

Detailed technical specifications of Proton Exchange Membrane (PEM) Fuel cell Test bench system

S.No	Item description	BHEL specifications	Vendor specifications/ Deviations
1	Specifications for Electronic load box and gas flow rates	<p>The detailed technical specifications</p> <p>Typical test items: Single cells active area ranging from 200 to 500 cm².</p> <p>Maximum power rating: 1200 Watt.</p> <p>Ambient Temperature Range: 20 to 40 Deg C.</p> <p>a. Electronic load box details</p> <ul style="list-style-type: none"> ● Voltage : 0- 5 VDC ● Accuracy : ± 0.25 % of the selected value over the range ● Current : 0-500 A ● Accuracy : ± 0.5% of the selected value over the range ● Load box should be capable of drawing current up to 500 A at 0.3 VDC <p>Provision for operating under three modes</p> <ul style="list-style-type: none"> ● Constant current ● Constant voltage ● Constant resistance <p>b. Gas flow :</p> <ul style="list-style-type: none"> ● Anode gas flow range : 0.5 to 15 NL/min for hydrogen with check valve, gas filter, MFC and solenoid valve. ● Cathode gas flow range : 0.5 to 75 NL/min for Air with check valve, gas filter, MFC and solenoid valve. ● Nitrogen gas flow range: 0.5 to 25 NL/min provided with check valve, gas filter, MFC and solenoid valve. <p>Provision to be enabled to mix N2 in either of existing line of anode or cathode for dilution of live pure gases of Hydrogen or Air.</p> <ul style="list-style-type: none"> c. Mass Flow Controller accuracy: ± 0.25 % FS ± 1 % of actual value. d. Onboard N2 storage: Test station should comprise SS 	

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		<p>tank of volume capacity 5 lts or higher for automatic filling of Nitrogen gas from supplyline provided with 3-5 bar pressure.</p> <p>e. N₂ Purging:</p> <ul style="list-style-type: none"> • Nitrogen gas should be circulated through anode and cathode gas supply lines of inlet to exit during shut down • Provision to supply required quantity of N₂ gas into either of the anode or cathode gas supply line during testing. 	
2	Humidification of anode and cathode reactant gases	<ul style="list-style-type: none"> • Saturated gases of anode and cathode should be free of water droplets • All the humidifier lines provided with heating arrangement to control humidifier exit gases at required set temperatures • Provision for automatic refilling of DI water from overhead DI water tank (atmosphere pressure) to the respective humidifiers of anode and cathode • Dew-point control range: Ambient to 65°C • Dew-point control accuracy: ± 1 °C steady state • Dry Gases: Provision for dry gases through by-pass • Trace heating: Heating hoses from humidifier until test item to avoid condensation and to achieve highly precise gas temperature control accuracy. <p>All Piping Material should of SS316 or PTFE for all wetted parts.</p>	
3	Temperature controllers and thermocouples	<ul style="list-style-type: none"> • Precise temperature control of anode and cathode gas flow and test item temperature with Pt 100 temperature sensors • Thermocouples of OD 1.5 mm or lower tip diameter minimum of 60 mm probe length and 1-meter cable length • Total thermocouples required - 8 Nos. (5 Nos. thermocouples required for monitoring the local temperatures and 3 Nos. for feedback application along with temperature controllers. • 3 nos. of onboard temperature controllers with power supply of 	

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		<p>220 VAC and 500 W receptacle for blower / heater (5000W/220 VAC) for cooling /heating the test cell to maintain set temperature</p> <ul style="list-style-type: none"> ● Gas temperature control range: Ambient to 90°C for maximum gas flow rates as mentioned in the mass flow specifications ● Maximum heated hose temperature: 90 °C max ● Gas temperature control accuracy: ± 1 °C (steady state) 	
4	Pressure controllers	<ul style="list-style-type: none"> ● Onboard front and back pressure local displays for anode and cathode sides ● Monitoring differential pressures between anode and cathodes inlets and outlet respectively via programmable software ● Manual back pressure control range at cathode and anode: 1.1 to 2.5 bar ● Control and measurement points: Anode and cathode outlets ● Accuracy in pressure displays: ± 30 mbar of the measured value <p>Accuracy in pressure control: ± 30 mbar (steady state)</p>	
5	PLC/ equivalent functional Safety system against H ₂ leaks	<p>Onboard Hydrogen leak detector with 3-level alarm management system for safe and unattended 24/7 operation, auto shut-down of test station in case the leaks exceeds the permissible set values of lower explosive limits (LEL) of H₂. The test bench should be provided with overhead visual LED display with color coding of Green (<0.5 LEL), Orange (0.5 to 1.5% LEL) and Red (1.5 to 3% LEL)</p>	
6	Programming Requirements	<p>The programmable test station should have the following provisions for testing the cell performance characteristics.</p> <p>a. Continuous test cycle: Test cell life time testing under constant load and variable load profiles. of ramp, step and random at various intervals of time.</p> <p>b. ON/OFF test cycles: It has to be programmed such that the electronic load, humidifiers, reactant preheaters etc. have to be</p>	

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		<p>active (ON) once the cell temperature meets the specified value.</p> <p>c. Provision for feeding minimum of 4 load profiles for testing at different time scales when the load is ON /active.</p> <p>d. Cell has to be turned OFF after completion of load profiles and has to be cooled back to room temperature and cell has to be heated back to specified temperature.</p> <p>e. Items b & d is considered as one cycle, such cycles have to be repeated for specified number of cycles with an inbuilt program as input.</p> <p>f. Save and recall facility of load profiles.</p> <p>g. Dynamic efficiency: GUI should be enabled with cell efficiency in % based on actual power out against the lower heating value (LHV) of H₂ combustion</p> <p>h. Overall efficiency: GUI to be enabled with overall cycle efficiency in % based on the actual cumulative power out (kWh) against the lower heating value (LHV) of total H₂ consumption in Litres.</p>	
7	Cell performance evaluation curves	<p>Cell performance evaluation in terms of I-V characterization curves for the following operating modes.</p> <ul style="list-style-type: none"> ● Constant current mode ● Constant voltage mode ● Constant power mode 	
8	Data logging & Display	<p>Display monitor not less than 32" or higher size and compatible software to be provided by the vendor to supervise the variables of interest and to monitor the complete process and to store the data of key process parameters (storage capacity not less than 1 tb, RAM : 8 GB; processor: Intel i5 – 3.1 GHZ)</p>	
9	Accessories	<p>Offer shall include all the accessories required for trouble free operation of equipment at BHEL R&D. Only proto type 3 cell stack</p>	

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		would be provided by BHEL while commissioning of test system at BHEL R&D, Hyderabad	
10	Certificate of conformity	<ol style="list-style-type: none"> 1. CE conformity according to the product safety directives 2001/95/EC. 2. Confirm to risk assessment ISO 13849 and 12100 	
11	Types of solenoid valves to be used in test bench	All the solenoid valves used in test bench should be of ATEX approved as per the directives of 2014/34/EU	
12	Pre-dispatch inspection of test system (PDI)	Continuous operation of fuel cell test station with the sample cell for a minimum period of 100 Hrs to be carried out at manufacturers/ collaborator site in presence of BHEL executives for rated gas flow rates and current of 500 A. Cost of travelling and stay would be borne by BHEL	
13	Manufacturers test certificate	Manufacturer's test Certificate for 100 hours of continuous operation with test sample cell has to be provided by the OEM/joint collaborator prior to PDI intimation given to BHEL.	