contacts. The earth cable only has to be used. No steel members shall be used as earth leads.
- xvi. Electrical crews must be qualified for the equipment and tools they work on, including being trained in Cardio-Pulmonary Resuscitation (CPR) methods and First Aid for rendering help in the event of electric shock.

y. Qualified Persons for Electrical Works

(One who is trained and wiremen licensed to Govt. of Respective State and familiar with the construction, operation and safety hazards of the equipment upon which they are permitted to work.)

- i. Qualified persons are intended to be only those who are well acquainted/experienced with and thoroughly conversant in the electric equipment and electrical hazards involved with work being performed.
- ii. Only qualified persons may be permitted to work on or near exposed energized parts. Such persons are required to have been trained in three specific areas:
- iii. Qualified persons must be capable of working safely on energized circuits;
- iv. Must be familiar with the proper use of special precautionary techniques and procedures bases on equipment and exposure; and
- v. Must be familiar with required personal protective equipment, insulating and shielding materials, and insulated tools.

- vi. Qualified persons are expected to be able to evaluate unknown situations and adjust their activities in such a way that only safe work practices are used. Such behavior is the responsibility of the qualified person.
- vii. It is possible and likely for an individual to be 'qualified' with regard to certain equipment in the work place, and unqualified on other equipment they must know their limitation and stop work if not qualified on what equipment they were to work on.
- viii. An employee who is undergoing on-the-job training, who, in the course of such training, has demonstrated an ability to perform duties safely at his or her level of training, and who is under the direct supervision of a qualified person is considered to be a qualified person for the performance of those duties. The process must be documented as proof.

z. Mandatory PPEs of electrical work on LV & HV

- i. HV arc flash suit with protective hood (for protection of face and head) as specified for hazard risk category-4 in NFPA-70E or similar IS specification for working on HT switch gear (for all voltage >690 V) to the concerned licensed electrician or competent person.
- ii. LV arc flash jacket/FR as specified for hazard risk category-4 in NFPA-70E or similar IS specification having ATPV rating of 8.5 to 9 cal/cm² for working on LV (>260V and ≤690V) to the concerned licensed electrician or competent person.



- iii. The LV arc flash jacket as shown above shall be worn continuously while working on LV (>260V and ≤690V). The color specification of LV arc flash jacket should be blue.
- iv. Electrical hand gloves should have following specification: Flame resistance, arc flash and cut protection of voltage rating (>260V and ≤690V).
- v. Electrical safety over shoe of relevant IS make for foot protection of licensed electrician or competent person while working in HV & LV line or equipment.

9. USE OF HAND TOOLS AND POWER-OPERATED TOOLS

a. General Provisions

- i. All hands and power tools and similar equipment, shall be maintained in safe condition.
- ii. When power operated tools are designed to accommodate guards, they shall be equipped
- iii. with such guards, when in use;
- iv. Belts, gears, shafts, pulleys, sprockets, spindles, drums, fly wheels, chains and other reciprocating, rotating or moving parts of the equipment shall be similarly guarded;
- v. Personnel using hand and power tools and exposed to the hazard of falling, flying, abrasive, and splashing objects, or exposed to harmful dusts, fumes, mists, vapors, or gases shall be provided with the particular personal protective equipment necessary to protect them from the hazards;

- vi. All hand-held powered platen sanders, grinders, grinders with wheels of 5 cm or less, routers, planers, laminate trimmers, nibblers, shears, scroll saws and jigsaws with blade shanks of 0.5 cm wide or less shall be equipped with only a positive on-off control.
- vii. All hand-held powered drills, tappers, fastener drivers, horizontal, vertical or angle grinders with wheels greater than 5 cm in diameter, disc sanders, belt sanders, reciprocating saws, saber saws and other operating powered tools shall be equipped with a momentary contact on control provided that turnoff can be accomplished by a single motion of the same finger or fingers that turn it on.

b. Hand Tools

- i. The subcontractor shall not issue or permit the use of unsafe hand tools;
- ii. Wrenches including adjustable pipe end and socket wrenches shall not be used when saws are sprung to the point that slippage occurs;
- iii. Impact tools such as drift pins, wedges and chisels shall be kept free of mushroomed heads;
- iv. The wooden handles of tools shall be kept free of splinters or cracks and shall be kept tight on the tools.

c. Power Operated Tools

- i. Electric power operated tools shall be either of the approved double-insulated type or shall be grounded;
- ii. The use of electric cords for hoisting or lowering loads shall not be permitted;
- iii. Pneumatic power tools shall be secured to the hose or whip by some positive means to prevent the tool from becoming incidentally disconnected;
- iv. Safety clips or retainers shall be securely installed or maintained on pneumatic impact (percussion) tools to prevent attachments from being incidentally expelled;
- v. All pneumatically riveting machine staplers and other similar equipment provided with automatic fastener feed, which operate at more than 7 kg/cm² pressure at the tool a safety device on the muzzle to prevent the tool from ejecting the fasteners unless the muzzle is in contact with the work surface;
- vi. Compressed air shall not be used for cleaning purposes except when the pressure is reduced to less than 2 kg/cm² and that too with effective chip guarding. The 2 kg/cm² pressure requirement does not apply to concrete form, mill scale and similar cleaning purposes;
- vii. The manufacturer's safe operating for hoses, pipes, valves, filters and other fittings shall not be exceeded;
- viii. Only personnel who has been trained in the operation of the particular tool shall be allowed to operate power-actuated tools;
- ix. The tool shall be tested each day before loading to see that the safety devices are in proper working condition. The method of testing shall be accordance with the manufacturer's recommended procedure;
- x. Any tool found not in proper working order, or that which develops a defect during use, shall be immediately removed from service and not used until properly repaired;
- xi. Tools shall not be loaded until just prior to the intended firing time. Neither loaded nor empty tools are to be pointed at any other person. Hands shall be kept clear of the open barrel end;
- xii. Loaded tools shall not be left unattended;
- xiii. Fasteners shall not be driven into very hard or brittle materials including, but not limited to, cast iron, glazed tiles, surface hardened steel, glass block, live rock, face brick or hollow tiles;

- xiv. Driving into materials that can be easily penetrated shall be avoided unless backed by a
- xv. substance that will prevent the pin or fastener from passing completely through and creating a flying missile hazard on the other side;
- xvi. No fastener shall be driven into a palled area caused by an unsatisfactory fastening;
- xvii. Only non-sparking tools shall be used in an explosive or flammable atmosphere;
- xviii. All tools shall be used with the correct shield, guard or attachment as recommended by the manufacturer.

d. Abrasive Wheels and Tools

- i. All grinding wheel must be ISO certified only.
- ii. All grinding machines shall be supplied with sufficient power to maintain the spindle speed at safe levels under all conditions of normal operation;
- iii. Grinding machines shall be equipped with suitable safety guards;
- iv. The maximum angular exposure of the grinding wheel periphery and sides shall not be more than 900, except that when the work requires contact with the wheel below the horizontal plane of the spindle, the angular exposure shall not exceed 1200. In either case, the exposure shall begin not more than 8.650 above the horizontal plane of the spindle. Safety guards shall be strong enough to withstand the bursting of the wheel;
- v. Floor and bench-mounted grinders shall be work-rests, which shall be rigidly supported and readily adjustable. Such work-rests shall be kept at a distance not to exceed 5 mm from the surface of the wheel;
- vi. Cup type wheels used for external grinding shall be protected by either revolving cup guard or a band type guard;
- vii. When safety guards are required, they shall be mounted as to maintain proper alignment with the wheel and the guard and the guard and its fastening shall be adequate strength to retain the fragments of the wheel in case of incidental breakage. The maximum angular exposure of the grinding wheel periphery and sides shall not exceed 1800;
- viii. Portable abrasive wheel used for internal grinding shall be provided with suitable safety flanges;
- ix. When safety flanges are required, they shall be used only with wheels designed to fit the flanges. Only safety flanges, of a type and design and properly assembled so as to ensure that the pieces of the wheel will be retained in case of incidental breakage, shall be used;
- x. All abrasive wheels shall be closely inspected and ring tested before mounting to ensure that they are free from cracks or defects;
- xi. Grinding wheels shall fit freely on the spindle and shall not be forced on. The spindle nut shall be tightened only enough to hold the wheel in place;
- xii. All employees using abrasive wheels shall be protected by suitable eye protection equipment.

e. Wood Working Tools

- i. All fixed power-driven woodworking tools shall be provided with a disconnect switch that can either be locked or tagged in the off-position;
- ii. The operating speed shall be attached or otherwise permanently marked on all circular saws over 0.5 m in diameter or operating at over 3000 peripheral rpm. Any saw so marked shall not be operated at a speed other than that marked on the blade. When a marked saw is re-tensioned for a different speed,

- the marking shall be corrected to show the new speed;
- iii. Automatic feeding devices shall be installed on machines wherever the nature of the work will permit. Feeder attachments shall have the feed rolls or other moving parts covered or guarded so as to protect the operator from hazardous points;
- iv. All portable power-driven circular saws shall be equipped with guards above and below the base plate or shoe. The upper guard shall cover the saw to the depth of the teeth, except for the minimum arc required to permit the base to be tilted for bevel cuts. The lower guard shall cover the saw to the depth of the teeth, except for the minimum arc required to allow proper retraction and contact with the work. When the tool is withdrawn from the work, the lower guard shall automatically and instantly return to the covering position.

10. START UP, COMMISSIONING AND TESTING:

There are various activities involved prior to commissioning- the major ones are -Hydraulic Test, Steam Blowing, Transformers Charging, Boiler Light Up, Rolling and Synchronisation and Full loading of unit.

- a. These activities shall be personally supervised by the site executive along with the commissioning engineer.
- b. Appropriate Work Permits shall be taken as applicable
- c. The readiness of upstream and downstream system shall be ensured before taking up.
- d. These shall be handled strictly by the authorized persons only and the team shall be suitably briefed about the activity including hazards & risks involved and control plan by the concerned executive-in-charge before start.
- e. Entry of persons to the area of activity shall be suitably restricted and the emergency functions like Ambulance, first aid center and Fire station shall be intimated about the plan well in advance.
- f. Tag-in/ Tag-out shall be in place while charging transformer and whenever necessary.
- g. Electricians with valid wiremen license only shall be permitted to work on power lines.
- h. The area and the passage shall be adequately illuminated.

11. FIRE SAFETY

- a. The Fire Prevention, Protection and Preparedness Program is an integral part of the overall HSE Program. Effort and consideration must be given to safety, life and potential for delays in construction schedules and plant startup, as well as protection of property on a given project. The purpose of which is to prevent
 - i. Inception of fire
 - ii. Loss of life or personal injury
 - iii. Loss of Property
 - iv. Interruption of operations
- b. Site-in-charge / Safety Officer will make periodical review of the site Fire Protection, Prevention Preparedness Programme, Site conditions and available fire protection equipment. It is very imperative that the Sub-contractors along with BHEL to establish good contact with Local fire station for availability of Fire tender in case of emergencies, in addition to their own fire equipment.
- c. Fire Protection, Prevention and Preparedness Inspections - The Contractor /Sub-Contractor will be required to make frequent fire prevention inspections of his work site and operating facilities. Deficiencies will be corrected at once.
- d. Area where Hot work activities are carried out (Gas cutting / Welding/ any other spark producing work)

- above a working spot, a GI / fire-resistant non-asbestos sheet or suitable material shall be placed to prevent the fall of hot sparks. A bucket of water shall be kept nearby while doing hot work
- e. Hot work shall be preferably carried out in a designated area with a standing Hot Work Permit, to be renewed monthly. The designated area shall have fire extinguishers.
 - f. Any hot work outside designated area shall require a Hot Work permit and fire watch. No flammable material shall be stored within 35 feet from any fire load.

12. PAINTING:

- a. Requirements provide a detailed procedure to be implemented by all concerned employees and sub-contractors involved in painting activities.
- b. Significant Environmental Hazards:
 - i. Chemical hazard due to inhalation of lead fumes (lead containing paint)
 - ii. Chemical hazard due to inhalation of VOC's from painting operations
 - iii. VOC's from painting and coating operation
 - iv. Disposal of paints and coats drums
- c. Control Procedure for Painting:
 - i. Chemical products used in painting and coating operation shall have proper MSDS sheet in place. Whenever any doubt arises with respect to handling and safety point of view it should be accessed to all concerned.
 - ii. Toxic substances and hazards relate the toxic chemicals shall be identified.
 - iii. Proper PPE shall be used including plastic gloves appropriate overall etc.,
 - iv. Arrangement for cleaning of spillage shall be ensured
- d. Only trained workers shall be allowed and proper training should be imparted to the works.
- e. Exposure limits of the toxic substances shall be checked before starting the work and nobody shall be allowed to carry the work beyond the permissible limit.
- f. Ventilation or exhaust facility shall be provided at place where painting and coating operations are carried out.
- g. Overalls shall be supplied by the contractors/subcontractors to the workmen and adequate facilities shall be provided to enable the painters to wash at the cessation of work.
- h. Smoking, open flames or sources of ignition shall not be allowed in places where paints and other flammable substances are stored.
- i. A caution board in national /regional language "**smoking strictly prohibited**" shall be displayed in the vicinity.
- j. Suitable fire extinguishers/sand buckets shall be kept available at places where flammable paints are stored, handled or used.
- k. In case of indoor painting or painting in confined spaces, exhaust ventilating shall be provided. If adequate ventilation is not provided a proper respirator shall be provided and used by persons who are trained and fit tested.
- l. The VOC's from painting and coating operations shall not exceed the permissible level of CPCB/ SPCB norms. The paints and coats must be selected as per the guidelines.
- m. Workers shall thoroughly wash their hands and feet before leaving the work.

13. "HAZARDOUS ENERGY" CONTROL PROCEDURE/ LOCKOUT/TAGOUT (LOTO)

Hazardous Energy Control Procedures, known as "Lockout/Tagout (LOTO)" refers to specific practices and procedures to safeguard employees from the unexpected energization or startup of machinery and equipment, or the release of hazardous energy during service or maintenance activities.

Contractors must develop and submit a written LOTO program. This requires that a designated qualified individual turns off and disconnects the machinery or equipment from its energy source(s) before performing service or maintenance and that the authorized employee(s) either lock and tag the energy- isolating device(s) to prevent the release of hazardous energy and test the machine or equipment to verify that the energy has been isolated effectively.

a. Minimum Requirements:

The following are minimum requirements that must be included in the Contractor's LOTO program:

- i. Inspection of equipment by a trained individual who is thoroughly familiar with the equipment operation and associated hazards.
- ii. Identification and labeling of lockout devices. Purchase of locks, tags, and blocks. Development of a standard written operating procedure, permitted through a controlling authority that is followed by all workers.

b. General Requirements

The following steps must be taken to protect workers that install or service equipment and systems:

Follow the hazardous energy procedures and statutory regulations. Follow the manufacturer's service/repair instructions. Identify and label all sources of hazardous energy. Before beginning work, accomplish the following:

- i. De-energize all sources of hazardous energy:
- ii. Disconnect or shut down engines or motors.
- iii. De-energize electrical circuits.
- iv. Block fluid (gas or liquid) flow in hydraulic or pneumatic systems.
- v. Block or secure machine parts against motion.
- vi. Block or dissipate stored energy.
- vii. Discharge capacitors.
- viii. Release or block springs that are under compression or tension.
- ix. Vent fluids from pressure vessels, tanks, or accumulators—but never vent toxic, flammable, or explosive substances directly into the atmosphere.
- c. Lockout and tag out all forms of hazardous energy including electrical breaker panels, control valves, etc. Make sure that only one key exists for each of your assigned locks and that access to the key is controlled. Verify by test and/or observation that all energy sources are de- energized.
- d. After completion of the work, accomplish the following:
 - i. Inspect repair work before removing the lock and activating the equipment.
 - ii. Make sure that only the worker that installed the lock removes his/her assigned lock.
 - iii. Make sure that all workers are clear of danger points before re-energizing the system.

e. LOTO Procedure**PURPOSE AND SUMMARY**

This procedure provides the requirements and responsibilities of Hazardous Energy Control and the process for Lockout / Tag out (LOTO) of energy isolating devices (valves, circuit breakers, disconnect, etc.). Its use

shall ensure that machinery, equipment, or systems are isolated from all potentially hazardous energy to prevent unexpected energization, startup, or release of stored energy which may cause personnel injury or property damage.

This procedure applies to all BHEL personnel and subcontractors working on the WBPDC (1X660MW) STAGE-III projects where equipment must be taken out of service for the performance of work activities such as installation, maintenance, repair, construction, or equipment removal. The procedure may also be used to isolate equipment of which the energization or operation may present danger to personnel or property. Lockout / tag out are not required for electrical equipment that can be unplugged from the source and the person performing the work has control of the plug.

This procedure shall be applied to prevent injury or damage caused by the unexpected release of active or stored energy. Hazardous energy sources could be in the form of the following:

- Electrical
- Hydraulic
- Chemical
- Thermal
- Mechanical
- Pneumatic

Preplanning of work activities includes the identification of all potential hazardous energy sources so that they may be properly controlled and isolated, locked, and tagged out.

Prior to initiating work activities on or around locked out / tagged out equipment, the equipment must be tested and tried by or in the presence of the person(s) performing the work activities.

RESPONSIBILITIES

- The Engineers in Charge is responsible for implementing and enforcing this procedure and approving lockouts /tag outs that impact the operation of the project.
- The Engineer in Charges responsible for authorizing Lockout /Tag out Requests.
- The Lockout / Tag out Coordinator is responsible for maintaining the Lockout / Tag out Log. Each shift should have a designated Lockout / Tag out Coordinator.
- The Isolator is responsible for determining the proper isolation devices and device positions required to isolate all potential energy sources so that the work stated on the Lockout /Tag out Request Permit may be safely performed. The Isolator must be familiar with the equipment and energy type(s) that require isolation. For this reason, in some cases the Isolator may be more than one person (i.e. Engineer, System Operator and/or Electrician). The Isolator shall position the specified device points, and apply locks and tags, and sign the tags and the LOTO Permit isolation point blocks.
- The Safety Manager is responsible for conducting an annual audit that is documented to ensure all procedures and requirements are current and being followed as written.

DEFINITIONS

Affected Employee: -

An employee whose job requires him/her to operate or use machinery or equipment on which servicing or maintenance is being performed under a lock out/tag out procedure or whose job requires him/her to work in an area in which servicing or maintenance is being performed under a lockout/tag out procedure

Authorized Employee: -

An employee who implements a lockout/tag out procedure on machinery, equipment, or systems in order that servicing or maintenance may be performed. Often an authorized employee and an affected employee may be the same person.

Danger “Do Not Operate” Tag

A tag used to identify energy isolation devices and specify the required position of the device. The tag should be affixed to the isolation device such that it is in plain view of anyone attempting to operate the device. The tags shall be sequentially numbered and shall specify the lockout/ tag out request number. The tag shall also state the purpose, and the expected duration of the lockout /tag out

Isolation Device

A device that is designed and intended to prevent the passage of energy. These devices, usually located at the energy source, are typically valves, circuit breakers, etc. Isolation devices should have a means of being locked in position

Lockout Device

A device that uses a positive physical means such as a lock, either key or combination type to maintain an energy isolation device in the safe position and prevent the inadvertent energization of machinery, equipment, or systems. Device locks should serve no other purpose other than hazardous energy control isolation

Lockout Tag out Request Permit

A pre-numbered form used to request that machinery, equipment or systems be taken out of service. A Lockout/Tagout Request Permit may be initiated by any one requiring energy isolation for work activities or for taking faulty equipment out of service

Lockout / Tag out Request Log

A record of all Lockout /Tag out Request Permits shall be maintained by the Lockout /Tag out Coordinator.

PROCEDURE**1. REQUESTING A LOCKOUT / TAGOUT PERMIT**

When machinery, equipment, or systems are partially or completely taken out of service for work activities or equipment protection, a lockout / tag out shall be requested. The requestor shall be familiar with scope of work required and shall provide a brief description of the work on the Lockout / Tag out Request Permit. The requestor shall also provide the proposed start time and estimated duration of lockout / tag out. If familiar with the machinery, equipment, or system to be taken out of service, the requestor may identify the devices that are required to be isolated. The LOTO Request Permit shall be forwarded to the Authorized Lockout / Tag out Coordinator for reviewed and signature, along with Permit to Work number to be entered on the LOTO Request Permit.

- a. The Lockout / Tag out Coordinator shall record the necessary information on the Lockout / Tag out Request Log and forward the request to the Engineer in Charge for approval.
- b. The Safety Manager or Engineer in Charge shall review the Lockout / Tagout Request Permit for impact on project operations. Project operations could be impacted by the equipment being taken out of service or by the required isolation to take the equipment out of service. If project operations are impacted by the Lockout / Tagout, the request shall be forwarded to the Engineer in Charge for approval.
- c. The Engineer in Charge shall provide the lockout / tag out isolation points necessary to perform the task stated on the request. The device identification, device location, device position, and locking mechanism

shall be entered into the appropriate blocks on the Lockout / Tag out Request Permit.

- d. The Engineer in Charge indicates approval of the Lockout / Tagout Request Permit by signing in the appropriate space on the request. If the Lockout /Tag out Request Permit is rejected, the Engineer in Charge shall return it to the requestor, via the Lockout / Tagout Coordinator with a written explanation of the rejection.
- e. Once approved, the Lockout / Tag out Request Permit shall be forwarded to the Lockout / Tag out Coordinator to assign tags and locks.
- f. The log shall show current status of all Lockout / Tag out Request Permits from submittal to approval, through lifting of locks and tags to final closeout. The log shall be maintained by the Lockout / Tag out Coordinator in their office.

2. PLACEMENT OF LOCKS AND TAGS

- a. The tags shall be filled out to match the information on the LOTO Request Permit. Appropriate locks for the types of isolation devices specified shall be collected and placed with the tags and the Lockout / Tag out Request Permit.
- b. The isolator(s) shall take the device locks, tags, and the Lockout / Tagout Request Permit to position the specified isolation devices, sign and hang the tags, and place the locks. If the isolator does not agree with or understand the Lockout / Tagout Request Permit, or has a problem performing the isolation, the problem should be brought to the attention of the Safety Representative or Area Supervisor immediately and the lockout / tag out should be postponed until the situation is resolved.
- c. Once the Isolator has placed all “locks” on isolation points, they will “test ”and “try” the machinery, equipment, or system to ensure all hazardous energy has been completely removed and the isolation is one totally accomplished, and has initialed and signed the Lockout /Tag out Request Permit indicating all isolation points have been confirmed. Examples of “lock”, “test” and “try”:
 - by checking that all locks on the LOTO Request Permit have been applied and are in the specified position open/closed, on/off, etc.; metering test of electrical circuits, opening of drain valves, checking pressure gauges or indicators; and try by pushing start buttons and on/off switches, etc.
 - Testing shall be performed by person(s) knowledgeable of the energy source(s) being isolated (e.g., an electrician should meter electrical circuits).
- d. A copy of the completed Lockout /Tag out Request Permit shall remain with the Work Package and used as part of the daily Pre-Job Briefings

3. WORKING UNDER A LOCKOUT / TAGOUT REQUEST

- a. Prior to starting the work activity, the person(s) performing the work shall review the Lockout / Tag out Request Permit and place the necessary tags and personal locks on the identified isolation devices. Personal locks may be placed only on devices that have already been locked and tagged in accordance with the Lockout / Tag out Request Permit.
 - All personal locks shall be accompanied by a tag that is signed and dated by the worker(s) and specifies the work activity being performed.
 - Personal locks should be of a different color than device locks for ready identification.
- b. Verification of the effectiveness of the isolation by the Isolator shall be performed for Worker’s working under the lockout / tag out, by demonstrating the checks on “lock”, “test” and “try”,
- c. When the work activity is finished, personal locks and tags shall be removed and the Safety Representative

shall be notified that the Lockout / Tagout is no longer required. If work under a lockout / tag out is to be delayed or interrupted for a period in excess of 24 hours, personal locks shall be removed until the work restarts. Personal locks shall be removed prior to the worker(s) leaving the project at the end of shift unless the key(s) are maintained at the project.

4. REMOVAL OF LOCKS AND TAGS

- a. When the lockout / tag out is no longer required, the Safety Representative or Area Supervisor shall obtain the Lockout / Tagout Request Permit from the work package for LOTO removal. Prior to removing locks or tags that may allow equipment to be energized, a check shall be made to verify that the equipment is free to safely operate (i.e., will not cause damage or injury). The locks and tags shall be removed and returned to the Lockout / Tagout Coordinator. Isolation devices may be repositioned at the discretion of the Engineer in Charge according to operational requirements. The Isolator shall complete the Lockout / Tagout Request Permit indicating each lock and tag has been removed and the Safety Representative or Area Supervisor forward to the Lockout / Tagout Coordinator.
- b. The Lockout / Tagout Coordinator shall discard the tags and maintain the completed Lockout / Tagout Request Permit for future reference.
- c. In the event that an employee leaves the job site without removing the personal lock I tag, the following measures shall be taken and documented. The measures listed below are a minimum set of guidelines and under all circumstances, refer to the site-specific safe work plan for detailed procedures:
 - Attempt calling / contacting the employee to return to the site for removal.
 - In the event an employee cannot be contacted, the Site Manager and Safety Manager shall sign an Emergency Lockout/Tagout Removal Form, which has been completed by the Area Supervisor.
 - Employee shall be notified upon returning to the site, prior to beginning any work.

5. INTERRUPTION OF A LOCKOUT / TAGOUT

Operational Emergency

The Engineer in Charge / Safety Manager /Area Supervisor may deem it necessary to temporarily remove the locks and tags from isolation devices, prior to the end of the work activity. The standard procedure for removal of locks and tags shall be followed. Extreme caution shall be taken by the Isolator removing the locks and tags to prevent personnel injury.

Testing

When the performance of a work activity requires the functional testing of a machine, component, or system, the locks and tags may be temporarily removed in accordance with the tag removal, to perform the test. As a result of the testing, if it is determined that the equipment needs further work, the locks and tags shall be positioned back on to the device. If it is not necessary to replace all the locks and tags, then the unnecessary locks and tags may be returned to the Lockout / Tagout Coordinator. The Engineer in Charge shall initial the Lockout / Tag out Request Permit in the removal block to indicate that these locks and tags have been removed. When testing has been satisfactorily completed, the locks and tags shall be removed.

ISOLATION DEVICES

- In most industrial applications, there are isolation devices that were not designed to accommodate a locking device. In these instances, an acceptable alternative that physically obstructs or prevents the use of the isolation device shall be found. Chains shall be placed on valves or electrical panels. Wires shall be determinate, pulled back, taped, and secured.

- If an isolation device does not accept a lock, a tag only is acceptable; however, all possible precautions shall be undertaken to provide a level of safety for the workers. The tag shall be readily visible to anyone attempting to operate the device.
- If more than one Lockout / Tagout Request Permit requires that a single isolation device be locked and tagged, a lock and tag for each request shall be placed. Each lock in itself prevents the inadvertent operation of the device.

GROUP / COMPLEX LOCKOUT

In a multiple lockout / tag out procedure, each person working on the machinery or equipment must place a lock or tag on the energy isolating device. If the energy isolating device will not accept multiple locks or tags, a hasp (a multiple lockout device, may be used. The locks or tags must be placed in such a way that energy cannot be restored to the machinery or equipment until every lock or tag is removed. As each employee involved no longer needs to maintain lockout / tag out protection that employee removes his - her lock and/or tag. The employee attaching the lock or tag is the only person authorized to remove the lock or tag.

6. TRAINING

The training must include recognition of hazardous energy source, type and magnitude of energy available, methods and means necessary for energy isolation and control. Each authorized employee shall receive adequate training. The training should address that all affected employees are instructed in the purpose and use of the energy control procedure. There should be training provisions included for any other employee whose work operations are or may be in an area where energy control procedures may be utilized. The employee training should also address when tag out systems are used including the limitations of a tag (tags are warning devices and do not provide physical restraint). The training should also include that a tag is not to be removed without authorization. The tag is never to be ignored or defeated in any way. Retraining is required when there is a change in job assignments, in machines, a change in the energy control procedures, or a new hazard is introduced. All training and I or retraining must be documented with employee's name and dates of training.

7. PROGRAM REVIEW

The lockout / tag out program must be reviewed at least annually. The review must ensure that procedures are being followed and that they are effective. A documented review of the inspection must include the date, the equipment, employees involved & the inspector. The inspector must be someone other than those actually using the lockout / tag out in progress.

ATTACHMENTS

#1. Danger (DO NOT OPERATE) Tags



#2. Device & Personal Locks and Multi Lock Hasp:



#3. Lockout / Tagout Request Permit

		LOCKOUT / TAGOUT REQUEST PERMIT			LOTO Request Permit No.: Work Permit No.:	
Equip. Out of Service:	LOTO Date Required by: ____/____/____	Estimated Duration:	LOTO Requested Date:			
Scope of Work:			LOTO Authorization Signed by: Date:			
			LOTO Removal Authorization Signed by: Date: Time:			
Tag No.	Device to be Tagged / Locked I.D. No.	Device Location	Device Position OPEN / CLOSE D -	Lock No.	Tag/Lock Placed by Print/Sign - Date/Time	Tag /Lock Removed by Print/Sign - Date/Time
Comments Instructions: Attachment 3.Lockout / Tag out Request Permit:						

#4. Lockout / Tag out Request Log

LOTO Permit No.	Request or Name	Equipment & Location	Est. Work Completed Date	Approval Date	LOTO Placed Date	LOTO Removed Date	Comments

14. RISK ASSESSMENT

Risk and Hazard Analysis

In order to produce an overall Project EHS Plan, a project must be assessed for its risks. There are two components to the risk and hazard analysis. The procedure used to examine and plan for the identified risks and hazards is called a General Hazard and Risk Assessment.

JSA/HIRA review

Prior to commence the following activities Method statement and JSA/HIRA to be prepared by the concern engineer in coordination with EHS officer and submit to the client for review and approval. After getting approval the work will be started under PTW after clearance. For HIRA and criteria for the defining the high, medium & low risk the relevant annexure be referred. In case any deviations required in the approved method statement the concerned engineer/supervisor has to prepare additional HIRA/JSA to cover the new activities and associated risk. Following activities to be covered,

- Deep excavation (more than 5 feet)
- Significant concrete pouring (like heavy foundation, TG deck, Slab casting etc.)
- Confined entry
- Blasting
- Working on electrical/ energized equipment's
- Steel erection more than 5-Ton weight
- Working at height prior to completion of stairs/ladders/hand railing etc.

Definition:

HAZARD - Any potential or present danger to persons or property within the project site, e.g., oil on the floor is a hazard.

INCIDENT - An unintended happening that may result in injury, loss or damage, e.g., Slipping on the oil is an Incident.

INJURY – Physical harm, the result of an Incident, e.g., a sprained wrist from the fall would be an injury.

Hazard Analysis Document

- For high risk and dangerous work identified, the Applicant shall complete and submit a Hazard Analysis Document together with the PTW request. It will be a JSA (Job Safety Analysis) or Preliminary Hazard Analysis Checklist. And it shall be reviewed and approved by respective Construction and HSE Representatives.
- Issues such as work interface, coordination, drawings, toolbox meetings and work type/duration shall be detailed and included with supporting documentation for the Applicant's request for PTW.
- If applicable, Hazard Analysis Document shall be used as the foundation for development of Safe Work Method Statement. Each hazard identified shall be addressed in the Safe Work Method Statement and be submitted as part of the Applicant's submittal package.

Evaluation of Sub-contractor Risk Assessments includes

- Experience and expertise in performing similar type work.
- Duration of work performed
- Location of the work to be performed.

- Nature of the work to be performed.
- Potential for a subcontractor performing the work to expose themselves, other persons or employees, to hazards.
- Potential for exposure to work site hazards.

Review of Subcontractor specific issues

Preventive and protective measures must be introduced according to the following order of priority

- Eliminating the hazard by removing the activity from the work process. Examples include substitution with less hazardous chemicals, using different manufacturing processes, etc.
- Controlling the hazard at its source through use of engineering controls. Examples include local exhaust ventilation, isolation rooms, machine guarding, acoustic insulating, etc.
- Minimizing the hazard through design of safe work systems and administrative or institutional control measures. Examples include job rotation, training safe work procedures, lock-out and tag-out, workplace monitoring, limiting exposure or work duration, etc.
- Providing appropriate personal protective equipment (PPE) in conjunction with training, use, and maintenance of the PPE.

15. HSE PREPAREDNESS FOR ADVERSE CLIMATES AND WEATHER

All Preventive and Precautionary measures to ensure Health & Safety of workers in all possible adverse weather conditions based on the analysis of the local area conditions to be taken by the subcontractor

15.1 SUMMER

1. The Working Time and Lunch Hour will be as per instruction of Statutory Authorities (no work between 11am to 3:30pm). However, in case temp comes down due to rain/cloudy weather work will continue as per normal routine.
2. During long lunch break, worker will be allowed to go back home for rest. Those who will like to stay back will avail at the facility of rest shed or other designed area.
3. They will be allowed to take small break during work as per their need.
4. Water sprinkling will be done on roads to reduce dust concentration.
5. Workers will be provided with adequate cool drinking water and Butter milk/Lemon water etc.
6. Adequate ORS stock will be made available at the work location in the First-Aid Box for use as needed and at First-aid Centre for emergency need.
7. Fire prevention shall be on high alert, with removal of dry grass and bushes, etc, inside and outside the surrounding work areas. No smoking, and control of open flame/sparks shall be maintained and monitored.
8. Worker will be informed about the Do's and Don'ts to be followed during summer in the Pre Job Brief.

Dos & Don'ts

1. Drink plenty of cool water and other non-alcoholic fluid and keep body well hydrated.
2. Eat salt in food to replenish loss of salt through sweating.
3. Avoid over physical exercise.
4. Have adequate sleep at night.
5. Eat light and less spicy food
6. Avoid eating food which was cooked long time ago.

7. Nobody should use small water bodies such as pits, running rain water through crevices etc. for drinking and cleaning purpose as it may be unhygienic.

Emergency Handling

In case of emergency due to heat disorder:

1. Rescue the victim from workplace and place under shed.
2. If to be rescued from height, use stoke basket or rescue kit.
3. Inform Ambulance immediately.
4. If nearby any air conditioned room/shed is available, place him inside the room/shed.
5. Administer First aid by trained First aider for Heat Disorder
6. If conscious, give him ORS solution to drink.
7. If required send the victim hospital immediately.

15.2 MONSOON**A. Height Work & Structural Safety:**

1. Ensure that all height work platforms are barricaded and avoid any highly hazardous
2. Height work.
3. Ensure that all personnel have good quality and intact safety shoes
4. Stop all dangerous height work during rain
5. Explain Do's and Don'ts to workers during Tool Box Meetings
6. Ensure that there are no weak structures, boards etc. that can fall during high winds
7. Do not allow any loose material (e.g. GI sheet, Ply board, empty cement bag, aluminium foil, foam sheets etc.) on roof sheds or top of structures.
8. Do not permit any one to ride up or come down scaffolds frame work during heavy wind or rain.
9. Provide "anchor" of adequate strength to scaffolds and other high-rise structures.
10. All rest sheds and GI sheds will be anchored into the round and wall and roof panels will be secured with J hook to prevent shed from blowing over or parts/pieces becoming airborne. Proper earthing per IS standard is also to be installed.
11. Do not go alone nor permit anyone to stay at tower-tops, roof-tops, high structures or on electrical poles during the course of stormy weather or heavy rain.

B. Electrical:

1. All electrical connections / loads have to be routed through ELCB / RCCB (residual current circuit breaker) whose rating should be 30mA.
2. RCCB operational checks need to be done DAILY / WEEKLY during monsoon season.
3. Avoid joints on power cables which need to be laid over-head or under-ground, better not to have any joint at all. In case joints become essential, such cables must be housed rigidly and insulation must be provided as per approved standard. The joint shall be suitable for outdoor use.
4. All electrical distribution board shall be properly covered at top and sides to protect from rain water. Extension boards shall be protected from rain water.
5. Ensure proper "earthing" for each and every electrical appliance.
6. Double earthing need to be provided for 3-phase power supply and for voltage more than 220V.

7. Provide lightening arrestors at the top of Boiler 3 and boiler 4 and rest sheds which are not covered by existing lightening arrestor of other installation.

C. Others:

1. Maintain smooth flow on open drains. i.e. no obstruction or blockade shall be made on storm water drains. If required, make temporary drains.
2. Arrange back-filling of excavated pits on war-footing basis.
3. Arrange bringing down booms of all cranes, hydra machines during stormy weather (wind speed 40-50 km/hr)
4. Confirm that all gantry cranes are effectively choked to prevent rolling and toppling.
5. Do not forget to deep ready a dew battery operated lights at site-offices during rainy season.
6. Avoid using wet damp clothes.
7. Hard Barricade excavated zone filled with water with scaffolding pipe & clamp with reflective net
8. Engage diesel operated water pump to dewater work area. For electrically operated water pump, the starter shall be protected from rain water. All rotating parts shall be guarded. Ensure availability of sufficient water pumps.

D. Health and hygiene:

1. Monsoon reduces the immunity of our body and makes us vulnerable to many diseases which are commonly associated with this season. It is time for us to keep our body challenging against disease by boosting our immunity and taking safety measures against these diseases.
2. The diseases associated with monsoon are Malaria, Jaundice, Gastro-intestinal infections, like typhoid, cholera etc. apart from these viral infections like cold and cough also make their presence felt. Majority of above said diseases are on account of:
3. Puddle of water formed due to rain become breeding grounds for mosquitoes which spread disease like, malaria and dengue fever. As a precautionary measure against mosquito-bite disease one can use mosquito net around the end which is better choice to mosquito repellents like mats and coils.
4. Pollution of drinking water during monsoon is very common. It is very necessary to drink clean and pure water when water-borne monsoon diseases like diarrhoea and gastro-intestinal infections threaten us.
5. Walking in dirty water during rainy season leads of numerous fungal infection which affect toes and nails. Diabetic patients have to take a special care about their feet. Keeping feet always dry and clean is very necessary. Avoid walking in dirty water. Keep shoes socks and raincoats dry and clean.

E. Workmen will be made aware of following Do's and Don'ts:

1. Do not sleep in daytime.
2. Avoid over physical exertion.
3. During lightning and thunder storm, do not take shelter under tree. Take shelter inside rest shed or store room.
4. Wash vegetables with clean water and steam them well to kill germs.
5. Avoid eating un-cooked foods and salads should be washed properly before consumption.
6. Drink plenty of water and keep body well-hydrated.
7. Always keep the surrounding area dry and clean. Don't allow to get water accumulated around.
8. Keep body warm as viruses attack immediately when body temperature goes down.

9. Do not enter air conditioned room with wet hair and damp cloths.
10. Dry your feet and webs with soft dry cloth whenever they are wet.
11. Eat light and less spicy food.
12. Avoid eating food which was cooked long time ago.
13. Eat salt in food to replenish loss of salt through sweating.

15.3 EMERGENCY WEATHER CONDITIONS

Cyclone/Severe thunder storm

In the event of Cyclone/Severe thunder storm, alert will be issued by subcontractor on notification received by Govt. authorities/Metrological departments Customer or BHEL.

The actions required during cyclone/rough weather:

1. Check and advice subcontractors to clean-up work area. Pick up all loose and unused material of respective supervisor's area.
2. Tie to secure all gas cylinders to avoid displacement and unsafe conditions which could be due to wind pressure.
3. Secure portable electricity generating sets and other equipment, pumps, hoses etc.
4. Make preparation for removal of water logging.
5. Take review of work activity and make preparation for removal of equipment and material from vulnerable areas.
6. Isolate/turn off all electrical power form the main panel/switches. Secure and anchor panels properly.
7. Recheck anchorage/tie of all temporary structures/sheds, tall objects, cranes, rigs, scaffolds etc. to avoid toppling due to wind force.
8. Cranes boom shall be secured, either locked or lowered the booms as reasonably and practicably possible and rigs to safe position for the safety point of view.
9. Group up all trash barrels, wooden pallets, forms; wooden decks etc. and anchor properly.
10. Welding machines, air compressors and such equipment are to be grouped together and secured to the stable objects. Welding leads, electrical cables, hoses are to be rolled up and secured properly.
11. Set on site vehicles on high ground in the site area with brakes set firmly.
12. Anchor all tanks, vessels, gas cylinders that may be moved by high wind and water.
13. Evacuate job site.

Personnel Evacuation:

1. Personnel Evacuation will be required if predicted wind speed and storm surge heights are beyond acceptable limits as per the instructions from Govt. Authorities/ Metrological departments or Customer.
2. Once the warning is received for personnel evacuation, an emergency response team shall be formed. The team will work with local authorities and other agencies formed/deployed to evacuate and transport all personnel involved in the project to the cyclone shelter.
3. Cyclone may be followed by the calm "EYE", be aware of it. If the wind suddenly drops, don't assume the cyclone is over. Violent wind may resume from the opposite side direction. Wait for the official "All clear Signal".

4. After the cyclone, do not go outside until officially communicated about safe situation outside. Use recommended routes for returning. Do not panic or rush while returning.
5. Checking of gas leaks and well-being of electrical appliances is essential before leaving the site.
6. Follow local communications for official warning and advice. The construction Manager shall also obtain updates from customer/metrological departments and communicate to the personnel on project site.

15.4 PREVENTION OF COVID-19 (COVID-19 HERE TO BE READ AS COVID-19 AND OTHER PANDEMICS/ COMMUNICABLE DISEASES) AT PROJECT SITE & LABOUR COLONY:

Resumption of Construction Activities after Lock Down and Prevention of Coronavirus Infection during Site Operations and OCP 61A: Prevention of COVID-19 Infection in Labor Colony will be strictly followed.

A. Preventive measures at project site:

- BHEL and Agencies shall nominate COVID Marshalls, who will be responsible for monitoring the COVID prevention measures and apprising management on the same.
- Mandatory health check-up for every worker/ official joining the site
- All activities to be carried out using least amount of paperwork and physical proximity as far as possible.
- **HSE Observer App** to be used to monitor HSE Activities and follow up with agencies for closure of non-conformities.

a. Strict Control at the Gate/ Banning Entry to Anyone Not Wearing Masks

- i. Security personnel at the gate may erect a barricade preferably approx. 10 meters from the gate and only allow personnel who are wearing proper masks inside.
- ii. Public address system may be used to warn any non-compliant visitors
- iii. Near entry gate, round markers at minimum 1-meter distance to be ensured so that distancing is ensured
- iv. A hand-wash or hand sanitiser facility is preferable at the gate to allow entry after hand wash or hand sanitisation. These are also to be provided at key locations to enable hand wash / hand sanitisation before starting work, before eating, etc.
- v. Gutkha, Paan, tobacco etc. to be banned from the site. Spitting to be strictly prohibited.

b. Screening at Gate with Contactless Thermometer & Action on Suspected Cases

- i. Security Personnel at the Gate to screen each person entering the premises using a non-contact infrared thermometer, which is duly serial numbered and calibrated.
 - ii. In case any site worker/ official is found to have fever more than 99 Degrees Fahrenheit or found coughing/ sneezing, he/she may be advised rest till recovery and entry to be permitted after obtaining clearance from medical officer/assistance/attendants.
- Parcel to be collected from gate by concerned person preferably with provision of Special Box
 - Any construction material received at site, unless properly sanitized, to be kept undisturbed for at least 3 days and to be used only after that period.
 - During Toolbox Talks, minimum 1-meter distance between any two workers to be ensured

c. During site execution activities:

For all site execution activities, social distancing is to be maintained. In case this is not possible due to nature of work, speciality of work, etc, ensure sensitisation of the labour/staff involved and use of appropriate PPEs, especially mandatory face mask. In any case, close working to be allowed only in special

circumstances and ensuring these activities are preferably time staggered to the extent possible

d. In office premises:

- i. Sharing of items like pens, water bottles etc. in office premises to be avoided
- ii. Doors preferably to be in open condition to avoid contact
- iii. All common touch points to be frequently disinfected in a day.

e. Regular disinfection of all Areas, Equipment and facilities

- i. A dedicated disinfectant gang to be identified for the task by each agency. The disinfectant gang to be provided full body suits for the task.
- ii. All areas (including office premises, site areas, chairs, tables, furniture etc.), tools & equipment to preferably be disinfected by dedicated gang every day before resumption of work.
- iv. Common touch points like handrails, lift buttons, door/window knobs or handles, vehicle door handles, taps, conference room & dining hall tables/chairs, common sofas/chairs, visitor sofa/chairs, files & folders, etc to preferably be disinfected regularly at frequent intervals every day.
- v. Pool vehicles, to be disinfected after every use. Social distancing to be maintained inside the common pool vehicles as per Govt./ statutory body guidelines.

f. Disinfecting the operator/driver touch points of Vehicles/cranes, T&Ps etc.

Disinfection to also be carried out for all Cranes, Vehicles, Equipment, consoles, T&Ps etc. which come into contact with operating personnel.

g. Posters on COVID-19

Sufficient Posters on COVID-19 to be ensured across the site in languages understood by most workers.

h. Brief guidelines for hand washing are as below:

- i. Soap to be provided at each wash basin and replenished regularly.
- ii. Washing with soap for at least 20 seconds is recommended.
- iii. As a general guideline, for every 100 workers, 1 wash-basin may be provided at site areas.
- iv. Close queue to be avoided near wash-basins and 1-meter distance to be maintained. Round markers at 1-meter distance can be ensured as guidance

Composition of Disinfectant:

- i. Readily available 1% hypochlorite solution or 4%
- ii. Liquid chlorine-1% solution
- lii. Surgical spirit-95% alcohol content
- iv. Hand sanitizer should have: Isopropyl alcohol-75%, Glycerol-1.45%, Hydrogen Peroxide-0.125%

B. Prevention of COVID-19 Infection in Labor Colony:

- Spacing of minimum 2 meters between living areas of workers inside a room may be maintained. Preferably, the living area of each worker may be partitioned using sheet of cloth, plastic etc.
- Rooms to be properly ventilated as far as possible
- Sanitation to be given prime importance and personal hygiene to be promoted
- Face masks shall be worn by everyone inside the colony premises
- Spitting of Pan. Gutkha etc. inside the colony and urinating etc. outside the toilets to be strictly avoided
- Regular visits by Doctors to the labor colony can be arranged on non-working day for check-up of all workers
- **Identification of "COVID Wardens" (CWs) by each agency for maintaining the following:**
 - i. Keeping an eye on the health of workers and report any suspected cases of fever, coughing etc. to the

management

- ii. Keeping an eye on the social distancing measures in the labor colony and report any non-conformances to the management.
- iii. Educate the workers about social distancing and COVID prevention measures.
- Training/ Awareness regarding COVID-19 to be provided to workers regularly.
- Workers to be instructed to maintain social distancing of minimum 1 m at all time
- **Posters on COVID-19:** Sufficient Posters on COVID-19 to be ensured across the labor colony in languages understood by most workers.
- All workers to be instructed to inform any suspected cases of illness (individual or others) to an emergency contact number of CW, the emergency contact numbers and CW contact numbers to be displayed at prominent locations
- **Inspection & Review**
 - i. Daily Inspection by concerned COVID Wardens and reporting to Agency
 - ii. Regular inspection by Agency & BHEL

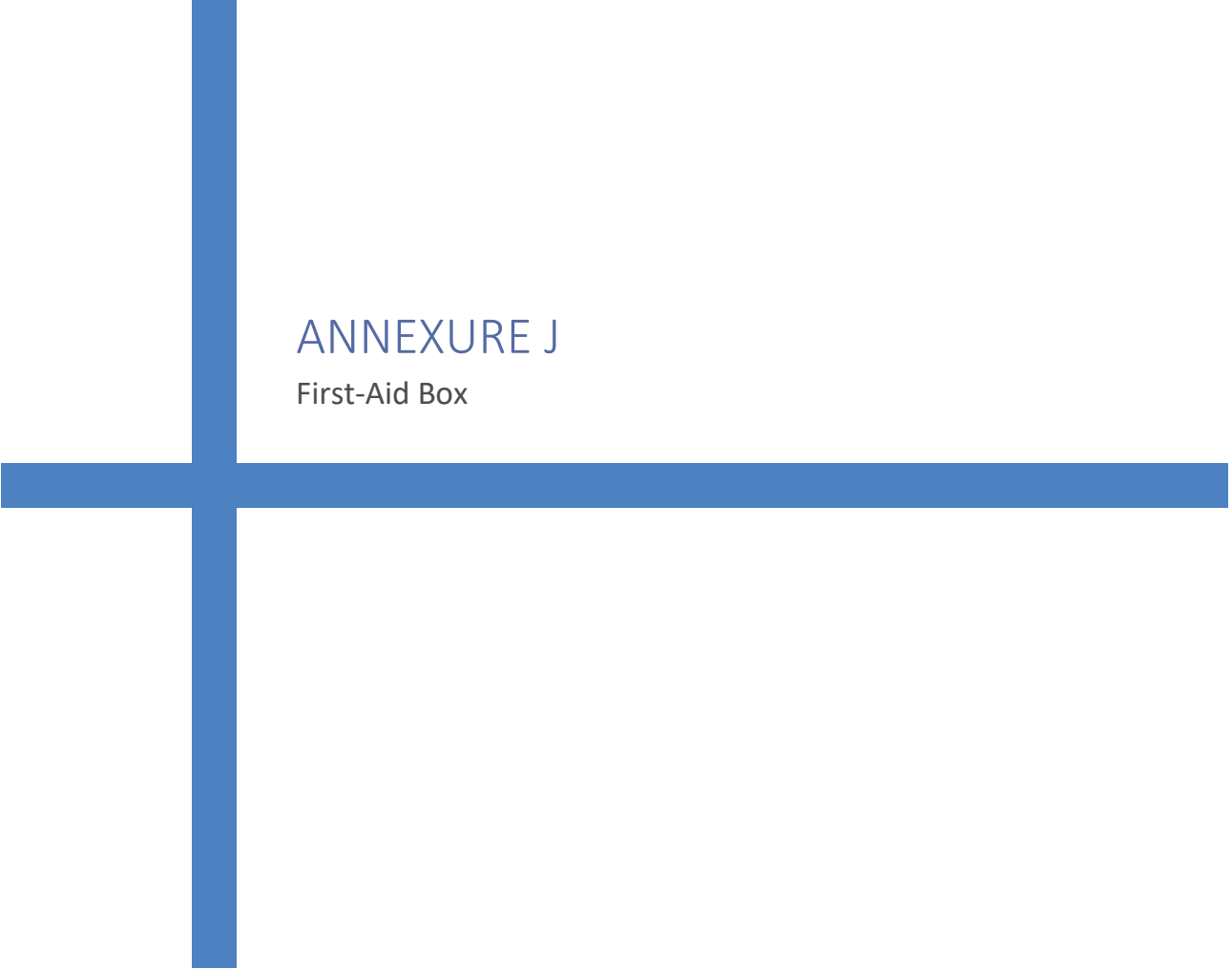
15.5 Noise Mitigation

High noise is harmful to the human health and it can cause impairment if exposed for long duration at regular intervals, and also cause disruption in nearby communities.

- Noise monitoring shall be carried out in all construction locations periodically.
- Use of silent DG is allowed at site during construction.
- Low noise generation equipment's to be preferred.
- Work areas where noise levels exceed the 85db shall be posted as hearing protection required.
- Use of PPEs / ear plug/ear muff for personnel entering into high noise area.
- Activities generation High noise will be planned in day shift.

Noise Level Chart

Parameter	Night Noise level dBA	Daytime Noise Level dBA
At 1-meter from each piece of equipment	85	85
At Property boundary	70	70



ANNEXURE J

First-Aid Box

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Details & Contents of First Aid Box as per Contract Labor (Regulation & Abolition Act), Central Rules, 1971

- (1) The first-aid box shall be distinctively marked with a Red Cross on a white background and shall contain the following items, namely:

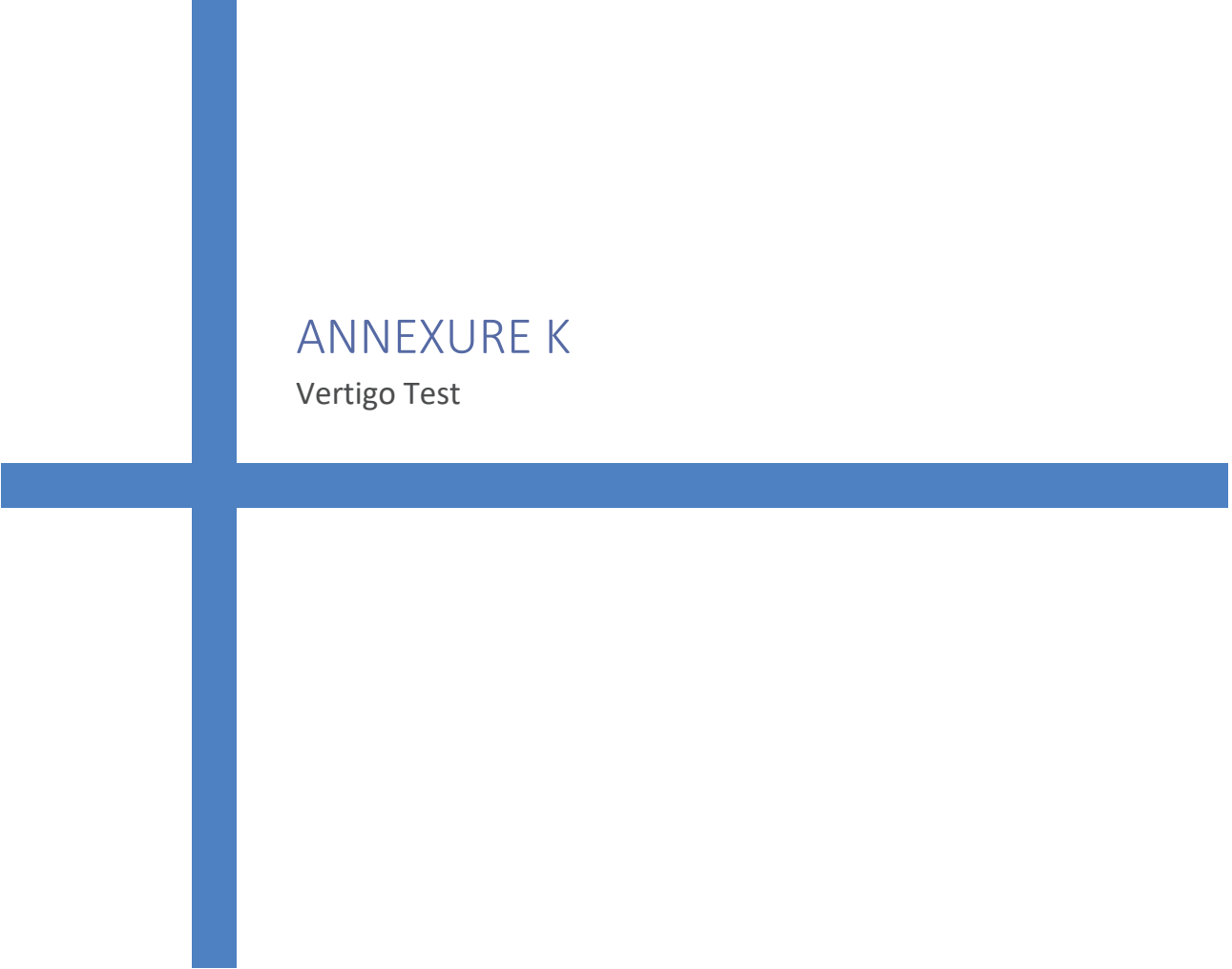
(a) For establishments in which the number of contract labor employed does not exceed fifty, each first aid box shall contain the following equipment:

(i)	6 small sterilized dressings
(ii)	3 medium size sterilized dressings
(iii)	3 large size sterilized dressings
(iv)	6 pieces of sterilized eye pads in separate sealed packets.
(v)	6 roller bandages 10 cm wide.
(vi)	6 roller bandages 5 cm wide.
(vii)	One tourniquet
(viii)	A supply of suitable splints
(ix)	Three packets of safety pins.
(x)	Kidney tray.
(xi)	3 large sterilized burn dressings.
(xii)	1 (30ml) bottle containing a two percent alcoholic solution of iodine
(xiii)	1 (30 ml) bottle containing Sal volatile having the dose and mode of administration indicated on the label
(xiv)	1 snake bite lancet
(xv)	1 (30gms) bottle of potassium permanganate crystals.
(xvi)	1 pair scissors
(xvii)	1 copy of the First-Aid leaflet issued by the Director General, Factory Advice Service and Labor Institutes, Government of India.
(xviii)	A bottle containing 100 tablets (each of 5 grains) of aspirin
(xix)	Ointment for burns
(xx)	A bottle of suitable surgical anti-septic solution

(b) For establishment in which the number of contract labor exceeds fifty each first-aid box shall contain the following equipment:

(i)	12 small sterilized dressings
(ii)	6 medium size sterilized dressings
(iii)	6 large size sterilized dressings.
(iv)	6 large size sterilized burn dressings
(v)	6 (15 grams) packets sterilized cotton wool
(vi)	12 pieces of sterilized eye pads in separate sealed packets.
(vii)	12 roller bandages 10 cm wide.
(viii)	12 roller bandages 5 cm wide.
(ix)	One tourniquet.
(x)	A supply of suitable splints.
(xi)	Three packets of safety pins.
(xii)	Kidney tray.
(xiii)	Sufficient number of eye washes bottles filled with distilled water or suitable liquid clearly indicated by a distinctive sign which shall be visible at all times.
(xiv)	4 per cent Xylocaine eye drops, and boric acid eye drops and soda by carbonate eye drops.
(xv)	1 (60ml) bottle containing a two percent alcoholic solution of iodine
(xvi)	One (two hundred ml) bottle of mercurochrome (2 per cent) solution in water.
(xvii)	1 (120ml) bottle containing Sal volatile having the dose and mode of administration indicated on the label.
(xviii)	1 roll of adhesive plaster (6 cmX1 meter)
(xix)	2 rolls of adhesive plaster (2 cmX1 meter)
(xx)	A snake bite lancet.
(xxi)	1 (30 grams) bottle of potassium permanganate crystals.
(xxii)	1 pair scissors
(xxiii)	1 copy of the First-Aid leaflet issued by the Director-General, Factory Advice service and labor Institutes, Government of India.
(xxiv)	a bottle containing 100 tablets (each of 5 grains) of aspirin
(xxv)	Ointment for burns
(xxvi)	A bottle of a suitable surgical anti septic solution.

- (2) Adequate arrangement shall be made for immediate recoupment of the equipment when necessary.



ANNEXURE K

Vertigo Test

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Vertigo Test Procedure/ Guidelines

This document specifies minimum requirements for vertigo test. These may be supplemented by any additional requirements deemed fit by the medical examiner/ HSE department)

Fear of height may be physiological or psychological. Therefore, to rule out any possibility of physiological factor, detailed medical check-up of workers is carried out before vertigo test. Medical check-up of workers includes the following:

history of past illnesses (like epilepsy, drug allergy, diabetics/ hypertension, unconsciousness etc.), general physical examination (like height, weight, BMI, build and nourishment etc.), measurement of pulse rate, Blood Pressure, respiratory rate.

After this check-up, those who are found suitable for height work by examining doctor, are allowed to undergo vertigo test.

During this health check-up, psychology of workers is also studied. If any worker finds it extremely difficult/ frightening to climb the monkey ladder & walk on the beam, during/after performing vertigo test or even before performing, then he is treated as disqualified.

As per standard, during vertigo test, worker is allowed to climb on a foundation through monkey ladder, walk on a beam, then steps down at the other end of beam, through monkey ladder. Height of the beam should be at least six feet from ground level. All necessary safety precautions are taken during this test. Worker has to wear full body harness with double lanyard. A horizontal lifeline is run parallel to the beam and worker has to put his lanyards into the lifeline. Additionally, a safety net is also put below the beam for rescue of the victim in case of a fall from beam.

Following activities are suggested to be carried out during testing:**1. Walking Bench Training:**

- a. Person should walk over the channel. He should maintain balance & walk without much problem.
- b. If the person has problem to balance himself on repeated chances, he may be having flat foot or some other problem. So, he may not be fit for height work.

2. Rope Climb Training:

Person should be able to climb the rope up to the top channel for ensuring that in case of fall, a person hanging on the safety harness, will be able to safely climb back to the platform within minimum time period before the safety harness start breaking down under the load.

3. Height Work Training:

Person should walk freely on the middle channel while holding the top channel with the help of safety harness.

4. Ladder for Vertical fall arrestor Training:

Vertical fall arrestor rope is fixed from top to bottom of the ladder. It will ensure:

- Usage of vertical fall arrestor.
- Usage of two lanyards of a safety harness.
- Ensure 3-point contact on the ladder while climb.

5. Chair for work at height Training:

- Climb through vertical ladder with two lanyard ropes.
- Hooking of two lanyard ropes to life line. With this safe arrangement, he can walk to chair.
- Sits in the chair safely, comes out & walks back to the vertical ladder & come down from vertical ladder. After completion of vertigo test, blood pressure of worker is again measured. If it is not within acceptable limits for any worker, concerned worker is denied height pass.

Only those who pass the above training are to be considered as fit for height work.