



BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT, NOIDA

Date-31-Jul-19

CORRIGENDUM- 06

PROJECT	:	1X660 MW UPRVUNL PANKI TPP EXT
PACKAGE	:	PRETREATMENT PLANT
ENQUIRY NO	:	E-6215/2019 Dated. 06.06.2019
SUBJECT	:	TECHNICAL AMENDMENT

Type of Corrigendum			
Technical Corrigendum -	☐	Commercial Corrigendum -	☒

In reference to the above mentioned tender enquiry for **PRETREATMENT PLANT** package

Please note the following.

Technical amendment 01 attached with this corrigendum shall be considered as part of NIT.

All the other terms and conditions of the tender enquiry remain unchanged. All the bidders are requested to quote accordingly.

Yours faithfully,

For and on behalf of BHEL

R P Yadav
Dy. Manager



AMENDMENT ON TECHNICAL SPECIFICATION
FOR
PRE TREATMENT PLANT (PT PLANT)
1X660 MW PANKI THERMAL POWER STATION

SPECIFICATION NO.: PE-TS-426-158A-A001

AMENDMENT NO # 1

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ANNEXURE-A

The following modifications with respect to Technical Specification for **PRE TREATMENT PLANT (PT PLANT)** BHEL's Technical specification no **PE-TS-426-158A-A001** shall apply. Bidder to note that existing clauses/ details as appearing in the specification stands deleted and clauses/details as mentioned in "Modified to or Read as" column shall be applicable and complied by the bidder as listed below in **SCHEDULE A**.

SCHEDULE-A

MODIFIED CLAUSES/ PAGE NUMBERS:

SI no.	Vol. No.	Section/ Description	Clause no	Page no	Existing clause/details	Modified to be Read as
1.	IIB	SECTION-C1	3.0, Point No.1	15 of 1451	Raw water inlet piping to aerator Complete with piping, fitting and valves. The inlet piping is to include motorized butterfly type control valve with manual upstream and downstream isolation valves along with motorized by-pass valve with necessary instrumentation. Clarifier by-pass line before upstream inlet of clarifier shall discharge water in common channel of clarifier before CW tank.	Raw water inlet piping to aerator complete with piping, fitting and valves. The inlet piping is to include motorized butterfly type control valve with manual upstream and downstream isolation valves along with manual by-pass valve with necessary instrumentation. Clarifier by-pass line before upstream inlet of clarifier shall discharge water in common channel of clarifier before CW tank.
2.	IIB	SECTION-C1	3.0, Point No. 11	16 of 1451	One (1) no. RCC Sludge Pit of effective capacity 250 cum (in twin section) with common sump interconnected through valves as per P&ID.	One (1) no. RCC Sludge Pit with pump house of effective capacity 250 cum (in twin section) with common sump interconnected through valves as per P&ID.
3.	IIB	SECTION-C1	3.0, Point No. 14	16 of 1451	One (1) number of RCC Sludge thickener of required capacity, pumps , associated valves, piping etc..	One (1) number of RCC Sludge thickener of required capacity, associated valves, piping etc.
4.	IIB	SECTION-C1	3.0, Point No. 15	16 of 1451	One (1) no. RCC thickened waste/sludge sump (in twin section) with common sump interconnected through valves.	One (1) no. RCC thickened waste/sludge sump with pump house (in twin section) with common sump interconnected through valves.
5.	IIB	SECTION-C1	3.0, Point No. 17	16 of 1451	Two (2) number of air blowers of oil free type of required capacity, its drives and associated accessories, air (Galvanised CS) piping from	Two (2) number of air blowers of oil free type of required capacity with acoustic enclosure , its drives and associated accessories, air



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					blowers to each section of the Thickened waste sump for air scouring of sump.	(Galvanised CS) piping from blowers to each section of the Thickened waste sump for air scouring of sump.
6.	IIB	SECTION-C1	3.0, Point No. 20	16 of 1451	One (1) no. RCC Supernatant collection sump (in twin section) with common sump interconnected through valves.	Clause Deleted. May be read as Pt no 20 : Void
7.	IIB	SECTION-C1	3.0, Point No. 21	16 of 1451	Thickener supernatant shall be transferred to stilling chamber through gravity pumps with piping, valves, fittings and instrumentation up to Stilling Chamber	Thickener supernatant shall be transferred to stilling chamber through gravity along with piping, valves, fittings and instrumentation up to Stilling Chamber. If gravity flow of water from thickener to stilling chamber is not possible, then bidder has to provide sump with pump of capacity 2X100 % along with associated valves, instruments etc.
8.	IIB	SECTION-C1	3.0, Point No.24	16 of 1451	Three (3) nos. Lime Solution dosing Tanks having minimum total effective capacity of 24 hrs. requirement with 20 % margin considering both clarifier running simultaneously or 22 cub M (each tank) or whichever is higher, with motorized stirrer, flushing arrangement, instrumentation, valves, fittings and piping up to the Clarifiers.	Three (3) nos. Lime Solution dosing Tanks having minimum total effective capacity of 24 hrs. requirement with 20 % margin considering both clarifier running simultaneously or 22 cub M (each tank) whichever is higher, with motorized stirrer, flushing arrangement, instrumentation, valves, fittings and piping up to the Clarifiers.
			21.1 Minimum effective storage Capacity of all tanks	98 of 1451		
9.	IIB	SECTION-C1	3.0, Point No.26	16 of 1451	Two (2) nos. common bulk FeCl ₃ storage tank with Piping, valves & instrumentation etc. Capacity of each tank, in m ³ /hr: 15 days requirement of PT plant.	Two (2) nos. common bulk FeCl ₃ storage tanks with Piping, valves & instrumentation etc. Capacity of each tank, in m ³ : 15 days requirement of PT plant. FeCl ₃ bulk storage tanks shall be located in open outside the chemical house.
10.	IIB	SECTION-C1	3.0, Point No.28	17 of 1451	Three (3) nos. Coagulant [Ferric Chloride (FeCl ₃)] Solution Preparation Tanks having minimum total effective capacity of 24 hrs. requirement with 20 % margin considering both clarifier running simultaneously or 20 cub M	Three (3) nos. Coagulant [Ferric Chloride (FeCl ₃)] Solution Preparation Tanks having minimum total effective capacity of 24 hrs. requirement with 20 % margin considering both clarifier running simultaneously or 20 cub M (each tank)



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			19 – Minimum effective capacity	97 of 1451	(each tank) or whichever is higher with motorized stirrer, flushing arrangement, instrumentation, valves, fittings and piping up to the Clarifiers.	whichever is higher with motorized stirrer, flushing arrangement, instrumentation, valves, fittings and piping up to the Clarifiers.
11.	IIB	SECTION–C1	3.0, Point No.30	17 of 1451	Two (2) nos. Coagulant aid (Polyelectrolyte) Preparation Tanks having minimum total effective capacity of 24 hrs. requirement with 20 % margin considering both clarifier, thickener and centrifuge running simultaneously or 16 cub M (each tank) or whichever is higher with motorized stirrer, flushing arrangement, instrumentation, valves, fittings and piping up to the all Clarifiers.	Two (2) nos. Coagulant aid (Polyelectrolyte) Preparation Tanks having minimum total effective capacity of 24 hrs. requirement with 20 % margin considering both clarifier, thickener and centrifuge running simultaneously or 16 cub M (each tank) whichever is higher with motorized stirrer, flushing arrangement, instrumentation, valves, fittings and piping up to the all Clarifiers.
			21.2-Tank-Capacity	99 of 1451		
12.	IIB	SECTION–C1	3.0, Point No.48	17 of 1451	Necessary pipe, piping, fitting, valves, drains, vents, sampling etc. required for the complete PT Plant. Pipe racks shall be provided by BHEL wherever available. Wherever pipe racks are not available, pipe shall be laid on pedestal (BHEL or vendor's scope as per civil scope sheet). However all auxiliary steel structure (U-clamps, nuts, bolts, channels etc.) for fixing pipes on pedestal or racks for complete pre-treatment plant shall be in bidder's scope.	Necessary pipe, piping, fitting, valves, drains, vents, sampling etc. required for the complete PT Plant. Pipe racks shall be provided by BHEL wherever available. Wherever pipe racks are not available, pipe shall be laid on pedestal. Construction of pedestal, all auxiliary steel structure (U-clamps, nuts, bolts, channels etc.) for fixing pipes on pedestal or racks for complete pre-treatment plant shall be in bidder's scope.
13.	IIB	SECTION–C1	10, Point No. 3	20 of 1451	Air conditioning, ventilation & firefighting facilities. However, heat dissipation data for all motors & panels as applicable shall be finished by the bidder during detail engineering for sizing of HVAC equipment.	Clause Deleted. May be read as Pt no 3 : Void
14.	IIB	SECTION–C1	Drawings	84 of 1451, Drawing No.-PE-DG-426-158-A001, Notes - 13	If gravity flow of water from thickener to stilling chamber is not possible. Then bidder has to provide sum with pump of capacity 2x100	If gravity flow of water from thickener to stilling chamber is not possible. Then bidder has to provide sum with pump of capacity 2x100%.
15.	IIB	SECTION–C1		86-87 of 1451,	Drawing no- PE-DG-426-172-N005, R2 (Invert level of inlet channel is EL(+) 0.95M)	Drawing no- PE-DG-426-172-N005, R4 (Invert level of inlet channel is at EL(+).1.45M)



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			Drawings	Drawing No.-PE-DG-426-172-N005		Revised drawing is attached.
16.	IIB	SECTION-C1	Drawings	84 of 1451, Drawing No.-PE-DG-426-158-A001	Note 11	Note 11 of P&ID of PT plant stands deleted. May be read as Note 11: Void
17.	IIB	SECTION-C1	Data Sheet-A, 14 Drawings	84 of 1451, Drawing No.-PE-DG-426-158-A001	Capacity - Not more than 10 Cum/hr	Capacity - Not less than 10 Cum/hr. However the final centrifuge capacity shall be as per process requirement.

NEW CLAUSES / SCOPE ADDED:

Sl no.	Vol. No.	Section/ Description	Clause no	Page no	Description
18.	IIB	SECTION- C1	3.0, Point No. 58	Page 18 of 1451	AC and Ventilation of PT plant building is in bidder scope. AC shall be provided for PT plant control room and VFD room (as per applicability). Ventilation shall be provided for pump and blower house, ladies and gents toilet etc. as applicable. Specification for HVAC is attached as Annexure-I.
19.	IIB	SECTION- C1	3.0, Point No. 59	Page 18 of 1451	Hoist and monorail of suitable capacity shall be provided for handling of Sludge transfer pumps and Sludge disposal pumps.
20.	IIB	SECTION- C1	3.0, Point No. 60	Page 18 of 1451	Chemicals such as Lime, FeCl ₃ , Polyelectrolyte required for PT plant operation are excluded from bidder's scope. However, any Chemical and reagent as required for analysers for first fill and one year's topping, requirements are in bidder's scope.
21.	IIB	SECTION- C1	9.0	Page 19 of 1451	Additional terminal points shall be as follows: 7. BHEL shall terminate sludge pipe from lamella clarifier/tube settler at 5



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					m away from PT plant sludge pit. PT plant supplier shall connect it with sludge pit. Necessary piping and paddle pipe etc shall be in PT plant supplier scope. 8. BHEL shall provide chlorine/disinfectant dosing in stilling chamber. 9. BHEL shall terminate DM back wash water in stilling chamber. 42 M3 of DM Filter back wash shall be fed to PT stilling chamber in once in a day. 10. Bidder shall provide one pipe of suitable size from sludge pump and terminate in Ash slurry pit. Bidder to consider 650 m of running length of pipe along with fitting etc in his scope of supply and associated Erection & commissioning. The detailed routing of this pipe shall be finalized during detailed engg. The plot plan is enclosed for reference.																				
22.	IIB	SECTION-C4			Below mentioned point is added in the clause "Bidder to consider the following but not limited to major items of PT plant excluding Chemical house and centrifuge shed. Levelling and grading of PT plant area is in bidder scope.																				
23.	IIB	SECTION- C1	3.0, Point No. 61	Page 18 of 1451	The various chemical handling and dosing equipment in the PT plant shall be designed for the following dosing rate i) Ferric Chloride - not less than 25 ppm. ii) Lime - 25 ppm (max.) iii) Polyelectrolyte - 2 ppm (max) iv) Raw water chlorination – 5 ppm (max) – BHEL SCOPE																				
24.	IIB	SECTION- C1	3.0, Point No. 62	Page 18 of 1451	A minimum free board of 300mm shall be provided in all the water retaining structure of PT plant (such as stilling chamber, clarifier etc.). Design velocity in the channel shall be sized for a maximum velocity of 0.6 m/sec. Pipe line carrying chemicals and compressed air should be sized on the following velocity <table><tr><td></td><td></td><td colspan="3">Velocity in m/sec.</td></tr><tr><td></td><td></td><td colspan="3">Pipe Size</td></tr><tr><td></td><td></td><td>Below 50 mm</td><td>50 – 150 mm</td><td>200 mm & above</td></tr><tr><td>a)</td><td>Pump suction for chemical</td><td>0.8-1.2</td><td>0.8-1.3</td><td></td></tr></table>			Velocity in m/sec.					Pipe Size					Below 50 mm	50 – 150 mm	200 mm & above	a)	Pump suction for chemical	0.8-1.2	0.8-1.3	
		Velocity in m/sec.																							
		Pipe Size																							
		Below 50 mm	50 – 150 mm	200 mm & above																					
a)	Pump suction for chemical	0.8-1.2	0.8-1.3																						

25.0 AIR CONDITIONING

25.1 General

The air conditioning ; system shall be provided so as to achieve inside design conditions for proper performance of equipment and personnel.

The extent of supply under this contract includes all items required to complete the intent of the contract notwithstanding the fact that such items may have been omitted from the specification or drawings.

The air conditioning ; system shall also meet the requirements specified elsewhere in the specification.

25.2 Codes and Standards

The design, manufacture and performance of equipment shall comply with all currently applicable statues, regulations and safety codes in the locality where the equipments are to be installed. Nothing in this specification shall be considered to relieve the bidder of this responsibility.

Unless otherwise specified, equipment shall conform to the latest applicable Indian or IEC standard. Equipment complying with other authoritative standards such as British, USA, ASHRAE etc. will also be considered if it ensures performance equivalent or superior to Indian Standard.

25.3 Design Criteria for Air conditioning system

25.3.1 Design ambient conditions

Season	Dry Bulb Temp (⁰ C)	Wet Bulb Temp (⁰ C)
Summer	42.8	25
Monsoon	36.1	28.3
Winter	7.2	5.6

For other details of ambient conditions, refer published documents for meteorological data for Plant site. (Refer Volume II)

25.3.2 All equipments of air conditioning system shall be designed for continuous duty.

25.3.3 All air conditioned areas like control room, control equipment rooms, service building, administrative building shall be maintained as per conditions indicated below .:

Dry bulb temperature : **24 $\pm$ 1.0°C**
Relative humidity : **50 $\pm$ 5 %**

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- 25.3.5 The fresh air quantity for air conditioned areas like control room/ control equipment rooms/ UPS etc shall be 0.45 m³/ min/ person or 1 air change per hour whichever is greater. However for areas like service building, administrative building etc, quantity of fresh air shall be minimum 1.5 air changes per hour.
- 25.3.6 Lighting load shall be minimum 2 Watts per Ft² or actual whichever is higher.
- 25.3.7 The occupancy for general area shall be minimum one person per 3 Sq. M and for conference room the same shall be one per 1.5 Sq. M. In the control rooms, control equipment rooms etc, the occupancy may be one person per 20 Sq. M (Minimum).
- 25.3.8 In air conditioning system the return air shall be through ducts and use of plenum space for return air shall be avoided. Further, for Service / Administrative / Training Centre Building where various floors are air conditioned and no intermediate or intervening floor are left non air conditioned, the space above false ceiling shall be used as return air plenum.
- 25.3.9 The supply & return air ducts shall be provided with automatic (motorised) fire dampers (of 90 minutes fire rating) at locations where ducts pass through walls & floors. Operation of these dampers shall be interlocked with the fire alarm system and shall also be possible to operate manually from the remote control panel. Required electrical contacts shall be provided in control panel of A/C plant by the contractor for further wiring upto fire alarm panels.
- 25.3.11 Design Chilled water flow shall not be less than 0.7 Cu. M / Hr per TR of air-conditioning load and design Condenser cooling water flow shall not be less than 1.0 Cu. M / Hr per TR air-conditioning load.
- 25.3.12 Coil face area of Air Handling Units shall be designed considering a face velocity of not more than 2.5 M/ Sec. Water piping shall be sized for a maximum velocity of 2.0 m/sec. However gravity flow/pump suction line shall be sized for a maximum water velocity of 1.5 m/sec. Air distribution system shall be sized to have constant frictional drop along its length and velocity through ducts shall not exceed 7.6 m/s.
- 25.3.13 Requirement of under deck Insulation (for A/C area)

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- 25.3.14 Under deck insulation of 50 mm nominal thickness of glass wool (32 kg/cum) or rock wool (48 kg/cum) shall be provided if
- i) Non A/ C area is located just above the A/C area. In this case, under deck insulation shall be provided underneath the ceiling of A/C area.
 - ii) Non A/ C area is located just below the A/C area. In this case, under deck insulation shall be provided underneath the ceiling of Non A/C area.
- 25.3.15 For Air Handling Unit (AHU) serving main plant control area, where DCS based equipments are located, the dehumidified air shall be filtered at three different stages i.e pre (coarse) filter followed by fine filter followed by HEPA filter before discharge it to air conditioned space. For all other areas, AHU's shall be provided with two stage of filtration i.e pre filter & fine filter. All fresh air supply shall also be filtered using pre & fine filter.
- 25.3.16 A minimum design margin of 10% shall be considered in design of AC Plant capacity for each area, 20% design margin shall be considered for the cooling tower capacity over the selected A/C capacity provided. Head of the pumps shall take into account minimum 10% margin on friction head. For pumps continuous motor rating (at 50 Deg C ambient) shall be at least 10% above the maximum load demand of the pump in the entire operating range.
- 25.3.17 For areas like ESP control rooms, water system control room, where A/C load is of the order 25-60 TR, direct expansion (D-X) type condensing unit shall be provided depending on the availability of space/ layout etc. For areas where A/C load is of the order of 15-25 TR, duct able split/ packaged A/C shall be provided. Smaller areas which are away from the D-X type condensing unit/ central chilling units which may require air conditioning upto 15 TR rating shall be served with Hi – Wall split/ Cassette air conditioner units as per requirement. For static excitation Control Room (if applicable) precision air conditioners of required capacity shall be provided.
- 25.3.18 Valves at discharge of pumps, outlet of chillers and inlet of cooling towers or any other valve in the system shall be motor operated type for remote operation of the air conditioning system.

25.3.21 Redundancy of Equipments

- **Effluent Treatment Control Building**
- Water Cooled / Air Cooled Condensing Units / Precision Air Conditioners - 2 x 100%
- Condenser water pumps - 2 x 100% (if applicable)
- FRP cooling towers (with VVFD Fans) - 2 x 100% (if applicable)
- Air handling units - 2 x 100% AHU shall be variable voltage frequency driven (VVFD).
- 100% standby shall be provided for areas served by precision/ cassette/ Hi wall split type AC for all other offsite control rooms.
- Fresh air fans shall be 2 x 100% for each AHU room.

Chilling Unit /Condensing Unit

Type	Water cooled type (Chillers for main plant shall be with multiple compressors)
Vibration isolators	: Steel spring/ Neoprene rubber cushy foot/ neoprene serrated rubber pad type with isolation efficiency not less than 85%.
Compressor Type	: a) Compressor shall be open/ semi hermetic/ multiple hermetic in case of Screw or centrifugal type operating on R134a/R407C refrigerant complete with accessories and automatic control facilities
Type of drive	: Motor driven, through direct/ V Belt along with star delta/ double delta starter
Accessories	: High / Low pressure cut outs, Oil pressure switches, relief valves, Pressure gauges at each stage, lube oil/Control oil pressure gauges, Suction and discharge stop valves, Muffler, Crank Case heaters, Oil filters, Magnetic oil Separators, Temperature indicators for Lube oil/ Heaters, Oil level indicators, Safety thermostat for crank case heater, Vibration Isolators etc.
Condenser	
Type	: Water cooled, shell and tube type.
Fluid	: Shell side – Refrigerant
	: Tube side - Water
Capacity	: To match with respective compressor and to provide at least 2°C sub-cooling. To store full charge of refrigerant.
Design fouling Factor	: Not less than 0.0002 (in MKS units)
Shell material	: Mild steel (IS:2062)/ SA 106 Gr B
Tube material	: Replaceable seamless copper (ASME B-111)
Fin material	Copper
Accessories	: Purge and drain connections, relief valves, liquid line shut-off valves, refrigerant filling charging, flow switches, Isolating valves, Pressure & temperature indicators at inlet and outlet etc.
Refrigerant	: For chilling Unit- R 134a/ R – 410A/ R 407-C

		or any other environment friendly refrigerant.
Steel structure	:	The complete condensing/ chilling unit shall be mounted on steel structure and shall be provided with necessary vibration isolators
Inlet Temperature	:	33 Deg C
Leaving Temperature Differential	:	Maximum 5 Deg C
Chiller		
Type	:	Shell and tube type
Superheating of	:	At least 2 ⁰ C
Design Fouling Factor	:	Minimum 0.0001 (MKS units)
Fluid	:	Shell side - Refrigerant
		Tube side - Water
Capacity	:	To match with respective plant capacity.
Shell material	:	Mild steel (IS:2062)/ SA 106 Gr B
Tube material	:	Plain Tube internally/ externally finned copper as per manufacturer's standard
Fin material	:	Integral
Accessories	:	Purge and drain connections, Isolating valves, flow switches, Pressure & temperature indicators at inlet and outlet, Anti-freeze thermostats, thermostatic expansion valve or float assembly as applicable, pilot solenoid valve, Relief valves, Operating thermostats for capacity control, supporting frame etc.
Steel Structure	:	The complete condensing/ chilling unit shall be mounted on steel structure and shall be provided with necessary vibration isolators.

25.7.3 Condensing Unit (Air Cooled / Water cooled D-X Type)

Type	Air Cooled / Water cooled type.
Vibration isolators	: Steel spring/ Neoprene rubber cushy foot/ neoprene cushy rubber pad type with isolation efficiency not less than 85%.
Compressor Type	: Compressor shall be screw / scroll, serviceable, either open type or hermetic type or semi hermetic type with load, unload and

		automatic capacity control (minimum 3 steps)
Type of drive	:	Motor driven, direct or through V belt.
Refrigerant	:	For chilling Unit- R 134a/ R – 410A/ R 407-C or any other environment friendly refrigerant.
Accessories	:	High / Low pressure cut outs, Oil pressure switches, relief valves, Pressure gauges at each stage, lube oil/Control oil pressure gauges, Suction and discharge stop valves, Muffler, Crank Case heaters, Oil filters, Magnetic oil Separators, Temperature indicators for Lube oil/ Heaters, Oil level indicators, Safety thermostat for crank case heater, Vibration Isolators etc.
Capacity	:	Minimum capacity shall be suitable for the identified/ selected at evaporating temperature and shall be indicated.

Note : upto 50 TR capacity chilling/ condensing unit can be of air/ water cooled type. However beyond this capacity unit shall be water cooled type only.

25.7.4 Air Handling Unit (AHU)

- a) Each AHU shall consist of casing, fan impeller section, cooling coil section, damper section, steel frame with anti vibration mountings (AVMs) having minimum 85% vibration dampening efficiency and flame retardant, water proof neoprene impregnated flexible connection on fan discharge. Isolation dampers at the suction and discharge of each AHU shall be provided, in case return air duct is directly connected to AHU. However, in case AHU room is used for return air, isolation dampers are required to be provided only at AHU discharge of each AHU. Pre-filter at the suction and fine (micro-vee type) and absolute (HEPA type) filters (wherever applicable) at the discharge of each individual AHU, and heater section in the common discharge of AHUs.
- b) The casing of AHUs shall be of double skin construction. Double skin sandwich panels (inside and outside) shall be fabricated using minimum 0.63 mm (24g) galvanized steel sheet (thickness of galvanization as per manufacturer's standard) , with 25mm thick polyurethane foam insulation of minimum 38 Kg/Cum density in between. Suitable reinforcements shall be provided to give structural strength to prevent any deformation/buckling.
- c) Face and bypass dampers (motor operated for DX type plant) of opposed blade type shall be provided. Dampers shall be made of 16 gauge G.S sheet metal (class 275 of IS: 277). The area of the bypass section shall be minimum 30% of the coil face area. Damper operating linkage and the operating motor shall be located outside the casing. Each AHU shall be provided with motorized volume control damper at air discharge.

- d) Cooling coil shall be of seamless copper tubes with Aluminium fins firmly bonded to copper tubes and shall be provided with suitable drains and vents connections.
- e) All filter plenum shall be provided with a walking platform inside the plenum chamber for filter cleaning purpose. Inspection door shall be provided at the plenum chamber and a removable type ladder shall be attached to plenum.
- f) Air handling units/centrifugal fans shall be provided with Variable frequency drive (VFD) and velocity sensor/static pressure sensor in supply air path to adjust air flow automatically. The minimum efficiency of VFD at full load shall not be less than 96%.
- g) Sloping condensate drain pan shall be made of minimum 1.2 mm thk stainless steel sheet. It shall be isolated from bottom floor panel through 25 mm thk heavy duty treated for fire (TF) quality expanded polystyrene or polyurethane foam. Drain pan shall extend beyond the coil.

25.7.5 Centrifugal Fan for AHU

a)	Fan Type	:	Double width double inlet (DWDI) centrifugal type.
b)	Fan impeller	:	Backward curved blade & centrifugal type.
c)	Casing material	:	GI/ Mild steel with minimum thickness of 3 mm.
	Impeller material	:	Carbon Steel
d)	Shaft	:	EN 8 Steel
e)	Fan bearings	:	Self aligning type, permanently lubricated, heavy duty with a design life of 10,000 operating hours.
f)	Critical speed	:	First critical speed of rotating assembly shall be at least 25% above the operating speed.
g)	Drive	:	Motor driven. With removable belt guard.

25.7.6 Mixing Box

Mixing box shall be complete with fresh and return air dampers. Mixing box shall be provided whenever the return air is ducted back to the AHU.

25.7.7 Pan Humidifier

Pan humidifier shall be made of 22 guage SS 304 tank, duly insulated with 25 mm thick resin bonded fibre glass insulation (min 24 kg/cum density) with 0.5 mm GSS cladding. The humidifier shall be complete with stainless steel immersion heaters, safety thermostat, float valve with stainless steel ball, sight glass, overflow and drain connections, steam outlet nozzle and float switch. Step controller shall be provided for switching on/ off heater banks as per system requirement.

25.7.8 HI- Wall Split/ Cassette/ precision air Conditioners

25.7.8.1 Hi Wall split/ Cassette air conditioners shall in general consist of the following :

1. Casing.
2. Hermetically sealed rotary/ scroll compressor.
3. Condenser.
4. Evaporator and condenser cooling fan.
5. Cooling coil.
6. Filters.
7. Piping, valves, refrigerant strainer etc.
8. Control, instruments, control panel/ starter panels.
9. Vibration isolation pads as required.
10. Refrigerant as per manufacturer's standard.

25.7.8.2 Indoor unit of ceiling mounted Cassette type unit (Multi Flow Type):

The housing of the unit shall be powder coated galvanized steel. All the indoor units regardless of their difference in capacity should have same decorative panel size for harmonious aesthetic point of view.

Unit shall have four way supply air grills and return air grill in centre.

Each unit shall have high lift drain pump and very low operating sound.

25.7.8.3 Precision Packaged Air Conditioners

Precision air conditioning system shall be designed for high sensible heat ratio. The system shall contain scroll compressor, evaporator blower & coil, heater, humidifier, air cooled condenser, externally equalized electronic expansion valve etc. All items except condenser shall be contained within the cabinet of the unit, which shall be placed inside room. Air cooled condenser shall be located outdoor.

- i. Compressor shall be high efficiency (EER should be not less than 3.5) scroll design and shall have inbuilt overloads. It shall be mounted on anti vibration mountings.
- ii. The condenser shall be water cooled shell and tube type having replaceable seamless copper tubes with integral fins and removable head. The condenser shall be provided with fusible relief plug and all other accessories as required.
- iii. The air handling fan shall be centrifugal type with forward curved blades and complete with belt drive and electric motor. Each PAC shall be provided with motorized volume control damper at air discharge.
- iv. Evaporator coil : The unit shall be fitted with large surface area cooling coil with split coil mechanism/ or any other equivalent method for dehumidification. The distance between fins shall not be less than 1.8 mm and face velocity shall not exceed 2.5 m/s.
- v. Filters- Filter chamber shall be integral part of the system & withdraw able from the unit. Filter shall be capable of filtering air to 95% down to 5 micron efficiency.
- vi. Refrigerant piping shall be heavy gauge copper or IS:1239 heavy class seamless MS pipe complete with thermostatic expansion valve, liquid line shut-off valve, high and low pressure gauges.
- vii. Refrigeration Circuit : The circuit shall be direct expansion type. It shall include a manual reset HP and auto reset LP switch, filter drier, charging port, electronic expansion valve, sight glass etc.
- viii. The indoor unit shall have forward/ backward curved centrifugal type double inlet width statically and dynamically balanced fans. Fan shall be electronically commutated type fan.
- ix. Electrical heating : The heating circuit shall include dual safety protection through loss of air and temperature controls.
- x. Air Cooled Condensers : The equipments shall be designed for 47 Deg C outside ambient condition. Low ambient refrigeration controls (LARC) shall also be available. The condenser frame shall be constructed from heavy duty galvanized steel and in corporate copper tube & aluminium fins.
- xi. Cabinet Construction:

The frame & panel shall be constructed of heavy gauge Zinc annealed corrosion resistant sheet steel. The fan section shall be insulated with fire retarded insulation. The cabinet shall be powder coated and have a textured finish.
- xii. Humidifier

Humidification shall be provided by boiling water in a polypropylene steam generator. The steam shall be distributed evenly into bypass air stream of precision air conditioning unit. Humidifier shall be fitted with an auto flushed cycle activated on demand from the control system. Further, humidifier shall be fully serviceable with replaceable electrodes. Waste water shall be flushed from the humidifier by initiation of water supply solenoid valve.

- xiii. The Units shall be designed for 68 DBA at 1 meter from the unit outlet quiet operation with all moving parts mounted on anti-vibration mounting and carefully balanced to ensure minimum vibration.
- xiv. The refrigerant shall be R-407C/ R-134a/ R-410A or any other environment friendly refrigerant.
- xv. All necessary operating and safety controls shall be provided including the following:

Controls:

The controls shall be DCS based programmable with PID (Proportional, integral and derivative control logic) controller. The controller shall have a LCD display screen, which shall be visible from the front of the unit without removing any covers/external panels. This LCD display screen should show the following information / data:

- a) Modes of operation (cooling, heating, humidification & de-humidification).
- b) Simultaneous graphical displays of set temperature and actual temperature and set Relative Humidity and actual Relative Humidity.
- c) Date, time and unit identification display.
- d) System component Auto / Manual status display on the controller screen.
- e) Backup battery charge status display on the controller screen.
- f) Visual system alarm indication (along with mutable audio alarm as well).
- g) Alarm display menu (incorporating various system alarms like temperature high / low, humidity high / low, Compressor HP/LP, Wet floor and loss of air flow conditions).
- h) 48 Hours temperature and relative humidity graph display menu.

- i) Programmable services interval indication display / alarm.

There should be a feature to enable operator to program the start-up and shut off of the system components (blower fan start / stop delay, first compressor start / stop delay, second compressor start / stop delay, etc.). Access to the controller settings shall be protected with passwords to prevent against unauthorized access.

Safety Protections:

The unit shall also incorporate the following protections:

- a) High pressure trip- Manual reset for each compressor
- b) Low pressure trip- Manual reset for each compressor.
- c) Single phasing preventers.
- d) Reverse phasing
- e) Phase unbalancing
- f) Phase failure
- g) Overload tripping (MPCB) of all components

Safety Interlocks:

Operation of heaters & humidifiers shall be possible only when blower fan is in operation.

Fire detection signal from fire detector system shall be able to switch off the package unit operation in event of fire in conditioned space.

- xvi. A suitable number of vibration isolation pads shall be provided for the packaged units.

25.7.9 Centrifugal Pumps

a)	Type	:	Horizontal Centrifugal, Axially split type casing pump
b)	Impeller	:	Closed type
c)	Material of Construction	:	
	i) Casing	:	2% Ni Cast Iron : IS:210 Gr. FG-260
	ii) Impeller	:	Bronze IS:318 Gr-2
	iii) Wearing rings	:	Bronze
	iv) Shaft	:	SS 410
	v) Shaft sleeve	:	SS 316
	vi) Lantern ring	:	Brass / Bronze
	vii) Packing	:	Asbestos free

viii) Base Plate	:	Carbon steel as per IS:2062
ix) Speed	:	Maximum 1500 rpm

For other requirements of pumps refer Chapter 34 of this volume.

25.7.10

Air Filters

a) Pre Filter

1)	Filter medium :	
i)	Washable non-woven synthetic fibre or high density Polyethylene (HDPE) media having 18G GSS/ 16G Al alloy frame. The filter media shall be supported with HDPE mesh on air inlet side & Aluminium expanded metal on exit side or GI wire mesh on both sides.	
2)	Type	
	Flange/ Cassette	
3)	Other requirements (as applicable) :	
a)	Suitable aluminium spacers be provided for uniform air flow;	
b)	Casing shall be provided with neoprene sponge rubber sealing.	
c)	Capable of being cleaned by water flushing.	
d)	Density of filter medium shall increase in the direction of air flow in case of metallic filter.	
e)	Filter media shall be fire retardant and resistant to moisture, fungi, bacteria & frost.	
4)	Efficiency :	
	Average arrestance of 65 - 80 % when tested in accordance with BS:6540/ASHRAE - 52 - 76/ EN-779.	
5)	Minimum thickness	: 50 mm
6)	Face Velocity	: Not more than 2.5 m/sec.
7)	Pressure drop	: Initial pressure drop - Not to exceed 5.0 mm WC at rated flow. Final pressure drop - Upto 7.5 mm WC.
8)	Location	
a) Fabric type		: 1) At the suction of each AHUs
		: 2) At the suction of each Fresh air fan
		: 3) At suction of each supply air fan
		: 4) at suction of air washer & UAF (Water repellent nylon type)

b) Fine Filters (Microvee type)

1)	Type	:	Flange/ Cassette
2)	Construction	:	Washable non-woven synthetic fibre or high density Polyethylene (HDPE) media having 18G GSS/ 16G Al alloy frame. The filter media shall be supported with HDPE mesh on air inlet side & Aluminium expanded metal on exit side or GI wire mesh on both sides.
3)	Frame	:	Aluminium alloy of (minimum 16 gauge conforming to IS:737)
4)	Other requirements	:	a) A neoprene sponge rubber sealing shall be provided on either face of the filter frame. b) Capable of being cleaned by air or water flushing. c) Filter media shall be fire retardant and resistant to moisture, fungi, bacteria & frost.
5)	Efficiency	:	Average arrestance of 99.5% UPTO 5 MICRONS
6)	Minimum thickness	:	150 mm or 300 mm.
7)	Face Velocity	:	Not more than 1.2 m/sec for 150 mm and not more than 2.4 m/sec. for 300 mm.
8)	Pressure drop	:	Initial pressure drop - Not to exceed 10 mm WC at rated flow ; Final pressure drop-Up to 25 mm WC.
	Location	:	i) At the discharge of each individual AHU. ii) At the discharge of each Fresh air fan. iii) At the discharge of each supply air fan having static pressure of 30 mm WC or more.

25.7.11

Cooling Towers

Type	Induced draft, cross or counter flow.
Capacity	120% of rated capacity of each cooling water pump.
Material of construction of Casing & Sump tank	F.R.P/ GRP
Fan	Cast Aluminium / FRP Propeller type and multi-blade aerofoil construction with adjustable pitch.
Fill	Non combustible PVC or Equivalent of light grey, cream or white colour.
Louvers	F.R.P / PVC / Aluminium.
Nozzles	Brass with chrome plating/Polypropylene.
Eliminators	In removable sections to reduce the drift loss to 0.2% of water flow.
Supporting structure	Mild steel with spray galvanisation or epoxy painting.
Strainer at water outlet	Plate strainer made of GI /SS wire mesh of 16 gauge.
Bird screen on top of tower	25 mm square made of GI/SS wire mesh of 16 gauge.
Ladder	Hot dip galvanised steel ladder for each tower.
Distribution Pipe (if any)	Galvanised MS pipe.
Accessories	a) Drain connection with isolation valve b) Make up connection with ball - float valve, back up gate valve and a bypass with a gate valve for manual operation. c) Overflow connection d) Equalizing connection to connect sump of all the towers wherever applicable. e) Access door in louvers / fan deck.

25.7.12

Non- Chemical Type Scale Preventer

The unit should be a non-chemical on-line type scale preventer not requiring any chemicals. Non-chemical water treatment system should prevent the formation of hard scale in cooling circuits of air conditioning equipment. It should work with a combination of Adsorption, and Turbulence. The inner core should be able to convert the hardness salts into colloidal particles. The unit should not require any electricity or any other source of energy. The unit should not have any recurring, operating and maintenance cost. The size of the unit shall be determined based on the water quality and water flow rate. The unit shall be installed in the condenser water circuit. The outer casing should be of stainless steel. The method of checking the performance of system through computer simulation shall be provided

25.7.13 Low Pressure Air Distribution System

- I) Through Galvanized sheet steel fabricated rectangular ducting shall be provided for the low pressure air distribution system. The Galvanised sheets shall confirm to 275 GSM IS-277 or Aluminium alloy (grade 19000/ SIC or 3100/ NS 3 of IS 737).

The thickness of rectangular ducts shall be as follows :

	Larger dimensions of Duct, mm	Thickness of GI sheet (mm)	Thickness of Aluminium sheet (mm)
a.	Upto 750	0.63 (24 G)	0.8
b.	751 to 1500	0.80 (22 G)	1.00
c.	1501 to 2250	1.00 (20 G)	1.50
d.	2251 & above	1.25 (18 G)	1.80

The thickness of round ducts shall be as follows :

	Diameter of Round Duct, mm	Thickness of GI sheet (mm)	Thickness of Aluminium sheet (mm)
a.	150 to 500	0.63	0.8
b.	501 to 750	0.80	1.00
c.	751 to 1000	0.80	1.00
d.	1001 to 1250	1.00	1.50
e.	1251 & above	1.25	1.80

25.7.13.1 Duct Fabrication & Supports

- Duct fabrication shall be as per the latest relevant BIS/ SMACNA standard.
- Ducts for AC system may be site fabricated or factory fabricated and installed at site. However in case of partly used factory fabricated ducts, vendor shall take back the unused ducts.
- The ducts routed inside the buildings with larger side greater than 2250 mm shall be supported by 16mm MS rods and 50x50x3 mm MS double Angles while those below 2250 mm shall be supported

by 10mm MS Rods and 40x40x3 MS angles. The duct supports shall be at a distance of not more than 2000 mm for A/C system. The MS rods for these ducts routed inside the building shall be hung from the existing floor beams/wall beams / roof beams/columns as provided by the owner with provision of necessary auxiliary or special steel members or by hooks or can be provided by contractor by dash fasteners fixed to the ceiling slab. No supports shall be taken from horizontal/vertical bracings of the structures. All items of duct support including MS rods, MS angles and double angles, auxiliary or special steel members, hooks, dash fasteners coach screws and all other supporting material required shall be provided by the bidder.

- d. Where the sheet metal duct connects to the intake or discharge of fan units, a flexible connection of fire retarding, at least 150 mm width shall be provided of closely woven, rubber impregnated double layer canvas or neoprene coated fibre glass.
- e. All curves, bends, offsets and other transformations shall be made for an easy and noiseless flow of air. The throat of every branch duct shall be sized to have the same resistance in the main duct to which the branch duct is connected. All elbows shall have the throat radius of at least seventy five (75) percent of the duct width. In case the throat radius is smaller, suitable single thickness vanes of approved details shall be provided.
- f. Wherever duct passes through wall, all the openings between masonry and duct work shall be neatly caulked or sealed to prevent movement of air from one space to the adjoining space. Where duct passes through the floor, at the lowest point in the elbow a drain trap of 100 mm width across the width of the duct and 50 mm deep shall be provided with suitable gauge valve.
- g. Access doors shall be provided in the duct work or casing on the both sides of the equipment to be serviced. All access doors shall be of adequate size and shall be lined with substantial felt edging to prevent air leakage. Access doors shall be of built up construction, structurally strong and each shall have at least two hinges. Access doors shall have two rust proof window sash of approved type. All doors shall be set so as to flush with insulation or plaster finish on the duct.
- h. Splitters and dampers shall be provided for equipment/area isolation and for proportional volume control of system. The same shall be minimum 16 gauge GS sheet of quadrant type with suitable locking device, mounted outside of duct in accessible position.
- i. All the plenum chambers or connections to fans, dampers etc, shall be constructed in 18 gauge GSS, supported on 40x40x6 mm MS angle frames. All vertical angles shall be rivetted at approximately 125 mm centres to the casing. 'Pecora' or equivalent caulking compound shall be inserted between the base of angle and all masonry construction to which angles are fastened.

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- j. Wherever pipe hangers or rods pass through the ducts, light and stream lined casement around the same shall be provided to maintain smooth flow of air.
 - k. All air terminals shall be of mill finish extruded aluminium profile construction.
 - l. The proposed ducting scheme, duct sizes, location of supply air grilles etc shown on the enclosed drawings is tentative and subject to finalisation during detailed engineering by the contractor. The bidders shall furnish in their proposal quantities of ducting, duct insulation, supply air grilles. However, these quantities may increase or decrease depending upon the final layout.
 - a. Each branch line shall have dampers to isolate the branch for maintenance purpose.

25.7.13.2 **Factory Fabricated Ducts**

- a. All ducting shall be fabricated of LFQ (Lock forming quality) grade prime GI.
- b. Unless otherwise specified here, the construction, erection, testing & performance of the ducting system shall conform to SMACNA – 1995 standards ("HVAC Duct Construction Standards – Metal and Flexible – second Edition – 1995" SMACNA)
- c. All ductworks including straight sections, tapers, elbows, branches, show pieces, collars, terminal boxes and transformation pieces must be factory fabricated by utilizing the machines and processes as specified in SMACNA or by equivalent technology. In equivalent method, the fabrication shall be done by utilizing the following machines and process to provide the requisite quality of ducts and speed of supply :
 - i. Coil lines to ensure location of longitudinal seams at corners/ folded edges only to obtain the required duct rigidity and low leakage characteristics. No longitudinal seams permitted along any face side of the duct.
 - ii. All ducts, transformation pieces and fittings to be made on CNC profile cutters for required accuracy of dimensions, location and dimensions of notches at the folding lines.
 - iii. All edges to be machine treated using lock formers, flanges and roll bending for turning up edges.
 - iv. Sealant dispensing equipment should be used for applying built in sealant in Pittsburg lock where sealing of longitudinal joints are specified. Sealing of longitudinal joints are specified. Sealing of longitudinal joint is compulsory for ducts over 2" w.g static pressure.
- d. All traverse connectors shall be 4-bolt slip on flange system with built in sealant, if any. To avoid any leakage additional sealant shall be used.

25.7.13.3 **Diffusers, Grills & Dampers**



Supply air diffusers/ grills with factory fitted volume control dampers to be provided for all air conditioned areas.

Return air diffusers of air conditioned areas shall be without volume control dampers.

The diffusers/ grills shall be extruded Aluminium of minimum 2mm thk with powder coating. The colour of powder coating shall be as per the interior decor.

Supply air grills shall be double deflection type and return air grills shall be single deflection type.

The nozzle type diffusers shall be fabricated from minimum 1.5 mm Aluminium sheet. The base shall be fixed type. The nozzle shall be of volute design with the spout diameter being half the base diameter and designed for low noise and long throw. The nozzle shall be able to rotate to any angle within the base. The whole assembly shall be powder coated as per interior decor.

All volume control (VC) dampers shall be operated by a key from the front of the grills/ diffusers and shall be of GI sheet.

The thickness of VC dampers shall be minimum 20 gauge and thickness of louvers shall be minimum 22 gauge.

Suitable vanes shall be provided in the duct collar to have uniform and proper air distribution. Bank of baffles wherever required shall be provided.

Fire dampers shall be motor operated type and shall have fire rating of minimum 90 minutes.

All plenum chambers of connections to fans, dampers, etc shall be constructed in 18 gauge GS sheet and supported in MS angle frames.

All ducting surfaces coming in contact with corrosive fumes or gases shall be painted with three coats of epoxy paint over a coat of suitable primer.

25.7.14 Thermal & Acoustic Insulation

Application

- a. All surfaces to be insulated both thermally and acoustically shall be thoroughly cleaned, dried and an adhesive be applied @ 1.5 kg/ sq m on the surface (CPRX compound of Shalimar Tar products or equivalent).
- b. Insulation material (either expanded polystyrene foam or glass wool/ glass fibre or equivalent) shall be struck to the surface. All the joints shall be sealed with bitumen.
- c. Insulation mass to be covered with 500 gauge polythene sheet with 50 mm overlaps and sealing all joints on hot side.
- d. Insulation finish of types specified under shall be provided thereafter.

25.7.14.1 Type of Insulation & Finish

S. No.	Surfaces	Insulation Material	Insulation Form	Thick, (mm)	Finish, (mm)
1	Supply & Return air duct of AC system	Resin bonded glass wool or closed cell elastomeric Nitrile rubber	Roll/ Slab Sheet	50	F-3
2	Refrigerant (Suction & Liquid Lines)	Closed cell elastomeric Nitrile rubber	Tube	19	As per manufacturer's std.
3	AHU Drain pipe	Closed cell elastomeric Nitrile rubber	Tube	19	As per manufacturer's std.
4	AHU Condensate pan (insulation if required)	Mineral wool or resin bonded glass wool.	Slab	25	As per manufacturer's std.
5	Chilled water piping, valves & specialties	Resin bonded mineral wool or resin bonded glass wool.	Pipe section	75	F-1
6	Chiller (Insulation if required)	As per manufacturer's std.			
7	Chilled Water Pumps	Resin bonded mineral wool or resin bonded glass wool.	Slab	50	F-1
8	Expansion tank with associated piping	Resin bonded mineral wool or resin bonded glass wool.	Slab/ pipe section	50	F-1
9	Acoustic Insulation of duct	Resin bonded glass wool	Slab	25	As per spec
10	Exposed air duct	Resin bonded glass wool	Roll	50	F-4

25.7.14.2 Specification for insulation shall be as follows :

Insulation Material	Code	Thermal Conductivity (w / m / Deg C)	Density, kg / m3
Resin bonded glass wool	IS:8183	0.049 at 50 Deg C	i) 24 (for thermal

Insulation Material	Code	Thermal Conductivity (w / m / Deg C)	Density, kg / m ³
			insulation) ii) 48 (for acoustic insulation)
Mineral wool pipe section Min Gr 2	IS 9842	0.043 at 50 Deg C	144
Closed cell Elastomeric Nitrile rubber		0.036 at 20 Deg C	60-70

Note : Insulation for HVAC application shall be CFC/ HCFC free.

25.7.14.3 The specification for various finishes shall be as follows :

a) **Finish F-1**

- Step – 1 Wrapping of Poly- Bonded Hessian (PBH- to act as vapour seal) on outer surface of insulation with 50 mm overlap stitching and sealing of overlap with synthetic adhesive like CPRX or equivalent compound.
- Step – 2 The surface then shall be wrapped with 19 mm mesh 24 SWG GI wire netting, butting all the joints and laced down with 22 SWG lacing wire.
- Step – 3 Sand cement (4:1) plaster shall be applied in two layers totalling to 12.5 mm thk. The second layer being brought to a smooth finish. A water proofing compound shall be added to cement before its application.

b) **Finish F-2**

- Step – 1 Insulation shall be covered with 500 g polythene with 50 mm overlap and sealing of overlap with synthetic adhesive like CPRX or equivalent compound.
- Step – 2 Same as Step-2 of Finish F-1 above.
- Step – 3 Same as Step-3 of Finish F-1 above.

c) **Finish F-3**

- Step – 1 Same as Step-1 of Finish F-2 above.
- Step – 2 The polythene shall be covered with 30 gauge Aluminium sheet and locking of joints with self locking screws at a pitch of minimum 100 mm.

d) **Finish F-4**

- Step – 1 Same as Step-1 of Finish F-1 above.
- Step – 2 Same as Step-2 of Finish F-1 above.
- Step – 3 Same as Step-3 of Finish F-1 above.
- Step – 4 Application of 3 mm thk coat of water proofing compound "SHALIKOTE 30" or equivalent and wrapped with fibre glass RP tissue followed by final coat of 3 mm thk water proofing compound "SHALIKOTE 30" or equivalent over thr RP tissue.
- Step – 5 After the above treatment, 22G Aluminium sheet cladding, properly stitched at all joints shall be provided over the external surface.

For all inspection covers and hatches on equipment, pump casing, valve bodies and flanges (100 mm & above), insulation shall be applied so as to facilitate removal without minimum damage to the insulation in 24 gauge GI box or 22 gauge Aluminium sheet metal boxes which are bolted together around the equipment. However continuity of the vapour seal between the static and removable portions of the insulation is maintained.

25.7.14.4 **ACOUSTIC INSULATION**

- All ducts up to a distance of 5 m from AHU shall be acoustically lined from inside with 25 mm thk resin bonded glass wool of 48 kg/ cum density with 30 gauge perforated Aluminium sheet having 5 mm dia perforation at 8 to 10 mm centre to centre distance. Insulation shall be fixed on wooden frame of 600 x 600 mm dimension.
- Fibre glass tissue sheet shall be applied over the outer surface of insulation before applying perforated Aluminium sheet. Application of acoustic insulation shall be in line with requirements specified above.

25.7.15 **Piping and Fittings**

Material of Construction for Piping & Fittings

a)	Piping for Chilled and Condenser water	Heavy grade-IS:1239 or Equivalent upto150 NB and IS:3589 or Equivalent for pipes beyond 200 lines NB with thickness as indicated
b)	Refrigerant piping	Seamless steel tubes conforming heavy grade IS:1239 or copper tubes as per IS:2501 (copper material as per IS:191 hard copper grade).
c)	Drain piping	Same as (a) above & galvanized as per IS:4736
d)	Fittings	1) The steel fittings shall

		conform to ASTM A234 Gr. WPB and dimensional standard to ANSI 16.9/ANSI B16.11 / equivalent for sizes 65 NB and above. 2) For sizes 50 NB and below, the material shall conform to ASTM A-105. 3) All steel flanges shall be of slip on type and shall conform to ANSI B 16.5 4) For pipe sizes above 350 NB, fabricated fittings from sheets of adequate thickness may be used. The bend radius in case of mitre bends shall be minimum 1.5 times the nominal pipe diameter and angle between two adjacent sections shall not be more than 22.5 deg and shall be as per BS:2633/BS:534. 5) Fittings, flanges and pipe joints of refrigerant piping shall conform to ANSI B31.5
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25.7.10

Valves

- i. Valves shall have full size port and Suitable for horizontal and as well as vertical installation.
- ii. Valves for regulating duty shall be of Globe type suitable for controlling through out its lift.
- iii. Gate, Globe and stop Check valves shall have bonnet back seat to facilitate easy replacement of packing with the valves in service.
- iv. All Safety / relief valves shall be so constructed that the failure of any part does not obstruct the free discharge.
- v. Manual gear operator be provided for valves of size 200 NB and above.
- vi. All valves with rising stem shall have position indicators.
- vii. All valves shall be provided with locking arrangement.

- viii. The refrigerant line valves shall have steel or brass body with TEFLON gland packing. The construction of disc shall be either globe or angle type. The valve seat shall have white metal lining or equivalent.
- ix. The butterfly valves shall be designed as per AWWA C 504 and designed to fit between flanges. The butterfly valves shall be provided with flow control lever, black nitrile rubber integrally moulded seating, disc of aluminium bronze to BS 1400 Gr. AB2/AB1, shafts of stainless steel AISI 410. The butterfly valve shall be rated for 16 bar; body/disc tested at 24 bar and seat at 14 bar.
- x. Balancing / Controller Valves:

The valves of sizes 32 mm to 65 mm dia shall be of gun metal / cast iron construction with screwed ends angular design digital hand wheel with locking facility. Whereas valves of sizes 75 mm and above shall be of cast iron construction with internal parts of SS 410 and EPDM / Nitrile seat with flanged ends

25.7.11

Instruments, Protective Devices and Interlock

On-off thermostat with adjustable setting shall be provided with temperature control. Interlocks shall be provided such that compressor can start only after starting the air handling fan. Provision shall also be made to interlock the compressor with condenser water flow switch, chilled water flow switch / circulation pump. Safety devices such as high/low pressure cut out, hermetic motor winding thermostat etc. shall be provided. HP cut out shall be manual reset type while LP cut out shall be auto reset type. The control system shall be PLC based with redundant processor, power supply and communication modules, with CRT operator interface and peripherals serial link shall be provided for transfer of important signals to the DCS in the central control room.

Strip heaters shall be provided with an adjustable thermostat to control the temperature and a safety thermostat and safety interlock shall be incorporated to cut-off the electrical supply to the heater whenever there is failure of airflow.

Fire dampers (motor operated) shall be installed at places where supply air duct crosses fire barrier wall, floor slab, return air space (near the wall separating AHU rooms / PAC rooms and A/C area). The fire damper shall be of the same fire resistance as the structure but in no case less than 90 minutes and should be energized to close and the air conditioning equipment shall be tripped off in the event of fire.

25.7.12

Gravity Damper

Gravity dampers (self acting dampers) are provided to ensure pressurization of electrical rooms, switch gears rooms, substations etc. Dampers shall be of gravity type designed such as not to allow infiltration of air from outside. The louvers of the dampers shall be freely mounted on Spindles to allow the damper to open freely with the pressure developed in the premises. The damper shall be provided with flange at the inlet, the pressure inside the premises shall be 1-2mm WC.

25.7.13

Fresh Air Unit for Air Conditioning system



The fresh air unit shall consist of:

- Wall cowl with bird screen, tube axial fan with motor.
- Pre-filter made up of HDPE and efficiency 90% down to 10 microns and maximum face velocity of 2.25 m/sec. The pre filter used for evaporative coolers and ventilation system shall be of same specification.
- Fine filter made up of HDPE and efficiency 99.5% down to 5 microns and maximum face velocity 2.25 m/sec.
- Volume control damper, ducting, fixing frame and necessary supports.
- Filter frame shall be of aluminium and shall be flanged.

25.8

Plant Control for Air conditioning system

a) General

Brief scheme of controlling the operation is described below. Detailed description of the control system for safe and efficient operation of the plant shall be elaborated, got approved from Bidder. The descriptions in the sub-sections of the Control & Instrument sections shall also be referred to.

b) Control Scheme of Air Conditioning System

- i. The Air Conditioning System control system shall DCS based. The DCS configuration and detailed specification of the same shall be as per Control & Instrumentation requirements specified elsewhere in the specification.
- ii. Each system shall be provided with required I/O modules and two numbers of Operator Work (OWS) Stations. All the functional requirements specified below and general control logic specified under this section shall be implemented in the respective PLCs.
- iii. The basic function of the system shall be to closely control and monitor temperature and humidity conditions inside the air-conditioned spaces, to optimize/minimize energy consumption by automated operation, to provide remote centralized monitoring & control for various mechanical facilities including sequential start/stop of the whole HVAC System, automatically calculate record and cooling load for each hour/ day/season, to generate maintenance data & alarms, to maintain records of plant operation & energy consumption for varying loads, duty cycling to operate all the equipment including standby equipment for equal duration, automatic start-up of standby equipment in case of failure of operating unit and displaying fault alarm status of the tripped unit, activating/ deactivating water valves to start-up/stop water flow through chiller/condenser circuit. For sequential operation /duty cycling, Programmed start-up/stop of individual AHU as per operating requirements and inside room temperature and humidity of CR, CER, ESP Control Room, UPS and battery charger room shall be maintained by controlling the chilled water flow by means of motor operated three way

modulating valve and by varying the air flow of AHU through VFD driven motor, humidified system and duct heater. For service building & administrative building inside room temperature and humidity shall be maintained by varying the chilled water flow of chilled water pumps through VFD driven motor and by varying the air flow of AHU through VFD driven motor, humidified system and duct heater. For sequential operation/ duty cycling, programmed start up/ stop of individual AHU's, pumps and cooling towers as per operating requirements and inside room temperature and humidity.

- iv. PLC provided for the Control of AC system shall suitably interface with integral microprocessor based controls of Chiller units.
- v. The PLC based control system of Air Conditioning system shall also interface with Wide Area Network of the Station to be supplied by the Bidder.

c) Water Chilling Plant Control

- i. Microprocessor based controls shall be provided along with facilities to interface with central PLC and to meet the requirement of all system operations and controls.
- ii. Water chilling unit control system shall be designed to have a constant chilled water outlet from evaporator at all load condition by means of controlling ON-OFF thermostat (one for each compressor). The closure of liquid line solenoid valve and tripping of compressor at lower water temperature and opening of solenoid valve and starting of compressor at high set point shall be automatic through the thermostat. Between the above set points the compressor capacity shall be controlled automatically.
- iii. Water chilling unit shall be equipped with superheat control of water chilling unit through thermostatic expansion valve, which gets its impulse from temperature element connected with suction line after chiller outlet.
- iv. High discharge pressure cut-out and oil pressure (OP) differential cut-out shall be of manual reset type and low pressure cut-out shall be automatic reset type. The OP cut-out shall trip the compressor in case of low oil pressure.
- v. On-off toggle switch to close the liquid refrigerant line solenoid valve shall be provided to shut the compressor by the operation of the operation of low pressure cut-out (after the refrigerant has been pumped to the condenser).
- vi. Switching of Crank case heaters shall be interlocked with starting and stopping/tripping of compressor motor. Further, the safety thermostat shall switch off the crank-case heater in the event temperature rises above safe limit.
- vii. Provision shall also be made for the manual restarting of the compressor.

- viii. On-off type anti-freeze thermostats, one for each chiller shall be provided in addition to the controlling on-off thermostat for safety purpose and shall act in the event of failure of on-off thermostat to close the liquid line solenoid valve and also to trip the compressor simultaneously.
- ix. Compressor starting/running shall be interlocked with the flow switches to be provided at the outlet of each chiller and each condenser and as well as with pressure in the inlet of the condensers. In addition closure or open status of various valves through limit switches shall be used for interlock, alarm and control of Air Conditioning System.
- x. The standby condenser water pumps, standby chilled water pumps, & standby AHU shall be started automatically when the working equipments are stopped/ tripped. Auto/Manual selector Switches and working/ Standby selector switches for the pumps/AHU/fresh air fan shall be provided in the panel.
- xi. Closure of fire dampers shall raise an annunciation in the panel.
- xii. There shall be provision in control panel for temperature and flow readings in chilled water inlet and outlet line across AHUs to monitor the air conditioning load of each area.
- xiii. Operation of Air conditioning system shall be interlocked with the required minimum pressure and temperature of cooling water at inlet to the condenser through pressure and temperature transmitters. Status indication of Station auxiliary Cooling water pumps & associated cooling towers shall be provided in the control panel of air conditioning plant.

d) Air Handling Unit

- i. Control of the inside room temperature and humidity shall be by controlling the chilled water flow by means of motor operated three way modulating valve and by varying the flow by means of VFD driven AHU's which shall get signal from the control system for main plant A/C system. For service building & Administrative building inside room temperature & humidity shall be controlled by varying the chilled water flow of chilled water pumps through VFD driven motor and by varying the air flow of AHU through VFD driven motor.
- ii. Humidity sensor & Geyzer stat located in the return air duct shall actuate the pan humidifier to obtain the desired degree of humidification.
- iii. Separate Humidistat and thermostats shall be provided and interlocked in steps with winter heater / re-heater / strip heaters for monsoon and winter re-heating or heating as the case may be.
- iv. Heater banks shall be interlocked with the running of AHU, temperature of return air, humidity of return air and safety thermostat (Geyser stat located in front of the each heater in the supply air duct)

- v. AHU shall be started either from its local panel or from the main control panel of AC system by means of Remote/Manual selector switches.
- vi. The closure of fire dampers, automatic tripping of AHU fans and fresh air fans shall be interlocked with fire Detection System.
- vii. Each AHU shall be provided with temperature indicators and flow indicator in the chilled water piping inlet and outlet to monitor the air-conditioning load of each area.
- viii. Miscellaneous control requirements
- ix. Separate emergency local stop push button shall be provided for each pump, compressor, fans etc. of AC system.
- x. Lamps shall be provided for indicating the status of each pump, compressor, fans etc. of AC system in the main and local panel.
- xi. All the annunciation related to failure of equipments, tripping of equipments, source of failure / reason due to which the equipment is stopped / tripped, low & high limits of parameters such as level, temperature, pressure drop, pressure etc shall be provided for each pump, fan, compressor, AHU, PAC etc. in the respective panel.
- xii. Fully wired, twenty percent (20%) spare annunciation windows shall be provided in all the panels.

e) D-X Air Conditioning System

- The control and interlocks described above for water chilling plants are applicable for this system also.
- Further the compressor starting/ running shall be interlocked with the flow switches in condenser water circuit as well as with AHU motors.
- The standby condenser water pumps, fresh air fan & standby AHU shall be started automatically when the working equipments are stopped/ tripped. Auto/ Manual selector switches and working/ standby selector switches for the pumps, fresh air fans and AHU shall be provided in the panel.

f) Cassette / Hi- wall Split Air Conditioners

The control and interlocks for these type of units shall be as per manufacturer's standard practice.

g) General

-
- Separate emergency local stop push button shall be provided for each pump, compressor, fans etc of A/C system.
 - Status shall be provided of each pump, compressor, fans etc of A/C system and ventilation system on HMI system at control room.
 - All the annunciations related to failure of equipments, tripping of equipments, source of failure/ reason due to which the equipment is stopped/ tripped, low & high limits of parameters such as level, temperature, pressure drop, pressure etc shall be provided for each pump, fan, compressor, AHU, PAC, AWY etc.
 - The fans (both supply & exhaust fans) associated with mechanical ventilation system shall be operated locally.
 - Relative humidity and temperature measurement of all control rooms and CER's, ESP control room and all major air conditioned areas shall be available in DDCMIS. Relative humidity and temperature measurement for main plant control room and CRE's to be available in multiple numbers.
 - Vibration and noise level of screw chillers, condensing units, pumps with motor shall be measured during PG test. Permissible limit of vibration for pumps shall be 75 micron peak to peak. For fans/ screw chillers/ condensing units, the same shall be in line with VDI-2056 Group-T machines (maximum vibration level 7.1 m/s r.m.s).
 - The maximum noise level shall be 85 dBA at 1.5 m elevation and at a horizontal distance of 1 m from the equipment.

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR(FOR EPC PROJECTS)**PACKAGES : AIR CONDITIONING SYSTEM****SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT****PROJECT: 1X660 MW PANKI TPS**

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V MCC	BHEL	BHEL	240 V AC (supply feeder)/415 V AC (3 PHASE 4 WIRE) supply shall be provided by BHEL based on load data provided by vendor at contract stage for all equipment supplied by vendor as part of contract. Any other voltage level (AC/DC) required will be derived by the vendor.
2	Local Push Button Station (for motors)	BHEL	BHEL	Located near the motor.
3	Power cables, control cables and screened control cables for a) both end equipment in BHEL's scope b) both end equipment in vendor's scope c) one end equipment in vendor's scope	BHEL BHEL BHEL	BHEL Vendor BHEL	1. For 3.b) & c): Sizes of cables required shall be informed by vendor at contract stage (based on inputs provided by BHEL) in the form of cable listing. Finalisation of cable sizes shall be done by BHEL. Vendor shall provide lugs & glands accordingly. 2. Termination at BHEL equipment terminals by BHEL. 3. Termination at Vendor equipment terminals by Vendor.
4	Junction box for control & instrumentation cable	Vendor	Vendor	Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 10-12 mtrs) and trunk cable.
5	Any special type of cable like compensating, co-axial, prefab, MICC, optical fibre etc.	Vendor	Vendor	Refer C&I portion of specification for scope of fibre Optical cables if used between PLC/ microprocessor & DCS.
6	Cable trays, accessories & cable trays supporting system 100/ 50 mm cable trays/ Conduits/ Galvanised steel cable troughs for local cabling	BHEL Vendor	BHEL Vendor	Local cabling from nearby main route cable tray (BHEL scope) to equipment terminal (vendor's scope) shall be through 100/ 50 mm. cable trays/ conduits/ Galvanised steel cable troughs, as per approved layout drawing during contract stage.
7	Cable glands ,lugs and bimetallic strip for equipment supplied by Vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty tinned copper lugs for power and control cables.
8	Conduit and conduit accessories for cabling between equipment supplied by vendor	Vendor	Vendor	Conduits shall be medium duty, hot dip galvanised cold rolled mild steel rigid conduit as per IS: 9537.
9	Lighting	BHEL	BHEL	
10	Equipment grounding (including electronic earthing) &	BHEL	BHEL	Refer note no. 4 for electronic earthing

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR(FOR EPC PROJECTS)**PACKAGES : AIR CONDITIONING SYSTEM****SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT****PROJECT: 1X660 MW PANKI TPS**

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
	lightning protection			
11	Below grade grounding	BHEL	BHEL	
12	LT Motors with base plate and foundation hardware	Vendor	Vendor	Makes shall be subject to customer/ BHEL approval at contract stage.
13	Mandatory spares	Vendor	-	Vendor to quote as per specification.
14	Recommended O & M spares	Vendor	-	As specified elsewhere in specification
15	Any other equipment/ material/ service required for completeness of system based on system offered by the vendor (to ensure trouble free and efficient operation of the system).	Vendor	Vendor	
16	a) Input cable schedules (Control & Screened Control Cables) b) Cable interconnection details for above c) Cable block diagram	Vendor Vendor Vendor	- - -	Cable listing for Control and Instrumentation Cable and electronic earthing cable in enclosed excel format shall be submitted by vendor during detailed engineering stage.
17	Electrical Equipment & cable tray layout drawings	Vendor	-	For ensuring cabling requirements are met, vendor shall furnish Electrical equipment layout & cable tray layout drawings (both in print form as well as in AUTOCAD) of the complete plant (including electrical area) indicating location and identification of all equipment requiring cabling, and shall incorporate cable trays routing details marked on the drawing as per PEM interface comments. Cabling arrangement of the same (wherever overhead cable trays, trenches, cable ducts, conduits etc.) shall be decided during contract stage. Electrical equipment layout & cable tray layout drawing shall be subjected to BHEL/ customer approval without any commercial implications to BHEL.
18	Electrical Equipment GA drawing	Vendor	-	For necessary interface review.

NOTES:

1. Make of all electrical equipment/ items supplied shall be reputed make & shall be subject to approval of BHEL/customer after award of contract.
2. All QPs shall be subject to approval of BHEL/customer after award of contract without any commercial implication.

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR(FOR EPC PROJECTS)**PACKAGES : AIR CONDITIONING SYSTEM****SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT****PROJECT: 1X660 MW PANKI TPS**

3. In case the requirement of Junction Box arises on account of Power Cable size mis-match due to vendor engineering at later stage, vendor shall supply the Junction Box for suitable termination.
4. Vendor shall indicate location of Electronic Earth pit in their Civil assignment drawing.



GENERAL

Basis of design all calculations including heat load calculations for summer seasons, equipment selection criterion, layout drawings/ schemes/G.A. dwg and documents like data sheet/ technical particulars etc are subject to Customer approval during detail engineering stage.

Vendor to furnish characteristic curves for all major equipment offered indicating duty point during detailed engineering.

All drawings and documents shall be computer based.

All commissioning spares & consumables for trouble free operation until handing over of the system shall be provided

Quality Requirements in the Technical Specification are indicating minimum requirements for inspection and testing. Vendor shall note that quality plan is subject to Customer & BHEL-approval during detail engineering stage.

Fixing frame works for diffusers and grilles in the scope of Vendor.

Anchor fastener shall be used by vendor for fixing duct pipes etc. wherever applicable.

Necessary supports and structures / frames etc. as required for supporting the duct / piping / equipment etc. as lump-sum basis is in the scope of Vendor and no unit rates shall be applicable for these items. However, Primary Support Structure shall be provided by BHEL.

Drain piping within room up to the drain point to be provided by the Vendor.

Vendor shall furnish schedule of power and control cables. Vendor shall also furnish cable termination details interconnection drawings etc. during detail engineering stage.

The tools and machine required for erection of equipment shall be arranged by Vendor.

Tools & tackles as required for regular maintenance shall be supplied by Vendor.

Instruments required for performance testing of various equipment / system of the package shall be arranged by Vendor at site.

Instrument for testing shall be calibrated by Air-conditioning plant supplier before taking up testing.

Temperature gauges shall be provided with thermo wells and fixing arrangement.

Pressure gauges shall have provision for air venting. Three way valves shall be used which shall have air venting provision.

Matching sockets / stubs (weld type) for flow switches and other instruments shall be supplied.

Bidders shall guarantee to maintain specified inside design conditions during summer, monsoon and winter and also even if the internal equipment load varies from 100% to 25%.

	1x660MW PANKI STPP AIR CONDITIONING SYSTEM SPECIFIC TECHNICAL REQUIREMENT	SPECIFICATION No: PE-TS-426-553-A001	
		SECTION : I	
		SUB-SECTION : C 1	
		REV. 00	
		Page 12 of 14	

Besides the system performance as above, bidder shall guarantee major technical parameters of various equipment as per design basis / details furnished.

For motorized fire damper / 3 Way valve actuators / motorised valves, power supply shall be derived by vendor from respective control panels. BHEL shall not provide any feeder for them. Suitable transformer shall be provided by bidder (if required) to derive the power input. Further distribution through junction box / distribution board shall be in vendor scope and shall have provision for isolation of individual fire damper/ valves.

Bidder should suitably group the signals coming from various instruments etc. & the same shall terminate in local JB, from Local JB common cable to DCS / panel / MCC shall be selected. Any Electrical / C&I items and accessories like junction box, glands etc. shall be included by vendor in his scope.

In the event of any conflict between the requirements of two clauses of this specification documents or requirements of different codes and standards specified, the more stringent requirement as per the interpretation of the owner shall apply.

Bidder to note that BHEL reserve the right for drg/doc submission through web based Document Management System. Bidder would be provided access to the DMS for drg/doc approval and adequate training for the same. Bidder to ensure proper net connectivity at their end.

The drawings/ documents submitted by vendor shall be complete in all respects with revised drawing submitted incorporating all comments. Any incomplete drawing submitted shall be treated as non-submission with delays attributable to vendor's account. For any clarification/discussion required to complete the drawings, the bidder shall himself depute his personal to BHEL / Customer's place as per the requirement for across the table discussions/ finalizations/ submissions of drawings.

Sealing of duct opening, grouting of foundation / foundation bolts etc. including special type of grouting like GPX2 etc. are in the scope of Air-conditioning system vendor.

Flat, platform type RCC / PCC foundation shall be provided for installing Chiller/ PUMP, AHU and FAN etc. Vendor shall fix the equipment using anchor fasteners, as applicable, to secure the equipment obtain parameters related to vibration and noise.

RCC foundation of cooling tower shall be provided by BHEL. However, steel beam / joist etc as required shall be supplied by air-conditioning plant supplier.



**1x660MW PANKI STPP
AIR CONDITIONING SYSTEM
SPECIFIC TECHNICAL REQUIREMENT**

SPECIFICATION No: PE-TS-426-553-A001

SECTION : I

SUB-SECTION : C 1

REV. 00

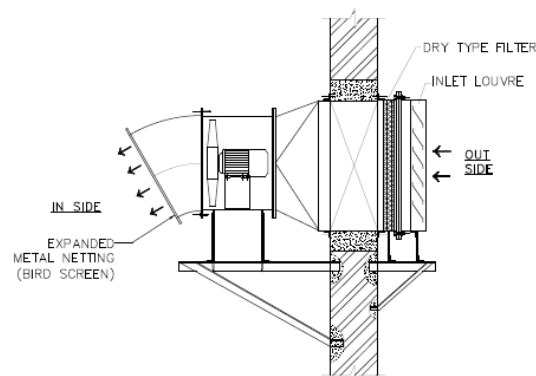
Page 13 of 14

Each motor terminal box shall be provided with cable gland and lugs for the size and type of power and control cable of respective motor.

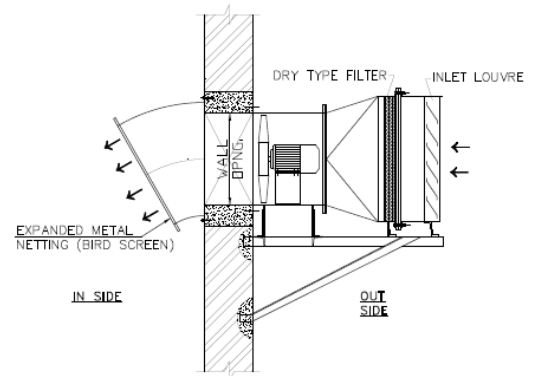
All electrical equipment shall be suitable for the power supply fault levels and other climatic conditions indicated in project information / synopsis / specifications enclosed.

The bidder shall furnish complete tech. Particulars in data sheet and schedules as specified elsewhere in the specification during detail engineering.

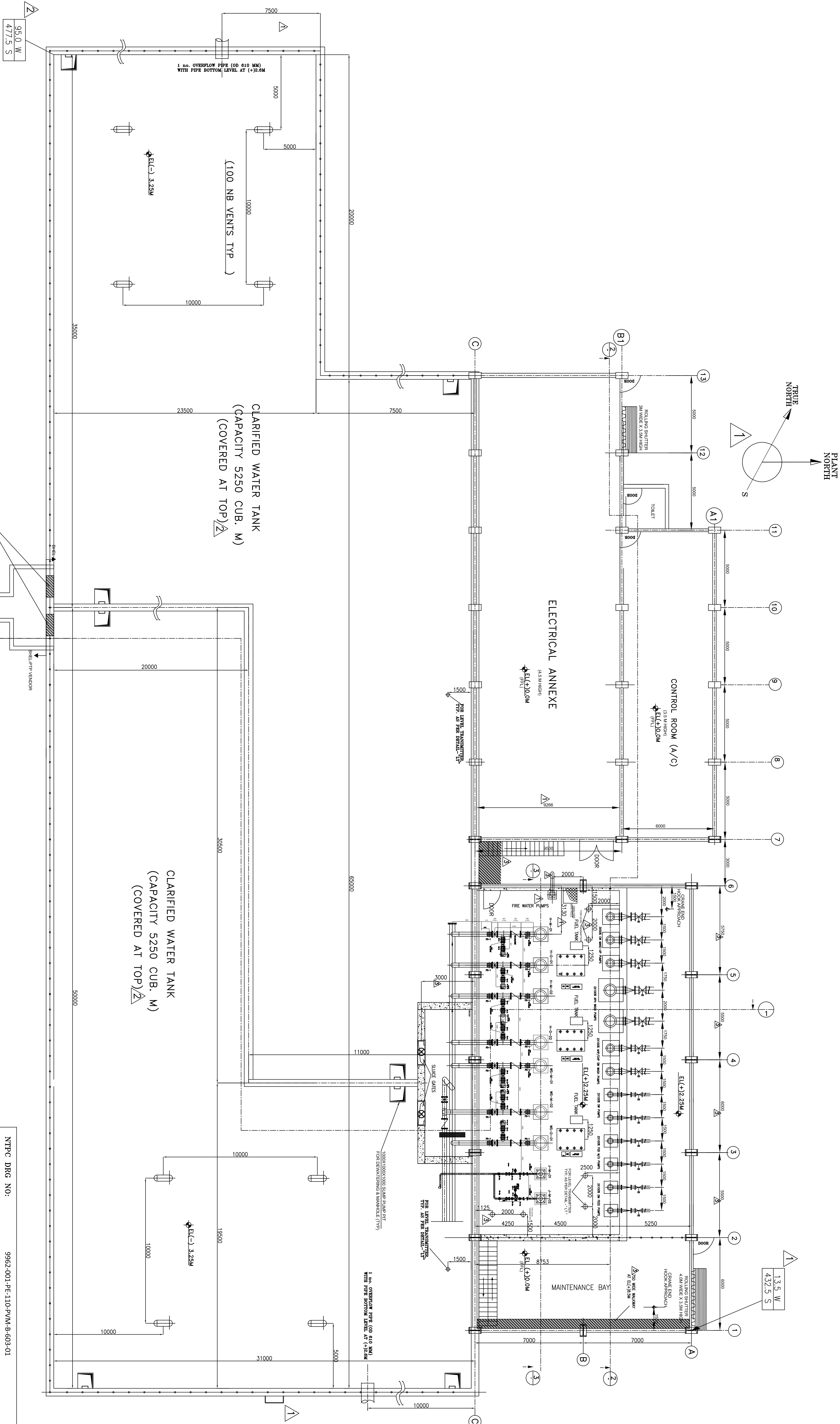
Supports required for supporting the fan and/or filter section for FA fans shall be under bidder's scope



SUPPLY AIR FAN WITH
DRY TYPE FILTER UNIT
(ALTERNATIVE-1)



SUPPLY AIR FAN WITH
DRY TYPE FILTER UNIT
(ALTERNATIVE-2)

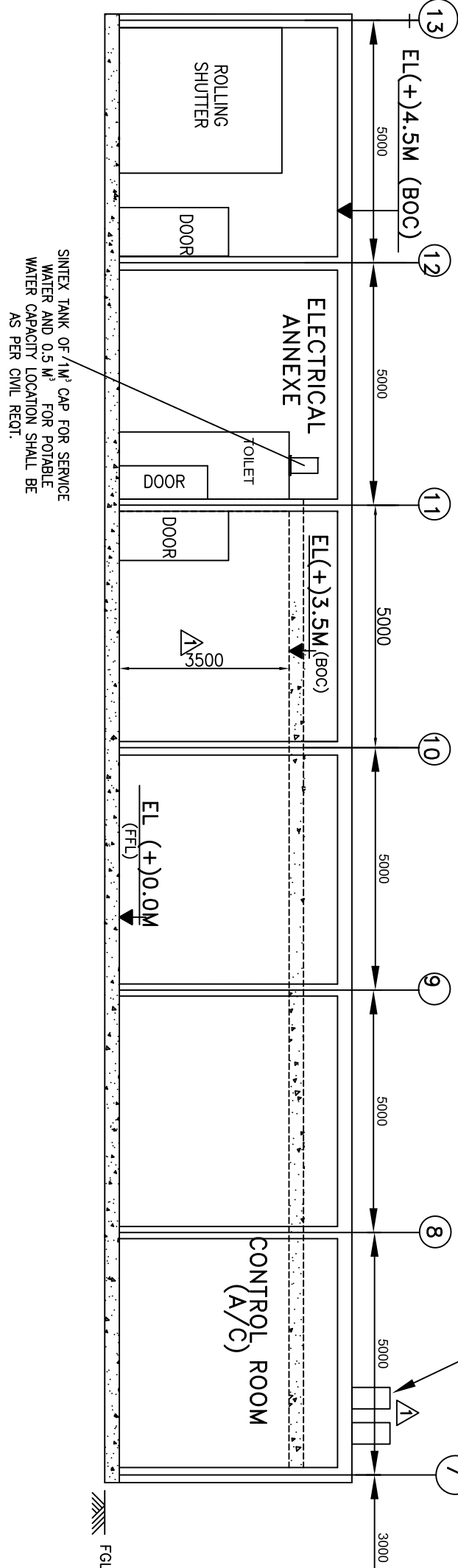
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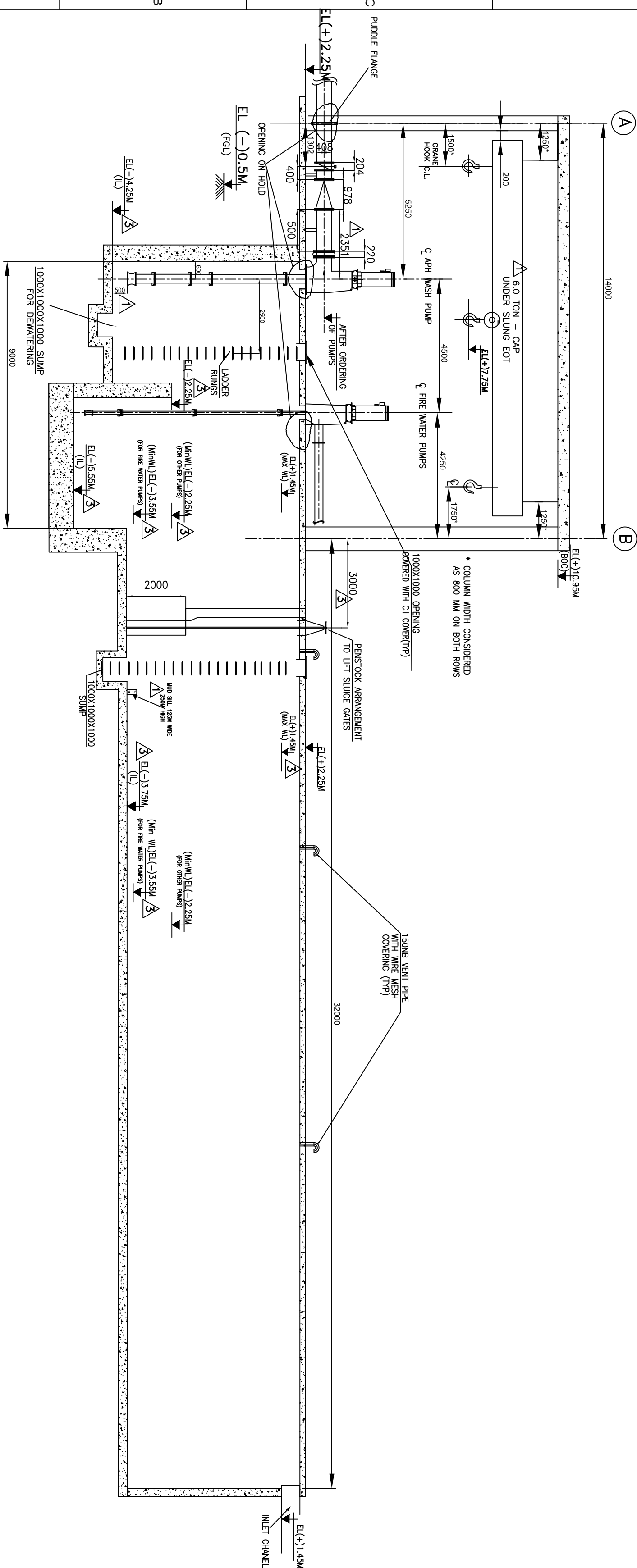
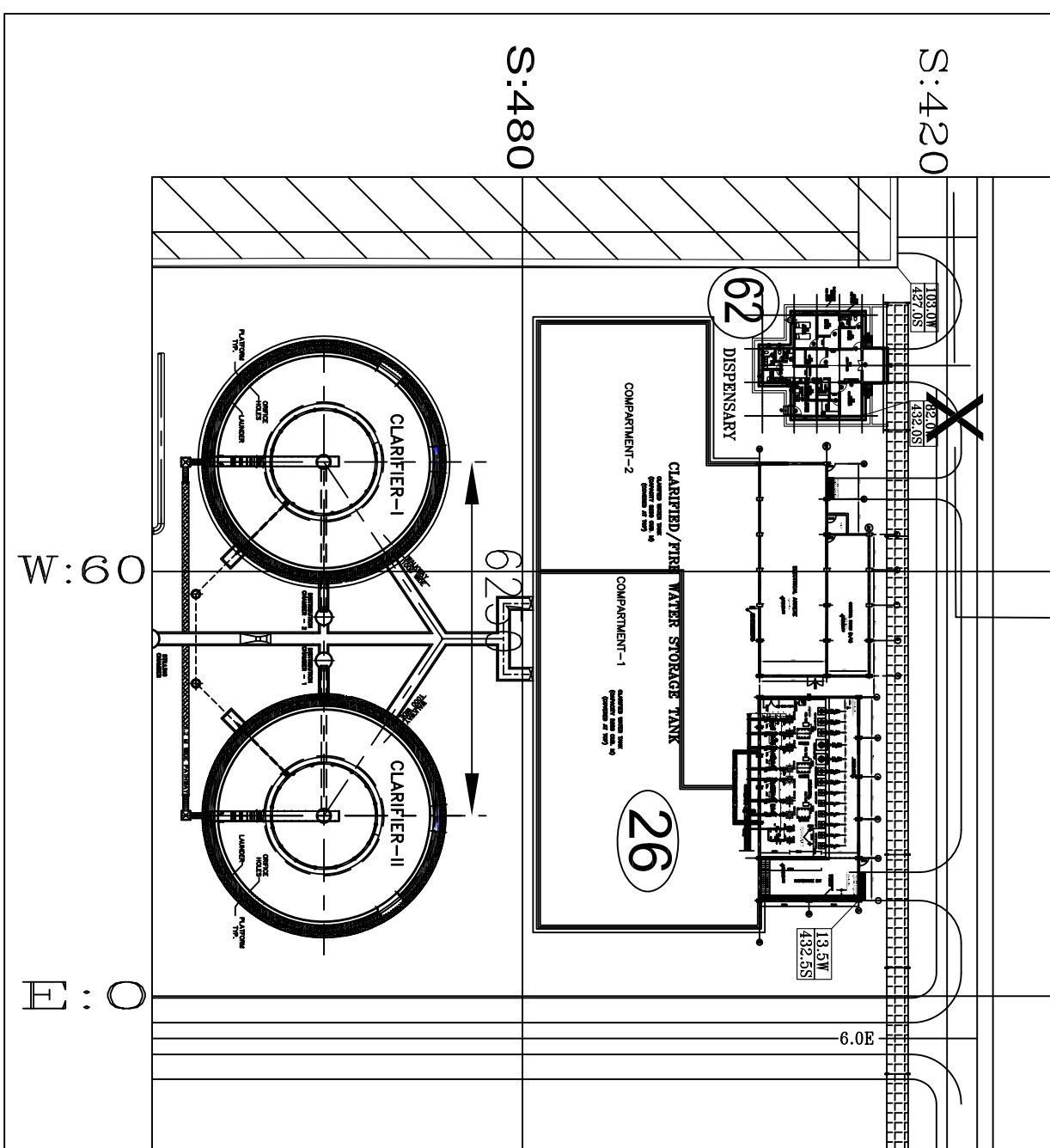
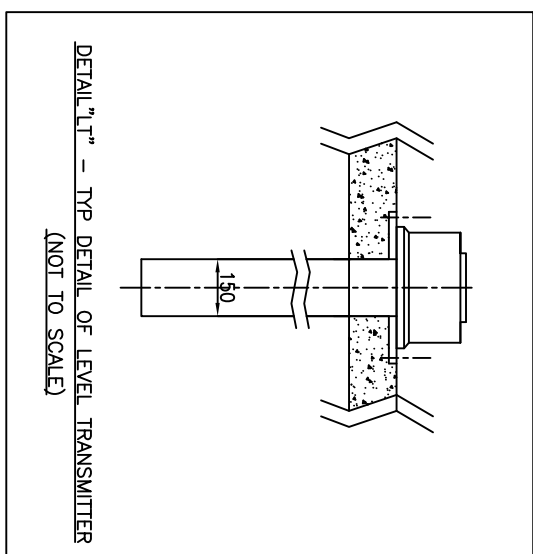
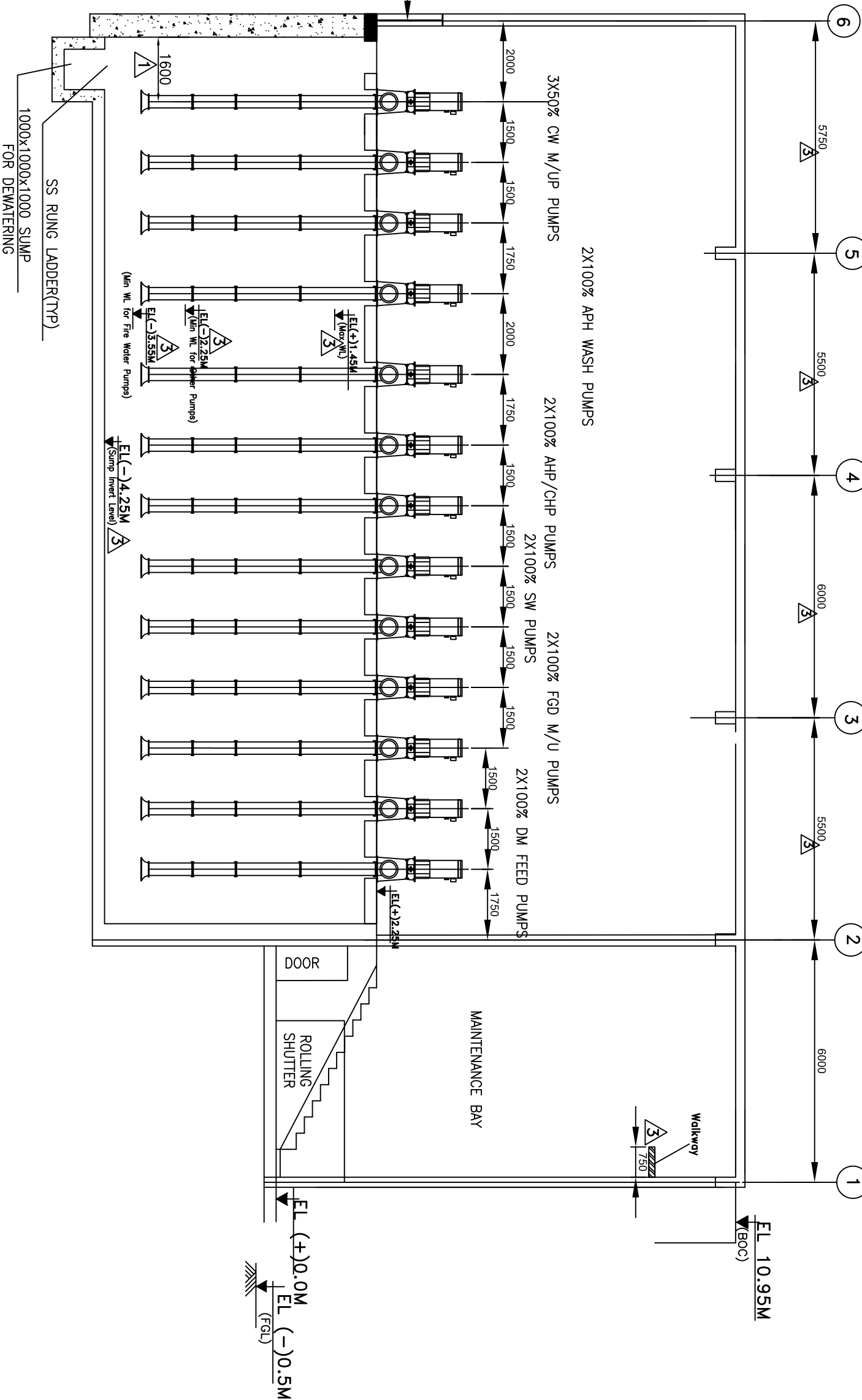
1. ALL DIMENSIONS ARE IN MM AND ALL ELEVATIONS ARE IN METRES UNLESS OTHERWISE STATED.
2. WS SLUICE GATE (TOTAL 2 NOS.) SHALL BE FABRICATED AND SUPPLIED BY CIVIL CONTRACTOR.
3. 1 NO. UNDER SLUNG EOT. CRANE OF 6.0T CAP SHAL BE PROVIDED.
4. ALL ELEVATIONS ARE REFERRED TO AS EL 0.0M WHICH CORRESPONDS TO RL (+) 126.5M.
5. SLUICE GATE HEIGHT SHALL BE DESIGNED FOR SUMP OPENING HEIGHT VIZ. 2000MM.
6. 1 NO. PORTABLE STOOL CUM LADDER SHALL BE PROVIDED FOR ACCESS TO TOP BEARING OF MOTOR.
7. OPENINGS INSERTS ETC. REQUIRED FOR C&I INSERTS, PIPE/VALVE SUPPORTS ETC. SHALL BE INDICATED AFTER FINALIZATION OF RESPECTIVE INSTRUMENTS PIPE LAYOUT ETC.
8. OVERFLOW PIPE OF 600 NB SHALL BE PROVIDED.
9. REFERENCE DRAWING:

- Δ A) P&ID-PLANT WATER SYSTEM, DRG NO: 9962-001-PE-110-PWM-F-081
- Δ B) PLOT PLAN, DRG NO: PE-DG-426-100-M001
- Δ C) ELECTRICAL EQUIPMENT LAYOUT DRG FOR CLARIFIED WATER P/H, (9962-001-PE-200-PVE-F-109)
- Δ D) LAYOUT OF CLARIFIED WATER PIPING SYSTEM, (9962-001-PE-131-PWM-P-006)
- Δ E) FOR VENTILATION-DRG NO: 9962-001-148-PWM-H-001, FOR AC-DRG NO: 9962-001-147-PWM-H-080.
- Δ F) CRANE DRG NO: 9962-001-148-PWM-H-001.
- Δ G) CLARIFIED WATER TANK GA & RC DETAILS OF FOUNDATION (9962-001-PE-315-PVC-C-0624)
- Δ 10. SINTEX TANK OF 2.0 CUM CAPACITY FOR SERVICE WATER AND 1.0 CUM CAPACITY FOR POTABLE WATER. LOCATION SHALL BE AS PER CIVIL REQUIREMENT.

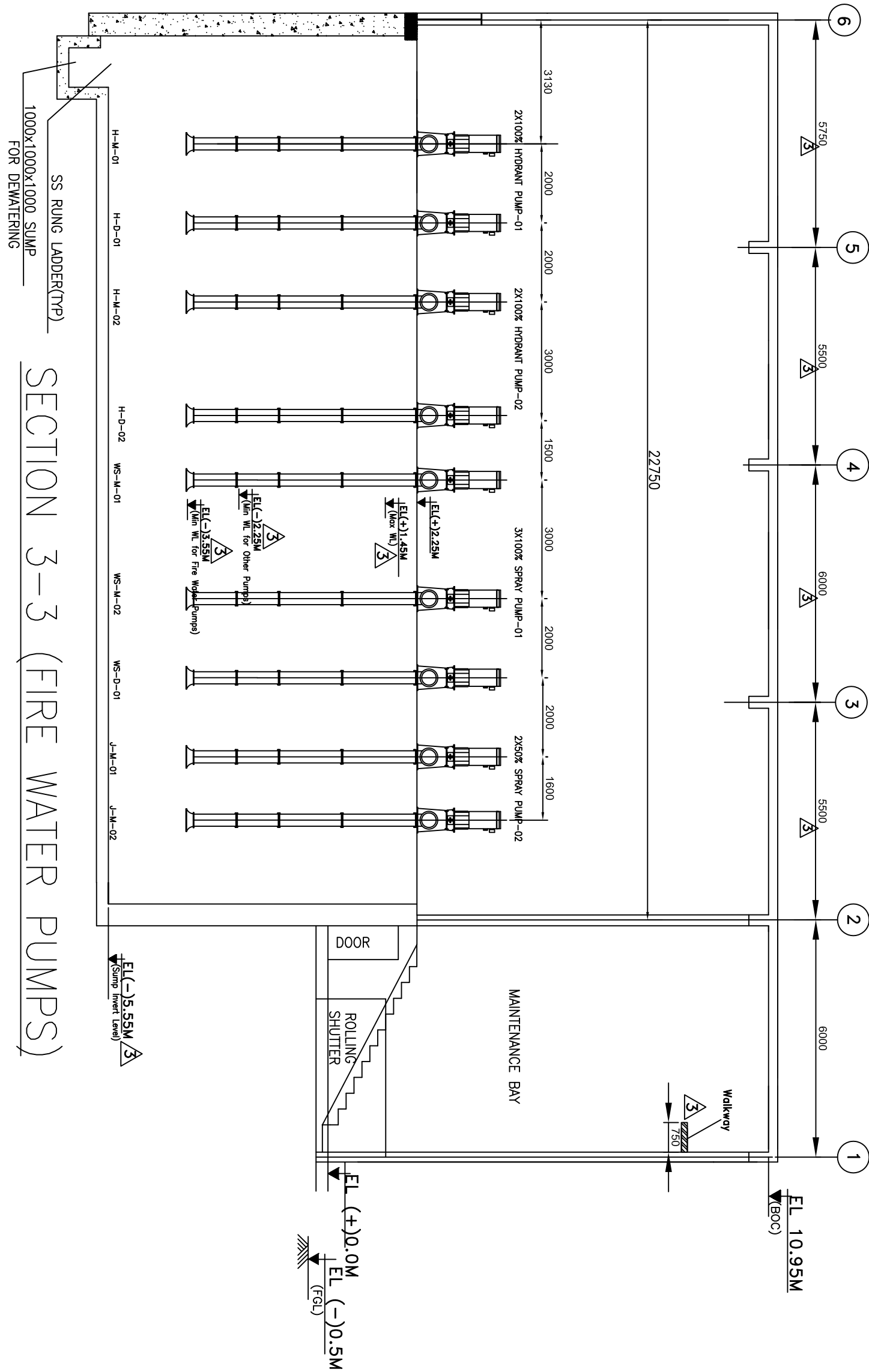
REFER NOTE NO: 10.



SECTION 2-2



SECTION 1-1



SECTION 3-3 (FIRE WATER PUMPS)

NTPC DRG NO: 9962-001-PE-110-PWM-B-603-03

CUSTOMER: UTTAR PRADESH VIDYUT UTPADAN NIGAM LIMITED

NTPC LTD.

DEVELOPMENT CONSULTANTS PVT. LTD., KOLKATA

1 X 660 MW PANKI TPS EXTENSION

DESIGNATION: CONTRACT

DESIGNER: BHAKT HARY ELECTRICALS LTD

PROJECT ENGINEERING MANAGEMENT

MECHANICAL GA OF CLARIFIED WATER P/H

DRAWING NO: PE-DG-426-172-M005

SHEET 2 OF 2

REV: 01