

SPECIFICATIONS OF ATMOSPHERIC PLASMA SPRAYING SYSTEM

Supply, installation, commissioning and system prove out of an atmospheric plasma coating system	
1.	<u>Over all System Description:</u>
1.1.	Atmospheric plasma spraying system comprising of
	- Plasma control console
	- Power supply unit
	- Powder feeder unit
	- Water chiller unit
	- Gas management unit
	- Junction and monitoring unit
	- Electrical distribution unit
	- Plasma gun
	- Robotic drive system with controller for plasma gun and hardware manipulation
	- Acoustic booth
	- Dust extraction system
	- Interconnection cables, ducts and hoses required for installation
1.2.	Type: Non transferred arc plasma spraying system
1.3.	Electrical standards : Plasma console : IEC 60529-IP50/ latest equivalent Electrical systems : IEC 60204-11/latest equivalent
1.4.	Control, monitoring and operation: PLC based system
1.5.	Power rating: 40kW (Nominal)
1.6.	Coating Material form: Powder
1.7.	Primary plasma gas: Nitrogen/Argon
1.8.	Secondary plasma gas: Hydrogen
1.9.	Powder carrier gas: Primary gas (Nitrogen/Argon)
1.10	Coating powders compatibility: Capable of coating all thermal spray powders, especially Nickel Aluminide, Zirconium oxide and chromium oxide. It shall be capable of coating other ceramic powders also.
2.	<u>Plasma Control console:</u>
2.1	<u>Technical specifications:</u>
2.1.1	Control, monitoring and operation: PLC controlled (meeting the conditions given in 2.2.13)
2.1.2	Type: Fully automatic
2.1.3	Plasma power control capability: 40kW (Nominal)
2.1.4	Process gases: Argon, Nitrogen, Hydrogen
2.1.5	Process gases flow rates: Hydrogen - 0 to 10 NLPM @ 6bar Nitrogen - 0 to 100 NLPM @ 6bar Argon - 0-100 NLPM@ 6bar Accuracy of gas flow rates: ±2% of the set value
2.1.6	Cooling gas: Compressed air
2.1.7	Cooling gas Pressure: 0 to 4bar
2.1.8	Cabinet protection classification: IEC 60529:2013/latest equivalent
2.1.9	Ingress protection: IP 54/latest equivalent (for electrical cabinet)

	IP 33/latest equivalent (for gas cabinet)
2.1.10	Display panel: LED/LCD display
2.1.11	Plasma gases regulation: Mass flow controller
2.1.12	Process gases flow rates read out: Display unit
2.1.13	Process gases pressure read out: Display unit
2.1.14	Process voltage read out: Display unit
2.1.15	Process current read out: Display unit
2.2	<u>Features and operational requirements:</u>
2.2.1	PLC based fully automatic system for the control, monitoring and operation of the entire atmospheric plasma spraying system
2.2.2	It shall be the operator console for setting the desired process parameters like current, primary gas flow rate and secondary gas flow rate
2.2.3	Also it shall be the display unit for displaying the actual process parameters and alarm signals during coating operation
2.2.4	Necessary Human Machine Interface (HMI) shall be made available in the console with touch screen
2.2.5	It shall be interfaced with and shall have control over the functioning of the other subsystems like junction unit, powder feeder unit, power supply unit, chiller plant, dust extraction unit, acoustic booth system and robotic drive system for gun and job manipulation
2.2.6	It shall be capable of lighting the gun, adjusting the plasma plume to preset parameters and automatically starting the powder feeders and also proper shut down of the system once the coating operation is over.
2.2.7	It shall enable soft start ignition using only Argon to maximize electrode and nozzle life.
2.2.8	It shall be self diagnostic and give alarm to the operator in case of any adverse conditions mentioned in under interlocks and alarms title
2.2.9	The control console shall continuously monitor the basic parameters like plasma gas pressures, cooling water temperature and pressure, cooling air pressure, current value and the entire spraying process including external alarms and external interfaces and shall be capable of shutting down the plasma gun in case of any abnormalities or interlock failures
2.2.10	It shall contain inbuilt emergency devices and relays
2.2.11	Shall be capable of storing the product process parameters in the form of recipes
2.2.12	Shall have provision to store 100 recipes
2.2.13	All the process parameters shall be logged and stored. The data shall be in retrievable from the system after completion of the coating process or after certain period of time. The system shall be capable of storing parameters of 1000hrs of operation at a sampling rate of 1s.
2.2.14	A suitable computer along with data acquisition software shall be provided along with the system. The computer shall be interfaced with the thermal spraying system towards the data acquisition and monitoring of the process parameters during coating. The system shall have provision to record the following process parameters (but not limited to) current, voltage, power, primary gas flow rate, secondary gas flow rate, carrier gas flow rate, powder parameters, cooling water inlet and outlet temperature. The data shall be in retrievable form was on when required. The computer shall also be loaded with necessary software in order to control the thermal spraying process so that this can act as a redundant to HMI

	system.
2.2.15	All the display parameters shall follow both metric and British standards
3.	<u>Powder Feeder:</u>
3.1	<u>Technical specification:</u>
3.1.1	Capacity: 5.0 -12.5 liters capacity (5.0 liters minimum)
3.1.2	Working principle: Volumetric design
3.1.3	Control: PLC controlled
3.1.4	No of hoppers: 2
3.1.5	Powder feed rate: 5 to 300 g/min (nominal)
3.1.6	Powder particle size: micro to nano powders
3.1.7	Accuracy: ±1% (of the powder feed rate set value)
3.1.8	Carrier gas compatibility: Nitrogen/Argon
3.1.9	Carrier gas flow rate control : Mass flow controllers
3.1.10	Material of construction of powder hopper : Aluminum- Silicon alloy/ other alloys which will not react with the spraying powders.
3.1.11	Powder compatibility: All thermal spray powders (Nominal particle sizes -90+53µm, -90+45µm, -53+11µm, -53+5µm). Shall be compatible for other micro and nano ceramic and metallic powders.
3.2	<u>Features and operational requirements:</u>
3.2.1	Shall have closed loop feed rate monitoring and control for precise powder feed rate
3.2.2	Shall be compatible to wide range of powder morphologies like spherical, angular and blocky materials
3.2.3	An alarm shall be given in case the desired powder feed rate does not match with the actual powder feed rate
3.2.4	Must be interlocked with the plasma control console's PLC so that in case of any abnormalities the total spraying system will be shut down.
3.2.5	Must be able to operate the powder feeder unit remotely from the plasma control console
4.	<u>Power Supply Unit:</u>
4.1	<u>Technical Specifications:</u>
4.1.1.	Output power: 40 kW (Nominal)
4.1.2	Output current: 0-550A DC
4.1.3	Ingress protection: IP42/Latest Equivalent
4.1.4	Type : Inverter based/IGBT
4.1.5	Accuracy: 2% of the set value
4.2	<u>Features and operational requirements:</u>
4.2.1	Shall give constant current regardless of ±10% voltage fluctuations and changes in electrical arc resistance
4.2.2	The unit shall have a high resolution closed loop control system to produce the desired current and output power
4.2.3	Shall have proper smoothening choke to provide low residual ripple for repeatable coating performance
4.2.4	Shall have effective cooling and ventilation for continuous coating operations
4.2.5	Shall initially start the plasma ignition with a preset current and then slowly

	buildup to the set parameters
4.2.6	Shall be interfaced and interlocked with the PLC of the plasma control console
4.2.7	The current value shall be set only from the plasma control console
4.2.8	Shall be interlocked with all the subsystems so that in case of any abnormalities the plasma gun must be immediately switched off
4.2.9	Proper earthing and other safety and emergency systems shall be inbuilt within the system
5.	Junction and monitoring unit
5.1	<u>Technical specifications:</u>
5.1.1	Plasma power: 40kW (Nominal)
5.1.2	Cooling water flow range: As per plasma gun requirements
5.1.3	Cooling water temperature range: As per plasma gun requirements
5.1.4	Plasma gas pressure switch: As per plasma gun requirements
5.1.5	Cooling water monitoring: Flow switch
5.1.6	Power supply connection: From the plasma control console
5.2	<u>Features and operational requirements:</u>
5.2.1	Shall measure and monitor the cooling water inlet temperature, outlet temperature and flow rate to the plasma gun
5.2.2	Shall be completely interfaced and interlocked with the plasma control console
5.2.3	Shall continuously measure and monitor plasma voltage and plasma gas pressure during the spraying operation
5.2.4	Ignition shall occur automatically from the control signal available from the plasma control console
5.2.5	Shall be suitable for a wide range of plasma spraying guns
6.0	Gas Management Unit
6.1	<u>Technical Specifications</u>
6.1.1	Primary (Nitrogen) gas flow rate control : Mass flow controller 0 to 100 NLPM @ 6bar
6.1.2	Primary (Argon) gas flow rate control : Mass flow controller 0 to 100 NLPM @ 6bar
6.1.3	Secondary (Hydrogen) gas flow rate control : Mass flow controller 0 to 10 NLPM @ 6bar
6.1.4	Compressed air pressure control : Proportional pressure control valve 0-4 bar
6.1.5	Accuracy : $\pm 2\%$
6.2	<u>Features and operational requirements:</u>
6.2.1	This shall be a standalone system or shall be an integral part of plasma control console
6.2.2	Necessary pressure switches to monitor the inlet gas pressures shall be provided in the system
6.2.3	Necessary pressure governors, pressure gauges, mixing chamber etc shall be part of the system
6.2.4	The gas hoses shall be designed suitably for the operating pressures
6.2.5	The hoses carrying Hydrogen shall be steel hoses with braided covering
6.2.6	Hydrogen sensor shall be provided in the system to monitor for any hydrogen leak during operation. The same shall be interlocked with the main PLC
6.2.7	Since hydrogen gas is involved the electrical cabinet in the system shall be

	purged with compressed air/nitrogen maintaining positive pressure. The cabinet pressure shall be monitored and interlocked with the PLC
6.2.8	The system shall be completely integrated with the plasma control console and the process gas flow rates shall be set from the HMI panel. The mass flow controllers shall control the process gas flow rates to the set value and feedback shall be given to the plasma control console. The same shall be monitored and interlocked during the entire spraying process
7.	Water Chiller unit
7.1	<u>Technical Specifications</u>
7.1.1	Type : Refrigerant type DM water chiller unit
7.1.2	Control : Micro controller/PLC controlled
7.1.3	Outlet pressure : As per Plasma gun requirements
7.1.4	Outlet temperature : As per Plasma gun requirements
7.1.5	Outlet flow rate : As per Plasma gun requirements
7.1.6	Cooling capacity : As per Plasma gun requirements
7.2	<u>Features and operational requirements:</u>
7.2.1	This shall be the only chiller unit for the system operating in closed loop and no plant water circuit will be provided by IPRC
7.2.2	Shall be designed to meet the plasma system requirement
7.2.3	Shall be interfaced and interlocked with the plasma control console
7.2.4	Shall be able to circulate and condition demineralised gun cooling water at a pressure and flow rate required to cool the plasma spray gun
7.2.5	Shall be able to be operated remotely from the plasma control console through a PLC output signal
7.2.6	Shall have automatic control of water temperature, pressure and flow rate
7.2.7	Shall be able to monitor, control and send feedback signals to the plasma control console regarding the flow rate and temperature of the gun cooling water
8.	Electrical distribution unit
8.1	<u>Features and operational requirements:</u>
8.1.1	This shall be the common power terminal for the entire spraying system
8.1.2	The electrical power required for various subsystems shall be distributed from this system
8.1.3	Fuses, ELCB's, MCB's etc designed for the suitable ratings shall be part of the system. The Fuses, ELCB's, MCB's etc shall be reputed make like Sneider/ L&T/ Allen Bradley/ Siemens/ ABB/ equivalent
8.1.4	The entire system's earthing (including body earthing) shall be terminated in the system
8.1.5	Additional power output provisions shall be provided as spare for future requirements
8.1.6	Necessary UPS system shall be introduced between the electrical distribution unit and the subsystems with control electronics and PLC systems with a minimum power backup of 20 minutes under full load. UPS is under the scope of supply by the party and to be installed along with the equipment
9.	Plasma gun
9.1	<u>Technical specifications:</u>
9.1.1	Power rating: min 40kW
9.1.2	Suitable for: Nitrogen/Hydrogen, Argon/Hydrogen plasma
9.1.3	Current: 500A (nominal)
9.1.4	Hydrogen flow rate: 0-20NLPM (nominal)
9.1.5	Nitrogen flow rate: 0-100NLPM (nominal)

9.1.6	Argon flow rate:	0-100NLPM (nominal)
9.1.7	Ignition:	soft ignition at lower current with argon
9.1.8	Type:	Machine mount
9.1.9	Spray distance:	Suitable for process qualification
9.1.10	Cooling type:	water cooled
9.1.11	Cooling water flow rate and temperature:	As per plasma gun design requirements
9.1.12	Arc initiation and electrode erosion:	The plasma gun shall be designed in such a way that the arc initiation and electrode erosion happens in multiple locations to avoid excess wear at a single point leading to gun failure.
9.1.13	The consumable elements in the plasma gun like electrode and nozzle shall be capable for minimum 2.5 hours of continuous non-stop operation at a nominal power of 40kW.	
9.1.14	The life of electrode and nozzle used in the plasma guns shall be mentioned by the party. The life shall be considered for a nominal operating power of 40kW.	
9.1.15	The preferred material of construction of electrode shall be tungsten coated copper and the nozzle shall be copper alloy.	
9.1.16	The plasma gun power rating is mentioned in 9.1.1. Party shall quote for either one or more plasma guns meeting the technical requirements	
9.2	<u>Features and operational requirements:</u>	
9.2.1	Shall be suitable for spraying powdered materials using atmospheric plasma spraying process and in no way should contaminate the powders	
9.2.2	Shall be compatible with the plasma control console, power supply unit, chiller unit and junction unit	
9.2.3	Operation of the plasma gun shall be controlled only from the plasma control console	
9.2.4	Perfect electrical insulation shall be provided between the spray gun and the gun manipulator	
9.2.5	Proper insulation and mounting brackets shall be supplied along with the plasma gun	
9.2.6	Shall be suitable for mounting the powder port directly on the gun with tight clearances	
9.2.7	Shall be suitable for mounting the cooling air jet nozzles on the plasma gun	
9.2.8	The party shall quote for suitable plasma gun which shall be used for coating of the thermal barrier and wear resistance coatings as per specifications	
10.	Acoustic Booth:	
10.1	<u>Technical specifications:</u>	
10.1.1	Chamber size:	Outside dimension : 10000mm x 3700mm x 3600mm (Approx) Inside dimension: 9800mm x 3500mm x 3500mm (Approx)
10.1.2	Door opening:	3500mm x 3500mm x 3500mm(on two sides ie one side and top) (Approx)
10.1.3	Window sizes:	1000mm x 1000mm (2 numbers on the door and fixed side wall) 1000mm x 1000mm (1 number on the back wall) (Approx)
10.1.4	Lighting:	Dust proof 40W twin tube lights with fixture 4Nos. are to be provided inside the chamber.
10.1.5	Ventilation:	10000 m3/hr (approx) fresh air inlet with hood & filter.
10.2	<u>Features and operational requirements:</u>	
10.2.1	Construction: Double walled construction.	
10.2.2	Outer wall fabricated out of 16 Gauge (1.5mm) steel sheets stiffened wherever necessary.	
10.2.3	Inner wall of the cabin consist of 18 gauge galvanized perforated steel sheet 3mm dia hole steel sheet	
10.2.4	In between these two walls 100mm thick Inert non consumable & vermin proof	

	lightly resin bonded rock wool mattress with additional qualities for the application of thermal spray is to be lined which has high acoustic insulation properties. The insulation thickness shall be 100 mm minimum
10.2.5	All the windows shall be double glazed with UV protection films fixed on it with effective glare protection. The windows shall be vacuum filled and made of toughened glass
10.2.6	All the side panels, roof panels and doors shall be of modular in design and shall be assembled on site and dismantled if necessary.
10.2.7	Rubber Gaskets shall be provided on the door frames and with each leaf properly to prevent any leakage of sound from door gaps.
10.2.8	Doors shall be equipped with rocker arm locking device.
10.2.9	Noise reduction: < 89DB measured one meter outside from wall as per industry specification for three hours exposure.
10.2.10	Special L- shape sliding door construction opens a section of the cabin giving easy crane access for loading & unloading large work pieces.
10.2.11	Door opening shall be motorized with geared motor All metallic surfaces shall be powder coated from outside. Perforated sheet shall be coated with paint.
10.2.12	Air inlet shall be equipped with suitable filter which will ensure clean air inside the chamber during spray operation.
10.2.13	Inlet and outlet conduits on the roof or on the side of sound proof cabin equipped with sound attenuators.
10.2.14	The acoustic booth shall be provided with limit switches for open/close sensing and the same shall be interfaced with the plasma control console
11.	Dust extraction system:
11.1	<u>Technical Specifications:</u>
11.1.1	Type : Dry filter cartridge type dust collection system
11.1.2	Particulate to be removed : Dust/Powder
11.1.3	Capacity : 7650 CFM (nominal)
11.1.4	Filtration area : greater than 250 m ²
11.1.5	Number of cartridges : 15 -25 nos
11.1.6	Dust emission level : 10 mg/m ³ (nominal) Fractional efficiency : 99.999% on 0.5 micron particles
11.1.7	Fan Motor capacity : 35 HP (nominal)
11.1.8	Method of cleaning : Online Pulse jet
11.1.9	Exhaust fan : Ground mounted
11.1.10	Dust removal system : Manual operated butterfly valve/cam lock dust bin
11.1.11	Casing, Impeller, base frame : GI steel
11.1.12	Hopper : GI steel
11.1.13	Compresses air header : GI steel
11.1.14	Filter bags : Non woven polyester spun bond/better
11.1.15	Gaskets : Poly isoprene moulded closed cell gasket/better
11.2	<u>Features and operational requirements:</u>
11.2.1	The dust collector will be kept in open atmosphere, hence suitable anti rust painting shall be provided in the dust collector system
11.2.2	The dust collection system suction pressure shall be measured by a air flow switch and the same shall be integrated with the plasma control console
11.2.3	Differential pressure transducer shall be installed in the dust collection system in order to check for the pressure drop across and enable cleaning of filter bags
11.2.4	The dust collection system shall be remotely switched ON/OFF from the plasma control console
11.2.5	Necessary star delta timer and other electrical systems shall be provided in the system.

11.2.6	The dust collection system shall have online air pulse jet system for shedding of the powders from bags and the same shall be collected in a collection bin through a valve. The system shall have provisions hassle free and safe operation during cleaning
12.	Drive system with Industrial Robot and Tilting turn table
12.1.	<u>Technical specifications:</u>
12.1.1	<u>Plasma gun manipulator : Industrial robot mounted on linear track system</u>
12.1.1.1	Type : Six axis robot with linear track system
12.1.1.2	Robot reach: 2.4m (minimum). Robot and linear track systems together shall meet the requirement for coating 9 components envelop mentioned in Annexure-A. The mentioned 9 components are the minimum requirements for the system and the system shall be capable of coating other hardware also within the working envelope. The system shall be capable of coating, hardware which are 20% larger in dimensions (3 directions) as compared to the largest hardware mentioned in annexure-A. Length of robot track shall be selected accordingly considering the robot reach.
12.1.1.3	Working envelope of gun manipulator : Suitable to coat all the 9 component envelop as mentioned in annexure-A
12.1.1.4	Loading capacity of the robot : 30kg minimum or suitable for the plasma gun quoted
12.1.1.5	Positional Repeatability : ± 0.1 mm or better
12.1.1.6	Incremental movement : 0.1mm or better
12.1.1.7	Path repeatability at 1m/s : < 0.4 mm or better
12.1.1.8	Control system : Control and drive module with controller software
12.1.1.9	Built : Suitable for harsh thermal spray environment inside an acoustic sound booth
12.1.2	<u>Job manipulator : Tilting turn table</u>
12.1.2.1	Capacity : 800 kg minimum
12.1.2.2	Tilting angle : 0 to 90°
12.1.2.3	Tilting accuracy : ± 0.5 °
12.1.2.4	Tilting resolution : 0.1°
12.1.2.5	Rotation : 0-200 RPM
12.1.2.6	Rotation accuracy : ± 3 RPM
12.1.2.7	Face plate diameter : 1000mm diameter minimum
12.1.2.8	Face plate thickness : 35mm minimum
12.1.2.9	Face plate tool fixture: To be suitable for fixing the hardware mentioned in Annexure-A. Additional 3 jaw manual chuck shall also be supplied for mounting small diameter hardware.
12.1.2.10	Face plate run out : < 0.1 mm
12.1.2.11	The drawings of the 9 components which shall be mounted on the turntable are attached in annexure. The drawing of the largest component along with centre of gravity is also given in annexure. The offset/eccentric loading on the turntable shall be calculated based on support design and turn table offset load carrying capacity shall be selected accordingly.
12.2	<u>Features and operational requirements:</u>
12.2.1	The drive system shall be supplied with suitable control and drive modules along with HMI pendant and associated systems like measurement board and cables for the drive system.
12.2.2	The drive system shall be equipped with an absolute measurement system on all the axis. The position data shall be backed up so that after system power shutdown, no synchronization of the drive system is necessary on restarting
12.2.3	The drive system shall be supplied with mechanically active brakes on all the axis.

12.2.4	The drive system shall automatically braked at emergency stops, power failure, manipulation failure, thermal spray failure, when taken to STAND BY mode or SYSTEM OFF mode.
12.2.5	The safety and emergency stop systems shall be interlocked with the thermal spray and manipulation system so that all emergency stop buttons, system errors etc the thermal spray gun and manipulator shall be stopped instantly in the case of failure or emergency stop.
12.2.6	The control module shall be equipped with necessary I/O modules, analog modules, memory devices, software, operator controls etc for interfacing and interlocking with the thermal spray system.
12.2.7	The necessary interlocks shall be provided to stop the spraying process in case of any error/failure/malfunctioning in the drive system.
12.2.8	The drive system shall have error log, operation log and storage device for the same
12.2.9	The drive system shall have provision to store 100 path programs
12.2.10	The drive system shall have proper integration and interface for allowing process controls like start/stop plasma gun, selecting plasma spraying recipe, start/stop powder feeders, start/stop cooling air, start/stop turntable and set to desired RPM.
13.	Safety Aspects to be addressed in the system:
13.1	The electrical installations shall be made in accordance with EN 60204-11 or other latest equivalent safety standards
13.2	The pressure regulators and manometers are to be as per DIN EN ISO 2503 or latest equivalent standards
13.3	At Hydrogen line, standardized safety devices like back flash arresters must be fitted in order to prevent gas flow - back and fire blow out
13.4	Pipes for gases used in the system shall be made of chrome steel and must be checked for pressure leaks and seal tightness
13.5	Proper earthing shall be provided with earth resistance value <1 ohms and neutral to earth voltage <2V
13.6	Proper electrical insulation shall be provided in all the electrical installations
13.7	Emergency push buttons shall be provided at various critical subsystems like spray controller, drive system controller, acoustic booth panel box etc and the same shall be interlocked with the PLC of plasma control console
13.8	Necessary Pictograms shall be made available at different subsystem and various locations wherever required
14.	Interlocks and Alarm Conditions:
14.1	The functional interlocks and the alarm conditions shall be monitored by the PLC in the plasma control console, either by the digital signals assisted by relay based circuits or by analog signals from the measurement transducers through remote Input/output modules.
14.2	The following are interlocks shall be provided in the system in addition to any other interlocks/shut down conditions provided by the party <ul style="list-style-type: none"> - Emergency push buttons pressed - Gun cooling water flow rate too low - Gun cooling water outlet temperature too high - Plasma gas pressure too low - Nitrogen gas inlet pressure too low - Hydrogen gas inlet pressure too low - Argon gas inlet pressure too low - Cooling air gas inlet pressure too low - Purge pressure in the electrical cabinet of the gas management unit too low - Improper and inappropriate parameter setting

	<ul style="list-style-type: none"> - Failure of any of the communication cable between the subsystems - Set process parameter does not match with the actual parameter - Carrier gas pressure too low - Large variations in voltage at the inlet of power supply unit - Set current parameter does not match with the actual current value - Main power failure - Robotic drive system failure - Robotic drive system mode changed from Auto
	<ul style="list-style-type: none"> - Any Error message from robotic drive system - Any communication failure - Malfunctioning/error from any of the subsystems
14.3	The interlocks mentioned in clause 14.2 shall be demonstrated by the party at the time of installation.
15.	Pre dispatch inspection (PDI) and clearance at supplier's site
15.1	The system shall be demonstrated for its complete operation including the proper functioning of all the subsystems in the presence of IPRC representative
15.2	All the technical specification mentioned in purchase order shall be met with by the individual subsystems as per purchase order. The system shall be demonstrated to the requirements of Tentative Factory Acceptance Test (FAT) and Quality Acceptance Protocol (QAP) attached in annexure. Final FAT and QAP will be communicated along with PO.
15.3	The proper functioning of the drive system shall be demonstrated during PDI
15.4	Upon successful demonstration of the system and its readiness as per system prove out clause, clearance shall be provided for dispatch of the equipment.
15.5	Acoustic booth building and ducting associated to dust collection system shall be demonstrated at IPRC after final installation. Readiness of the items shall be confirmed at the time of PDI.
16.	Installation and commissioning at IPRC
16.1	The party has to install and commission the plasma spraying system at IPRC site and ensure complete startup, functioning of the systems and demonstrate coating of uniform thickness and quality on a trial hardware after successful completion and of system prove out as mentioned system prove out clause. The following are the scope of work under installation and commissioning
16.2	Before installation at IPRC site all the systems shall be visually inspected for any damage during shipment and unloading
16.3	Installation of all the subsystems as per layout approved by IPRC. The drawing approval should not absolve the responsibility of the party
16.4	The system layout shall be approved by IPRC before final realization. The drawing approval should not absolve the responsibility of the party
16.5	The ducting between the acoustic booth and dust extraction system shall be under the scope of party. The same shall be finalized after placement of order. The party shall visit IPRC after placement of order to finalize the floor plan and other installation requirements
16.6	The final drawings of the acoustic booth and the drive system shall be cleared by IPRC before realization. The drawing approval should not absolve the responsibility of the party
16.7	Interconnection and interlocking of all subsystems of the plasma spraying system including plasma control console, powder feeder, power supply unit, junction and monitoring unit, dust collection system, acoustic booth, chiller unit, robotic drive system, gas management system and electrical distribution unit. Cables and hoses for interconnection are under the scope of party and the same shall be suitable to Indian tropical conditions
16.8	External cooling air system shall be supplied along with the system for Job

	cooling during coating. The same shall be interfaced with the system.
16.9	Commissioning of the entire plasma spraying system
16.10	Functional tests on individual sub systems and on the entire spraying system
16.11	Demonstration of proper functioning of the system
16.12	Verification of safety and functional interlocks in the system
16.13	The party has to carry out the system prove out of the system as per details mentioned under system prove out clause.
16.14	On successful completion of the system prove out the system will be declared to be ready to use by IPRC
16.15	Party has to develop robot path programs for the components given in annexure-A drawings in order to achieve uniform coating thickness with the process parameters which will be supplied after placement of PO. Trial components shall be supplied by IPRC for robot path program development.
16.16	The party has to establish the performance of the system by coating one hardware as per annexure-A drawings to demonstrate uniform thickness during the entire spraying operation
16.17	After successful completion of the commissioning activity, the operating personnel shall be trained as mentioned under training column under general terms and conditions
17.	General terms and conditions:
17.1	<p>The party has to supply spares for 2 years trouble free operation of the system including PLC and other electronic system spares. Envisaged list of spares is mentioned below. The party shall supply the same in addition to other spares as recommended by the party. The party shall also supply list of recommended spares and their prices along with the quotation</p> <ol style="list-style-type: none"> a. Electrodes – 30 nos b. Nozzles – 30 nos c. Powder feeder exhauster – 5 nos d. Powder feeder spreader – 5 nos e. Powder injection ports – 10 nos f. O –rings for plasma gun – 5 sets g. Critical circuit boards – 1 each h. Critical Transducers – 1 each i. Critical sensors – 1 each j. Critical relays – 1 each k. Critical I/O modules – 1 each l. Fuses – 2 in each type m. Batteries applicable – 2 each <u>n.</u> Oil if applicable – 1 batch <p>The party shall submit the unpriced list of spares along with the technical bid. Spares cost shall not be mentioned in the technical bid. Separate spares quote with price details shall be submitted in the price bid only.</p>
17.2	<p>The special tools required for the assembly and disassembly of plasma gun and for other subsystem operation and maintenance activities shall be supplied along with the system. The envisaged tools are</p> <ol style="list-style-type: none"> a. Electrode removal tool b. Nozzle removal tool c. Electrode holding nut removal tool d. Nozzle ring nut removal tool
17.3	A Warrantee of 1 year shall be applicable to the system from the date of successful completion of testing and evaluation and commissioning
17.4	The party shall also supply a standard PC with the latest softwares to meet the requirements as indicated earlier.
17.5	The quotation shall also include quote for annual maintenance and contract (non

	<p>comprehensive) for a period of 7 years after warrantee expiry. The scope of AMC shall be for the entire integrated system including all the subsystems and drive system. The AMC shall be for the entire system supplied as turnkey.</p> <p>The scope of AMC will be as follows: Type : Non comprehensive No. of calibration visit: 1 per year No. of P.M. visit : 2 per year No. of break down visit : 1 per year Party shall quote for per visit charges in their price bid only. AMC charges shall not be mentioned in the technical bid.</p>
17.6	<p>The party shall provide 3 sets of complete documentation for all the subsystems (in English) including</p> <ul style="list-style-type: none"> - system manual - product manual - part list - troubleshooting manual - electrical wiring diagram - operational manual - fabrication drawings of mechanical items - Manuals from OEM for bought out items - Calibration certificates - Preventive maintenance plan
17.7	A copy of the programming software used in the system shall be provided in CD for backup.
17.8	The material handling equipments like turn table interface flange, roller supports and self centering 3 jaw chuck etc shall be supplied along with system for coating hardware mentioned in annexure-A
17.9	The party shall not declare any of the subsystem to be obsolete for the next 7 years from the date of installation
17.10	Party shall comply for the availability of spares and consumables required for the system for next 10 years
17.11	The mentioned specifications are generic. Parties shall quote to the nearest matching specifications from their standard models.
17.12	Functional approval shall be obtained from IPRC for the system configuration and drawings before starting fabrication. Our approval shall not absolve the vendor from their responsibility to comply with the specification.
17.13	Party shall mention the details facility requirements towards installation and commissioning at IPRC including electrical requirements, gas and consumable requirements, material handling systems, civil requirements, grouting requirements etc. after obtaining the purchase order.
18.	Other details to be provided along with the quotation
18.1	Bill of materials
18.2	Single line diagram for power and control circuits of the system
18.3	Facility requirements for the spraying system
18.4	List of spraying powders which the system can coat
18.5	<p>Details of gas purity level are mentioned below. Party shall mention their compliance for the same towards the operation of the system</p> <p>Hydrogen – 99.995% Purity Nitrogen – 99.8% Purity Argon – 99.998% Purity Compressed air – ISO 1.4.1/latest equivalent</p>
18.6	Schematic drawing of the subsystems along with their dimensions
18.7	Details of functional and safety interlocks provided in the system
18.8	Details of PLC used in the system along with their make and model number

18.9	<p>Details of make of major electronic and mechanical systems used in individual subsystems and their model numbers shall be submitted. The make of items shall be as per table-1 mentioned below</p> <p style="text-align: center;">Table-1</p> <table border="1"> <tr> <td>PLC</td> <td>Allen Bradley /ABB /Siemens /Snider /Fanuc /equivalent</td> </tr> <tr> <td>Servo Motors</td> <td>ABB/Fanuc/Siemens/equivalent</td> </tr> <tr> <td>Robot</td> <td>ABB/Fanuc/Kuka/ equivalent</td> </tr> <tr> <td>Drive</td> <td>ABB/Fanuc/Siemens/equivalent</td> </tr> <tr> <td>Relays/contractors/ELCB/MCB/Fuse/other electrical elements</td> <td>Snider/L&T/Allen Bradley/Siemens/ABB/equivalent</td> </tr> <tr> <td>Sensors</td> <td>Rosemount/Yakohowa/Honeywell/equivalent</td> </tr> <tr> <td>Plasma spraying system</td> <td>Metco/AMT/GTV/Praxair/equivalent</td> </tr> <tr> <td>Dust extraction system</td> <td>Metco/Donaldson/equivalent</td> </tr> <tr> <td>Plasma gun</td> <td>Metco/AMT/GTV/Praxair/equivalent</td> </tr> </table>	PLC	Allen Bradley /ABB /Siemens /Snider /Fanuc /equivalent	Servo Motors	ABB/Fanuc/Siemens/equivalent	Robot	ABB/Fanuc/Kuka/ equivalent	Drive	ABB/Fanuc/Siemens/equivalent	Relays/contractors/ELCB/MCB/Fuse/other electrical elements	Snider/L&T/Allen Bradley/Siemens/ABB/equivalent	Sensors	Rosemount/Yakohowa/Honeywell/equivalent	Plasma spraying system	Metco/AMT/GTV/Praxair/equivalent	Dust extraction system	Metco/Donaldson/equivalent	Plasma gun	Metco/AMT/GTV/Praxair/equivalent
PLC	Allen Bradley /ABB /Siemens /Snider /Fanuc /equivalent																		
Servo Motors	ABB/Fanuc/Siemens/equivalent																		
Robot	ABB/Fanuc/Kuka/ equivalent																		
Drive	ABB/Fanuc/Siemens/equivalent																		
Relays/contractors/ELCB/MCB/Fuse/other electrical elements	Snider/L&T/Allen Bradley/Siemens/ABB/equivalent																		
Sensors	Rosemount/Yakohowa/Honeywell/equivalent																		
Plasma spraying system	Metco/AMT/GTV/Praxair/equivalent																		
Dust extraction system	Metco/Donaldson/equivalent																		
Plasma gun	Metco/AMT/GTV/Praxair/equivalent																		
18.10	Detailed technical specifications along with data sheets, technical catalogue etc shall be submitted along with the tender																		
18.11	Detailed compliance statement mentioning compliance / details of deviation if any addressing each clause in technical annexure shall be submitted along with the tender																		
18.12	Party shall mention details of similar system installations within India (preferably government organizations) along with contact details																		
19.	Other terms and conditions:																		
19.1	The vendor is required to submit quotation for the entire works mentioned herein. If any of the details required as per tender is not provided, the offer will be summarily rejected. The deviation, if any, with respect to this document shall be explicitly mentioned in the schedule of deviations to be provided in the quotation. If the vendor does not mention any deviation, it shall be construed by the Department that the vendor agrees to comply with each and every aspect of this document.																		
19.2	Pre-bid meeting will be conducted within two weeks from the date of tendering. Bidders should intimate their willingness to participate in the pre-bid meeting within one week from the date of tendering. Offers of bidders who participate in pre-bid meeting will only be considered																		
19.3	<p>The bid shall be submitted in two parts.</p> <ul style="list-style-type: none"> - Part 1 of the bid will be the techno-commercial bid – All techno-commercial details should be indicated such as detailed technical compliance, data sheets, technical catalogue, technical bulletin, clause by clause compliance, local content details including break up, previous Purchase orders of similar work, work completion certificate, audited balance sheets, company profile, compliance to commercial clause, unpriced list of spares etc. Price should not be indicated. Bid will be invalid if price is indicated in any form. - Part 2 of the bid will be the price comprising of the price details of the entire tender scope, AMC charges and cost of spares 																		
19.4	Cost of basic equipment for the entire tender scope, Cost of spare, cost of AMC and any other costs mentioned by the party shall be considered while ranking the price bid/evaluation of lowest offer.																		
20.	Pre Qualification Criteria for vendors																		
20.1	Vendor should be a manufacturer/Dealer/Indian agent of OEM for plasma spraying systems. In case of Indian agent or dealer authorization from Principal must be provided along with offer.																		
20.2	Vendor should provide copies of purchase orders preferably from Government																		

	Institutions/organizations/aerospace sector, as evidence for having done similar kind of work in the past (last 5 years), along with technical bid. The submitted PO shall be of similar kind of complete integrated turnkey system including all the systems like thermal spraying system, robotic drive system, chiller unit, dust collection unit, acoustic booth, etc. The referred PO shall be an executed/completed order. The referred PO shall be preferably within India.
20.3	Vendor should provide details including the name, address, phone numbers of parties to whom similar work was done.
20.4	The vendor shall elaborately bring out in their quotation their company profile, which shall be commensurate with the level demanded for the execution of the work specified in this document
20.5	The vendor shall submit audited company balance sheets for the last 3 years which shall be commensurate with the level demanded for the execution of the work specified in this document. The company balance sheet shall be audited by authorized chartered accountant
21.	Training details
21.1	IPRC personnel shall be trained on operation and maintenance of the system immediately after the commissioning of system. The following are to be included in the training agenda
21.2	Switching ON the system
21.3	Sequence in which the various sub systems will get switched ON
21.4	Reading the values on the control console during operation
21.5	Fault indications on the control console and their significance
21.6	Setting and reading the spraying parameters through the PLC in the plasma control console
21.7	Details of safety and functional interlocks provided in the system
21.8	Checking powder flow and its spray quantity
21.9	Firing the plasma gun and aspirating the powder flow and check the flame
21.10	Assembly and disassembly of plasma spraying gun
21.11	Switching OFF the system
21.12	Details of periodical preventive maintenance and the procedure to do the same
21.13	Procedure for replacing the critical spares, consumables in the system during maintenance and trouble shooting
21.14	Shutting OFF the system for prolonged duration
21.15	Probable reasons for break down and maintenance activities to be carried out to prevent them
21.16	Training on robot programming shall be given for path programming.
21.17	Training on operations of robotic drive system
22.	System Prove out trails
22.1	<u>System Prove out trials at Supplier's site:</u>
22.1.1	The system shall be integrated including all sub systems except acoustic booth and dust collection system and demonstrated for proper functioning . The robot track and robot shall be integrated during demonstration at the party site as part of PDI
22.1.2	The plasma gun shall be switched ON and the plasma gun shall be operated at the parameters mentioned in table-1 without any anomaly
22.1.3	The plasma gun shall be switched ON continuously for 2.5 hours as per clause 9.1.13. This shall be with/without powder flow.
22.1.4	All the tests and demonstration mentioned in FAT shall be demonstrated as part of system prove out
22.1.5	Specimen or samples shall be coated with the process parameters mentioned in the process window table furnished by IPRC after placement of order.
22.1.6	Necessary powders, specimens and fixtures shall be supplied by IPRC. Coated

	specimens and fixtures shall be returned back to IPRC.
22.1.7	The functioning of interlocks mentioned shall be demonstrated during system prove out
22.1.8	Other consumables like gas, water and electricity etc shall be arranged by the supplier
22.1.9	Readiness of the extraction system and acoustic booth shall be confirmed at the time of system prove out at supplier's site
22.1.10	Proper functioning of the robot and tilting turntable in all the axis shall be demonstrated during system prove out.
22.2	<u>System prove out trials at IPRC after installation and commissioning of the system:</u>
22.2.1	After successful installation of the complete system at IPRC, the system prove out trial shall be done as per the process parameters mentioned in table-1
22.2.2	The plasma gun shall be switched ON and the plasma gun shall be operated at the parameters mentioned in table-1 without any anomaly
22.2.3	All the tests and demonstration mentioned in FAT shall be demonstrated as part of system prove out
22.2.4	Specimen or samples shall be coated with the process parameters mentioned in the process window table furnished by IPRC after placement of order.
22.2.5	Proper functioning of the robot and tilting turntable in all the axis shall be demonstrated during system prove out.
22.2.6	One hardware each as mentioned in annexure-A shall be coated and demonstrated
22.2.7	Robot path programming required for hardware coating as per annexure-A shall be developed by the party for achieving uniform coating thickness
22.2.8	Necessary fixtures for coating of hardware shall be provided by IPRC.
23.0	Payment terms:
	100% payment within 30 days of receipt and acceptance of items at IPRC is our standard payment terms. However, in case of advance payment requirement from the vendor, the same shall be applicable subject to approval from competent authority of IPRC. In case of advance payment, the interest element will be loaded on to the vendor's price bid, during tender evaluation for comparison purpose.
24.0	Other commercial conditions:
24.1	Valid MSME certificate shall be attached along with the quotation to avail MSME benefits
24.2	Party shall declare the percentage of local content and its break-up along with the technical bid. Warranty, AMC, P&F, Freight and other service elements are not considered for local content percentage.
24.3	Security Deposit (SD) : Security Deposit shall be applicable to the successful bidder for satisfactory execution of the Purchase Order/Contract at the rate of 3% of P.O. value
24.4	Performance Bank Guarantee (PBG) ; Performance Bank Guarantee (PBG) shall be obtained as a security for fulfillment of warranty obligations by the vendor after satisfactory execution of the Purchase Order/Contract at the rate of 3% of P.O. value. PBG shall be released after warranty upon acceptance of AMC order.