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Title	To design, manufacture, supply, installation and performing acceptance test at ITER-India site for closed loop soda-water based heat absorption system of 1.5 MW level
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Abbreviations

Table 1 Abbreviations

AC	Alternating Current
AI	Analog Input
AO	Analog Output
ARW	Anti-Reset Windup
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing & Material
BOM	Bill of Material
CB	Circuit Breaker
CMU	Controller & Measurement Unit
COTS	Commercial-off-the-Shelf
DC	Direct Current
DI	Digital Input
DO	Digital Output
DPDT	Double-Pole-Double-Throw
DR	Deviation Requests
FAT	Factory Acceptance Test
FIM	Free Issue Material
GA	General Assembly
GUI	Graphical User Interface
HAS	Heat Absorption System
HMI	Human Machine Interface
IEC	International Electrotechnical Commission
I/O	Input / Output
MIP	Manufacturing & Inspection Plan
NA	Not Applicable
NCR	Non-Conformity Report
NDT	Non-Destructive Testing
PFD	Process Flow Diagram
P&ID	Piping & instrumentation Diagram
PID	Proportional-Integral-Derivative
PLC	Programmable Logic Controller
PTP	Packing & Transportation Plan
RTD	Resistance Temperature Detector
SAT	Site Acceptance Test
SLD	Single Line Diagram
SOW	Scope of Work
SPST	Single-Pole-Single-Throw
SPDT	Single-Pole-Double-Throw
QAP	Quality Assurance Plan

Part A (II): Technical Part

1 Introduction

The heat absorption system comprises a closed-loop circuit utilizing soda water, supplemented by a secondary cooling system. The soda water is heated to a temperature of 70°C, and a control system is necessary to maintain the set point temperature. This document outlines the electromechanical peripheral components required to complement the soda water circuit, as detailed below.

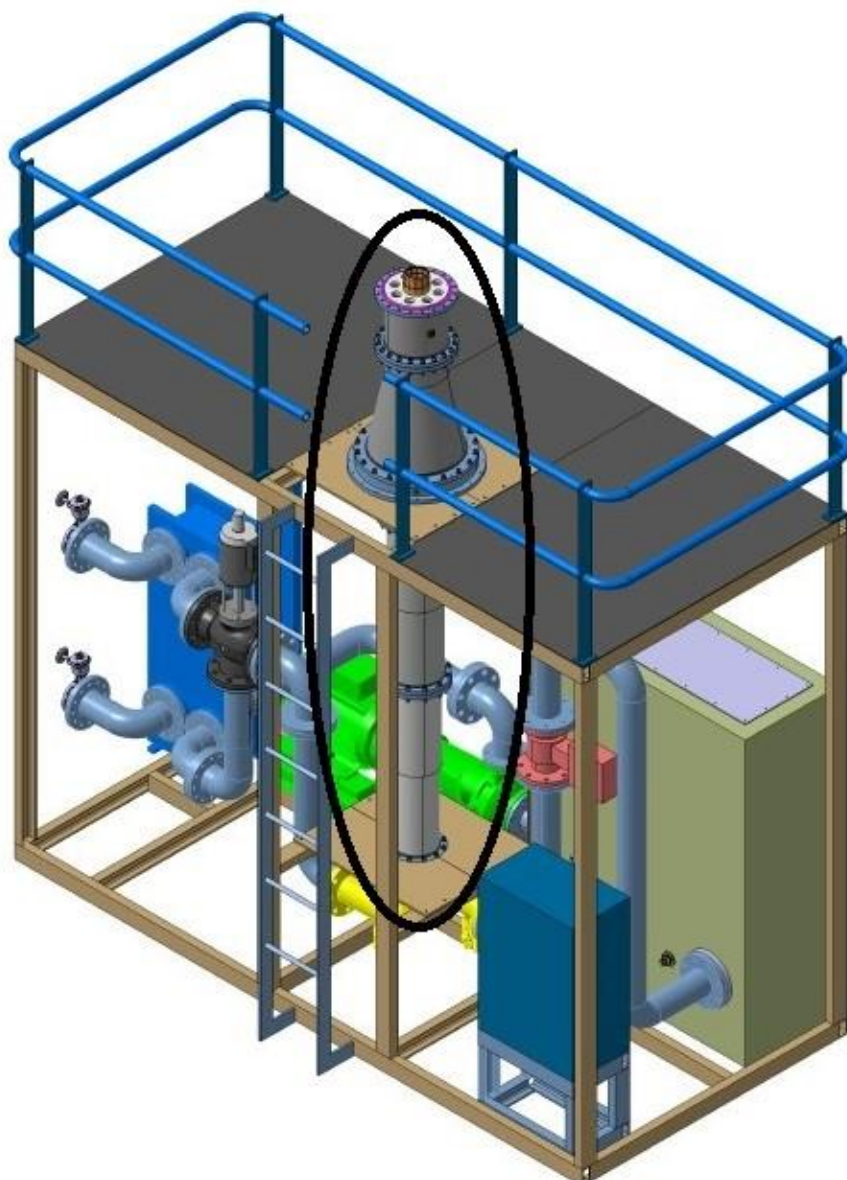


Figure 1: Heat absorption system

The encircled part in the Figure-1 is the load, R10 (FIM), is not a part of this contract, this will be integrated in ITER-India during SAT

Principle of operation:

Figure 2 illustrates the P&ID diagram, showcasing the soda water circulation loop. The process begins with tank WT, which is 3/4 full, and flows through pump PU, plate heat exchanger HX, three-way valve assembly 3WV, and flow meter FTX before returning to tank WT. The flow rate is regulated by valve GV7. Temperature measurements are taken at the load resistor's (FIM) input and output using RTD PT1000 (indicated by 12), while Analog Thermometer TG monitors and displays the soda water temperature before Load. To ensure Load's safety, the amplifier's interlocking circuit incorporates three protective elements: thermostat TS2 (set to 85°C), flow control switch FS1&2, and pump status monitoring. This configuration guarantees immediate amplifier shutdown in case of cooling system failure or overheating.

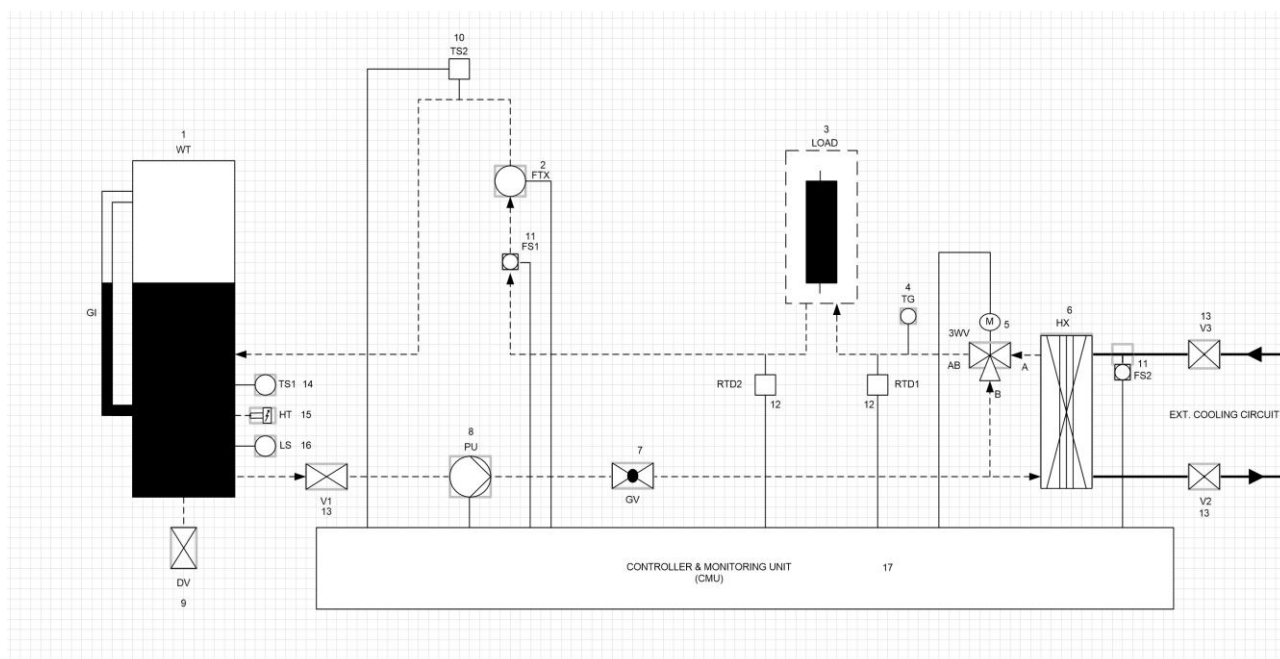


Figure 2: P&ID

The regulating three-way valve A5 is fitted direct into the soda water circuit. The soda water amount from the heat exchanger and from the bypass are regulated by controller A4 so that the average soda water temperature will always be $70^{\circ}\text{C} \pm 2^{\circ}\text{C}$. The average is calculated by summing temperature before and after Resistor R10 and divided by two.

Initially temperature is 30°C . Heater R2 will make it 65°C . Thermostat K2 used to turn off R2 at 65°C . K3 (Differential Pressure Switch) will avoid turning ON Heater R2 in case of insufficient water in the tank.

List of items shown in the Figure-2 is given below in Table-2:

Table 2 : BOM

S. No.	Component No	Nomenclature	Component Name	Quantity
1.	1	WT, GI	Water Tank with Glass Indicator	01

2.	2	FTX	Flow Meter	01
3.	4	TG	Thermometer	01
4.	5	3WV	Three-way Valve	01
5.	6	HX	Plate Heat Exchanger	01
6.	7	GV	Globe Valve (Regulating Valve)	01
7.	8	PU	Soda Water Pump	01
8.	9	DV	Drain Valve	01
9.	10	TS2	Safety Thermostat for load	01
10.	11	FS1&2	Flow Switch	02
11.	12	RTD1&2	PT1000 4-Wire sensor	02
12.	13	V1, V2 & V3	Butterfly Valve	03
13.	14	TS1	Tank Thermostat	01
14.	15	HT	Immersion Heater	01
15.	16	LS	Differential Pressure Switch	01
16.	17	CMU	Controller	01
17.	-	-	Piping	10 RMT (approx..)

2 Scope of Work

1. Comprehensive scope of work for HAS, encompassing design, manufacturing, Factory Acceptance Testing (FAT), supply, site installation, and Site Acceptance Testing (SAT), in accordance with the Piping and Instrumentation Diagram (P&ID) depicted in Figure 2.
2. Preparation of QAP, and MIPs based on ITER-India's template and submission of the same for ITER-India's approval. MIP (**Annexure-IV** for reference) should include the provision for traceability.
3. To validate the specifications of components/sub-systems given in section 3 by the bidder for interfaces between components.
4. The CATIA step file is given for reference only in **Annexure-III**. In case of size variation in COTS items like heat exchanger, motor-pump, valves, flanges, etc., the bidder will make appropriate modifications to accommodate those changes. Final integrated 3D drawings will be prepared & submitted by the bidder in step file format for the II approval.
5. Bidder shall provide comprehensive mechanical designs and associated drawings for all individual components based on inputs given by ITER-India and submit the same for ITER-India's approval before procurement/manufacturing/fabrication/integration starts. The design scope includes Preparing manufacturing drawings as needed, carrying out pressure drop calculations, creating PFD and P&ID, and detailed design of support structures with all components installed.
6. The Electrical Panel that houses Circuit breakers, soft starters, relays, protection devices, etc. must be as per IEC 61439 for wiring practices. Bidder has to submit wiring diagram, protection scheme, SLD, General assembly diagram of the control panel, etc. based on the reference SLD's provided in the **Section-4** before the start of procurement/manufacturing/fabrication/integration.
7. Preparation of final Bill of Material (BoM) as per **Section 3 & 4**, and submit the same for ITER-India's approval before the start of procurement /manufacturing /fabrication/integration.

8. Procurement of all materials as per approved BoM and submit all Material test certificates for ITER-India's approval.
9. Procurement of all COTS items as per approved BoM and submit all relevant reports for ITER-India's approval.
10. Fabrication/ manufacturing & assembly of all components as per latest approved drawings/SLD's/GA.
11. Stage-wise inspection of individual components as per approved MIP and QAP. All weld joints shall be designed as per ASME section-IX and inspected as per ASME Section-VIII division –II.
12. All the Manufactured items shall be thoroughly cleaned for dust/ grease/ any coolant/ foreign material etc. as per mutually agreed cleaning process given in **Annexure- I**, which will be prepared by bidder. Final cleaning acceptance shall be done based on swiping with lint-free cloth as per approved procedure.
13. Assembly steps of all the components and Inspection at factory as specified in the approved MIP shall be witnessed by ITER-India's representative.
14. Bidder shall develop PLC-based controller for HAS as per the detail given in section 3.15.
15. Bidder shall install all hardware components in control panel as per approved GA.
16. Bidder shall prepare wiring diagram along with cable routing diagram and submit the same for II approval. Bidder shall also submit the details for the cable tray arrangement.
17. Bidder shall do complete internal wiring of the system as per approved SLD.
18. Bidder shall provide earthing/grounding point wherever needed as per IEC safety standard IEC 62305-3:2011.
19. Bidder shall provide one-week basic training at site for different software modules used for execution of this contract for 2 (Minimum) ITER-India Engineers.
20. Bidder shall conduct factory acceptance test with simulated signals for controller.
21. Submission of Documents during offer, execution of contract and before final acceptance as per **Annexure-II**.
22. Final integrated assembly and FAT shall be carried out as per **Section-8** at bidder's site, in the presence of ITER-India representative.
23. Bidder shall fabricate the necessary support structure for stable mounting of all the components as per mutual agreement with ITER-India.
24. Submission of final factory acceptance test report to ITER-India for getting dispatch clearance certificate.
25. Packing of all fabricated items and hardware's as per approved packing and transportation plan (PTP) and delivery of items to ITER-India lab, IPR site with adequate packing to avoid damage during transportation.
26. Un-packing of delivered items and assembling them to final integrated assembly at ITER-India Lab, IPR site and perform SAT as mentioned in the **Section-9**.
27. Preparation of site acceptance test report and submit to ITER-India for Final acceptance.
28. To submit all revised drawings after implementing all DRs (Deviation requests) if any.
29. If any Non-conformity found during inspection, it has to be rectified by the vendor after taking necessary approvals from ITER-India.
30. Inspection call should be raised before 15 days of inspection to make the necessary arrangement.
31. Bidder shall note that even after approval of drawings by II representative, if some minor changes need to be done to achieve the overall functionality and integrity of the HAS, it shall be under the bidder's scope.

32. Bidder shall prepare and submit the final version of documents considering all amendments during FAT & SAT.
33. Bidder shall provide standard warranty of 1 years after final acceptance of the system at ITER-India site.
34. Safety protocols have to be followed as per document given on https://www.ipr.res.in/documents/safety_protocols.html

3 List of the components & their technical specifications

3.1 Water Tank

The water tank must store and provide a certain minimum volume of soda water required for the system to operate. 1kg (Approx.) H_2CO_3 is added in approx. 750-800 liter of water.

Table 3: Water Tank Specifications

Soda Water Tank			
S. No.	Specification	Range	Remarks
1	Dimension	1.0 m x 0.5 m x 1.5 m (LxBxH)	
2	Wall thickness	3mm	
3	Material	SS304L	
4	Max Volume capacity	Approx. 750 Litre	
5	Application	Soda water at 90 °C	
6	Water tank to be equipped with:	<ul style="list-style-type: none"> - Heater elements (3.2) - Thermostat (3.3) - Glass level indicator - Differential pressure switch for soda water level measurement (3.4) - Input output flanges (4) - Manhole on top (400mm (L)X 300mm (W)) - Drainage Valve (3.13) 	
7	Design Pressure	10 bar	
8	Quantity	1	

3.2 Heater

Heater is required to raise the temperature of soda water to around 70 °C.

Table 4: Heater Specifications

Water Heater (immersion)			
S. No.	Specification	Range	Remarks
1	Input	3 phase 415 V	Star/ delta connection
2	No. of elements	9	3 for each phase
3	Element Rating	2kW each, 230V, Resistive	+/-10% tolerance
4	Length of element	Approx. 300 mm	
5	Total Power	18 kW	
6	Safety Standard applicable	IEC 60335-2-73:2024	Equivalent IS standard will also be considered.
7	Quantity	1	

3.3 Thermostat

It is required to operate at 65 °C and 85 °C. To be inserted for heater and interlock for the safety of Load & Heater.

Table 5: Thermostat Specifications

S. No.	Specs	Range	Remarks
1	Application	For Soda water circuit	
2	Length of element	As per standard	
3	Operational Range	10- 120 °C, Adjustable	
4	Type	Threaded / Flange type immersion	
5	Voltage	230 V	
6	Output	SPDT or DPDT	
7	Reset type	Automatic	
8	Protection	IP65	
9	Quantity	2	

3.4 Differential Pressure Switch

For protection of heating element, the heaters should not turn ON if water level is below a pre-set level (0.5m). Setting resolution should be 0.01 bar so that the water level can be set in steps of 10 cm.

Table 6: Differential Pressure Switch Specifications

S. No.	Specification	Range	Remarks
1	Application	To assure a minimum volume of soda water in tank	
2	Max Temp	90°C	
3	Switch Type	SPDT / DPDT	
4	Max Pressure	0.5 bar	
5	Nominal Pressure	0.05 bar	
6	Setting resolution	0.01 bar	
7	Electrical rating	230 V, 5A	
8	Accuracy	Better than 5%	
9	Connection type	¼ inch BSP or Flange type	
10	Protection	IP65	
11	Quantity	1	

3.5 RTD

A sensitive temperature sensor is required for monitoring and controlling the temperature of soda water in the circuit. Select PT1000 4-wire sensor. Cable length up to 5 m length to be included in the cost of each instrument / sensor.

Table 7: RTD Specifications

S. No.	Specification	Range	Remarks
1	Application:	Soda water at 90 °C	
2	Insert length	50mm	
3	Sensing element	PT1000	
4	Output signal	4 wire	
5	Nominal temperature	85°C	
6	Maximum Temperature	120°C	
7	Process Connection	½ inch	
8	Cable	10 m minimum	
9	Quantity	2	

3.6 Bimetallic dial thermometer

The thermometer is to be installed in line to monitor the maximum temperature of the system.

Table 8: Thermometer Specifications

S. No.	Specification	Range	Remarks
1	Application	Temperature of soda water	
2	Type	Analog Bimetallic Type	
3	Range	0- 120 °C	
4	Dial size	63 mm	
5	scale	single marking in °C	
6	steam length	75 mm	
7	process connection	1/4 “ bsp	
8	casing	SS304	
9	overload	1.3	
10	protection	IP65	
11	mounting	direct bottom	
12	Quantity	1	

3.7 Flow sensor and monitor

Flow sensing and monitoring is critical for the safety of the system. The flow rate below a certain value is an indication of insufficient cooling in line which will cause in temperature rise in system. The signal shall be given to controller for measurement and display and to analog interlock for protection.

Table 9: Flow Sensor & Monitor Specifications

S No	Specification	Range	Remarks
1	Application	Soda water	
2	Type	Electromagnetic / Vortex	
3	Connection type	Flange ended type with 4’’	
4	Nominal flow rate	1200 lpm	
5	Maximum flow range	1500 lpm	
6	Process Temperature	Up to 100°C	
7	Process pressure	Up to 10 bars	
8	flow meter local display	Digital display	
9	flow sensor transmitter output	0-10 V or 4-20 mA	
10	Cable	Suitable cable with 10 m length	
11	Supply	24 V dc	
12	Protection type	IP67	
13	Quantity	1	

3.8 Pump and Motor

Table 10: Pump & Motor Specifications

S No	Specification	Range	Remarks
1	Type	Back pullout (Centrifugal)	
2	Pumping rate	80 m ³ /hr.	
3	Pump head	35 m	
4	Cooling Type	IC 411 TEFC	
5	Motor Type	3 phase Induction Motor	
6	Motor IP rating	IP 55	
7	Nominal delivery and suction size	3''/4''	
8	Nominal power	15 kW / 20 HP	
9	Soda water maximum temperature	95°C	
10	Frequency & IE class	50 Hz ±2%, IE2	
11	Input Voltage	415 VAC ±10%	
12	No of Poles	2	
13	Body Material	Cast Iron	
14	Sealing	Mechanical seal (carbon and ceramic)	
15	Impeller	SS 316/304	
16	Duty	S1	
17	Soft starter	Required	
18	Quantity	1 set of pump and motor	

3.9 Heat Exchanger

Table 11: Heat Exchanger Specifications

S No	Property	Units	Hot side	Cold side
1	Fluid		Soda water	DMDI Water
2	Density	kg/m ³	1085	988.8
3	Specific heat capacity	kcal/kg,°C	0.94	1.00
4	Thermal conductivity	kcal/m,h,°C	0.594	0.547
5	Viscosity inlet	cP	0.597	0.721
6	Viscosity outlet	cP	0.795	0.503
7	Volume flow rate	m ³ /h	80.0	72.0
8	Inlet temperature	°C	80.0	35.0
9	Outlet temperature	°C	62.5	55.0
10	Pressure drop	mwg	8.95	6.60
11	Heat Exchanged	Mcal/h	1425	
12	L.M.T.D.	K	26.2	
13	Plate material		SS316	
14	Sealing material		EPDM CLIP-ON	EPDM CLIP-ON
15	Connection material		Stainless steel	Stainless steel
16	Connection standard	Mm	100	100
17	Nozzle orientation		S1 -> S2	S4 <- S3
18	Pressure vessel code		ASME Sec VIII Div.1	

19	Flange rating		ANSI B 16.5 150#	
20	Design pressure	Barg	10.0	8.0
21	Test pressure	Barg	13.0	10.4
22	Quantity	No	01	

3.10 Flow switch

Table 12: Flow Switch Specifications

S.No.	Specification	Range	Remarks
1	Product type	Flow controller	
2	Measurement principle	Deflector plate	
3	Product positioning	For clean liquids	
4	Measured media	Liquids	
5	Process pressure	max. 16 barg	
6	Process temperature	-40...+300°C/ -40...+570°F	
7	Materials for measuring tube	Austenitic stainless steel (1.4435/316L)	
8	Flange connections	ASME (B 16.5)	
9	Discrete outputs	Limit switches	
10	Flow indication	Flow indication without power supply	
11	Quantity	02	

3.11 Three-way valve

Table 13: Three-way Valve Specifications

S No	Specification	Range	Remarks
1	Type	3 way modulating control valve with magnetic actuator	
2	Application	Splitting of soda water	
3	Size	4"/100NB	
4	Material	SS304	
5	Media	Soda water	
6	Flowrate	80 m3/hr	
7	Permissible Pressure	10 bar	
8	Maximum temperature	120 °C	
9	Max. admissible pressure differential	3 bar	
10	Actuator	to be equipped with electronics for positioning control and position feedback	
11	Operating Voltage	AC, 24 V	
12	Frequency	50 Hz	
13	Rated Apparent Power	80 VA	

14	Positioning time	<2 s	
15	Positioning signal	DC 0-10V	
16	Accuracy	Better than 3%	
17	Valve Characteristic	Linear	
18	Protection class	Class III to EN 60730	
19	PN Class	PN16	
20	Housing protection	IP31	
21	Manual Control	Possible, up to 90%	Screw type or Standard means
22	Quantity	01	

3.12 Butterfly valve

The valves should give higher “Cv” values with replaceable EPDM/ Teflon seat. The valve should be of wafer type with total SS 304 construction, disc & stem should be SS 316, pressure class PN 10 or class 150 as per the details in SOQ. The valves shall have centering lugs, locking lever handle. Preferably, the valves will be of two-piece body. The disc should provide bubble tight shut-off in both flow directions with minimum torque & longer seat life.

Table 14: Butterfly Valve Specifications

S.No.	Specifications	ITER-India	Remarks
1.	Size / Qty	DN100 (4 inch) / 03 Nos.	
2.	Type / Class	Wafer Type Pressure gauges / Class 150	
3.	Material of all body parts: (Enclose details)		Provide the required curves / catalogs/specification sheet
4.	Body	SS304	
5.	Flange specifications	SS304	
6.	Seat / Disc	SS316	
7.	Stem / Trim	SS316	
8.	Bearing/ sleeve	As per standard	
9.	Operating lever.	As per standard	
10.	Fasteners:	As per standard	
11.	Operating range & limits: Pressure (Bar)	0-10 bar	
12.	Cv value	Suitable as per manufacture's recommendation	provide the required curves / catalogs/specification sheet
13.	Max. Shut of pressure	As per standard	
14.	Test Pressure (Hydro – air) Shell / seat	As per standard	
15.	Leakage class	As per standard	
16.	Local indication	As per standard	

3.13 Drain Valve

Table 15: Drain Valve Specifications

S.No.	Specifications	ITER-India	Remarks
1.	Size	DN25 (1 inch)	
2.	Type / Class	Ball Type / Class 150	
3.	Material of all body parts:	SS304	
4.	End fitting:	Threaded BSPP	
5.	Operating lever.	As per standard	
6.	Fasteners:	As per standard	
7.	Operating range & limits: Pressure (Bar)	0-10 bar	
8.	Leakage class	As per standard	
9.	Local indication	As per standard	
10.	Quantity	01	

3.14 Regulating Valve

Table 16: Regulating Valve Specifications

S.No.	Specifications	ITER-India	Remarks
1.	Size	DN100 (4 inch)	
2.	Type	Straight-way globe valve with slanted seat	
3.	Material of all body parts:	SS304	
4.	Valve Disc material	EPDM	
5.	End flange	ASME B16.5	
6.	Operating range & limits: Pressure (Bar)	0-10 bar	
7.	Operating temperature	10 C to 110C	
8.	Leakage class	As per standard	
9.	Local indication	As per standard	
10.	Quantity	01	

3.15 Controller

Siemens make PLC with CPU-S7-1200/1500 series (only), compatible HMI, IO modules, power supply, chassis/backplane (485mm approx..) as per defined signal list in **Section 6.1** is chosen for controlling HAS operation.

- Application program in **Siemens TIA portal version 17** for monitoring different parameters of Heat Absorption System and to control the operation of the same. HMI and PLC shall be communicating through ProfiNet interface.
- Bidder shall submit editable source code with comments for PLC & GUI (HMI & WinCC) both.
- Bidder shall prepare GUI in HMI & WinCC both. GUI in HMI will be operated in local mode & WinCC in remote mode.
 - **Local Mode:** GUI in HMI which is mounted on the control panel located at the system.
 - **Remote Mode:** GUI in WinCC, installed in PC far from the system.
- Bidder shall provide calibration certificates for used sensors and transmitters. It shall be valid for 1 year at delivery of the system.
- PLC shall be able to communicate to HMI and WinCC through Profinet.

4 Electrical Control Panel Architecture

The electrical control panel houses circuit breakers, PLC with HMI, wiring, indicators, relays, protection circuit, motor starter, operating switches, etc. Bidder will submit electrical wiring diagrams for II review before finalizing the same as per SOW. The labeling of all components, wires, and terminals must be clear to make new operators understand the working conditions as per standard practice. All electric connections must be clear and separated from each other so that monitoring becomes easier. Necessary measures to save the control panel body from rusting or any pest attack. Following is the reference SLD's that depicts the operation of the system with various interlocks. Bidder needs to furnish detailed SLD's for II approval prior to finalize the scheme.

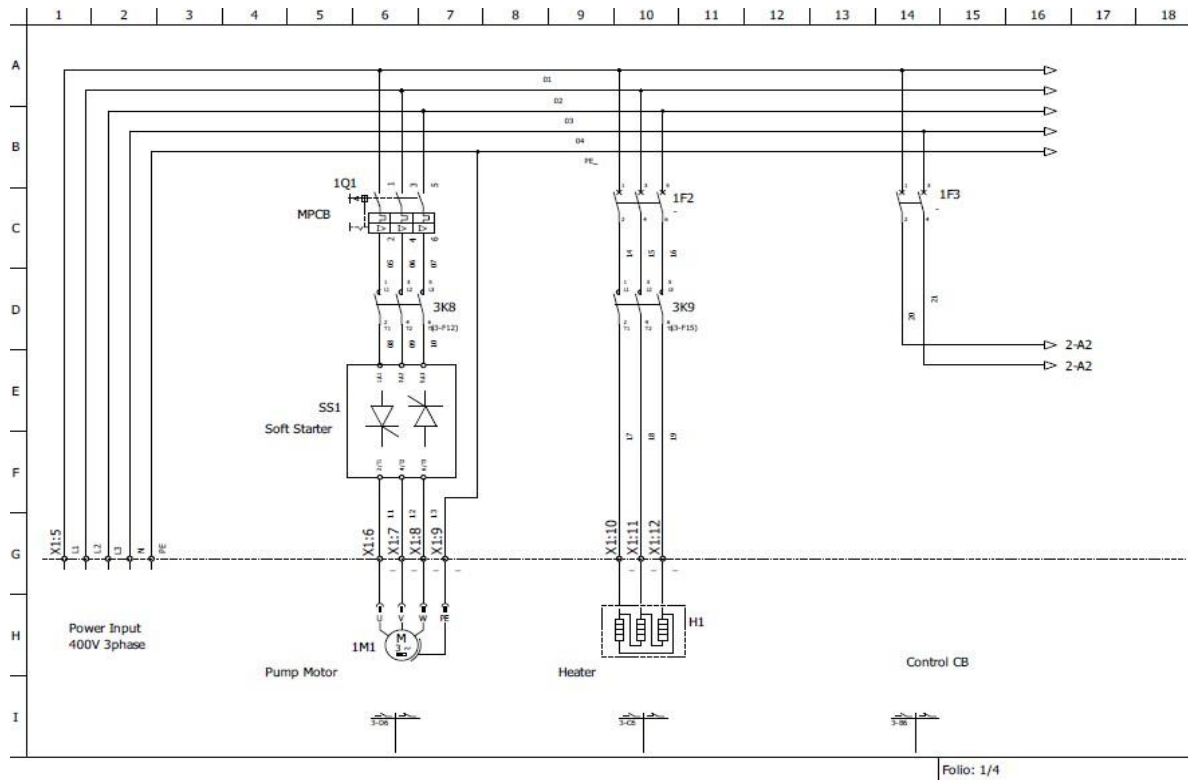


Figure 3: Power Circuit SLD

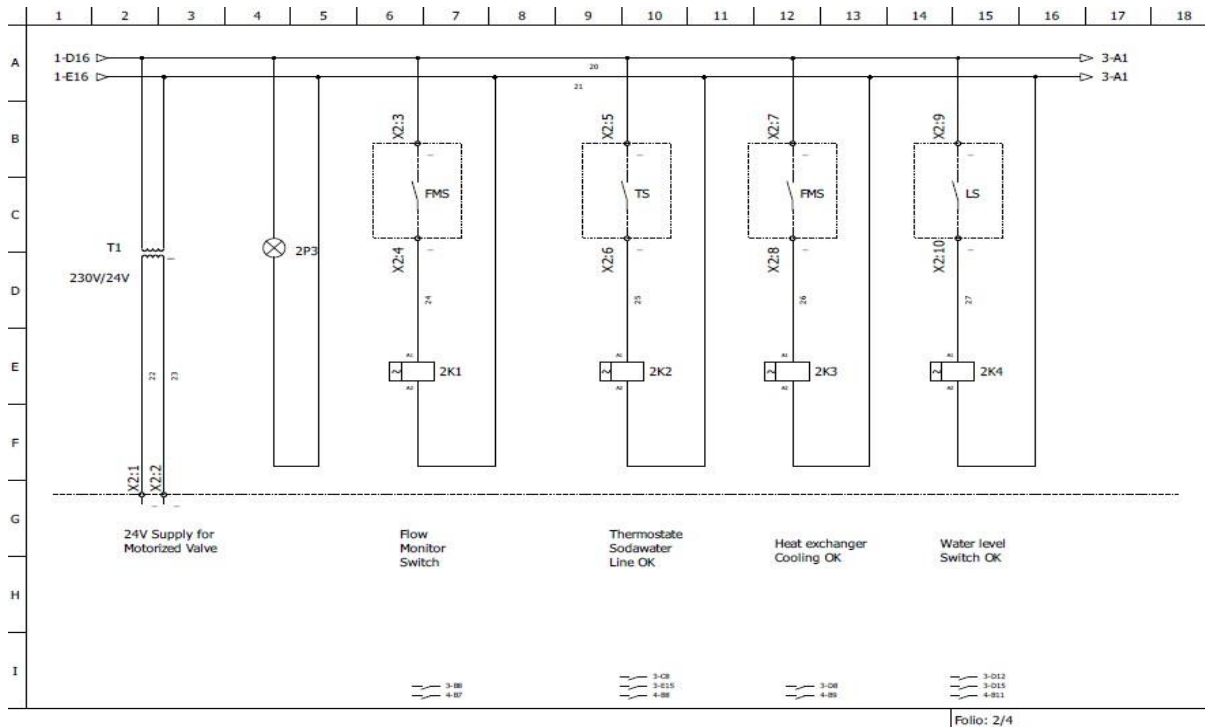


Figure 4: Controller Circuit SLD I

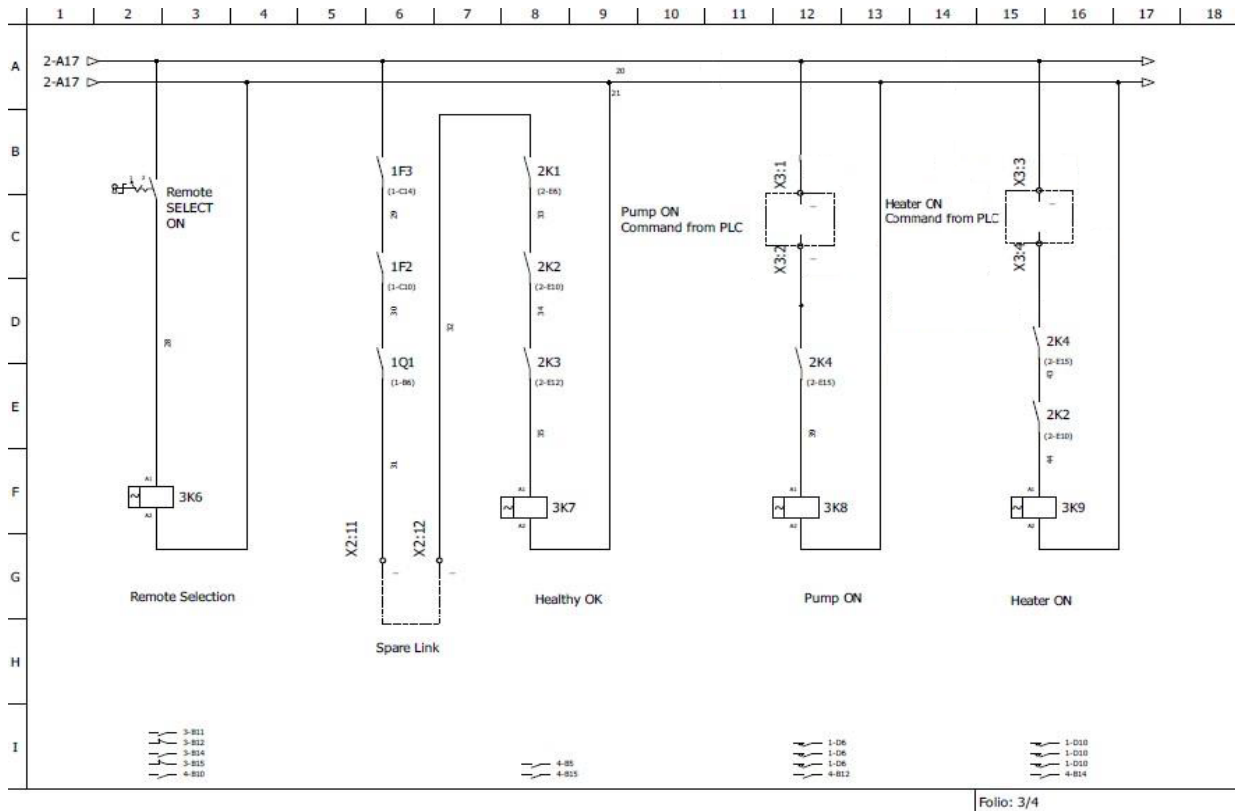


Figure 5: Controller Circuit SLD II

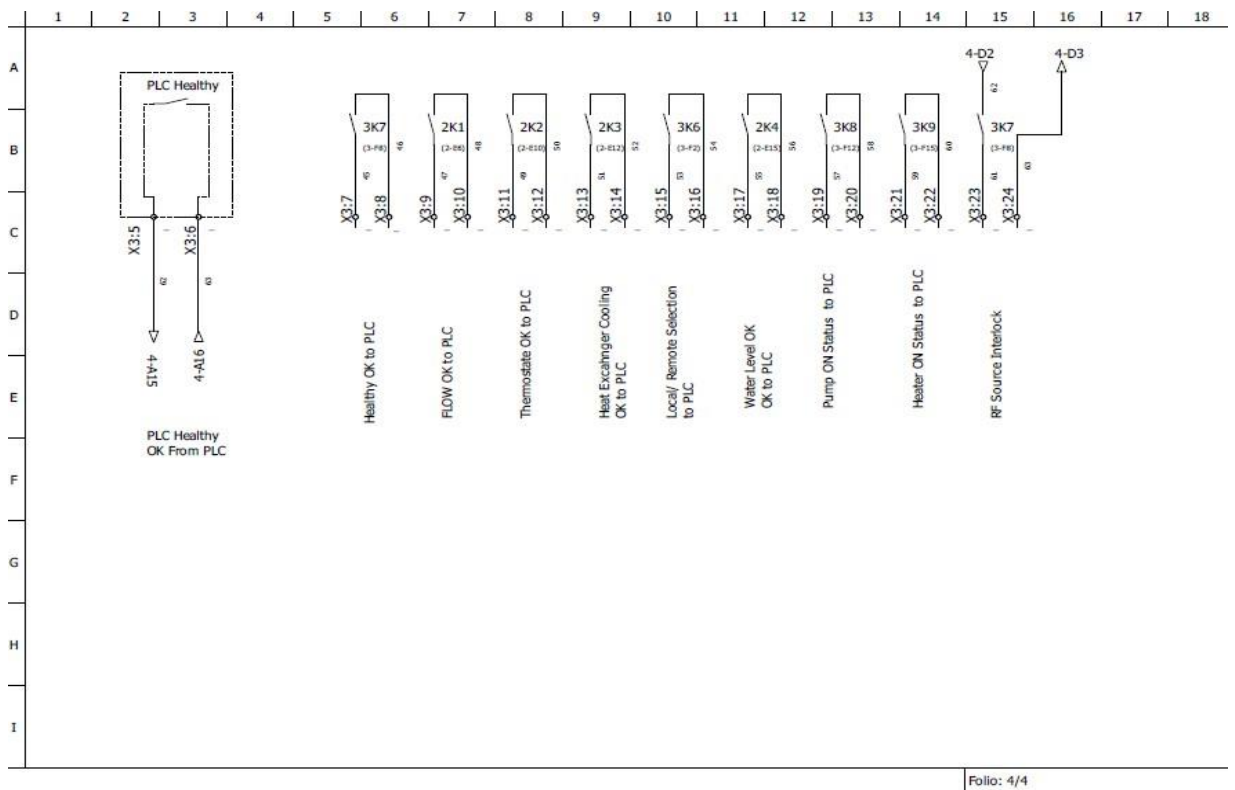


Figure 6: Controller Circuit SLD III

5 Support Structure

The material of construction for support structures can be mild steel or carbon steel. As per the detailed design submitted by bidder for II approval, the support structure design along with its material of construction will be finalized (section 2 point 4).

6 Controller & Measurement Unit (CMU):

The control and measurement unit will be used to monitor different parameters of Heat absorption system and executes control loop for maintain constant temperature of the soda water tank. Signal list and logic diagrams with flow charts are discussed below.

6.1 Signal List

This section indicates probable signals used for monitoring and control of the system.

Table 17: Signal List

Sr. No.	Signal description	Type	Voltage range	Remark
1	Pump status	DI	24V	
2	External Interlock status	DI	24V	
3	Thermostat Over Temperature (TH _L)	DI	24V	
4	Q-min. supervision through flow switch (soda water line): FS1	DI	24V	
5	Q-min. supervision through flow switch (secondary cooling line) :FS2	DI	24V	
6	Local/remote operation	DI	24V	
7	Heater ON status	DI	24V	
8	Tank Water level	DI	24V	
9	Spare 8 nos of channel	DI	24V	
10	Water flow monitor through flow transmitter: FT1	AI	4-20mA	
11	Water inlet temperature: T1	AI	PT1000 4-wire compatible module	
12	Water outlet temperature: T2	AI	PT1000 4-wire compatible module	
13	Spare	AI	PT1000 4-wire compatible module	
14	Spare	AI	PT1000 4-wire compatible module	
15	Spare	AI	4-20mA	

16	3-way valve control	AO	0-10V	
17	Spare	AO	0-10V	
18	Relay output-1 (Pump ON CMD)	DO	24V/relay contact	
19	Relay output-2 (Heater ON CMD)	DO	24V/relay contact	
20	Relay output-3 (Ready for operation)	DO	24V/relay contact	
21	Spare	DO	24V/relay contact	

6.2 Rack wiring guidelines

Bidder shall comply following standards where ever applicable.

- Standard industrial practice for internal cubicle wiring for Electrical Panel & CMU.
- All components should be tagged properly as per approved wiring/schematic diagram.
- Standard IEC 60204-1 for internal cubicle wiring.
- Standards IEC 60947-1, IEC 60947-2 for circuit breakers.
- Standards IEC 61439 for cabling

6.3 Development of Application Program

6.3.1 Operation of controller

There are two mode of operation Local and remote. Selection of local and remote mode will be through manual selector switch mounted on panel.

Local Mode:

In local mode, pump and heater operation will be carried out using Local HMI only. Local HMI will be used for calibration of PT1000, 3-way control valve & Parameters setting.

Remote Mode:

In remote mode, operation will be carried out by WinCC HMI (remote HMI) installed on computer. Pump and heater will be operated through remote HMI. Remote HMI will also be used for calibration of PT1000, 3-way control valve & Parameters setting.

Profinet will be used as protocol to interface between local HMI, remote HMI and Siemens PLC. Control parameters are enabled as per selection of mode (local/remote). However, monitoring parameters shall be displayed on both HMIs.

6.3.2 Display parameters in case of normal operation

The following parameters are indicated on the GUI during normal operation.

1. Water inlet temperature (°C)
2. Water outlet temperature (°C)

3. Temperature difference (°C)
4. Inlet-outlet temperature mean (°C)
5. Calculated power (kW)

Using the inlet and outlet temperatures in case of soda water, their mean is controlled to a constant level by a PLC using three-way valve as external actuator.

6.3.2.1 Power Measurement Criteria

The power is calculated using the equation:

$$P = c.Q.\Delta T$$

$$P = c.Q.(T_2 - T_1 + T_{off})$$

Where c is the water heat capacity (4.182kJ/kg*K)

ΔT is the temperature difference between inlet & outlet in °C

Toffs is the offset between two PT1000 – sensor and Toff is generated as defined in calibration process in 5.5.1.4

Q is the mass flow rate of soda water in kg/s (mass flow rate=soda water density (kg/l) *flow rate (l/s))

There are analog inputs from PT1000 for measurement of temperature T1 & T2 and water flow Q. These data should be acquired at every 100ms to get accurate calorimetric power measurement.

6.3.2.2 Soda water Temperature Controller

Mean temperature i.e. $T_M = (T_1 + T_2)/2$ shall be maintained at T_{set} through PID control loop by actuating 3-way control valve.

6.3.2.3 Temperature Sensor Calibration

In the case where no power is dumped into the system, both inlet(T1) and outlet(T2) temperature should be same. If there is any difference, user can change the value of T_{off} to compensate the error. The T_{off} (+/-) value will be added to T2 to get final value of T2.

$T_2' = T_{off} + T_2$ where T2 is the value of RTD2 and T_2' will be corrected value of T2 which will be used for further display and calculation.

6.3.3 Control loop logic for soda water temperature controller

Figure-1 shows a flow chart of the operation and configuration of the Heat Absorption System (HAS) controller.

1. Initially in Power ON condition of controller, home screen appears in HMI.
2. As per selected mode of operation, HMI screen of respective mode is enabled. Control parameters are enabled as per selection of mode (local/remote). However, monitoring parameters shall be displayed on both HMIs.
3. In remote mode, control button will be provided on remote GUI to switch on/off Pump and heater provided the selector switch of pump & heater is in remote position.
4. There are two types of login: Admin and Operator

a. Admin: Admin login requires password protection. After password validation, admin can be allowed to configured the system parameters.

The list of parameters is as follows:

T_{mean} : Mean Temperature value should be maintained constant through the PID control loop.

T_{set} : Set by admin.

K_p , K_i , K_d , ARW: PID loop parameters

Cp: Specific heat of fluid (constant: should be entered by admin & used in further calculation)

Toff: Shall be entered by admin and used for further calculation

Soda Volume: This shall be entered by the admin and used for further calculation.

- A 3-way control valve test option shall be provided in which 0 to 10V user-defined value will be generated to test the functioning of the 3-way valve.
- After saving the parameter, the same will be used for calculation & display of defined parameters.

Once saved, exit the configuration screen and go to the Home screen

b. Operator: Operator login allowed normal operation of HAS.

- i. Generate analog output for 3-way control valve so that water flow will be in B→AB position.
- ii. Display data on HMI for T_1 , T_2 , ΔT , flowrate and power. Also, display heater & pump status and warning if any.
- iii. Value Checking of T_1 & T_2 within range or not? If not, display error message on HMI “Check T_1/T_2 ” and follow the flow chart.
- iv. Check the status of pump & heater, is it ON? If not, display error message on HMI “Pump status & Heater status” and follow the flow chart.
- v. Check the flow switch status: FS1 & thermostat status: TH_L , is it OK? If not, display warning on HMI “Not ready for operation & display respective fault” and follow flow chart
- vi. Generate DO for Ready for Operation & display on HMI if status of state defined in ii, iii & are healthy.
- vii. Display data on HMI for T_1 , T_2 , ΔT , flowrate and power. Also, display heater & pump status and warning if any.
- viii. Check the value of ΔT & if $\Delta T < 1^\circ\text{C}$, then display “Low power” status on HMI screen & Set $T_{set}^* = T_{set} - 5^\circ\text{C}$.
- ix. If $\Delta T > 1^\circ\text{C}$ then archive, calculate & display power P , T_{mean} , ΔT and set $T_{set}^* = T_{set}$ and T_{set}^* is used as setpoint in PID control loop.

$$T_{mean} = (T_1 + T_2 + T_{off})/2$$

- x. Execute PID loop to control the temperature T_{mean} in such a way that T_{mean} remains at $T_{set}^* \pm 2^\circ\text{C}$. The actuator of PID control loop is 3-way control valve.
- xi. Further possibility of Soda volume parameter will be explored to add in power measurement. It is defined as water pipe volume in (m^3) from the inlet temperature measurement T_1 to the outlet temperature measurement T_2 and is used for a variable delay compensation for the controller.

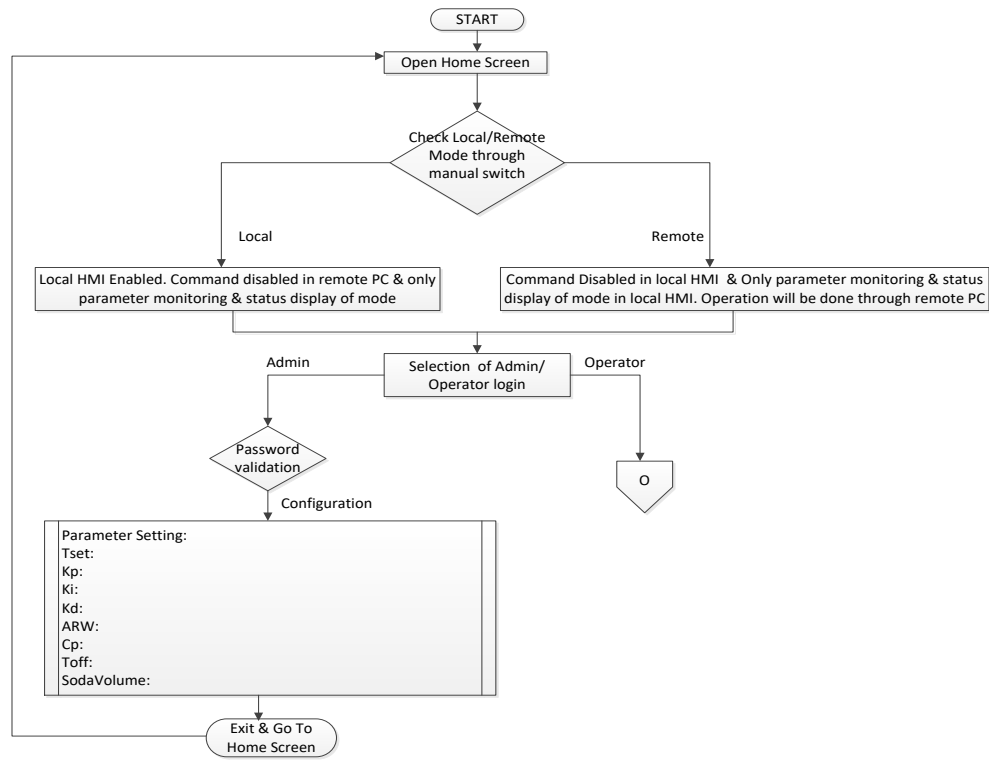


Figure 7: Algorithm & Flowchart I

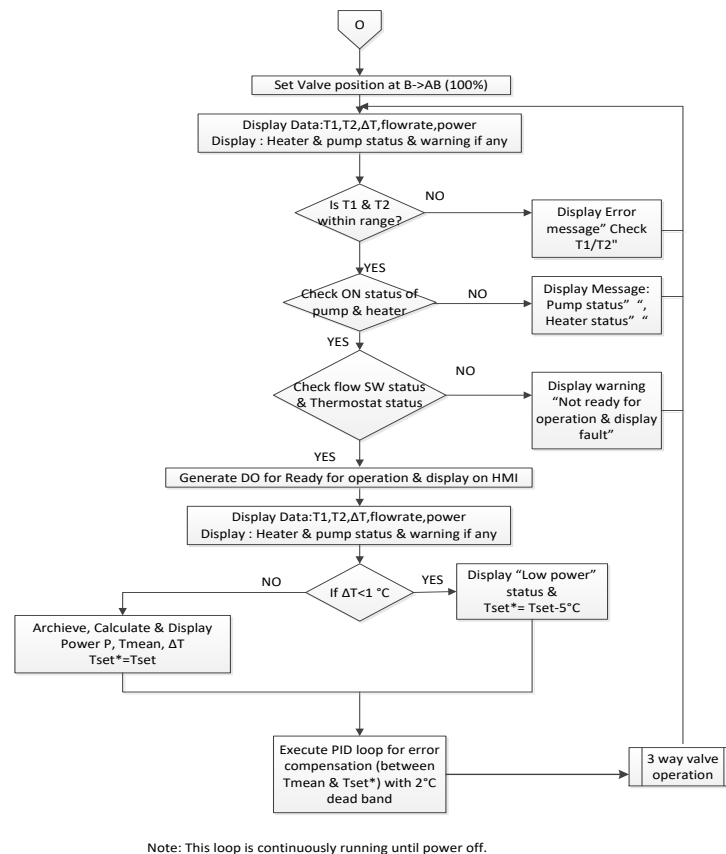


Figure 8: Algorithm & Flowchart II

7 Piping details

The piping design and calculations will be done first and thereafter submitted to II for approval. In general, the bidder should follow the following:

Tolerances for Fabrication of pipes and fittings:

Pipes:

Diameter: Tolerance: $\pm 0.5\%$ of OD (Check by circumference measurement), Length: $< 5\text{ mm}$ for 3 m length.

Roundness: 1% of Pipe Dia.

Fittings:

Angular Dimension: $\pm 1/8^\circ$ degree.

OD at Bevel: Nominal + 6.25 mm - 4.5 mm.

ID at Bevel: Nominal $\pm 2.25\text{ mm}$

Reinforcement Pads for Structural attachment: with gap $< 1.5\text{ mm}$.

- Unless otherwise specified, measurement for piping for the project shall be on the basis of center line measurements described herewith.
- Piping shall be measured in units of length corrected to centimeter along the center line of installed pipes including all pipe fittings, flanges (with gaskets, nuts, and bolts for jointing), unions, bends, elbows, tees, concentric and / or eccentric reducers, inspection pieces, expansion loops etc.
- The above accessories shall be measured as part of piping length along the center line of installed pipes, and no special multiples of pipe lengths for accessories shall be permitted.
- The Bidder may visit the site at their own cost to have an idea of the complexity involved in the system, prior to quote if they desire.

The pipe details are:

Table 18: Pipe details

Sr No	Item description	Value	Remarks
1	Supply, Installation, Testing and commissioning of following SS 304 pipes cut to required lengths and installed with all welded joints, necessary fittings, like elbows, tees, bends (Long/short radius), reducers, flanges, metric thread fasteners, PTFE / eq. gaskets (Sch-10) etc. <u>Schedule 10 pipes, fittings and flanges.</u> 100 NB Sch.10 SS 304 ERW	10 RMT	
2	Operating Pressure	5 bar	
3	Maximum Operating Pressure	9 bar	
4	Operating Temperature	75°C	
5	Maximum Operating Temperature	90 °C	
6	Applicable standard for design	ASME B 31.3	

Note:

Pipe length will be calculated in a running meter (RMT). The P&ID shown in Figure 2 is only for the representation of the system and for understanding. The scope of supply and work is governed by the details mentioned in this document.

8 Factory Acceptance Tests (FAT):

FAT of integrated system will not be carried out at factory. FAT of individual components/products shall be carried out in the presence of ITER-India representative (s) as per Table-19 at bidder site.

Table 19: FAT

1	Functional & Dimensional Inspection of the components/sub-assemblies as per Approved Drawings
2	Surface finish/ visual inspection of the assembly
3	All material test certificates from NABL-approved labs, Relevant test reports for heat exchanger, pump & motor, valve, controller, RTD, Pipe, Pressure switch, flow sensor & monitor, thermostat, and NDT reports (if applicable).
4	All Inspection reports of individual components, sub assembly and assembly.
5	Hydro test of all the pipes shall be performed at 5 bar for 30 minutes
6	Electrical Panel Layout, wiring diagram, SLD, protection scheme/interlocks & Mains distribution.

9 Site Acceptance Test (SAT):

SAT of complete integrated system will be carried out at the site including FIM. Following site acceptance test will be carried out at ITER-India site as per Table-20

Table 20: SAT

1	Dimensional Inspection as per Approved Drawings
2	FAT report/ MOM for any pending work
3	Assembly, Integration and Commissioning at I-I Lab with FIM
4	Hydro test of all pipes shall be performed at 5 bar for 30 minutes
5	CMU functionality test as per Section 6

10 Dispatch & Packing requirements:

All sub-assemblies after final assembly and successful FAT shall be dismantled for packing and dispatch along with all hardware's. The packing is to be performed with standard soft material to avoid damages to the machined surfaces. Further, unpacking of all sub-assemblies, inspection and final assembly at ITER-India site for SAT. All mating surfaces of flanges must be masked with proper covers to avoid damage during handling and transportation. Wooden packing shall be sturdy and rigid enough to withstand shocks and vibrations during transportation of the system.

Any damage to the components during handling & transportation or else, will not be accepted. Bidder shall take due care during the packing and forwarding of the system. It is the liability of the bidder to deliver the system in perfect working condition to **3rd floor ITER-India lab, IPR (17-meter height)**. Damaged components will be repaired/ replaced by bidder at free of cost.

11 Delivery Schedule

Detailed Delivery Schedule is given in Part-A(III) of ATC document.

12 Intellectual Property Right Clause

“Generated Intellectual Property” (GIP) for the final integrated & tested finish good product of this tender” means in this document any information including but not limited to inventions, technical data, designs, drawings, manufacturing plans, processes, materials, patents, license, know-how, software including its object and source codes, computer data bases, trade secrets or copyrights, shall remain the exclusive property of Institute for Plasma Research, Bhat, Gandhinagar, Gujarat, India. After final integration and testing of the finish good product of this tender, the GIP shall be considered as CONFIDENTIAL INFORMATION. Any copy and/or disclosure thereof in any form whatsoever are subject to Institute for Plasma Research’s prior written consent

13 Bidder Compliance sheet:

The bidder should fill the table-21 and return back along with the offers

Table 21: Compliance sheet

Sr. Nos.	ITER-India Specifications	Bidder Specifications	Complied? Yes / No	Remarks
1	Preparation of Quality Assurance Plan (QAP) and submission of the same for ITER-India’s approval.			
2	Preparation of shop floor drawing based on ITER-India’s supplied CATIA Model, PFD and submit the same for ITER-India’s approval before the start of Manufacturing.			
3	Preparation of MIP for each sub-assemblies and submission of the same for ITER-India’s approval			
4	Procurement of materials & hardware’s as per bill of material (Annexure-III for reference only) and submit the test reports for ITER-India’s approval.			
5	Fabrication/manufacturing of the system as per drawings & SoW			
7	Stage wise inspection of			

Sr. Nos.	ITER-India Specifications	Bidder Specifications	Complied? Yes / No	Remarks
	individual components and assemblies per approved MIP and QAP.			
8	All the items need to be thoroughly cleaned for dust/ grease/ any coolant/ foreign material etc as per Annexure-I.			
9	Assembly and checking of performance for at bidder site, in presence of ITER-India representative as per factory acceptance test written in Table-I of section-6			
10	Submission of factory acceptance test and packing completion reports to ITER-India to get the dispatch clearance certificate.			
11	Packing of all fabricated items and hardware's and delivery of items to ITER-India lab, IPR site with adequate packing to avoid damage during transportation as per section 8			
12	Un-packing, inspection and re-assembly to integrate the system at ITER-India site and testing as per Table no-II of section-7			
13	Preparation of site acceptance test report by ITER-India in presence of supplier.			

Note: - The bidder should also submit line by line / section wise technical compliance matrix along with offer indicating important remarks.

Annexure I: Clean work Plan

1. Introduction

This annexure describes the processes and requirements to clean all components and Assemblies.

2. Scope

Manufacturer will carry out cleaning of all components (including free issue components) and assemblies as per requirements described in this document.

3. Work description

3.1 Cleaning of components

Following steps will be applied on all components prior to start pre-assembly.

- (a) All components shall be cleaned with Isopropyl alcohol with fresh and stain free cotton cloth.
- (b) After cleaning all the components wrap it with plastic sheet to avoid dust particles and keep it in a cleaned room.
- (c) Checking of Cleanliness: Inspection will be carried out after dry wipe test and in case there is any stain/discoloration on cloth is observed, wet wipe test will be performed by dipping the lint free cloth in isopropyl alcohol. If there is any discoloration on lint free cloth, component will be sent back for cleaning again.
- (d) If alternative surface / cleaning procedures are proposed by the manufacturer then, it requires prior approval by I-I.
- (e) The manufacturer will also carry out Pickling and Passivation of all brazed/welded components as per ASME section-II Part-B. All copper/copper alloy components must be passivated immediately by dipping in a 1% aqueous solution of citric acid. Thereafter rinse thoroughly in DM water (to remove all traces of acid) then will be dried with hot air at temperature 65°C to dry out all the traces of DM water.

3.2 Cleaning after sub Assembly:

Before starting final assembly, all sub-assemblies will be cleaned with isopropyl alcohol and toughly packed with wrapping sheet to avoid dust and oxidation of surfaces and all components to kept in cleaned room.

3.3 Environment of Cleaning and Assembly

The environment for cleaning and assembly of the components shall conform to the following requirements:

- (a) Use of approved clothing: personnel shall wear clean clothes, clean shoes or overshoes and powder free latex gloves
- (b) Floors shall be covered with a smooth coating (permanent or removable). If the enclosure is permanent all walls and ceilings shall not produce dust

- (c) Inside the work area measures shall be taken to prevent dust penetrating into components already cleaned or in the process of being cleaned. Accordingly work on concrete shall be avoided
- (d) Floors shall be cleaned daily.
- (e) The boundaries of work areas shall be marked off physically
- (f) All components shall be thoroughly degreased, cleaned and sealed in a suitable envelope (polythene, etc.) prior to being introduced into the clean conditions assembly area.
- (g) An inventory of all items entering or leaving the clean area shall be maintained. This shall include tools, containers for transporting tools or components etc.
- (h) The surfaces of jigs, fixtures and tools that come into contact with the components shall be constructed of stainless steel; they shall never be made of carbon steel
- (i) Tooling or equipment that produces oil, grease, flux or any substance considered a harmful contaminant is not permitted. Only water soluble, non-halogenated, sulphur and phosphorus free machining fluids approved by Iter-India are permitted.
- (j) Overhead cranes and lifting equipment shall be arranged to avoid the dripping of oil in the clean conditions assembly area.
- (k) If components are not being worked upon more than a day, they will be properly covered with non PVC plastic sheet.
- (l) During manufacturing of component / transportation/ assembly, care shall be taken to exclude incompatible materials which could exercise the adverse effect on the properties and integrity of component / assembly. The main incompatible materials mercury, oxidizing acids, oxidizing heavy-metal salts, sulphur, ammonia (NH₃) etc.
- (m) It will be ensured while using wooden material that they do not contain nail or resin
- (n) Using only, I-I approved tapes, markers, couplant, magnetic inks, penetrants and paints.
- (o) It will be ensured that machinery shall not exhaust into the area identified for cleaning

After cleaning all surfaces shall be “metal clean” and free from, oil, grease, ink, paint, dust, rust spots, abrasive particles, chips and any other gross discontinuities. All surfaces show a uniform metallic colour and are absent from evaporation patches from cleaning agents.

3.4 Personnel working in the clean condition assembly area

Personnel working in the clean area should follow correct procedures. Persons involved in cleaning & final packing operations will be trained about cleanliness requirement during these operations & use of persons violating these requirements will be discontinued.

3.5 Handling

After cleaning the components shall be moved to a clearly identified clean conditioned assembly area, Handling equipment, such as slings, hooks, etc., are sheathed or protected with approved plastic (not PVC), clean wood etc., to avoid contact of the carbon steel pieces with components.

Final cleaned pieces made are not to be stored directly on the ground or bare floor. They are to be stored on clean surfaces, or surfaces covered with materials such as wood, plastic (not PVC), etc. No nails or resins are to be present on the wood.

Once a component is cleaned and inspected for acceptance, it is handled with the utmost care until final assembly is carried out. All components are visually inspected to check that the cleanliness condition is preserved. Prior to packing, all components are covered with approved plastic film (not PVC) to avoid the accumulation of dust or unwanted debris.

Annexure II: Deliverable documents list

List of documents need to be prepared:

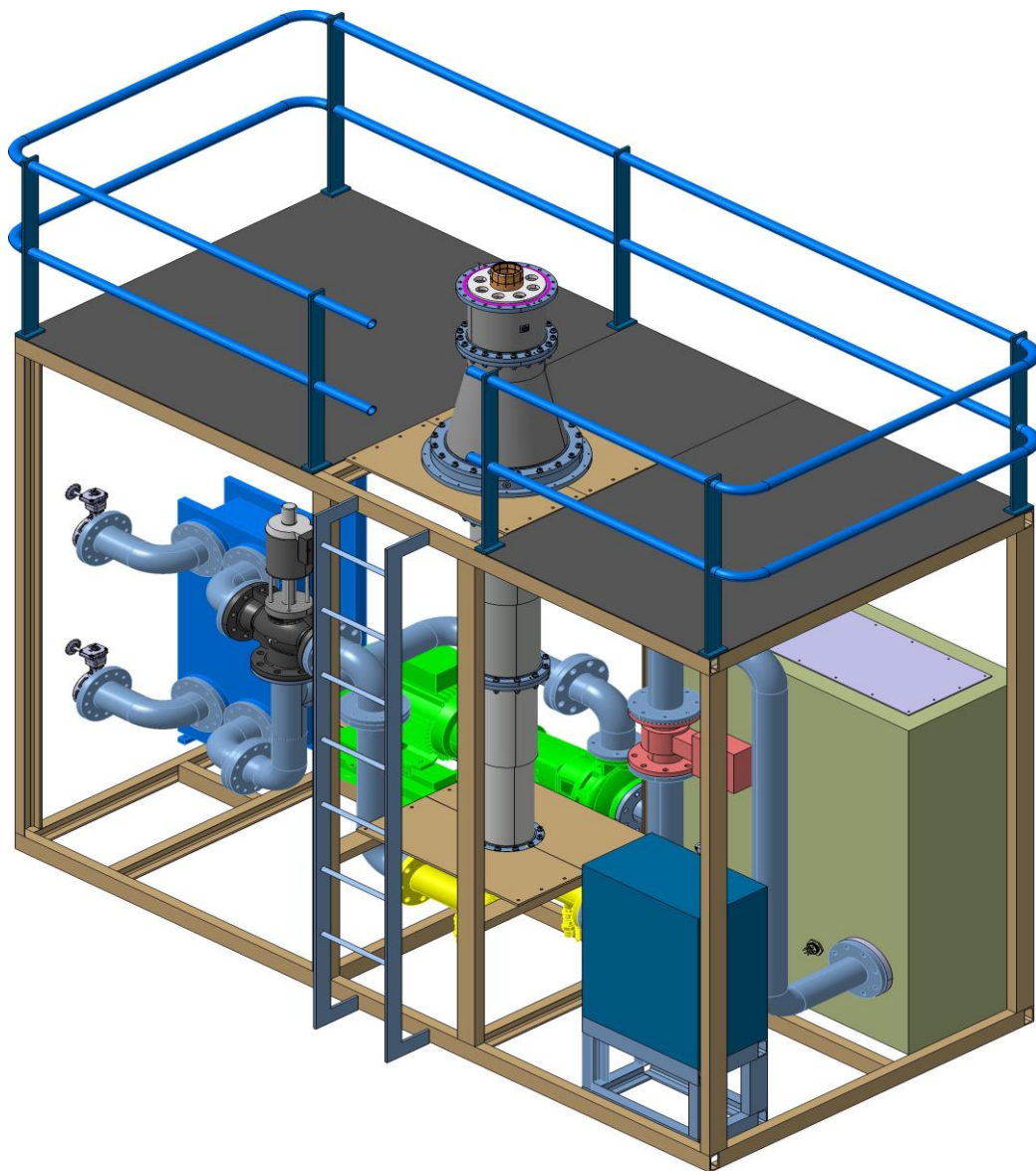
Documents to be supplied at various stages of the contract are given in Table 23. Bidder to start any activity only after Approval of the respective procedure.

Table 22: Document List

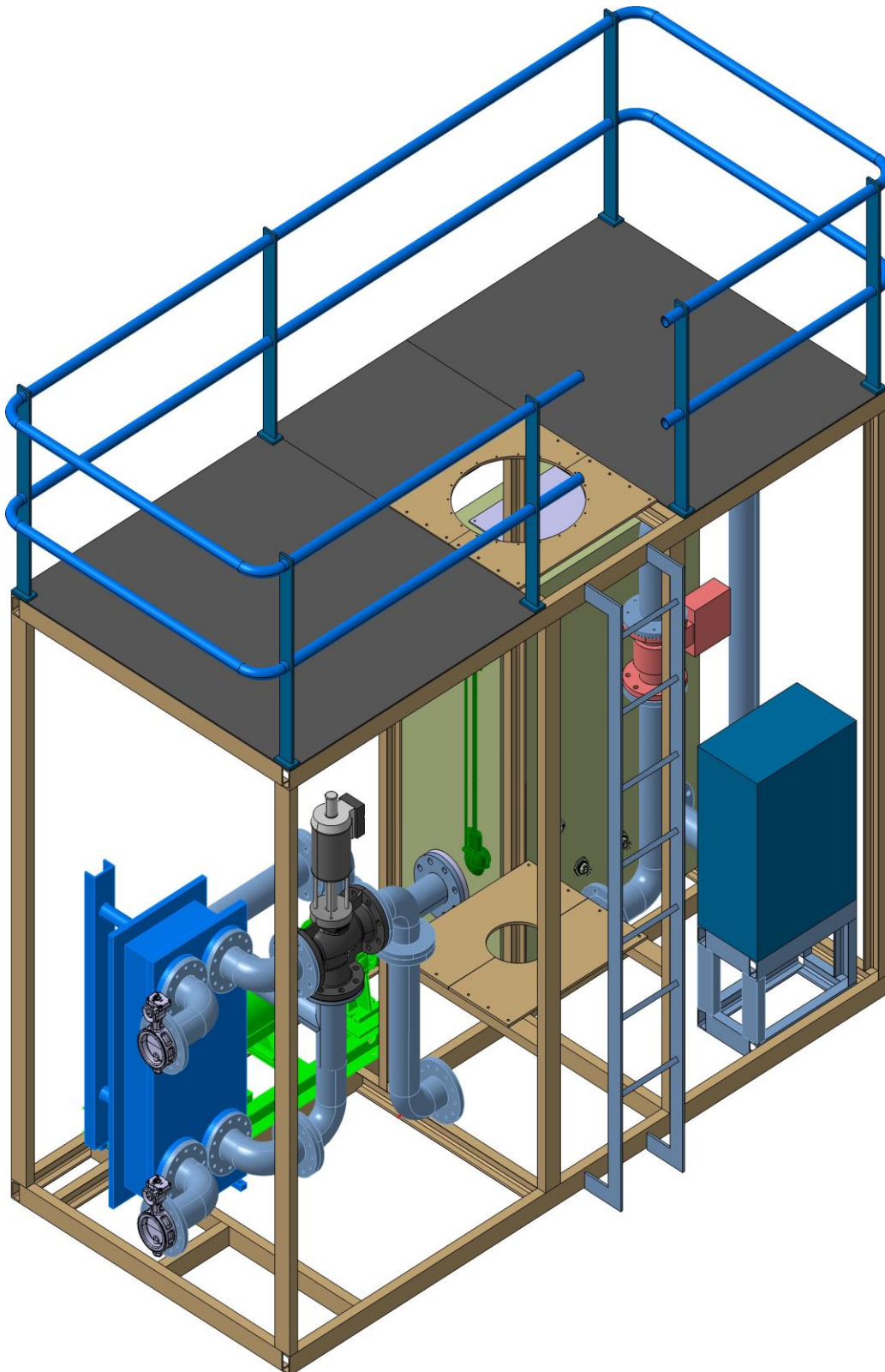
S. No.	Document to be supplied	Provider	Milestone*
1.	Quality assurance Plan (QAP) and Manufacturing & Inspection Plan (MIP), Procedure for Weld Repair.	Bidder	Kick-off meeting
2.	Detailed design report, Shop Floor drawings, Final BoM, Power & Control Wiring Diagrams & SLD's, Material documentation (incl. Procurement specification, material certificates, test and examination results)	Bidder	During Design Review
3.	Signed & Validated Manufacturing and inspection reports (As per MIP all test certificates and inspection reports)	Bidder	Before FAT
4.	Factory Acceptance test plan	I-I & Bidder	Before FAT
5.	FAT Report	Bidder	After FAT
6.	Site Acceptance test Procedure	I-I & Bidder	Before SAT
7.	SAT report, Installation & Configuration Manual, Operational Manual, Maintenance Manual, Warranty Certificates, Standard compliance certificates and test certificates, Software file.	Bidder	After SAT

Annexure III: Catia drawings

1. System Layout



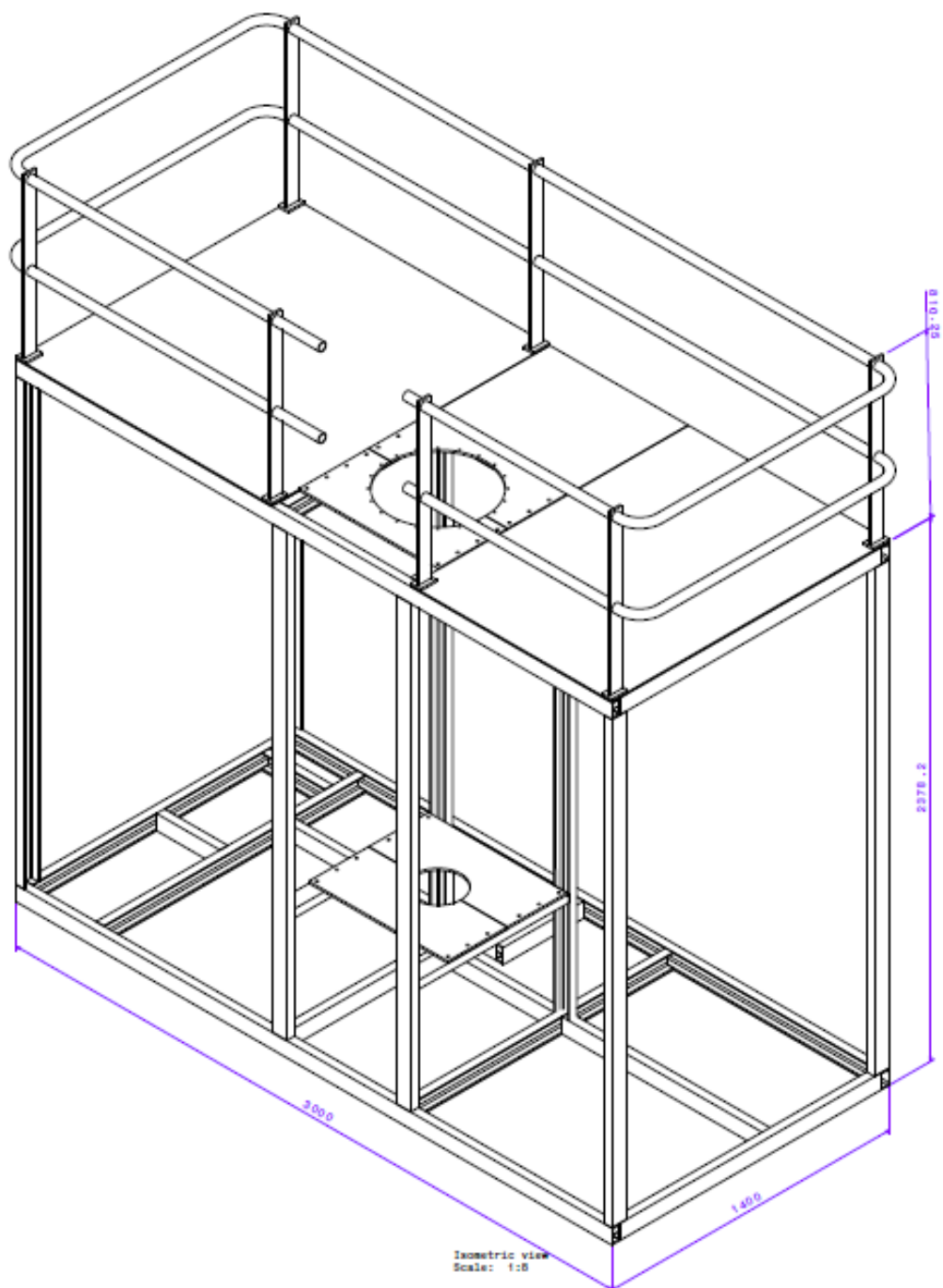
2. Scope of Supply



3. Dimensions of various components

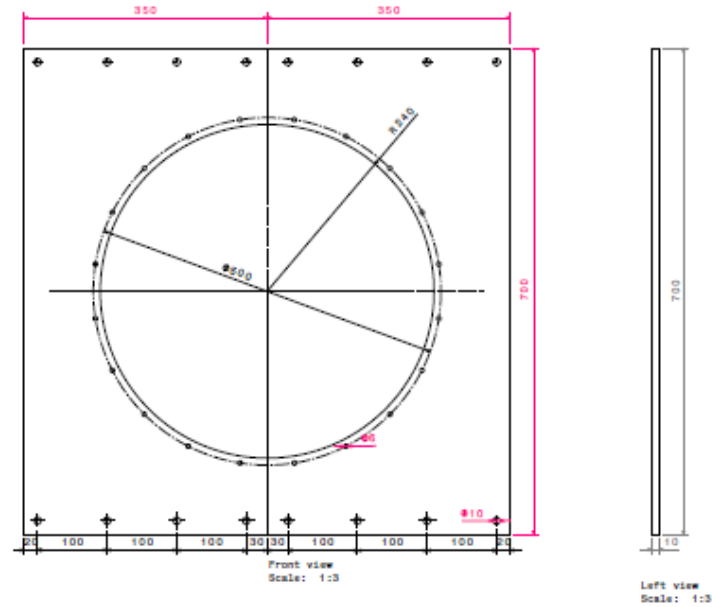
Below are the different parts of system, dimension mentioned in the drawings are reference purpose only.

3.1 Support Structure Dimensions:

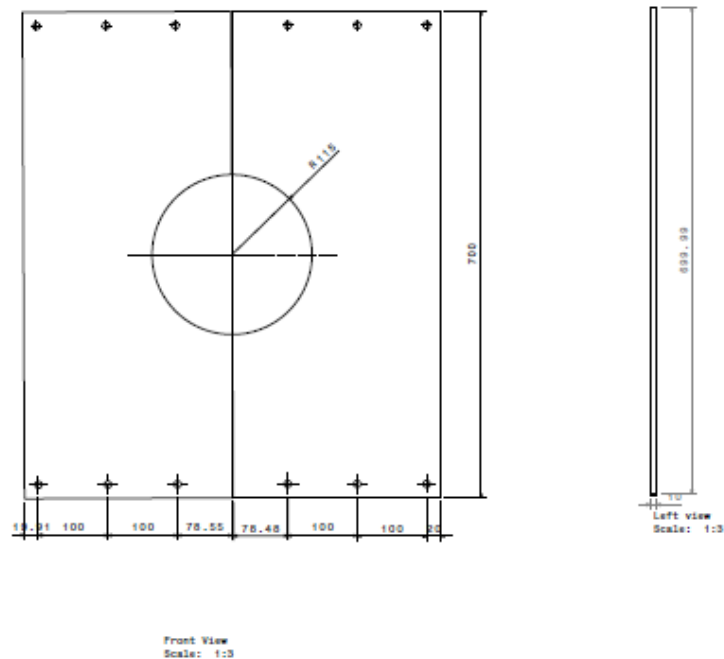


3.2 Support Plate for Hear absorption system:

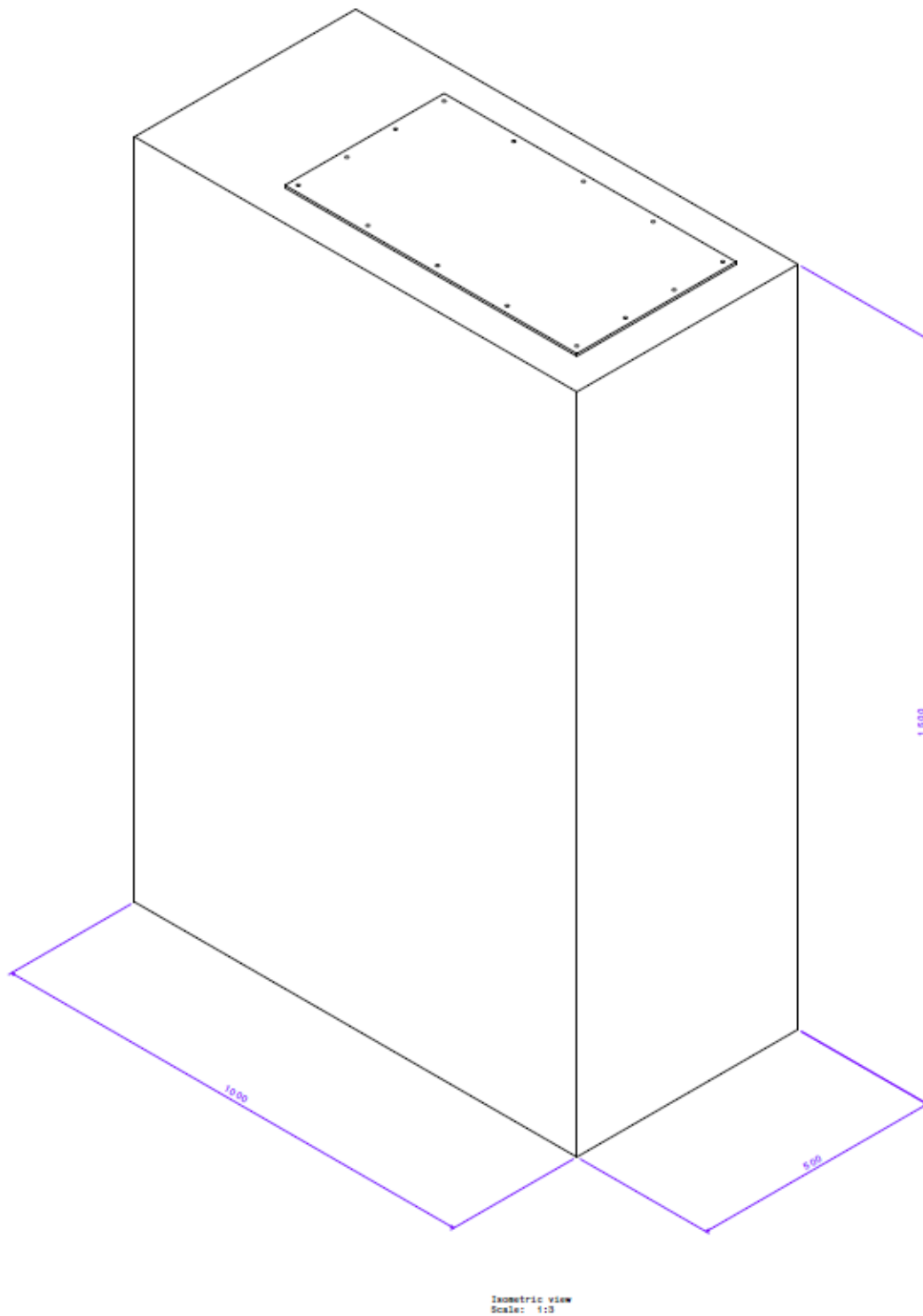
Top Support Plate



Bottom Support Plate



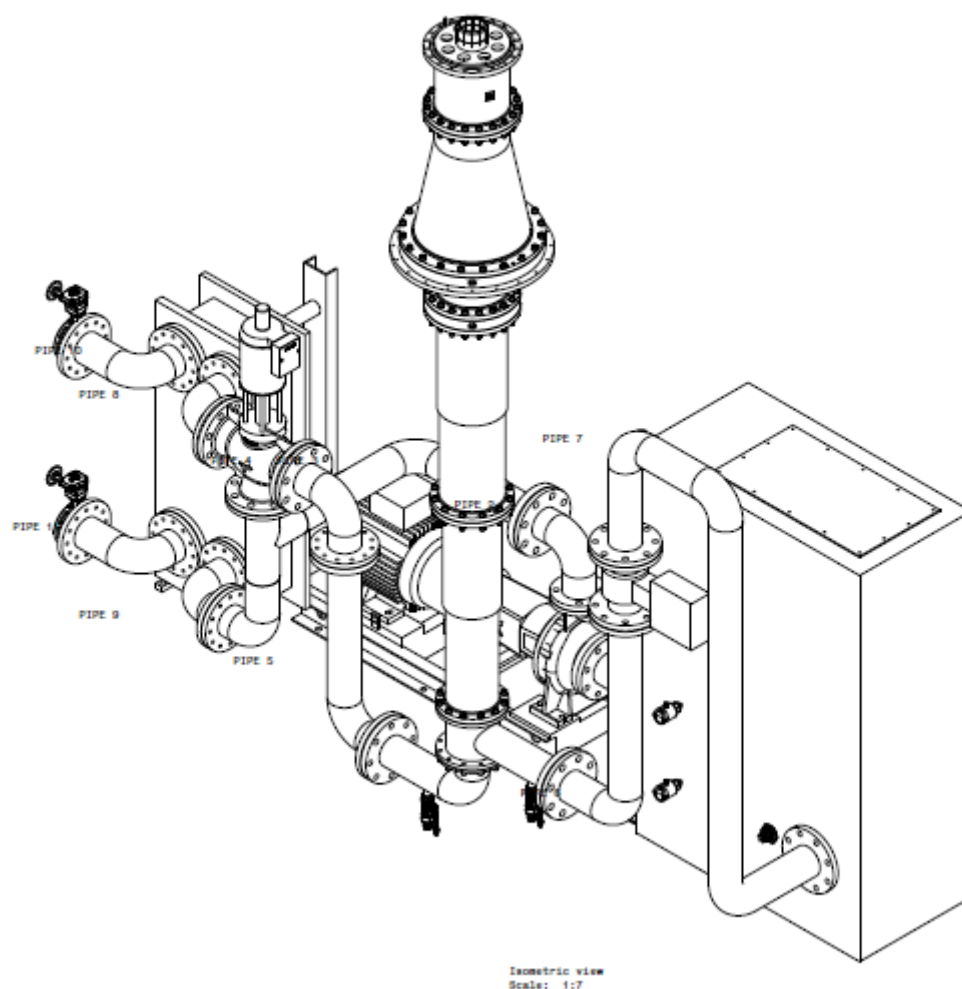
3.3 Soda water tank:

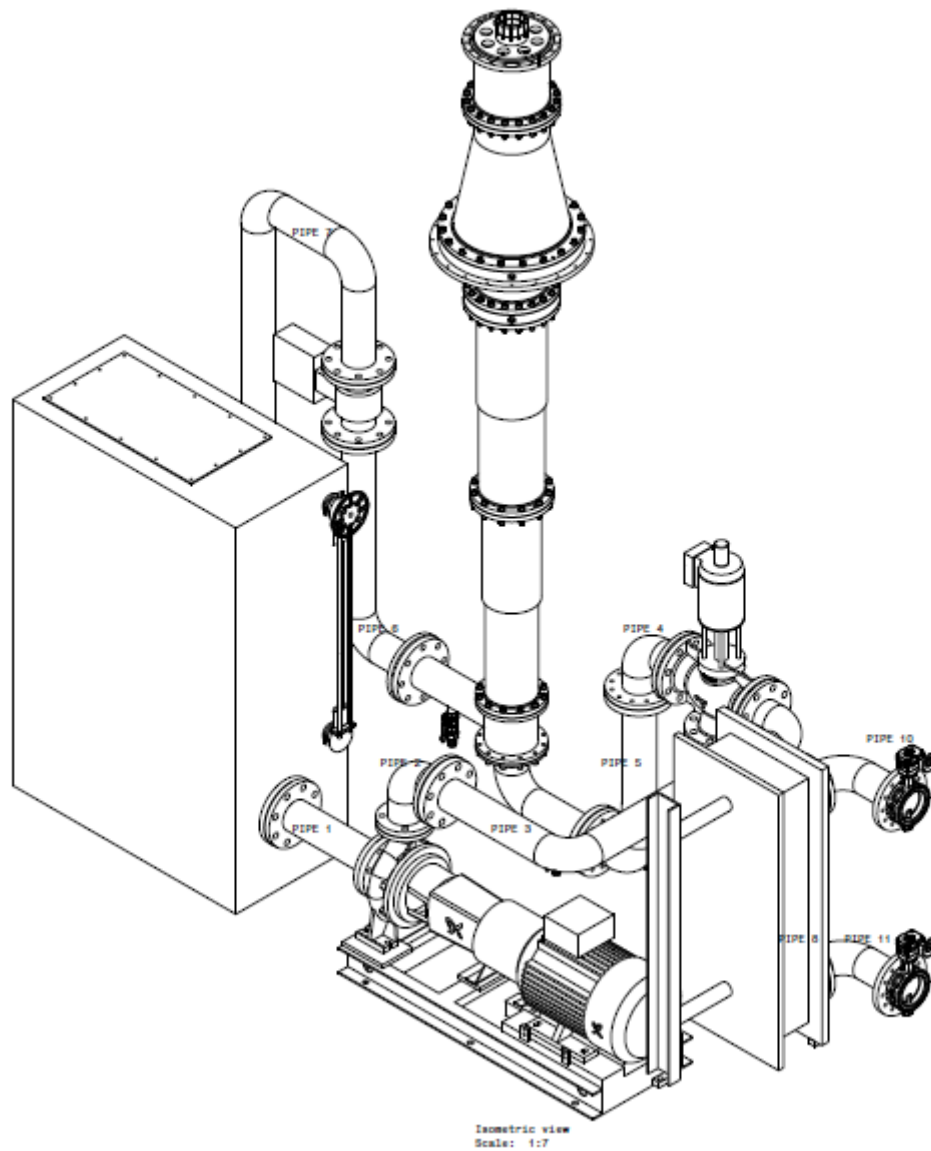


3.4 Piping layout of system:

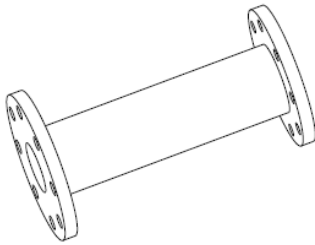
Pipe size = 4" or 100mm

Flange standard =ASME B16.5 CLASS 150
DN100

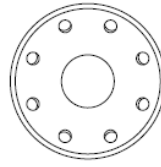




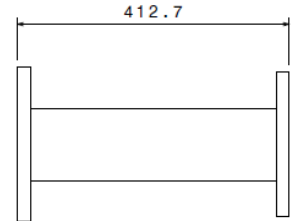
PIPE 1



Isometric view
Scale: 1:5



Front view
Scale: 1:5

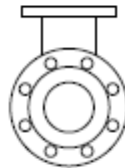


Left view
Scale: 1:5

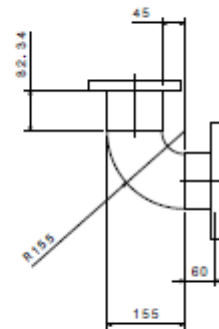
PIPE 2



Isometric view
Scale: 1:5

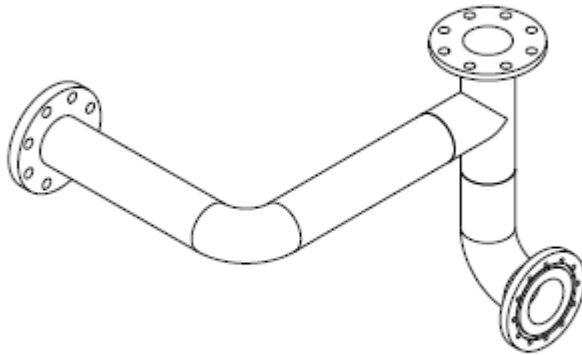


Front view
Scale: 1:5

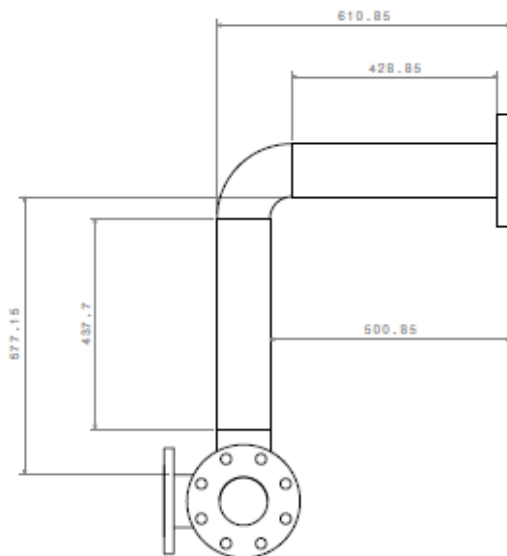


Left view
Scale: 1:5

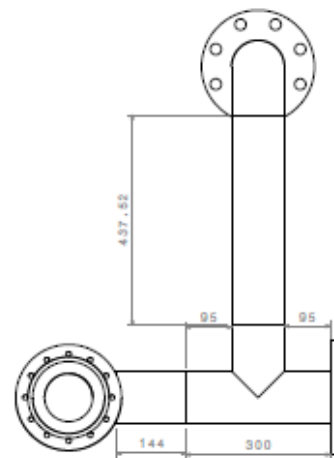
PIPE 3



Isometric view[2]
Scale: 1:5

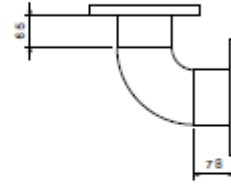
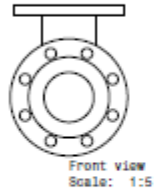
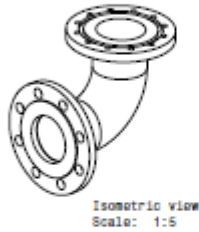


Bottom view[2]
Scale: 1:5

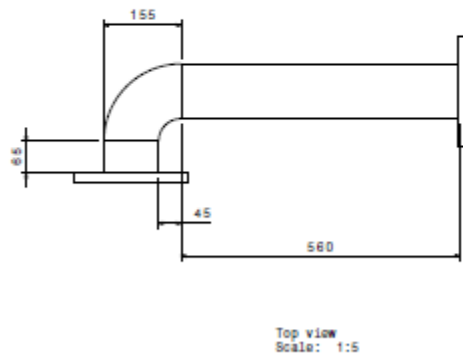
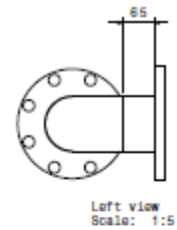
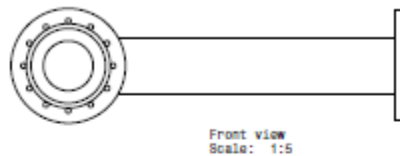
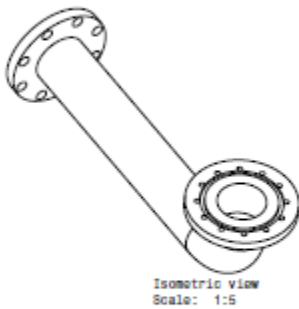


Auxiliary view A[2]
Scale: 1:5

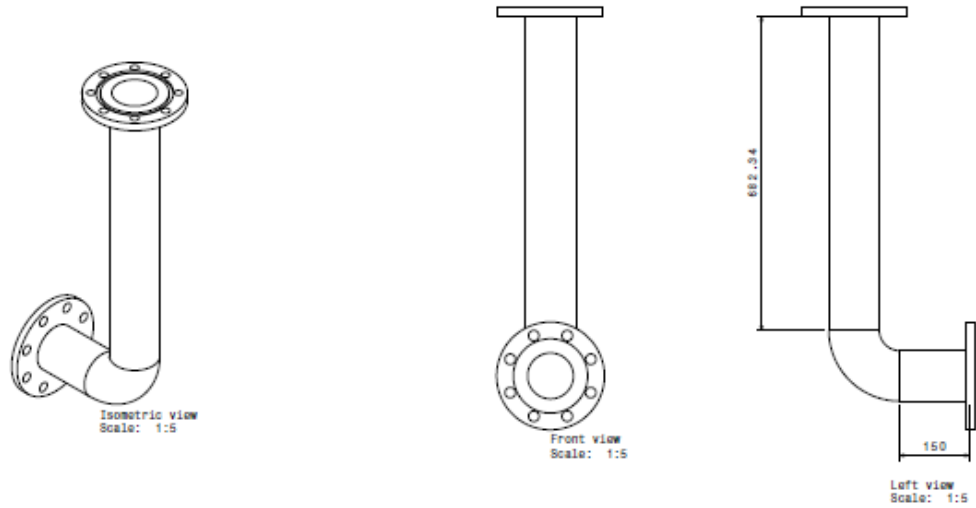
PIPE 4



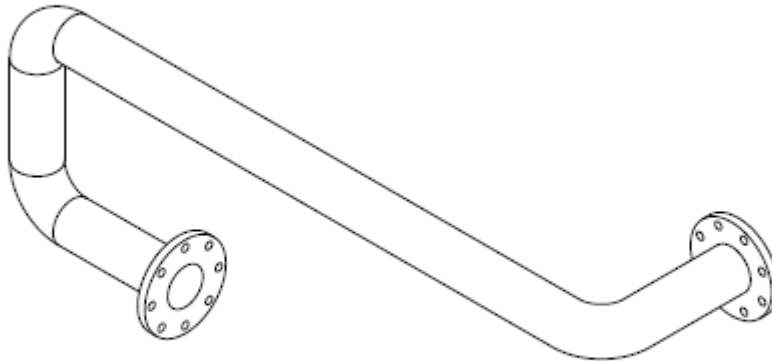
PIPE 5



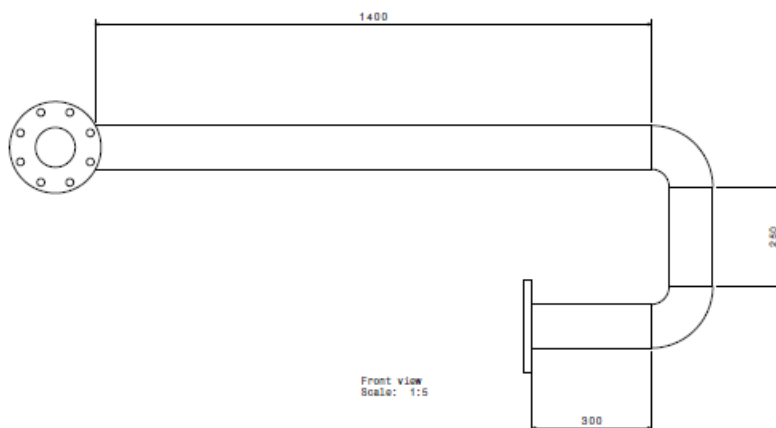
PIPE 6



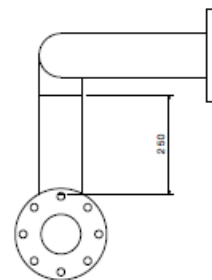
PIPE 7



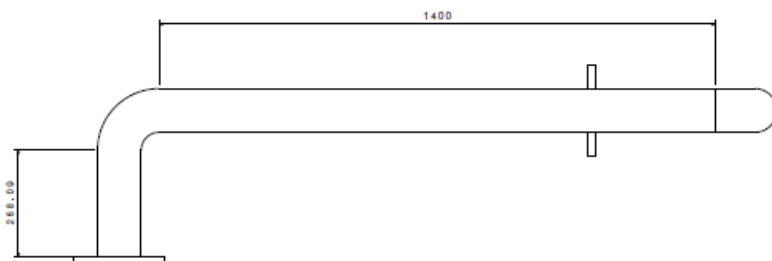
Isometric view
Scale: 1:5



Front view
Scale: 1:5

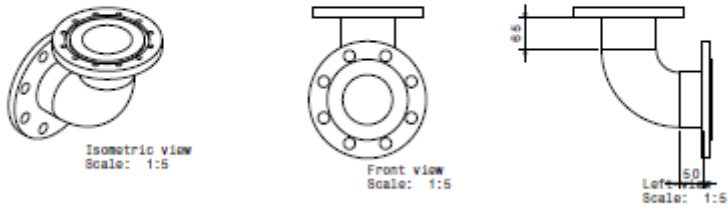


Left view
Scale: 1:5

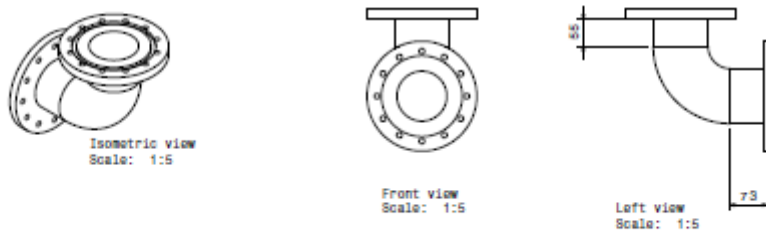


Top view
Scale: 1:5

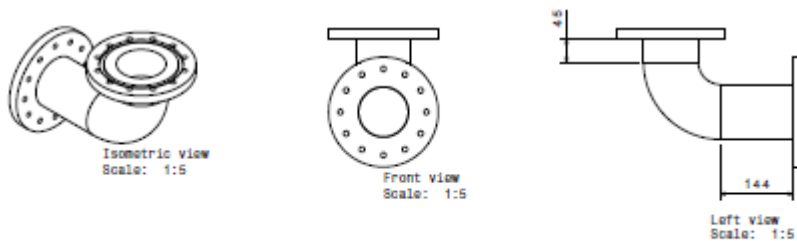
PIPE 8



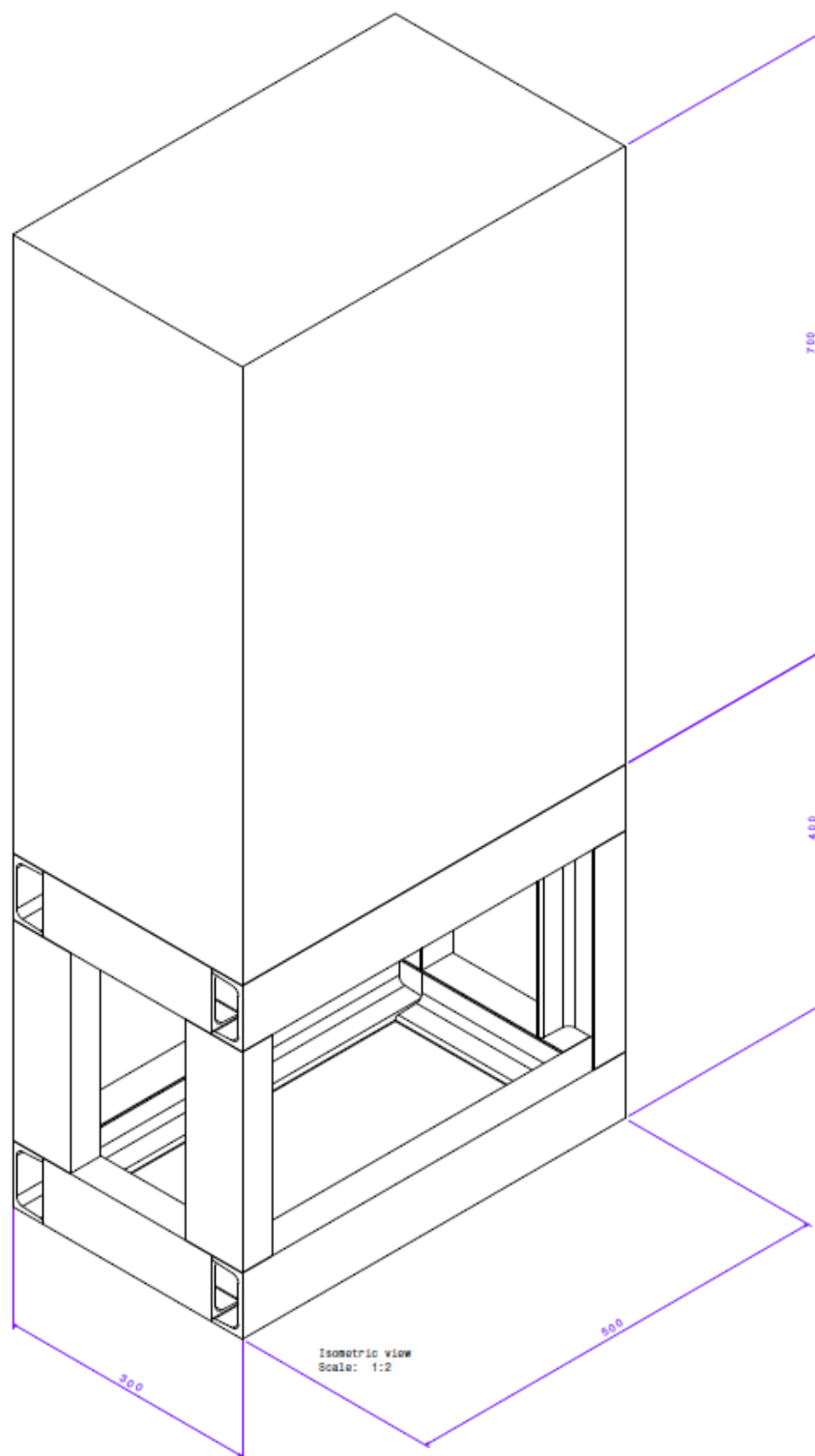
PIPE 9



PIPE 10 & PIPE 11



3.5 Electrical & Control Panel dimensions: Supplier can modify this as per the size of selected PLC controller & HMI to accommodate the unit above electrical panel.



Annexure IV: MIP Template

[Template for Manufacturing and Inspection Plan]

[Sheet: of]

MANUFACTURING AND INSPECTION PLAN									
Document Number:				Revision Number:					
Purchase Order Number:				Title of Item:					
Name of the Supplier:				Sub-Supplier:					
Prepared by supplier Name & signature: Position: Project Manager Date:		Approved by ITER-India Name & signature Position: Date:				Code* HP: Hold Point ATPP: Authorization to Proceed Point NP: Notification Point W: Witness of Operation S1: 100% Inspection, S2: Random Inspection R: Review Report			
Operations (Manufacture, Inspections & Tests, etc.)	Expected Date	Applicable document (procedures, drawings, instructions, etc.)	Inspection Body				Records (report, non-conformance number, etc)	Observation(s)	
			Supplier	ITER-India	TPI	TPI			
			Name, Sign & Date	Name, Sign & Date		Name, Sign & Date			
				*			*		