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Technical Specifications (In-Cash Procurement)

Technical Summary for CHOP Qualification and Testing facility

This technical summary is prepared for the launch of the procurement process for the CHOP qualification and testing facility. This summary will be followed by a detailed technical specification ITER_D_8PJ9VJ.

1. Background

The Vacuum Vessel Pressure Suppression System (VVPSS) is a system designed to protect the ITER Vacuum Vessel (VV) during accidental events. The VVPSS has three main functions; protect VV from overpressure, maintain dynamic confinement in the event of breach of VV, and reduce the concentrations of hydrogen, tritium, and dust sent to the downstream Detritiation System (DS).

The Hydrogen Mitigation System (HMS) is a subsystem of the VVPSS, specifically designed to perform the removal of hydrogen, tritium and dust from the non-condensable process gas stream. HMS accomplishes the reduction in concentration of hydrogen and dust through a series of igniting, scrubbing, and catalysed oxidation processes.

IO has developed two prototype catalytic hydrogen oxidation reactors, hereafter referred to the Catalytic Hydrogen Oxidation Prototypes (CHOP), which will be tested in an experimental facility to determine their functional performances and identify the preferred arrangement.

IO is seeking a partner to develop and operate the CHOP testing facility. This document is a summary of the technical specification for the CHOP Facility and corresponding test program.

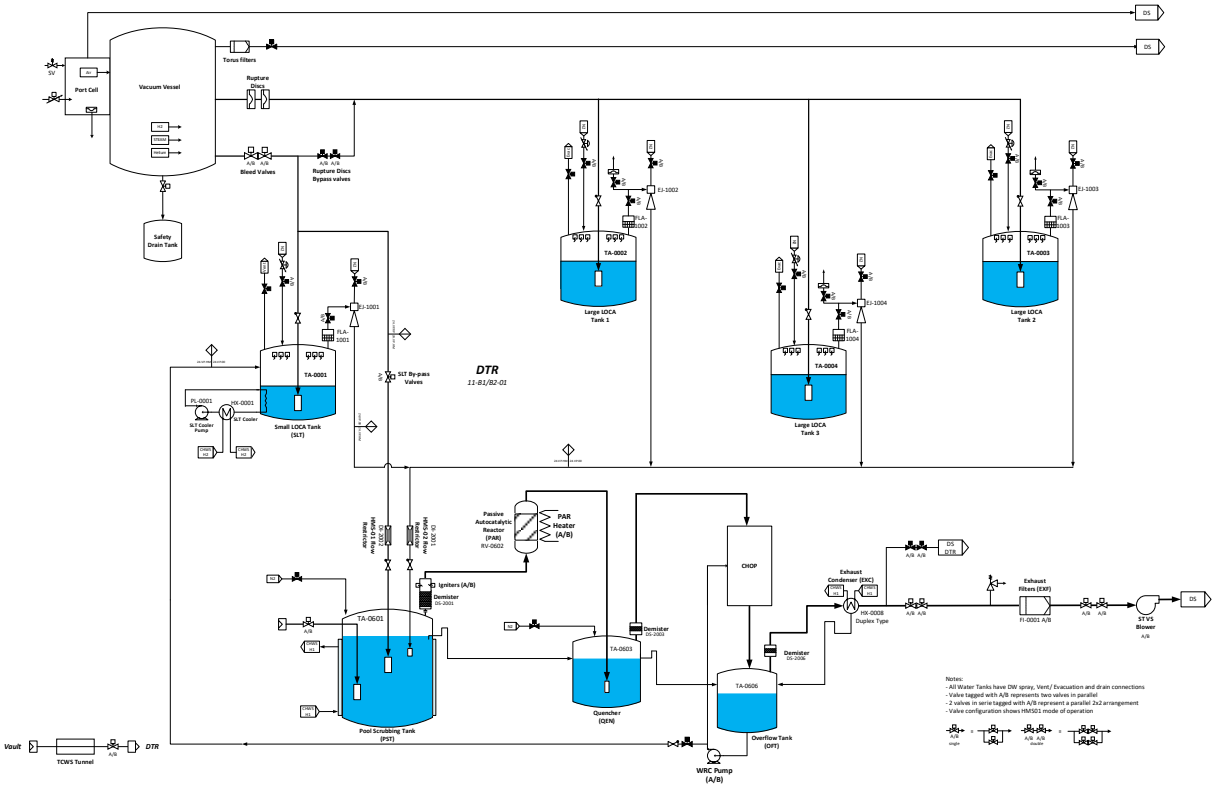

Figure 1 Process flow diagram of VVPSS indicating the location of CHOP

2. Scope of Work

Above all other requirements of this specification, the Contractor shall construct and operate a test facility that enables the determination of the performance of two free-issued prototype reactors.

The specific scope of work for this Contract shall include, but is not limited to, the following tasks:

1. Production of documentation as required by this specification;
2. Procurement of necessary equipment (that is not provided by the IO);
3. Assembly and preparation of the testing facility;
4. Commissioning and qualification of the testing facility;
5. Testing activities and supporting services (including modification of the test facility configuration);
6. Disassembly and return of all equipment to IO.

3. Scope of Supply

The Scope of supply under this Specification shall include as a minimum:

a) Quality Plan
b) Facility assembly documentation, including, but not limited to:
    a. Facility general arrangement drawing(s)
    b. Facility risk assessment, including a hydrogen safety plan (accident prevention and mitigation plan)
    c. Equipment list/datasheets
    d. Safety equipment test certificates
    e. Instrument calibration certificates
    f. Facility Acceptance Test (FAT) report for completed facility
c) Facility: A test facility capable of performing all the tests listed in Section 1111, the list of equipment is not limited to:
    a. Pipework
    b. Valves
    c. Instrumentation
    d. Flame Arrestors
    e. Support structures
    f. Data-logging, visualization and control equipment
    g. Consumables (gas cylinders)
    h. Access platform / Scaffolding
d) Solid state storage device containing all testing data

4. Deliverables

The Contractor shall develop, and submit to IO, a schedule demonstrating the ability to meet the expected deliverable due dates.
The estimated duration of this contract is 18 months from the Kick-off meeting.

Table 1: List of deliverables

Number	Deliverable	Due Date
D1	Kick-off meeting minutes	T0
D2	Quality Plan	T0 + 0.5 month
D3	Facility Design Report and Bill of Materials (HP)	T0 + 3 months
D4	Facility Acceptance Tests (HP)	T0 + 10 months
D5	Facility As-Built Drawings	T0 + 11 months
D6	Testing Phase 1 data	T0 + 12 months
D7	Facility Modifications (HP)	T0 + 12.5 months
D8	Testing Phase 2 data	T0 + 13.5 months
D9	Facility Modifications (HP)	T0 + 14 months
D10	Testing Phase 3 data	T0 + 15 months
D11	Delivery of equipment to IO (free issue and procured equipment)	T0 + 18 months

A testing period of 4 to 8 weeks is anticipated. The Contractor shall anticipate an extension of testing operations by 1 month.

5. Safety Requirements

The workshop shall employ an Occupational Health and Safety system and have ISO 18001 certification. The workshop shall have an Environmental Management System and have ISO 14001 certification. The workshop shall implement applicable ATEX guidelines as described in directive 2014/34/EU.
The CHOP Facility will contain fluids at elevated temperature, fluids under pressure, flammable gases, electrical currents, the lifting of heavy equipment and working at height. The hazards introduced by the CHOP facility shall be identified and a dedicated risk assessment and mitigation process implemented. The ITER Organization can assist the Contractor in the risk assessment process if required.
All personnel performing activities with the potential to cause harm shall be suitably trained and qualified for the tasks they are undertaking.

6. Control and Surveillance

ITER is a Nuclear Facility identified in France by the number-INB-174 (“Installation Nucléaire de Base”). The testing activities undertaken using the CHOP Facility are Protection Important Activities, i.e., they are activities that impact the safety of the ITER Facility. Under the French Order of 7th February 2012 (the “INB Order”) [12] which establishes the general rules for licensed nuclear installations, Contractors and Sub-contractors must be informed that:

- The INB Order applies to all protection important components and the protection important activities.
- Compliance with the INB Order must be demonstrated in the chain of external Contractors.
- In application of article II.2.5.4 of the INB Order, the Nuclear Operator (IO) shall undertake supervision of activities undertaken by external interveners (The Contractor and subcontractors).

7. Facility description

7.1. Proposal 1

IO has developed a schematic for the CHOP testing and qualification facility and is shown in Figure 2.

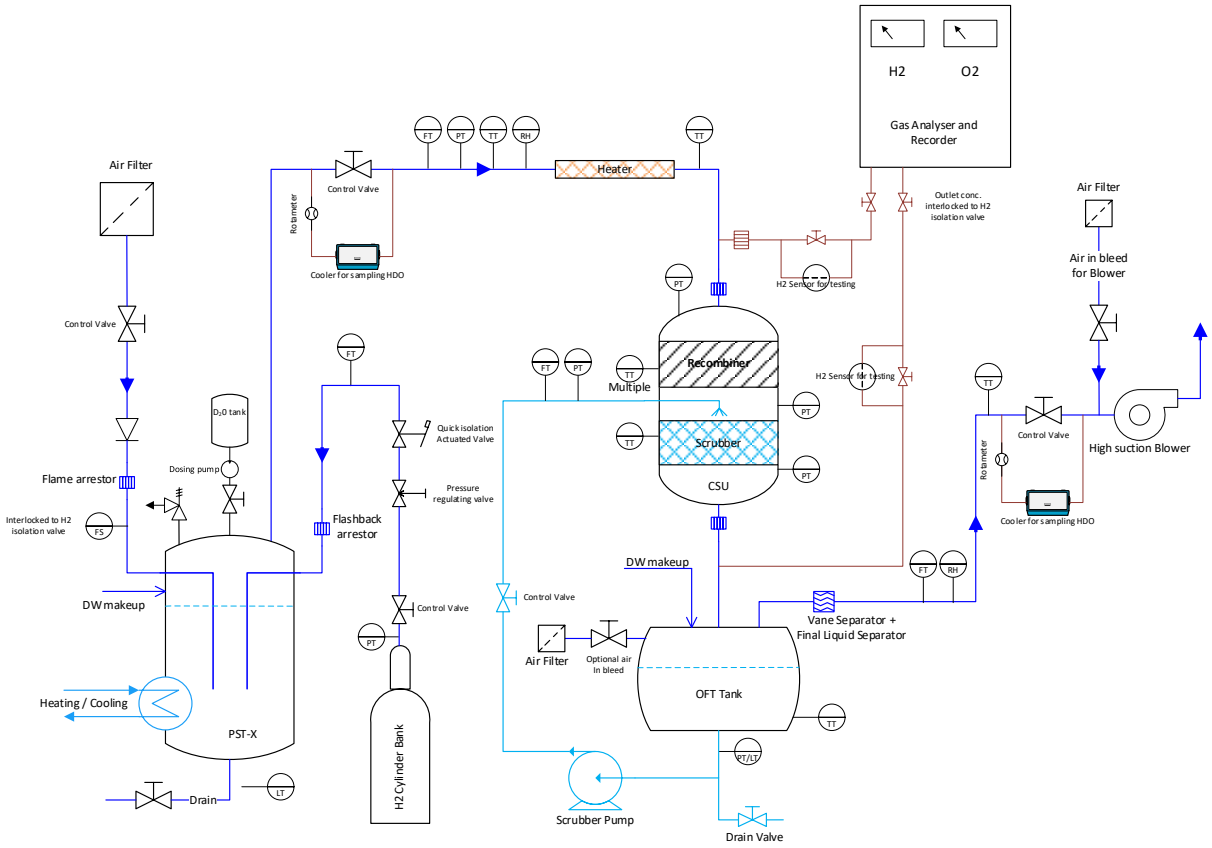

Figure 2: CHOP testing and qualification facility schematic (IO proposal)

The scheme proposed in Figure 2 includes the following components:

i. Three Air Filter for Inlet, OFT in-bleed and Blower in-bleed
ii. PST-X vessel (free issue by IO)
iii. D_20 dossing system
iv. H_2 cylinder bank
v. HDO sample collection system at inlet and outlet
vi. Inline heater
vii. Gas analyser (O_2 & H_2 analysis at inlet and H_2 analysis at outlet)
viii. CHOP vessels (free issue of two vessels by IO)
ix. OFT vessel (free issue by IO)
x. Scrubber pump
xi. Vane separator + Final liquid separator
xii. High suction blower
xiii. Valves
xiv. Flame arrestors for H_2 safety
xv. Instruments

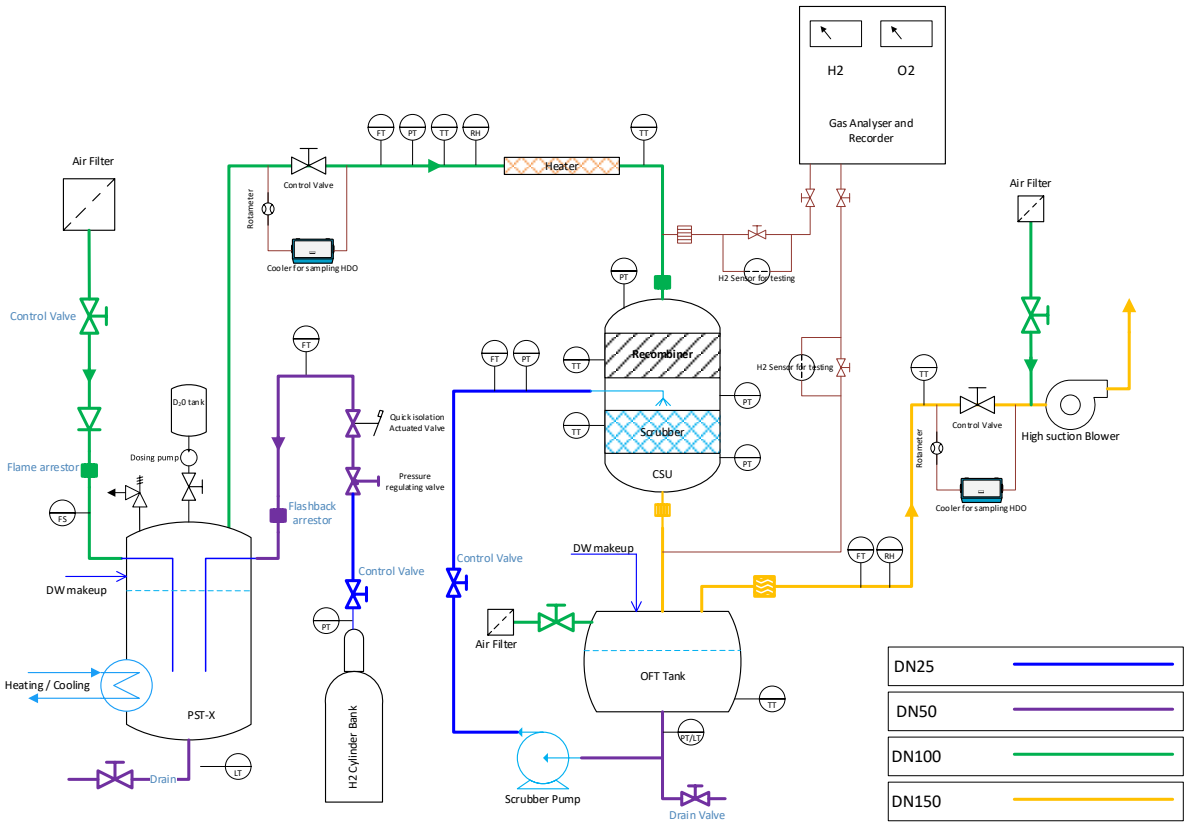

Figure 3: Pipeline size (estimate)

IO intends to test two prototypes one with a series configuration of the catalyst and scrubbing section and the second with an annular configuration of the catalyst and scrubbing sections (Figure 4 & Figure 5).

The annular vessel can be configured in two ways, one with the catalyst on the inside and the scrubbing section forming an annular arrangement around the catalyst section (Figure 5). The second one with a cylindrical scrubbing section with the catalyst forming an annular arrangement around the scrubbing section (Figure 4). Both arrangements must be tested at the qualification facility to ascertain the configuration which delivers the best performance.

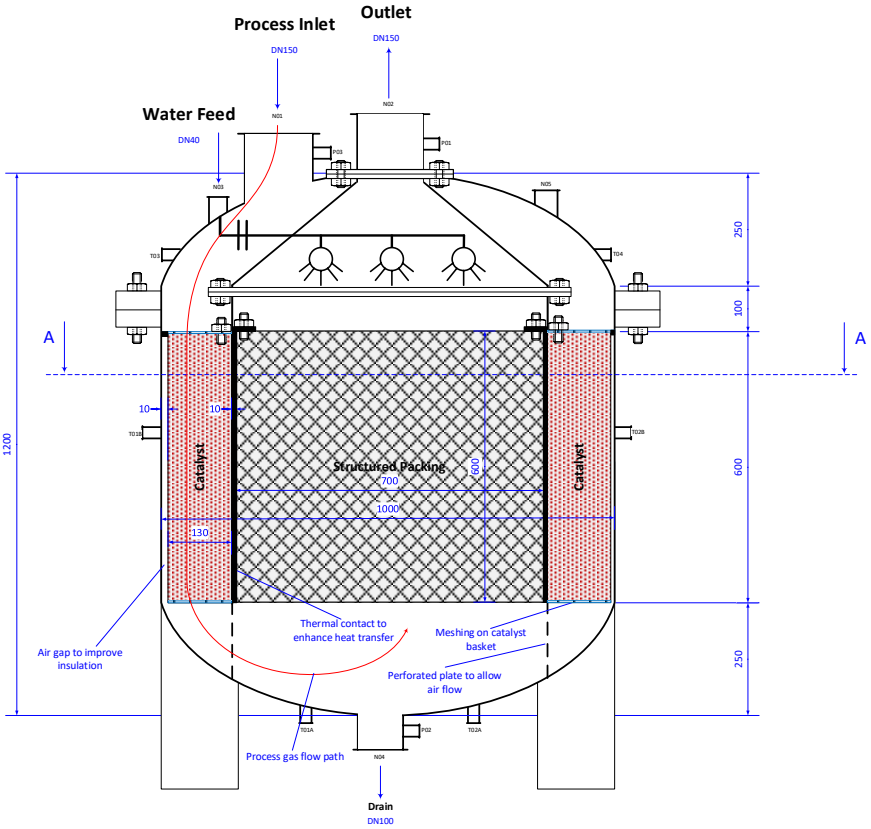

Figure 4: Annular configuration with cylindrical scrubbing stage

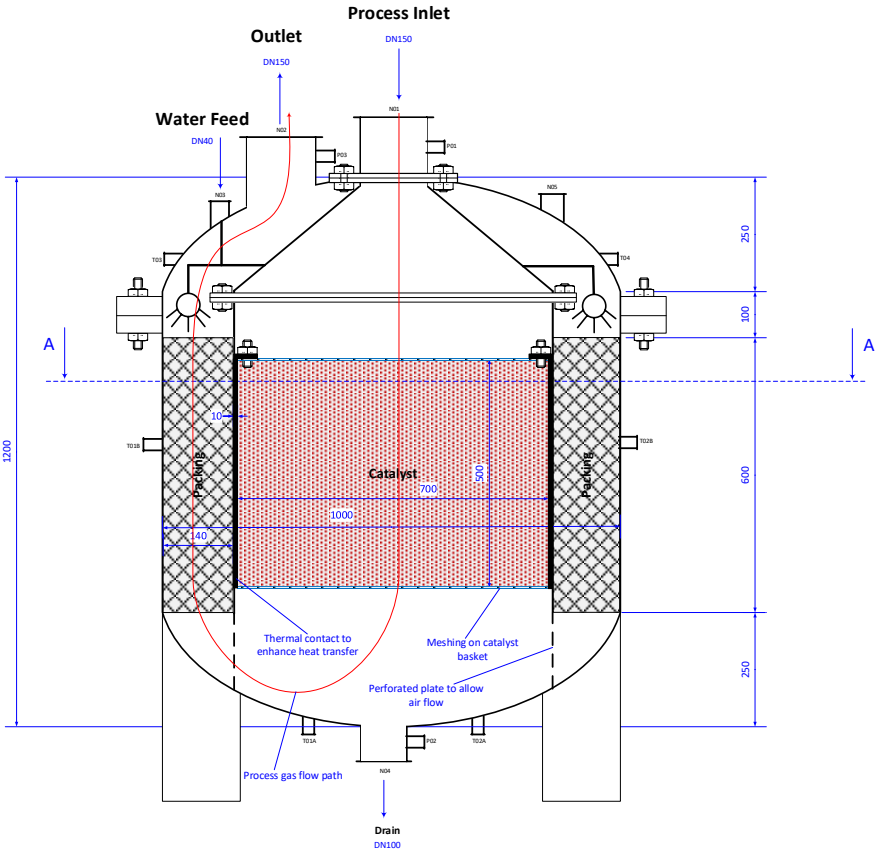

Figure 5: Annular configuration with annular scrubbing section

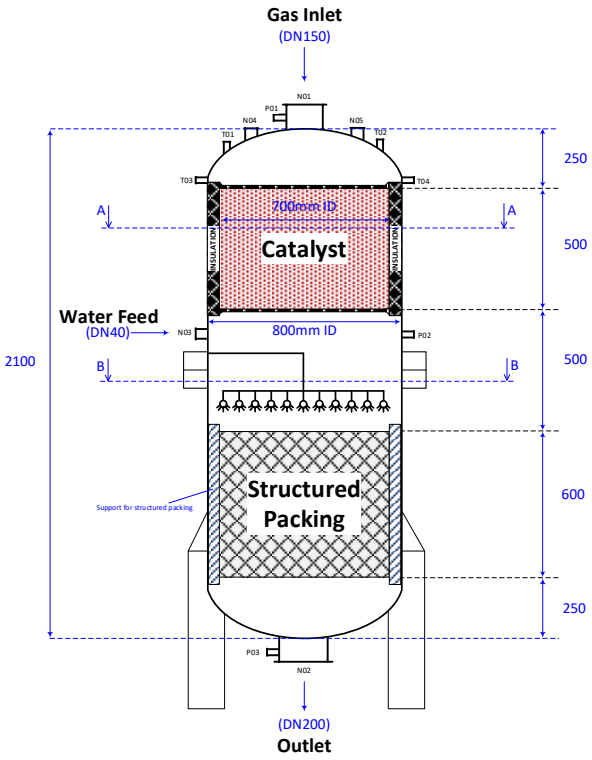

Figure 6: Series configuration of CHOP

7.2. Proposal 2

In this second scheme, the requirements for the input and output streams to the prototype are defined. This input stream may then be produced using services already available at the testing workshop. In this way the required amount of facility assembly is reduced, and advantage is taken of existing services.

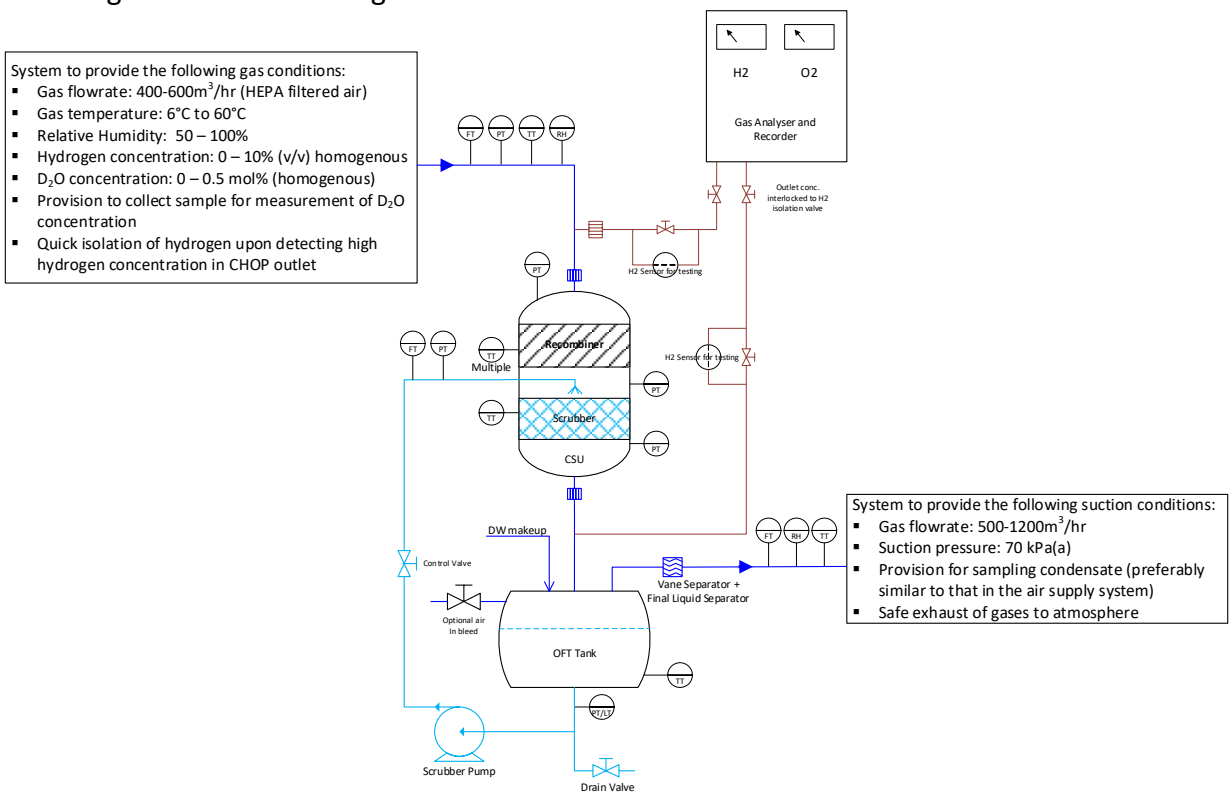

Figure 7: Second proposal defining the requirements from the facility

The scheme proposed in Figure 7 includes the following components:

i. Air Filter for OFT in-bleed

ii. Gas analyser (O_2 & H_2 analysis at inlet and H_2 analysis at outlet)
iii. CHOP vessels (free issue by IO)
iv. OFT vessel (free issue by IO)
v. Scrubber pump
vi. Vane separator + Final liquid separator
vii. Valves
viii. Flame arrestors for H_2 safety
ix. Instruments

8. Equipment specification

Table 2 lists the major specifications of the components of the facility described in Figure 2.

Table 2: Equipment specification table

Parameter	Value	Remarks
Facility design pressure	10 bar(g)	Considering H_2 deflagration
Facility design temperature	230 °C (between heater and CHOP)	
	60 °C (all other pipeline)	
Material of Construction	Stainless Steel	Preferably SS304L
Dilution air supply flowrate	500m^3/hr	HEPA filtered
OFT air supply flowrate	400-1200 m^3/hr	HEPA filtered
Blower air in-bleed flowrate	400-1200 m^3/hr	HEPA filtered
Air supply temperature	Ambient (20-30°C)	
Air supply pressure	Atmospheric (1 Bar(a))	
Hydrogen supply flow control	5-40 Nm^3/hr (±1% accuracy)	Quick isolation valve on hydrogen supply to isolate
Air Heater outlet temperature range	40-100 °C	15kW power (inlet at 20°C with 500Nm^3/hr)
Scrubber pump flowrate	1-8 m^3/hr	Pump type: canned motor Fluid – DM water
Scrubber pump developed head	2 bar(g)	
Vane separator efficiency	>95% removal of droplets above 20µm	
Mesh separator efficiency	>95% removal of droplets above 5µm	
Blower flow rate	800-2000Nm^3/hr	
Blower suction pressure	70 kPa(a)	(likely multi-stage blower with discharge to atmosphere)
Hydrogen analyser measurement range	0-10% (v/v) (accuracy ±0.1% or better)	
Oxygen analyser measurement range	0-30% (v/v) (accuracy ±0.1% or better)	

D_2O dosing rate	0.02-4ml/min (accuracy ±1% or better)	Dosing system should have volume integration function
Workshop size	60-80 m^2 (approx.)	
Crane capacity	2 MTe (min)	Mobile/ fixed overhead

Table 3: Valve list (indicative)

Tag	Element	Purpose
	Pressure Regulator	Hydrogen Supply
	Actuated Isolation Valve	Hydrogen Shutoff (Fail Close)
	Manual Control Valve	Hydrogen Supply
	Manual Valve	D_2O Supply
	Relief Valve	Overpressure protection of PST-X
	Manual Control Valve	Air supply control valve
	Non-Return Valve	Air supply to PST-X
	Manual Valve	PST-X Drain
	Manual Valve	OFT Drain
	Manual Control Valve	OFT Air in bleed
	Manual Control Valve	Scrubber flow control
	Manual Control Valve	Blower Air in Bleed
	Manual Control Valve	For introducing flow through inlet HDO Sampling
	Manual Control Valve	For introducing flow through outlet HDO Sampling

Table 4: Utility requirement

Utility	Requirement	Comments
Demineralized Water	$40m^3$	
Chilled Water	Min 40 kW cooling capacity	Supply at 6 °C, return at 14 °C max
Steam or Hot water	Min 40 kW heating (optional)	
Hydrogen gas supply	Bottles of hydrogen gas with appropriate pressure regulating valve. $250Nm^3$	An appropriate space for storage of high-pressure, flammable gas bottles shall be provided.
D_2O supply	D_20 at 99% (approx.) purity 10 litres	
Power supply	50 kW, both 3-phase & 2 phase supplies	(power for blower, air heater, pump, and data acquisition/control equipment)

9. Facility Layout

IO has developed approximate layout diagrams of the facility to better understand the space requirement for the CHOP testing and qualification facility. It shall be noted that the scheme proposed in Figure 8 and Figure 9 are indicative and not accurate.

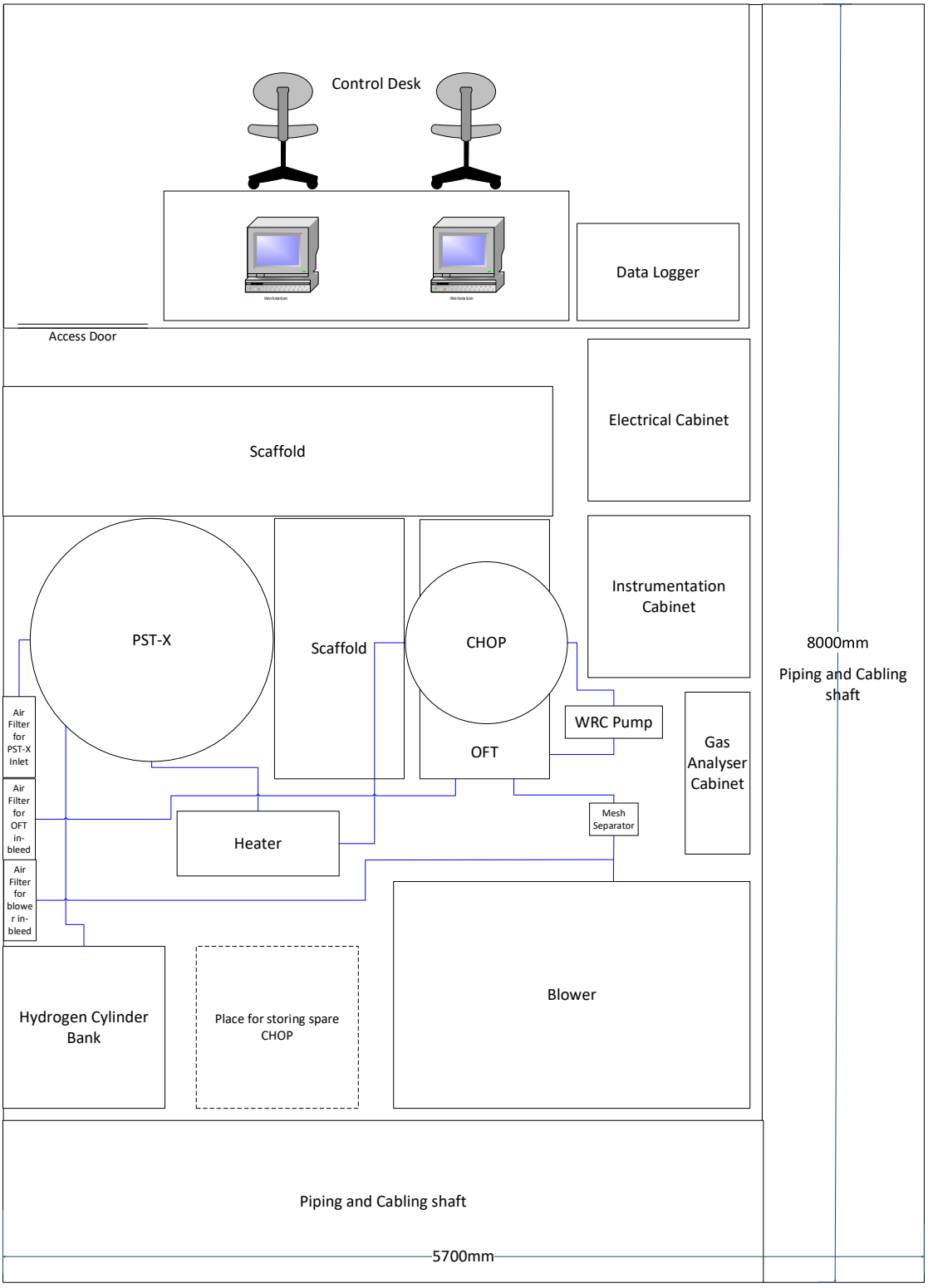

Figure 8: Plan of proposed CHOP qualification facility

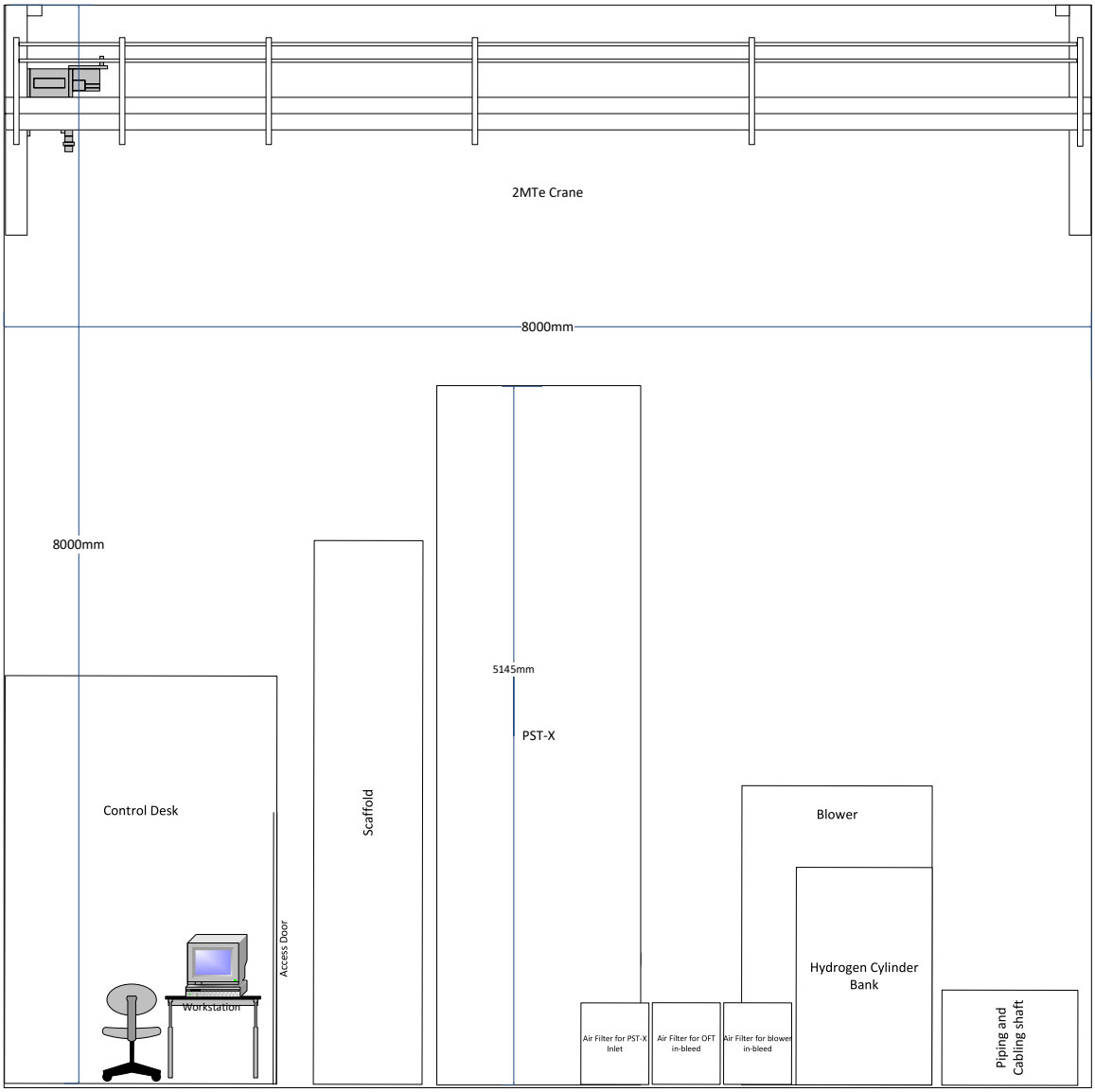

Figure 9: Elevation of proposed CHOP qualification facility

10. Facility Modification

The Contractor shall modify the facility to install the alternative Prototypes, additional equipment, and to perform additional measurements. As a minimum, the Contractor shall consider the following activities:

- Installation of Prototype 1;
- Reconfiguration of Prototype 1
- Installation of Prototype 2;
- Replacement of the catalyst two times for each prototype.

11. Proposed Test Matrix

The testing activity will be performed in stages, the following lists the proposed testing activities, the timing mentioned is approximate:

- Testing of Annular vessel with cylindrical structured packing with hydrogen (20hrs)

- Testing of Annular vessel with annular structured packing with hydrogen (10hrs)
- Testing of Series vessel with hydrogen (10hrs)
- Testing of Annular vessel with cylindrical structured packing with HDO (10hrs)
- Testing of Annular vessel with annular structured packing with HDO (20hrs)
- Testing of Series vessel with HDO (10hrs)