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CSIR - CENTRAL GLASS & CERAMIC RESEARCH INSTITUTE
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CORRIGENDUM

REFERENCE NO. : - P/NC/22/JM/SO(SB)/OTE/23-24 DATE: 25/09/2023

NAME OF EQUIPMENT: "SUPPLY, INSTALLATION, COMMISSIONING, DEMONSTRATION & TRAINING OF REVERSIBLE SOLID OXIDE ELETROLYSER (R-SOEC) TEST STATION OF RATING UPTO 2 KW"

NOTE: The Bids must be submitted in the Central Public Procurement Portal (URL:https://etenders.gov.in/eprocure/app) only. Manual/Offline bids shall not be accepted under any circumstances. Bidders should quote in INR only.

CONSEQUENT TO THE PRE-BID MEETING HELD ON 18/09/2023, THE REVISED SPECIFICATION IS GIVEN BELOW:-

Reversible Solid Oxide Electrolyser (R-SOEC) Test Station of rating upto 2 kW

Revised Technical Specification after Pre Bid Conference

Test item	Specification
Furnace details	
Number of cells	The furnace should be of capable holding the stack of cells having below mention capacity: Upto maximum 50 numbers of cells for standalone 1 kW SOFC and rating upto 2 kW for R-SOEC
Approximate dimensions (L x W x H)	The furnace should be capable of holding the stack with the following dimension: L ≥ 300 mm, W ≥ 300 mm & H ≥ 500 mm The furnace height should be able to hold the desired dimension of the stack as mentioned above and the height may vary slightly for the stack compression system as this might be needing to confirm the required stroke length
Furnace type	Top hat type/vertical split type furnace or equivalence should be provided with high-quality stainless-steel body with other necessary arrangements as required (furnace stand, metal structure, heat insulation etc.)
Furnace hearth	Furnace hearth should be capable of withstanding the load of the stack and combi nation of dead and pneumatic load(s) that is detailed in the stack compression section. Hearth should be made with arrangements of insertion of gas manifolding to be connected with the end plate of the stack. Detailed design and drawings will be provided for the furnace hearth by the customer (CGCRI) once the P&ID of the test station is received from the vendor and approved by the customer (CGCRI).
Temperature	Maximum temperature 1000°C, working temperature 800 -850°C with accuracy ±2°C or more using suitable thyristors, 3 phase AC and Kanthal or equivalent heating element
Temperature measurement and controller	One K-type thermocouple to be used for temperature measurement and control for the central hot zone of the furnace with at least two other K-type thermocouples for monitoring the temperature uniformity inside the furnace in the upper and lower region(s) of the furnace and the temperature uniformity for the complete upper to lower zone should be maintained with a tolerance of ± 5°C or less Over temperature protecting thermocouple should also be provided and must be kept with auto cut off safety interlock when it reached T≥ 50°C of the maximum temperature of operation and / or maximum temperature rating of the furnace. Eurotherm or suitable make furnace temperature controller and indicator with at least four programs and each of sixteen segments should be provided for the better control and uniformity of the temperature.
SOFC-SOEC stack compression arrangements	
Load	Combination of variable Dead and Pneumatic load or equivalence should be provided with digitally and / or suitable manual controlled system in the test station assembly with a shaft that must be aligned centrally of the stack dimension as given above
Stack compression	Maximum load capacity 0-200 kg (dead load arrangement should be there with a step option of 10 kgs upto 50 Kg, rest should be applied through the controlled pneumatic load application system)

Inconel support should be available with the pneumatic load arrangement (for both load application and as well as in the base of the stack). The system should also have the provision to apply the load on to the different capacity stacks as there will be different heights for different capacity stacks to be fitted within the earlier mentioned inside dimension of the furnace	
Gas Flow	
MFCs	Aalborg/Alicat/Bronkhorst or suitable make MFCs should be used for different gas flow arrangement and must be available with calibration for different gases as appended below:
Fuel flow 1 (Control range) Hydrogen	0.5 to 50 LPM
Fuel flow 2 (Control range) Argon	0.1 to 10 LPM
Fuel flow 3(Control range) Methane	1 to 30 LPM
Fuel flow 4 (Control range) Carbon dioxide	1 to 30 LPM
Fuel flow 5 (Control range) Carbon Monoxide	1 to 20 LPM
Fuel flow 6 (Control range) User specified	Additional MFC must be provided with the capability of calibrating with specified gas as per the need 1 to 30 LPM
Air Flow 1 (control range)	1.5 to 150 LPM
Oxygen 2 (control range)	0.4 to 40 LPM
The accuracy of the MFCs should be in the range of ±1 % FS ±0.5 % of actual value or better	
Provision of mixing for several fuel feed gasses must be included to generate simulated compositions of various recipes of gases to be mixed with definitive amount of moisture and / or steam for operations in SOFC and SOEC mode(s) respectively	
Oxygen and Air mixing possibilities should be present	
The fuel and air side feed line manifolding should be made with proper materials that can withstand chemical corrosive and physical erosive atmosphere of high temperature steam and gas fed	
Suitable tubing preferably Swagelok or equivalence should be made to accommodate the desired flowrates of the different feed gases as described above and the end connection for each line must be specified for easy end user connectivity	
Humidification - Option 1	**Fuel side**
Method	Humidification method
	• Saturator type or equivalent having necessary humidification arrangement with option to control should be provided in the fuel gas feed line in such a way that it should work as humidifier during the SOFC mode of operation and should work as steam generator during the SOEC mode of operation • Saturator type humidifier or equivalent type should be capable of controlling the level of humidification from 3% (SOFC) – 80 % (SOEC) operation having the arrangement of direct measuring the % Absolute Humidity (AH) in the outlet line of the humidifier and the system should also be having the suitable sensors for humidity monitoring • For standalone SOFC operation, the level of humidification must be increased to the higher percentage depending on Steam: Carbon (S:C) ratio for carbonaceous fuel with maximum molar flow of 1 mole/ min. In this connection, it is advisable to provide the variation of steam content in % with the variation of the dry gas flow rate • Air electrode side humidification provisions must be included as a future option for augmenting the humidification at both the feed lines. However, the level of humification may be optimum upto 10 % for SOEC application. For SOFC, this is not applicable.

Steam supply - Option 2	**Fuel side**
Method	Direct steam injection
	• The direct steam injection provision must be included with a control of superheating of steam ≥ 250 °C and having the requisite adaptable heating of the heat trace line before injection to the main flow line of the fuel feed • The steam feed rate range of 0.5 to 25 g/min • It is advisable to provide the variation of steam content in % with the variation of the dry gas flow rates
The selector valves or suitable arrangements must be included in the test station for subsequent selection of either option 1 / option 2	
Electronic Load & Power Supply – Combination	The test station should be provided with the combination of electronic load bank, power supply and / or potentiostat – galvanostat with proper addition of booster as per the requirement and / or bi-directional / polar power supply or similar type(s) of arrangements for seed and draw power from the stack of rating as mentioned below:
I-V characteristics including Continuous I, V and P mode(s) of operation	Rating of the power +2 kW (R-SOEC) to - 1 kW (SOFC)
Current range	+ 120 A (SOEC) to - 100 A (SOFC)
Voltage range for full rated current	0 to + 60 V (for both SOFC and R-SOEC operation)
	SOFC-SOEC operation with reversible direction of current sweep from + ve to –ve must be provided through zero current point (OCP) The system should be provided with measuring the voltage using sensing terminal and required feedback for applying the overpotential in the electrolyser mode of application for stacks of various rating The system should have the proper compliance voltage in the higher V range for the application in the range of + 60 V (especially applicable for SOEC) and below 0.0 V (especially for the application in SOFC) in order to operate both the stacks in the reversible modes of SOEC and standalone SOFC with the full rated current
Cell voltage monitoring	The Cell Voltage Monitoring (CVM) systems must be provided along with the Electronic Load & Power Supply – Combination system and the rating for the CVM DC should be proper for measuring the Voltages of the cell SOFC (0-2 V_{DC}) and SOEC (0-5V_{DC}) both modes for upto maximum 50 numbers of cells
Additional thermocouples for stack	The stack individual cell temperature measurement systems must be provided for the measurement in the temperature range up to 1000 °C with preferable tolerance of accuracy limit ± 5 °C for read out in both the modes of SOEC and SOFC operation for upto maximum 50 numbers of cells (compatibility with K type thermocouple)
EIS measurements	Impedance Analyzer for SOFC -SOEC stack to be integrated with electronic load bank & power supply combinations systems having frequency range of 100 mHZ to 20 kHz or higher (FRA module should capture EIS spectra for max. OCP upto +60 V)
Hydrogen storage	**Fuel side**
	Stack exhaust / outlet gases will be cooled by suitable mechanisms viz. a) Plate type Heat exchanger, b) Radiator type and c) Condenser with condensate separator to get the unutilized H_2 in SOFC mode and generated H_2 in SOEC mode of operations A storage system with necessary required arrangement like compressor etc. must be thought for collecting the generated H_2 at the outlet A Mass Flow Meter / Flowmeter or equivalent with proper calibration (range of flow 0- 75 NLPM) for reading the H_2 being generated / remained unutilized must be included for real field data evaluation after exhaust treatment

Steam supply - Option 2	**Fuel side**
Method	Direct steam injection
	• The direct steam injection provision must be included with a control of superheating of steam ≥ 250 °C and having the requisite adaptable heating of the heat trace line before injection to the main flow line of the fuel feed • The steam feed rate range of 0.5 to 25 g/min • It is advisable to provide the variation of steam content in % with the variation of the dry gas flow rates
The selector valves or suitable arrangements must be included in the test station for subsequent selection of either option 1 / option 2	
Electronic Load & Power Supply – Combination	The test station should be provided with the combination of electronic load bank, power supply and / or potentiostat – galvanostat with proper addition of booster as per the requirement and / or bi-directional / polar power supply or similar type(s) of arrangements for seed and draw power from the stack of rating as mentioned below:
I-V characteristics including Continuous I, V and P mode(s) of operation	Rating of the power +2 kW (R-SOEC) to - 1 kW (SOFC)
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Cell voltage monitoring	The Cell Voltage Monitoring (CVM) systems must be provided along with the Electronic Load & Power Supply – Combination system and the rating for the CVM DC should be proper for measuring the Voltages of the cell SOFC (0-2 V_{DC}) and SOEC (0-5V_{DC}) both modes for upto maximum 50 numbers of cells
Additional thermocouples for stack	The stack individual cell temperature measurement systems must be provided for the measurement in the temperature range up to 1000 °C with preferable tolerance of accuracy limit ± 5 °C for read out in both the modes of SOEC and SOFC operation for upto maximum 50 numbers of cells (compatibility with K type thermocouple)
EIS measurements	Impedance Analyzer for SOFC -SOEC stack to be integrated with electronic load bank & power supply combinations systems having frequency range of 100 mHZ to 20 kHz or higher (FRA module should capture EIS spectra for max. OCP upto +60 V)
Hydrogen storage	**Fuel side**
	Stack exhaust / outlet gases will be cooled by suitable mechanisms viz. a) Plate type Heat exchanger, b) Radiator type and c) Condenser with condensate separator to get the unutilized H_2 in SOFC mode and generated H_2 in SOEC mode of operations A storage system with necessary required arrangement like compressor etc. must be thought for collecting the generated H_2 at the outlet A Mass Flow Meter / Flowmeter or equivalent with proper calibration (range of flow 0- 75 NLPM) for reading the H_2 being generated / remained unutilized must be included for real field data evaluation after exhaust treatment

Exhaust treatment for the air / oxygen side	Stack exhaust / outlet gases will be cooled by suitable mechanisms viz. a) Plate type Heat exchanger, b) Radiator type and c) Condenser with condensate separator to get the unutilized air / O_2 in SOFC mode and generated O_2 in SOEC mode of operations
Feed pressure	Controllable in the range **0-10 barG** for matching the requirement of several MFCs in the feed lines
System pressurization	0-5 barG with suitable hardware using damper / butterfly / diaphragm valve or equivalence with a feedback arrangement to the feed pressure to be set in accordance to the opening of Solenoids in MFCs.
De-Ionized water supply	Must be specified for humidification both in SOFC and SOEC modes of operation (for saturator type humification or equivalence)
SOFC-SOEC Stack feed gas Preheater	
Fuel electrode Preheat	The fuel side preheater must be able to heat the desired flow of the fuel and mixed steam / moisture ≥ 550 °C in the line before entering to stack Single or subsequent preheating arrangements must be provided with the system to maintain the temperature ≥ 550 °C Necessary high temperature heat trace should be provided with the humification / direct steam injection outlet lines before mixing with the fuel feed line (gas lines) Suitable depth at the outlet of hearth to the inlet of the stack end plate must be allowed in the system for in-situ heating (6-8 inches length) of the fuel fed along with the steam to equilibrate at the stack operational temperature of 800 °C Necessary temperature measurements should also be provided for measuring the temperatures at various location of the feed lines and the inlets of end plate (fuel side)
Air electrode Preheat	The air / oxygen side preheater must be able to heat the desired flow of the air and oxygen ≥ 550 °C in the line before entering to stack Single or subsequent preheating arrangements must be provided with the system to maintain the temperature ≥ 550 °C in the line of feed gas Suitable depth at the outlet of hearth to the inlet of the stack end plate must be allowed in the system for in-situ heating (6-8 inches length) of the oxygen / air fed to equilibrate at the stack operational temperature of 800 °C Necessary temperature measurements should also be provided for measuring the temperatures at various location of the feed lines and the inlets of end plate (fuel side)
Cathode Preheater Limit	Preheater control should be specified to the maximum flow rates of total air electrode flowrate for any requirement preserve heater life, if applicable.
SS make with proper heat insulated separate preheating arrangements are required for both Hydrogen and Oxygen/Air line	
Safety Interlocks	User controlled safety alarm system must be included in the test station Safety interlocks must be coupled with TC of the furnace for stack operations, over temperature protector TC for the furnace, several TCs for the fuel along with the steam feed and air / oxygen feed line lines, requisite pressures for MFCs' operations, V_{DC} for stack and cells through current collectors and CVMs and also user defined safety tags as per the finalization of the detailed P & ID in consultation with the customer. Manual rotameters-based emergency Argon purge arrangement should be available in both line (fuel and Oxygen side) with normally open valve or with suitable arrangement(s) Pressure sensors, CO and H_2 sensors, non-return valves, indicators, needle valves etc. should be incorporated as per the need of operation and safety aspect

System start - up	PLC controlled system with user friendly software base user interface – Siemens or Beckhoff or Phoenix Contact or substantially equivalent.
PC interface	Suitable PC interface must be provided with user-friendly software to read the various temperatures, ramping of the furnace temperature and flow rates including read outs for the steady states, stack compressions, I-V characteristics with ramping up the current in bi-direction application(s), chronoamperometric and chronopotentiometric studies of the stack in SOEC and SOFC modes to be measured in constant current (CC), constant voltage (CV) and constant power (CP)modes, input parameters coupled with varieties of the safety interlocks as described above etc. with a supply of compatible PC.
Valid calibration certificates should be provided for all the necessary instruments	
Installation and commissioning	Should be made at the premises of CSIR-CGCRI, Kolkata and all pre-requisites for power and space must be mentioned during the approval of the P & ID from end user
Training	On – site training of the 4 persons for 4 working days
Warranty	Two-years warranty after successful installation and commissioning
AMC	The provisions should be made in accordance to incorporate AMC clauses after the expiry of the warranty period
Process & Instrumentation diagram must be added along with the Technical Bid and is needed approval from customer before start-up of the fabrication	
Pre-dispatch inspection for the test station at manufacture's site for 2 persons 3 days will be done by CSIR-CGCRI at its own cost.	
A certificate for similar rating of the test bench having similar technical specifications must be included along with the technical bid from the reputed customer(s) viz. GoI academic or R & D institutions/ Universities, reputed company in India or abroad having the detailed P & ID for the supplied system(s)	

Delivery period:Delivery period is amended to read as "210 days from the date of establishment of Inland Letter of Credit" instead of "280 days from the date of Purchase Order".

In the Chapter 4 of the tender document, the rating mentioned as "1kW" may be read as "2kW" instead of existing.

Deadline for Submission of Bid and Opening of Bid is remain unchanged as given in CGCRI Tender No. P/NC/22/JM/SO(SB)/OTE/23-24 dated **08/09/2023**.

The above amendments shall amount to amendments of the relevant terms of our Bid Document for CGCRI Tender No. P/NC/22/JM/SO(SB)/OTE/23-24 dated **08/09/2023.**

All other Tender terms and conditions remain unchanged.

Bidders should quote only in **INR**. Bidding is open to only Class I /Class II Local Bidders.

25.09.2023

(A. K. Pandey)
Stores & Purchase Officer
FOR & ON BEHALF OF CSIR

Anjani Kumar Pandey
Stores & Purchase Officer
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