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Tender no. IPR/TN/PUR/TPT/ET/20-21/5 dated 22/6/2020

Specifications of 100kW IGBT based power supply

Introduction:

This power supply is based on high frequency linked DC to DC converter topology. The high frequency link is desired to reduce the size of magnetic components such as transformer, inductors etc. Therefore, the implementation of IGBT in the power supply is required. This power supply is operated in current source mode of operation in order to withstand short circuited load. This power supply will be used to power a highly dynamic plasma arc (plasma torch) load.

Detailed Specifications:

The detailed specification of the 100kW IGBT based power supply is given below:

S. No.	Particulars	Specifications
1	Input power	3 phase, 415V±10%, 50Hz
2	Output power a) Open circuit voltage b) Full load voltage c) Full load current d) Current Resolution e) Mode of operation	300V DC 125V DC 800 A (Current should be adjustable from 100A to 800A with resolution of 1A) 1 A Constant current (Independent of the load voltage) mode
3	Interlocks a) Cooling water temperature, water flow (if water cooling is used) b) Stack temperature c) Over voltage d) Over current e) Single phasing f) Emergency Off g) Panel door	All Sensors' NO/NC input will be provided by IPR for interlock purpose except overvoltage, over current, single phasing, emergency off and panel door interlocks. The vendor should demonstrate the functioning of these interlocks using dummy inputs of 0 to 5 V /NO /NC as applicable. The interlocks operation should be implemented using PLC (Programmable Logic Control) and HMI (Human Machine Interface). Calibration certificate of all sensors and meters in the power supply unit will have to be submitted along with the delivery of the power supply.
4	Meters & display a) Input Voltage b) Input Current c) Output Voltage d) Output Current e) Water Temperature f) Digital Multifunction	All reading should be displayed on HMI. The kW, kVA, PF, V, I readings should be displayed by separate energy meter on the front panel.

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	Energy Meter g) Stack temperature	
5	Indications a) R, Y, B indications b) All interlocks status c) Mains ON d) Power supply DC ON/OFF e) All systems ON/OFF	Indications should be implemented through HMI. A separate R, Y, B indicators should be provided on the power supply panel.
6	Switches a) Push button ON b) Push button OFF c) Emergency OFF d) Input voltage selector switch e) Input current selector switch	The on/off provision should also be done through external control through 5V TTL except emergency switches. Other On/Off should be controlled through PLC and HMI on each power supply unit.
7	Current setting pot	The current setting should be done through HMI. The current setting should also be possible through external analog signal of 0 – 10V.
8	Grounding	The positive output terminal should be grounded along with the panel body. There should be two output positive bus-bars for two positive cables each of 800A current rating and one bus-bar for negative cable of 800A current rating.
9	External control	All external interlocks should be provided through 0-5V digital inputs. The external current control should be provided through 0-10V analog inputs.
10	Input and Output cable	<ul style="list-style-type: none"> ■ Flexible copper conductor. ■ Both input and output cables should be of 10 meter length each and should be of appropriate ratings as per the suitable IS standards for power cables to carry 800A current in each output cable. ■ There are two positive cables and one negative cable.
11	Input Power Factor	0.9 or better
12	Efficiency of power supply unit	90% or higher
13	Output DC current on plasma load	The output DC current should be always within $\pm 0.5\%$ of the set value. The ripple should be demonstrated by vendor one time during pre-dispatch inspection using oscilloscope for all ranges of current on plasma load.
14	IGBT Heat Sink Cooling	IGBT heat sink should be water cooled or forced air

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		<p>cooled. If air cooling is used, it shall be demonstrated for temperature rise of IGBT & essential components within limit as per standard. The inlet and outlet connection port (manifold) should be provided in case of water cooled. The inlet and outlet temperature of water manifold and the water flow rate should be displayed on HMI if water cooling is used. The separate chiller and compressor unit should be supplied by the vendor along with the power supply unit if water cooled heat sink is used. Water inlet and outlet should be through properly tight and panel mounted manifold.</p> <p>Appropriate cooling of heat sink is very important for long run of the power supply. The vendor will have to demonstrate One time 48 hours power supply operation at full load (100kW, 125V and 800A) on resistive load during pre-dispatch inspection. The electrical power for continuous testing of power supply should be arranged by the vendor at the time of pre-dispatch inspection.</p>
15	MCCB	MCCB of suitable rating with shunt release coil should be provided on the power supply panel.
16	Acceptance Criteria	<p style="text-align: center;">Factory Acceptance Test:</p> <p>(A) <u>The list of test preceding the arc load test:</u></p> <ol style="list-style-type: none"> a) The power supply will be tested for TWO consecutive successful testing operations at full load i.e. 125V and 800A on resistive load and each testing operation would be for continuous 20 hours. b) The output DC current should be within $\pm 0.5\%$ of the set value. c) All interlocks will be checked during the resistive load test. d) The output current and voltage should be cross checked using standard clamp on meter and multi meter. e) The provision of varying the load resistance online during the testing should be provided by vendor. <p>(B) <u>The list of test with the plasma arc load:</u></p> <ol style="list-style-type: none"> a) Graphite electrodes set up will be provided by IPR as FIM (Free Issue Material) for plasma arc load test at the time of FAT. b) This plasma arc load test will be performed on plasma arc load for min. 8 hours continuous

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		<p>operation for one time.</p> <p>c) All interlocks will be checked again during plasma arc load operation.</p> <p>d) The output current should be within +/- 0.5% of the set value.</p> <p>e) The power supply should be interlocked at safe temperature limit of the IGBT and the same should be mentioned in user's manual.</p> <p>Site Acceptance Test: The vendor will have to perform installation and commissioning of power supply at FCIPT, IPR. The power supply will be tested on actual plasma arc load at IPR for 2 consecutive successful testing operations. Each testing would be for continuous 20 hours operation for final acceptance. All the interlocks will be checked again during SAT.</p>
17	Users Manual	Vendor should supply user's manual mentioning sequence of operation, bill of material, circuit diagram, wiring diagram with ferrules, trouble shooting chart, preventive maintenance chart etc.
18	Warrantee	Vendor should provide one year full warrantee of the complete power supply unit and the chiller compressor unit (if supplied in case of water cooled system) from the date of installation and commissioning of power supply at IPR.
19	Panel support	Panel (Cabinet) should be mounted on heavy duty caster wheels; Panel should also have provision for lifting the panel from the top. Panel door should be mounted on appropriate hinges for smooth movement of the door. The sheet of the panel should have appropriate gauges as per the IS standards for electrical panel. Vendor should provide the panel details for approval within 20 days from receipt of purchase order for approval in terms of foot print and color of the panel. Panel should be powder coated. The color of panel should be ash grey or light blue with matt finish. All fasteners in the panel should be made of SS 304.
20	PLC and HMI	Vendor should provide PLC and HMI of reputed company and CE certified company such as Allen Bradley, Siemens, and Schneider etc. Vendor should also supply programming software and soft copy of the PLC and HMI program for operating this power supply. Vendor should provide following extra points for future use in each power supply unit: <ol style="list-style-type: none"> 1. Digital output: 20nos. 2. Digital input: 20 nos. 3. Analog output: 1 nos. 4. Analog input: 1 nos.

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		<p>5. Temperature input (R type) : 4nos 6. PWM output (8 kHz or higher): 3 nos. The DC power supply to PLC should be 24V, 10A rating through SMPS. 1A fuse through proper housing connector should be used in all input and output lines of PLC except temperature input.</p>
21	Ambient operating temperature	The vendor should design the power supply with considering the ambient temperature of minimum 50 Deg C.
22	<p>Working Details of Power Supply This power supply is going to be used in a plasma application on 24x7 operation basis. The power supply will generate plasma arc in current source mode at max 100kW power with 125V and 800A DC voltage and current respectively. The plasma arc will be generated across the graphite electrodes as shown in the figure 1 with two grounded anodes and one cathode electrodes. The power supply is interlocked for full safe and healthy operation. If any physical interlocked condition goes unhealthy, the power supply control system through PLC would cut off the main DC output power to the plasma arc and will also indicate the particular fault on the HMI through popping up. This power supply is a current source power supply i.e. the load current is constant at set value (Set through HMI) irrespective of the load voltage which enable it to work under short circuited load conditions. The higher switching frequency link using IGBT switching at greater than 5kHz reduces the size of the power supply significantly. The electrode movements are controlled by separate motorized mechanism provided by IPR. The electrodes get short circuited in the beginning to initiate the plasma arc. Once, the current starts flowing, the electrodes are separated apart through control mechanism. The voltage is built up by separating the electrode. Once the voltage reaches to the set value, the electrode movements are stopped. The arc sustains at this set voltage and set current value continuously. The power supply is based on SMPS (Switch mode power supply) topology which uses the high frequency link in DC to DC conversion for better regulation, better efficiency, compact size and easy control. All cable routing inside the penal including power cable should be as per IS standards.</p>	
23	All electrical bought out components should be of standard companies having CE certification for the components. All the components' ratings and the wiring should be as per IS standards.	

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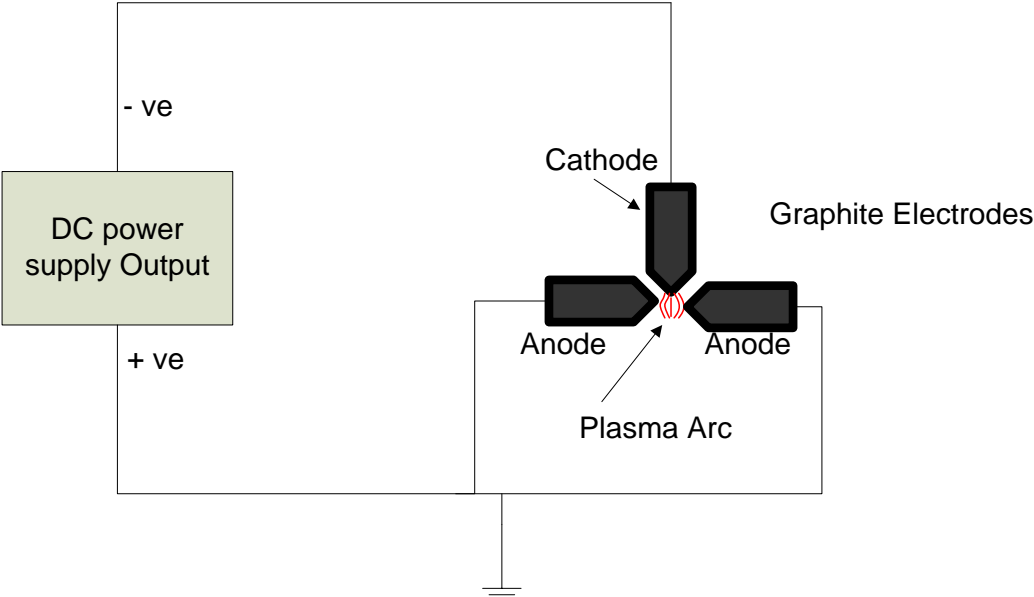


Figure 1 : Plasma Torch (Graphite Electrodes) Set up connected to 100kW DC power supply (IGBT based)