TECHNICAL SPECIFICATION

FOR

Design, Fabrication, Factory testing, delivery, Installation, site testing and Commissioning of 1 kA and 2.5 kA Pulsed Power Supplies of Large Volume Plasma Device (LVPD) Section at IPR

Contents

1. Introduction: 3
A. Discharge power supply (DPS): 3
B. Solenoid Power Supply (SPS): 4
Operation scenario: 5
2. Deliverables: 5
3. Scope and Guidelines: 6
A. Scope of Bidder: 6
B. Scope of purchaser (IPR) 6
4. Technical Specifications: 7
A. Technical Specifications for Discharge Power Supply (DPS): 7
B. Technical Specifications for Solenoid Power Supply (SPS): 12
5. Fiber Optic Signal Interface (FOSI): 16
6. Appendix A - Technical Bid Format (PART A) 17
1. Discharge Power Supply (DPS): 17
2. Solenoid Power Supply (SPS) 25
7. Appendix B - Pre-Dispatch & Acceptance Plan. 32
Acceptance Test Plan 32
1. Pre-dispatch Inspection of DPS: 33
2. Pre-dispatch Inspection of SPS: 34
8. Training to IPR Pesonnel 35
9. Appendix C - Execution Schedule 35

1. Introduction:

Two power supplies are required for laboratory investigations in Large Volume Plasma Device (LVPD) at Institute for Plasma Research (IPR), Gandhinagar. They are as follows.

Discharge power supply (DPS) for plasma arc generation.

Solenoid Power Supply (SPS) for energising a large solenoid.

A. Discharge power supply (DPS):

Discharge power supply is used for plasma generation by electrical breakdown of Argon gas due to the electric field produced by this power supply in a stainless vessel of ∅=2m diameter and 3 m length. This power supply is operated in pulsed mode for 10ms ≤ T_{ON}≤ 50ms across a cathode and the vessel (anode). Cathode is a directly heated multi filamentary electron emitter capable to source approximately 1000A on application of discharge voltage from DPS.

Figure 1 shows the circuit diagram of interconnection of Discharge and filament power supply. It may be noted that 10kA, 20V filament power supply is not in the scope of this tender and for making clear the understanding it is shown here.

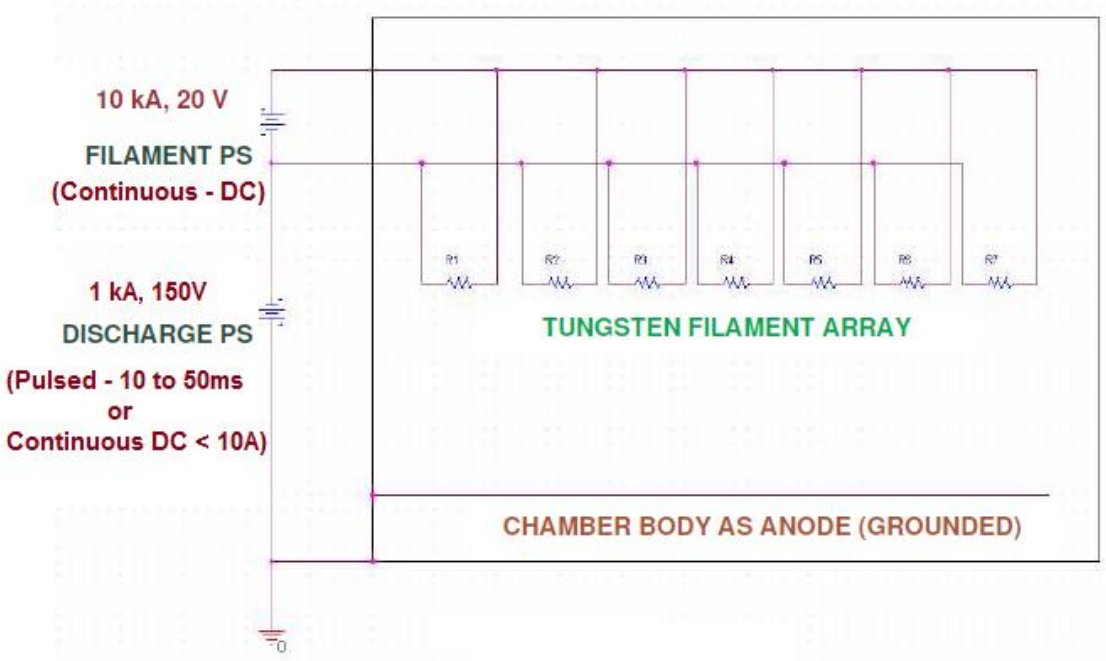


Figure 1. Schematic showing block diagram of electrical connections of discharge power supply and filament power supply.

Typical output pulse characteristic of DPS:

A typical form of discharge current (with a capacitor bank based pulse source), is shown in figure 2. It can be seen that the current rises slowly but fall time need to be ≤ 20 μs. This is required to have a long afterglow region of plasma free of energetic electrons for addressing some specific physical problems.

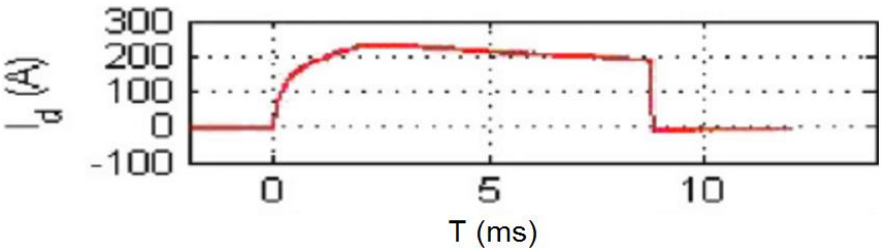


Figure 2. Typical current vs time waveform for ~8ms plasma discharge power supply.

In addition to pulsed operation, the DPS need to supply 10A DC current continuous operation mode at 70 V.

B. Solenoid Power Supply (SPS):

Energetic electrons produced by the acceleration of emitted electrons from filaments are made to pass through a solenoid to get trapped. This solenoid is fabricated in 19 sections connected in parallel. A power supply is needed to energize the solenoid referred as a Solenoid Power Supply (SPS). The equivalent load on the SPS is ~10μH and ~28 mΩ resistance.

The time sequence and typical pulse shapes (with capacitor discharge based supply) of DPS and SPS are shown below in figure 3. The SPS pulse can be seen to begin at least 1-2ms before the DPS and extends by 1-2 ms beyond the DPS pulse.

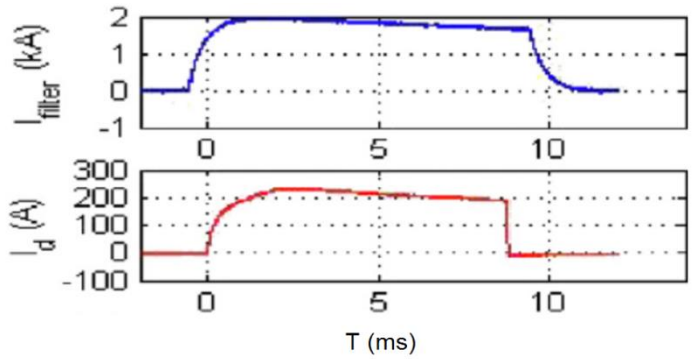


Figure 3. Typical temporal evolution (timing diagram) of output currents of discharge (~ 8ms period) and solenoid power supply (~ 10ms period). The plot(top)shows the current pulse of solenoid and (bottom) plot shown the discharge pulse.

Operation scenario:

The DPS and SPS must operate in local control mode, in stand-alone condition for individual testing OR in an integrated manner for experiments in remote control mode. Further, DPS need to operate in pulse or continuous mode as mentioned in their detailed specifications.

Topology:

Capacitor bank topology is selected because of experimental reasons and other topologies are not to be considered. Solid state switch at the output must be switched ON to start load current as per load impedance. After the intended pulse width output, switch OFF is necessary. Feedback control during the pulse output, for pulse shape control is not necessary. It may be noted that DPS need to switch OFF within ≤20µS as an experimental requirement. SPS switch OFF can be ≤100µS as mentioned in their detailed specifications. Both the power supplies would be tested with a resistive load for the rise time and fall time compliance.

2. Deliverables:

Design, Fabrication, Factory testing, delivery, Installation, site testing, Commissioning documentation and operational training, including unloading, shifting, handling with accessories etc. two pulsed power supplies of following ratings.

1) 1000A, 150V DC [Discharge Power Supply (DPS) for plasma arc generation]

2) 2500A, 175V DC [Solenoid Power Supply (SPS) for energising a large solenoid as electrical load]

Institute will provide 415V ± 10%, 3∅ AC, 50 Hz input power in the lab within 30 meters from the power supply. The two supplies are required to operate in synchronization with many interconnections. Hence, order shall be placed to a single party that meets all the specifications and whose total cost quoted for both the items together is lowest. Separate order for individual power supplies, to two different parties cannot be considered.

3. Scope and Guidelines:

A. Scope of Bidder:

Design, Fabrication, Factory testing, Delivery, Installation, Site testing, Commissioning, including unloading, Shifting, Handling with accessories, and Documentation and operational training, etc. of two pulsed power supplies on turn-key basis.

Minor civil works includes grouting/anchoring of the power supply sections.

One set of all important and necessary power devices should be supplied additionally as consumable spare.

B. Scope of purchaser (IPR)

Major Civil works as per detailed drawings that shall be supplied by the bidder at the drawing approval stage.

Mains input [3-ϕ, Neutral (N) and Power Earth (PE)] from a single point within 30m.

Dummy / Actual load for all the supplies within 10m at IPR.

System ground point shall be provided within 15m near Load.

Control PC at a distance of 40 m in shielded room. (Fiber optic link between Power supply and Control PC in bidder scope)

4. Technical Specifications:

A. Technical Specifications for Discharge Power Supply (DPS):

1. Discharge Power Supply (DPS)		
1.	Quantity	One
2.	Power Input	3ϕ- AC; 415V ± 10%; 50Hz
3.	Preferred Output cable	Twisted Pair / Shielded Twisted Pair. Shields if available would be connected to ground terminal.
4.	Load type	Dynamically changing Arc plasma load
5.	Topology	Capacitor bank discharge. Output current pulse ON/OFF controlled by Solid state switch (IGBTs).
6.	Operating Voltage	35V to 150 V (Pre-set default voltage 70V)
7.	Polarity	Positive or Negative depending on the ground connection to negative or positive output terminal respectively.
8.	Polarity reversal	Manual (by changing the ground connection at output terminals)
9.	Isolation	≥ 250 VDC. Output terminals must be suitable for floating at this voltage with respect to ground.
10.	Peak Current	1000 A
11.	Controls	Manual Selector Switch for Local or Remote

12.	Mode of Operation	Pulsed and Continuous (User selectable by front panel selector switch)
13.	Pulse Mode Operation	Ratings for both Local and Remote control
i.	Output Voltage (User settable)	35V to 150 V (In steps of 1V)
ii.	Pulse width	10 to 50mS
iii.	Pulse width setting (User settable)	In steps of: 100µS (Total ≥ 400steps to set from 10 to 50mS)
iv.	Current Droop	≤ 5% of peak current in 50mS
v.	Rise Time	< 100 µs (On resistive test load)
vi.	Fall time	< 20 µs (On resistive test load)
vii.	Duty cycle in Local Control	Only one pulse by pressing manual push button.
viii.	Duty cycle in Remote Control	One pulse of ≤50ms per second. Maximum 100Pulses continuously. (typical / default repetition rate of 1 pulse per seconds, could be slowed down to pulses repeating every 2 or 5 seconds settable as per the experimental needs)
ix.	Pulse profile (Local Control)	Intended for testing DPS in stand-alone mode by one output pulse to experimental load / dummy load.
	a) Voltage set	By a front panel 10 turn Potentiometer
	b) T_{ON}	It is the Pulse width in ms. Settable from 10 to 50mS in steps of 100µs
	c) Start	By a front panel Push button. To apply one output pulse only.
x.	Pulse profile (Remote Control)	Actual experiment in this mode with FOCI-(Fiber optic cable interface)
	a) Control Signal	Analog 0 to 10V corresponding to 0 to 150V.

	b) Output		Output pulses as per the input analog signal. Other limits as mentioned above.
14.	Continuous mode operation		
	i. Topology:		Same as pulse mode. Mainly capacitor bank's charger power supply is expected to meet this requirement. By off line manual connection changes, Capacitor bank need to be bypassed and 7Ω current limiting resistor suitable for ≤ 10A continuous current to be connected in series at 70V setting. Output cables would be same as for pulse mode. Detailed procedure of these changes to be provided elaborately in power supply manual.
	ii. Continuous Voltage		Control range between 35V to 150V. By 10 turn potentiometer.
	iii. Continuous Current		≤ 10 A at 70V
15.	Local Metering on Panel		Digital Panel Meters, Class A
	(i)	AC/DC	a) AC Voltage (415V; 3ϕ) (RY-YB-BR: by Selector Switch) b) AC Current (R, Y, B: by Selector Switch) c) DPS Capacitor bank Voltage
	(ii)	DC Output (Continuous)	a) Output Voltage b) Output Current
	(iii)	Pulse measurements	a) Current in last pulse (Peak Hold for ~800mS) b) Voltage in last pulse (Peak hold for ~800mS) c) 0 to 10V signal of Output Voltage (Rear Panel) d) 0 to 10V signal of Output Current (Rear Panel) (c, d above are isolated signals with BNC connecters suitable for local measurements by oscilloscope)

	(iv) Remote metering FOCI-(Fiber optic cable interface)	a) Fiber Optic Cable signal of Output Voltage b) Fiber Optic Cable signal of Output Current c) Fiber Optic Cable signal of Capacitor bank Voltage
	(iv) Remote status monitoring FOCI-(Fiber optic cable interface)	a) Fiber Optic Cable signal of Ready (when capacitor bank output voltage > 90% of set value) b) Fiber Optic Cable signal of Pulse ON (when output current >10 % nominal value) c) Supply On/Off d) Pulse/Continuous Mode e) External Trip f) Over Voltage Fault g) Over Current / Short circuit Fault
16.	Indications	LED Based Lamps on Front Panel
	Status	a) Supply On/Off b) Pulse/Continuous Mode c) External Trip (Refer: Sl.No.19.b.ii) d) Emergency Off e) Over Voltage f) Over Current / Short circuit
17.	Protections	a) Over Voltage: b) Capacitor bank voltage > Set Limit (Sl.No:18a) c) Over Current: d) Output Current > Set Limit (Sl.No:18b) e) Short circuit f) Over temperature g) Reverse Charging of Capacitor bank
18.	Manual Protections Limits Setting (Preferred range of Limits: 20% to ~110% of nominal rating)	a) Over Voltage Limit (10Turn potentiometer) b) Over Current Limit (10Turn potentiometer) (These two potentiometers should be provided with protective cover to distinguish from other potentiometers)

19.	Interlocks	a) Fiber Optic Cable signal of CCharge (Light) must be present for starting capacitor bank charging. b) Two potential free terminals at the rear panel i. Close –Enable ii. Open –Disable (Consider as external trip)
20.	Preferred Size	Width: 1m; Depth: 0.8m; Height:2m
21.	Conformance to National and International Standards & Safety Codes:	ANSI C34.2, ANSI/IEEE4, ANSI/NEMA ICS 1, ANSI/PC-A-610, IEC 146/ IS 4540

B. Technical Specifications for Solenoid Power Supply (SPS):

2. Solenoid Power Supply (SPS)		
1.	Quantity	One
2.	Power Input	3ϕ- AC; 415V ± 10%; 50Hz
3.	Output cable	Twisted Pair / Shielded Twisted Pair. Shields if available would be connected to ground terminal.
4.	Load type	Inductive (Typically 5-20 μH)
5.	Topology	Capacitor bank discharge. Output current pulse ON/OFF controlled by Solid state switch (IGBTs).
6.	Operating Voltage	≤ 175 V
7.	Polarity	Positive or Negative depending on the ground connection to negative or positive output terminal respectively.
8.	Isolation	≥ 250 VDC. Output terminals must be suitable for floating at this voltage with respect to ground.
9.	Peak Current	100 A to 2500 A
10.	Controls	Manual Selector Switch for Local or Remote
11.	Mode of Operation	Ratings for both Local and Remote control
i.	Output Voltage (User settable)	15V to 175 V (In steps of 1V)
ii.	Pulse width	15 to 55 ms
iii.	Pulse width setting (User settable)	In steps of: 100μS (Total ≥ 400steps to set from 15 to 55mS)
iv.	Current Droop	≤ 15% of peak current in 55mS
v.	Rise Time	< 100 μs (On resistive test load)

vi.	Fall time		< 100 μs (On resistive test load)
vii.	Duty cycle in Local Control		Only one pulse by pressing manual push button.
viii.	Duty cycle in Remote Control		One pulse of ≤55ms per second. Maximum 100Pulses continuously. (typical / default repetition rate of 1 pulse per seconds, could be slowed down to pulses repeating every 2 or 5 seconds settable as per the experimental needs)
ix.	Pulse profile (Local Control)		Intended for testing DPS in stand-alone mode by one output pulse to experimental load / dummy load.
	Voltage set		By a front panel 10 turn Potentiometer
	T_{ON}		It is the Pulse width in ms. Settable from 10 to 55mS in steps of 100μs
	Start		By a front panel Push button. To apply one output pulse only.
x.	Pulse profile (Remote Control)		FOCI-(Fiber optic cable interface)
	Control Signal		Analog 0 to 10V corresponding to 0 to 175V.
	Output		Output pulses as per the input analog signal. Other limits as mentioned above.
12.	Local Metering on Panel		Digital Panel Meters, Class A
	(i)	AC / DC	a) AC Voltage (415V; 3ϕ) (RY-YB-BR: by Selector Switch) b) AC Current (R, Y, B: by Selector Switch) c) SPS Capacitor bank Voltage

	(ii)	Pulse measurements	a) Current in last pulse (Peak Hold for ~800mS) b) Voltage in last pulse (Peak hold for ~800mS) c) 0 to 10V signal of Output Voltage (Rear Panel) d) 0 to 10V signal of Output Current (Rear Panel) (c, d above are isolated signals with BNC connecters suitable for local measurements by oscilloscope)
	(iii) Remote metering FOCI-(Fiber optic cable interface)		a) Fiber Optic Cable signal of Voltage b) Fiber Optic Cable signal of Current c) Fiber Optic Cable signal of Capacitor bank Voltage
	(iv) Remote monitoring		a) Fiber Optic Cable signal of Ready (when capacitor bank output voltage > 90% of set value) b) Fiber Optic Cable signal of Pulse ON (when output current >10 % nominal value) c) Supply On/Off d) External Trip e) Over Voltage Fault f) Over Current / Short circuit Fault
13.	Indications		LED Based Lamps on Front Panel
	Status		a) Supply On/Off b) External Trip (Refer: Sl.No.16.b.ii) c) Emergency Off d) Over Voltage e) Over Current / Short circuit
14.	Protections		a) Over Voltage: b) Capacitor bank voltage > Set Limit (Sl.No:15a) c) Over Current: d) Output Current > Set Limit (Sl.No:15b) e) Short circuit f) Over temperature g) Reverse Charging of Capacitor bank

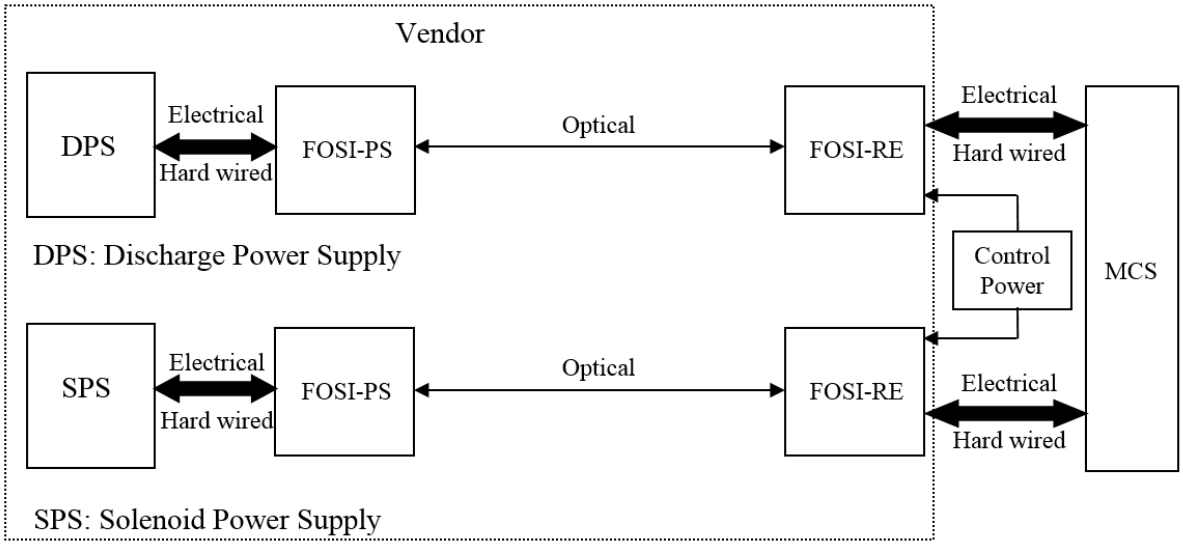
15.	Manual Protections Limits Setting (Preferred range of Limits is ~20% to ~110% of nominal rating)	a) Over Voltage Limit (10Turn potentiometer) b) Over Current Limit (10Turn potentiometer) (These two potentiometers should be provided with protective cover to distinguish from other potentiometers)
16.	Interlocks	a) Fiber Optic Cable signal of CCharge (Light) must be present for starting capacitor bank charging. b) Two potential free terminals at the rear panel i. Close –Enable ii. Open –Disable (Consider as external trip)
17.	Preferred Size	Width: 1m; Depth: 0.8m; Height:2m
18.	Conformance to National and International Standards & Safety Codes:	ANSI C34.2, ANSI/IEEE4, ANSI/NEMA ICS 1, ANSI/PC-A-610, IEC 146/ IS 4540

5. Fiber Optic Signal Interface (FOSI):

Analog and digital signals enable control and monitoring of Discharge power supply (DPS) and Solenoid power supply (SPS) from remotely located Machine Control System (MCS). It is intended to use only fiber optic cable (Approx. 40m length of each link) interface for all to and fro signal communications of machine control system (MCS). Any conflicting requirement should be brought-up during design approval phase.

FOSI-PS is a separate enclosure which is designed to convert analog and digital electrical signals of DPS into suitable optical signals. These are then connected by optic cables to FOSI-RE, installed near MCS for easy interface of its electrical signal outputs as shown in Figure-1. Analog signals from DC to 5 kHz bandwidth and 0 to 10V are intended to be exchanged for the monitoring and control applications for the Analog link. For digital links delay of less than 5 µs is required.

FOSI-PS uses control power at the power supply end, while FOSI-RE would use control power from MCS ensuring complete galvanic isolation between MCS and DPS, as well as MCS and SPS. The scheme allows DPS and SPS to operate independently or in integrated & timed manner or in any other manner as decided by MCS.



MCS: Machine Control System

FOSI-PS: Fiber Optic Signal Interface-Power supply end

FOSI-RE: Fiber Optic Signal Interface-Remote end

Signals: Both Analog and Digital as mentioned in technical specification

Figure 1: Scheme of interfacing

6. Appendix A - Technical Bid Format (PART A)

1. Discharge Power Supply (DPS):

(To be filled and attached with the quotation. Quotations without filling of following table are liable to be rejected)

S.NO	DESCRIPTION	IPR SPECIFICATIONS	VENDOR'S OFFER
1	Scope of bidder	As mentioned in technical specification	Agreed / ____ provide deviations in separate sheet
2	Scope of IPR	As mentioned in technical specification	Agreed / ____ provide deviations in separate sheet
3	Mains Input Voltage	415V±10%; 3ϕ; 50Hz; N, PE;	Yes / _____
		Single phasing preventer	Provided / Not provided
4	Input Power	Less than 180 kVA peak power (Preferably)	_____ kVA
5	Mains to DPS	Provide cable for 30m distance	Would be provided / _____
6	DPS Installation	Indoor Installation with forced or natural air-cooling for 45^0C maximum ambient temperature.	Yes /No
		All transformers and rectifiers of dry type only.	Yes /No
	Insulation sheet to Install DPS Housing	~10mm thick Glass Fiber for sufficient mechanical strength.	Yes /No
7	DPS to Load Output cable	Type of output cables	Shielded Twisted Pair / Twisted Pair / _____ (other specify)
		for 10m distance	_____ m
		Shields if available would be connected to ground terminal.	Suitable for ground connection / _____
8	Topology	Capacitor bank discharge. Output current pulse ON/OFF controlled by Solid state switch (IGBTs).	Yes / No

		Solid state switch used	IGBTs / _____
9	Operating Voltage	35V to 150 V	_____V to _____V
		Pre-set default voltage 70V	_____V
10	Polarity	Positive or Negative depending on the ground connection to negative or positive output terminal respectively.	Polarity Reversible by connection changes / _____
11	Polarity reversal	Manual (by changing the ground connection at output terminals)	Manual / _____
12	Isolation	≥ 250 VDC. Output terminals must be suitable for floating at this voltage with respect to ground.	≥ _____V_{DC}
13	Peak Current	1000 A	_____Amp
14	Controls	Manual Selector Switch for Local or Remote	Provided / _____
15	Mode of Operation	Pulsed and Continuous (User selectable by front panel selector switch)	Yes, Pulsed & Continuous are selectable by front panel selector switch / _____
16	Pulse Mode Operation	Ratings for both Local and Remote control	
17	Output Voltage (User settable)	35V to 150 V (In steps of 1V)	Settable in steps of ____V
18	Pulse width	10 to 50mS	____ to ____ms
19	Pulse width setting (User settable)	In steps of: 100µS	In steps of: _____µS
		Total ≥ 400steps to set from 10 to 50mS	Total _____Steps
20	Current Droop	≤ 5% of peak current in 50mS	≤ _____%
21	Rise Time	< 100 µs (On resistive test load)	< _____ µs
22	Fall time	< 20 µs (On resistive test load)	< _____ µs
23	Duty cycle in Local Control	Only one pulse by pressing manual push button.	manual push button /_____

24	Duty cycle in Remote Control	One pulse of ≤50ms per second.	≤_____ms per second.
		Maximum 100Pulses continuously.	Maximum _____Pulses continuously
25	Pulse profile (Local Control)	Intended for testing DPS in stand-alone mode by one output pulse to experimental load / dummy load.	
	Voltage set	By a front panel 10 turn Potentiometer	10 turn Potentiometer / _____
	T_{ON}	It is the Pulse width in ms. Settable from 10 to 50mS	10 to 50ms / _____
		in steps of 100µs	100µs / _____
	Start	By a front panel Push button.	On front panel / _____
		To apply one output pulse only.	One pulse / _____
26	Pulse profile (Remote Control)	Actual experiment in this mode with FOCI-(Fiber optic cable interface)	
27	Control Signal	Analog 0 to 10V corresponding to 0 to 150V.	Analog 0 to 10V / _____
			corresponding to 0 to 150V / _____
	Output	Output pulses as per the input analog signal. Other limits as mentioned above.	Yes / _____
28	All Analog/Digital and Input / Output Control Signals	All signals should be suitably routed to rear end terminal block, as per four distinct sets Analog Input (AI), Analog Output (AO), Digital Input (DI) and Digital Output (DO). To be connected to FOSI-PS	Yes /No
		To be connected to FOSI-PS	Yes /No

		Analog and digital signals at rear panel terminal block designated for connection to FOCI-PS are suitable for parallel checking by oscilloscope probes while they are connected to FOCI-PS	Yes /No FOCI-PS connections to be removed / No they are exclusively compatible to FOCI-PS only/ _____
29	Continuous mode operation		
	Topology:	Same as pulse mode.	Yes / _____
		Mainly capacitor bank's charger power supply is expected to meet this requirement.	Yes / _____
		By off line manual connection changes,	Off-line / _____
		Capacitor bank need to be bypassed	Capacitor bank would be by passed / _____
		7 Ω current limiting resistor to be connected in series.	___Ω would be connected in series
		suitable for 10A continuous current at 70 V	___ A continuous rating
		Output cables would be same as for pulse mode.	Yes / _____
		Detailed procedure of these changes to be provided elaborately in power supply manual.	Would be provided / _____
	Continuous Voltage	Control range between 35V to 150V. By 10 turn potentiometer.	By 10 turn potentiometer / _____
	Continuous Current	≤ 10 A at 70 V setting	≤ ____A
30	Local Metering on Panel	Digital Panel Meters,	Digital / _____
		Class A	Class ___
	(i) AC/DC	AC Voltage (415V; 3ϕ) (RY-YB-BR: by Selector Switch)	Would be Provided / _____

		AC Current (R, Y, B: by Selector Switch)	Would be Provided / _____
		DPS Capacitor bank Voltage	Would be Provided / _____
	(ii) DC Output (Continuous)	Output Voltage	Would be Provided / _____
		Output Current	Would be Provided / _____
	(iii) Pulse measurements	Current in last pulse (Peak Hold for ~800mS)	Would be Provided / _____
		Voltage in last pulse (Peak hold for ~800mS)	Would be Provided / _____
		0 to 10V signal of Output Voltage (Rear Panel)	Would be Provided / _____
		0 to 10V signal of Output Current (Rear Panel)	Would be Provided / _____
		c,d above are isolated signals	Isolated signals are Provided / _____
		c,d above are with BNC connecters suitable for local measurements by oscilloscope	BNC Connecter / _____
	(iv) Remote metering FOCI-(Fiber optic cable interface)	Fiber Optic Cable signal of Output Voltage	Would be Provided / _____
		Fiber Optic Cable signal of Output Current	Would be Provided / _____
		Fiber Optic Cable signal of Capacitor bank Voltage	Would be Provided / _____
	(iv) Remote status monitoring FOCI-(Fiber optic cable interface)	Fiber Optic Cable signal of Ready (when capacitor bank output voltage > 90% of set value)	Would be Provided / _____
		Fiber Optic Cable signal of Pulse ON (when output current >10 % nominal value)	Would be Provided / _____
		Supply On/Off	Would be Provided / _____

		Pulse/Continuous Mode	Would be Provided / _____
		External Trip	Would be Provided / _____
		Over Voltage Fault	Would be Provided / _____
		Over Current / Short circuit Fault	Would be Provided / _____
31	Indications	LED Based Lamps on Front Panel	LEDs / LED based Lamps / _____
	Status	Supply On/Off	Would be Provided / _____
		Pulse/Continuous Mode	Would be Provided / _____
		External Trip (Refer: Sl.No.19.b.ii)	Would be Provided / _____
		Emergency Off	Would be Provided / _____
		Over Voltage	Would be Provided / _____
		Over Current / Short circuit	Would be Provided / _____
	Protections	Over Voltage: Capacitor bank voltage > Set Limit (Sl.No:18a)	Would be Provided / _____
		Over Current: Output Current > Set Limit (Sl.No:18b)	Would be Provided / _____
		Short circuit	Would be Provided / _____
		Over temperature	Would be Provided / _____
		Reverse Charging of Capacitor bank	Would be Provided / _____
32	Manual Protections Limits Setting (Preferred range of Limits: 20% to ~110% of nominal rating)	Over Voltage Limit (10Turn potentiometer)	Would be Provided / _____
		Range of Limits	20% to ~110% of nominal rating / _____
		Over Current Limit (10Turn potentiometer)	Would be Provided / _____

		Range of Limits	20% to ~110% of nominal rating / _____
		The above two potentiometers should be provided with protective cover to distinguish from other potentiometers	Protective cover would be provided / They would be located in the enclosure /_____
33	Interlocks	Fiber Optic Cable signal of CCharge (Light) must be present for starting capacitor bank charging.	Would be Provided / _____
		Two potential free terminals at the rear panel Close –Enable Open –Disable (Consider as external trip)	Potential free terminals Would be Provided / Control voltage terminals (~12V) / _____
34	Preferred Size	Width: 1m; Depth: 0.8m; Height:2m	Width _____ Depth_____ Height_____
35	Enclosure	Generally conforming to standard IS: 12063-1987 and grade IP-41.	Yes / _____
		Pest proof	Yes / _____
		removable skins and/or doors,	Yes / _____
		Necessary cooling fans	Yes / _____
		Dust filters at all air entries	Yes / _____
		Panel lighting	Yes / _____
		Suitable power	Yes / _____
		control cable entries	Yes / _____
36	Capacitor Bank	Capacitor discharge device like Idiot Stick etc.	Yes / _____

		Capacitor discharge resistor for discharge in 5minutes.	5 min/ _____min
37	Conformance to National and International Standards & Safety Codes:	Standard & Safety Codes ANSI C34.2, ANSI/IEEE4, ANSI/NEMA ICS 1, ANSI/PC-A-610, IEC 146/ IS 4540	Confirms / Doesn't confirm ANSI C34.2 - Yes / No ANSI/IEEE4 - Yes / No ANSI/NEMA ICS 1 - Yes / No, ANSI/PC-A-610 - Yes / No, IEC 146/ IS 4540 - Yes / No
38	Conformance to undertake SAT & FAT as per Annexure C of this document.	Party shall agree to perform and demonstrate all the tests mentioned in Site acceptance and Factory acceptance tests as per details mentioned in Annexure C respectively for obtaining dispatch clearance and final acceptance as explained.	Confirms / Doesn't confirm / deviations if any.

2. Solenoid Power Supply (SPS)

(To be filled and attached with the quotation. Quotations without filling of following table are liable to be rejected)

S.NO	DESCRIPTION	IPR SPECIFICATIONS	VENDOR'S OFFER
1	Scope of bidder	As mentioned in technical specification	Agreed / ____ provide deviations in separate sheet
2	Scope of IPR	As mentioned in technical specification	Agreed / ____ provide deviations in separate sheet
3	Mains Input Voltage	415V±10%; 3ϕ; 50Hz; N, PE;	Yes / _____
		Single phasing preventer	Provided / Not provided
4	Input Power	Less than 525 kVA (peak power Preferably)	_____ kVA
5	Mains to SPS	Provide cable for 30m distance	Would be provided / _____
6	SPS Installation	Indoor Installation with forced or natural air-cooling for 45^0C maximum ambient temperature.	Yes /No
		All transformers and rectifiers of dry type only.	Yes /No
	Insulation sheet to Install SPS Housing	~10mm thick Glass Fiber for sufficient mechanical strength.	Yes /No
7	SPS to Load Output cable	Type of output cables	Shielded Twisted Pair / Twisted Pair / _____ (other specify)
		for 10m distance	_____ m
		Shields if available would be connected to ground terminal.	Suitable for ground connection / Not applicable / _____
8	Topology	Capacitor bank discharge. Output current pulse ON/OFF controlled by Solid state switch (IGBTs).	Yes / No
		Solid state switch used	IGBTs / _____

9	Operating Voltage	≤ 175 V	_____V
10	Polarity	Positive or Negative depending on the ground connection to negative or positive output terminal respectively.	Yes / No
		Negative terminal is connected to the power supply body inside the enclosure which is grounded (Not recommended)	Yes / No
		Negative terminal is available at output terminal without grounding. Ground connection is made external to power supply. (Recommended for ease in ground loop checks etc.)	Yes / No
11	Isolation	≥ 250 VDC. Output terminals must be suitable for floating at this voltage with respect to ground.	≥ _____V_{DC}
12	Peak Current	100 to 2500 A	_____Amp
13	Controls	Manual Selector Switch for Local or Remote	Provided / _____
14	Mode of Operation	Pulsed and Continuous (User selectable by front panel selector switch)	Yes, Pulsed & Continuous are selectable by front panel selector switch / _____
15	Pulse Mode Operation	Ratings for both Local and Remote control	
16	Output Voltage (User settable)	15V to 175 V (In steps of 1V)	Settable in steps of ____V
17	Pulse width	15 to 55mS	____ to ____ms
18	Pulse width setting (User settable)	In steps of: 100µS	In steps of: _____µS
		Total ≥ 400steps to set from 10 to 55mS	Total _____Steps
19	Current Droop	≤ 15% of peak current in 55mS	≤ _____%
20	Rise Time	< 100 µs (On resistive test load)	< _____ µs
21	Fall time	< 100 µs (On resistive test load)	< _____ µs

22	Duty cycle in Local Control	Only one pulse by pressing manual push button.	manual push button /_____
23	Duty cycle in Remote Control	One pulse of ≤55ms per second.	≤_____ms per second.
		Maximum 100Pulses continuously.	Maximum _____Pulses continuously
24	Pulse profile (Local Control)	Intended for testing SPS in stand-alone mode by one output pulse to experimental load / dummy load.	
	Voltage set	By a front panel 10 turn Potentiometer	10 turn Potentiometer / _____
	T_{ON}	It is the Pulse width in ms. Settable from 10 to 55mS	10 to 55ms / _____
		in steps of 100µs	100µs / _____
	Start	By a front panel Push button.	On front panel / _____
		To apply one output pulse only.	One pulse / _____
25	Pulse profile (Remote Control)	Actual experiment in this mode with FOCI-(Fiber optic cable interface)	
26	Control Signal	Analog 0 to 10V corresponding to 0 to 175V.	Analog 0 to 10V / _____ corresponding to 0 to 175V / _____
	Output	Output pulses as per the input analog signal. Other limits as mentioned above.	Yes / _____
27	All Analog/Digital and Input / Output Control Signals	All signals should be suitably routed to rear end terminal block, as per four distinct sets Analog Input (AI), Analog Output (AO), Digital Input (DI) and Digital Output (DO).	Yes /No
		To be connected to FOSI-PS	Yes /No

		Analog and digital signals at rear panel terminal block designated for connection to FOCI-PS are suitable for parallel checking by oscilloscope probes while they are connected to FOCI-PS	Yes / No FOCI-PS connections to be removed / No they are exclusively compatible to FOCI-PS only/ _____
28	Local Metering on Panel	Digital Panel Meters,	Digital / _____
		Class A	Class ___
	(i) AC/DC	AC Voltage (415V; 3ϕ) (RY-YB-BR: by Selector Switch)	Would be Provided / _____
		AC Current (R, Y, B: by Selector Switch)	Would be Provided / _____
		SPS Capacitor bank Voltage	Would be Provided / _____
	(ii) Pulse measurements	Current in last pulse (Peak Hold for ~800mS)	Would be Provided / _____
		Voltage in last pulse (Peak hold for ~800mS)	Would be Provided / _____
		0 to 10V signal of Output Voltage (Rear Panel)	Would be Provided / _____
		0 to 10V signal of Output Current (Rear Panel)	Would be Provided / _____
		c,d above are isolated signals	Isolated signals are Provided / _____
		c,d above are with BNC connecters suitable for local measurements by oscilloscope	BNC Connecter / _____
	(iii) Remote metering FOCI-(Fiber optic cable interface)	Fiber Optic Cable signal of Output Voltage	Would be Provided / _____
		Fiber Optic Cable signal of Output Current	Would be Provided / _____
		Fiber Optic Cable signal of Capacitor bank Voltage	Would be Provided / _____

	(iv) Remote status monitoring FOCI-(Fiber optic cable interface)	Fiber Optic Cable signal of Ready (when capacitor bank output voltage > 90% of set value)	Would be Provided / _____
		Fiber Optic Cable signal of Pulse ON (when output current >10 % nominal value)	Would be Provided / _____
		Supply On/Off	Would be Provided / _____
		External Trip	Would be Provided / _____
		Over Voltage Fault	Would be Provided / _____
		Over Current / Short circuit Fault	Would be Provided / _____
29	Indications	LED Based Lamps on Front Panel	LEDs / LED based Lamps / _____
	Status	Supply On/Off	Would be Provided / _____
		External Trip (Refer: Sl.No.19.b.ii)	Would be Provided / _____
		Emergency Off	Would be Provided / _____
		Over Voltage	Would be Provided / _____
		Over Current / Short circuit	Would be Provided / _____
	Protections	Over Voltage: Capacitor bank voltage > Set Limit	Would be Provided / _____
		Over Current: Output Current > Set Limit	Would be Provided / _____
		Short circuit	Would be Provided / _____
		Over temperature	Would be Provided / _____
		Reverse Charging of Capacitor bank	Would be Provided / _____
30	Manual Protections Limits Setting	Over Voltage Limit (10Turn potentiometer)	Would be Provided / _____

	(Preferred range of Limits: 20% to ~110% of nominal rating)	Range of Limits	20% to ~110% of nominal rating / _____
		Over Current Limit (10Turn potentiometer)	Would be Provided / _____
		Range of Limits	20% to ~110% of nominal rating / _____
		The above two potentiometers should be provided with protective cover to distinguish from other potentiometers	Protective cover would be provided / They would be located in the enclosure /_____
31	Interlocks	Fiber Optic Cable signal of Charge (Light) must be present for starting capacitor bank charging.	Would be Provided / _____
		Two potential free terminals at the rear panel Close –Enable Open –Disable (Consider as external trip)	Potential free terminals Would be Provided / Control voltage terminals (~12V) / _____
32	Preferred Size	Width: 1m;	Width _____
		Depth: 0.8m;	Depth_____
		Height:2m	Height_____
33	Enclosure	Generally conforming to standard IS: 12063-1987 and grade IP-41.	Yes / _____
		Pest proof	Yes / _____
		removable skins and/or doors,	Yes / _____
		Necessary cooling fans	Yes / _____
		Dust filters at all air entries	Yes / _____
		Panel lighting	Yes / _____
		Suitable power	Yes / _____

		control cable entries	Yes / _____
34	Capacitor Bank	Capacitor discharge device like Idiot Stick etc. is provided	Yes / _____
		Capacitor discharge resistor for discharge in 5minutes.	5 min/ _____min
35	Conformance to National and International Standards & Safety Codes:	Standard & Safety Codes ANSI C34.2, ANSI/IEEE4, ANSI/NEMA ICS 1, ANSI/PC-A-610, IEC 146/ IS 4540	Confirms / Doesn't confirm ANSI C34.2 - Yes / No ANSI/IEEE4 - Yes / No ANSI/NEMA ICS 1 - Yes / No, ANSI/PC-A-610 - Yes / No, IEC 146/ IS 4540 - Yes / No
36	Conformance to undertake SAT & FAT as per Annexure C of this document.	Party shall agree to perform and demonstrate all the tests mentioned in Site acceptance and Factory acceptance tests as per details mentioned in Annexure C respectively for obtaining dispatch clearance and final acceptance as explained.	Confirms / Doesn't confirm / deviations if any.

7. Appendix B - Pre-Dispatch & Acceptance Plan.

Acceptance Test Plan

1.	**General**	**Vendor's Offer**
	(i) All the specified tests as mentioned in section 7.1 & 7.2 of Appendix B. 1(DPS) & 2(SPS) will be carried out on dummy loads with standard instruments at the factory or any reputed laboratory before dispatch in presence of IPR representatives, to ensure that the power supply meets all mentioned specifications. Upon successful clearance of the Factory Acceptance Tests (FAT) only dispatch clearances shall be given to the party for supplying the units at IPR.	
	(ii) All the tests as mentioned above shall also be done on actual load or simulated loads as per site conditions at the Institute for Plasma Research during commissioning to qualify for the Site Acceptance tests.	
	(iii) The tests specified are the minimum required and will be elaborated within three months of placing the order with mutual discussions and understanding.	
	(iv) Sufficient design margins should be kept to ensure smooth operation and longer life of the Power Supply.	
2.	Stage Wise Progress	
	(i) IPR representatives would monitor stage wise progress, in order to ensure quality and optimized progress.	
	(ii) The stage wise progress to be made in the given time duration will be elaborated within one month of placing the order.	
3.	Other tests proposed (if any) for DPS, SPS by bidder	
4.	Tests (if any) for DPS, SPS that cannot be performed	

1. **Pre-dispatch Inspection of DPS:**

Measurement of size and check whether they are as per the approved drawings.

Power Input: Check input values, MCB / MCCB ratings, single phasing preventer etc.

Output cables: Megger test etc.

Isolation: Short positive and negative output terminals, when PS is OFF. Apply 250V to the shorted terminal with respect to ground /power supply body, by using another supply.

Check local controls from front panel

Check remote controls by giving input using signal generator to FOSI-RE

Check Pulsed and Continuous mode operation working properly

Voltage setting: –precision – default value (70V)
Protections and their limits functioning
Panel meters and indications functioning
Interlocks and their functioning
Signal interface units: FOSI-PS and FOSI-RE operation, freq. response etc.

Load tests on resistive dummy load

Positive polarity-Local control- continuous-10A, (at 70V)
Check: Pulse width setting, Current Droop, Rise Time, Fall time, Output Voltage, 7Ω resistor, connection changes etc.

Positive polarity-Remote control: - continuous-10A, (at 70V)
Check: Pulse width setting, Current Droop, Rise Time, Fall time, Output Voltage, 7Ω resistor, connection changes etc.

Positive polarity-Local control- single pulse @1kA
Check: Pulse width setting, Current Droop, Rise Time, Fall time, Output Voltage setting etc.

Positive polarity-Remote control: - single pulse, burst of pulses / max-number of pulses @1kA
Check: Pulse width setting, Current Droop, Rise Time, Fall time, Output Voltage setting etc.

Similarly for **Negative polarity**
Capacitors test report.
IGBTs data sheets
Output cables: **test certificates**

2. **Pre-dispatch Inspection of SPS:**

Measurement of size and check whether they are as per the approved drawings.

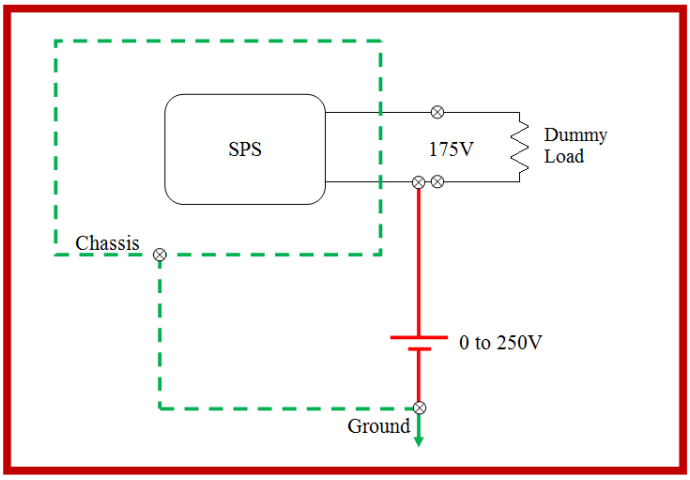
Power Input: Check input values, MCB / MCCB ratings, single phasing preventer etc.

Output cables: Megger test.

Isolation:

(a) Short output terminals, when PS is OFF. Apply 250V to the shorted terminal with respect to ground /power supply body, by using another supply.

(b) One of the Output terminals of SPS would be connected to another 250V supply as shown in following figure. First SPS output voltage is set at 175V. Then floating voltage is applied gradually from 0 to 250V. Test period would be One minute at 250V. During the test the monitoring, control etc. should not get affected. Similar test should be repeated on the other output terminal.



Check local controls from front panel

Check remote controls by giving input using signal generator to FOSI-RE

Check Pulsed and Continuous mode operation working properly

Voltage setting: –precision – default value (70V)

Protections and their limits functioning

Panel meters and indications functioning

Interlocks and their functioning

Signal interface units: FOSI-PS and FOSI-RE operation, freq response etc.

Load tests on **resistive dummy load**

Local control- single pulse @2.5kA

Check: Pulse width setting, Current Droop, Rise Time, Fall time, Output Voltage setting etc.

Remote control: - single pulse, burst of pulses / max-number of pulses @1kA

Check: Pulse width setting, Current Droop, Rise Time, Fall time, Output Voltage setting etc.

Capacitor test report.

IGBTs data sheets

Output cables: test certificates

8. Training To IPR Personnel

A complete training should be given to the IPR personnel for operation and maintenance after commissioning of the Power Supply.

9. Appendix C - Execution Schedule

	Milestones / Deliverables	Time	Vendor's proposal
1	Release of PO	T0	
2.	Design & Drawing Approval	T1=T0+4wk	
3.	Procurement of components	T2=T1+12 wk	
4.	Fabrication & witnessing of Testing at Vendor's/ manufacturer's Site or	T3=T2+14 wk	
5.	Site acceptance tests stage	T4=T3+4 wk	
6.	Delivery & Commissioning	T5= T4+6 wk	