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1. Scope of Supply

The Contractor shall supply, deliver, install, commission, test, and hand over a complete Hot Isostatic Press (HIP) system, fully operational and ready for use. The scope includes all necessary equipment, auxiliary systems, control systems, software, utilities interfaces, documentation, and services required for safe and reliable operation.

2. Minimum Technical Requirements

2.1 High-Pressure Vessel

- Internal diameter: 150 – 180 mm
- Internal length: 400 – 600 mm
- Maximum operating pressure: ≥ 200 MPa
- Closure system: Fully threaded closure, yoke/frame system, or equivalent certified safety closure.
- Design and manufacturing of pressure vessel in accordance with EN 13445 or equivalent standard.

2.2 Hot Zone Assembly

- Heating system: Graphite, Carbon-Carbon composite, or equivalent.
- Maximum operating temperature: ≥ 1800 °C
- Working hot zone dimensions:
 - Diameter: 70 – 100 mm
 - Length: 100 – 150 mm
- Heating rate: Adjustable up to 25 °C/min
- Temperature uniformity: ± 10 °C within the working hot zone at operating temperature ≥ 700 °C (under pressure conditions).
- Temperature measurement: At least two (2) independent Type C thermocouples (W/Re).
- Insulation: Multi-layer thermal insulation system with heat shielding suitable for high-temperature and high-pressure operation.

2.3 Pressurization and Vacuum System

The system shall allow controlled pressurization, holding, and depressurization during all phases of operation (hot and cold).

- **High-Pressure System:**
 - Argon gas compressor system capable of reaching ≥ 200 MPa.
 - High-pressure transmitters, gauges, and valves for pressure control, regulation, and relief.
 - Safety devices (rupture discs and safety valves) certified according to PED.
 - Status indication for critical valves on the control interface.
- **Low-Pressure & Purging System:**
 - Separate pressure measurement and control valves with position indication.
 - Shut-off valves for gas supply isolation and purging.
- **Evacuation System:**
 - Vacuum pump system (e.g., two-stage or equivalent) with isolation valves and vacuum measurement.
 - Achievable residual pressure: ≤ 100 Pa.

2.4 Power Supply System

- Thyristor/SCR-controlled power supply or equivalent.
- Step-down and isolation transformer.
- Monitoring of current, voltage, and short-circuit conditions.

2.5 Control System, Automation, and Data Logging

- **Hardware/Software:** Industrial control system (PLC-based with HMI) for automatic and semi-automatic operation.
- **Process Control:** Closed-loop recipe-based control of temperature, pressure, holding time, heating/cooling rates, vacuum levels, and purge cycles.

- **Data logging:** Continuous logging of process parameters. Data export in standard machine-readable formats (e.g., CSV, XLSX, or equivalent).
- **Safety & Security:** Multilevel user management (access control), visualization of alarms, and permanent software licensing. The system shall include emergency stop functions, safety interlocks, and fail-safe behavior in case of power or system failure.
- **Language:** HMI and control software shall be in English (German optional).

2.6 Cooling System

- Closed-loop internal cooling circuit with reservoir, pump, pressure gauge, flow meter, and temperature monitoring.
- Water-to-water heat exchanger or equivalent to interface with the customer's facility cooling water.
- All required valves, piping, and controls included.

3. Scope of Delivery and Services

- **System and Hardware:** Complete HIP system ready for operation.
- **Spares package:** Wear and spare parts sufficient for at least 1 year of standard operation (e.g., O-rings, thermocouples, rupture discs, heating elements, lubricants).
- **Documentation:** Complete technical documentation (drawings, manuals, maintenance instructions, spare parts list) provided in English (and/or German).
- **Acceptance Tests (FAT & SAT):**
 - **FAT (Factory Acceptance Test):** Verification of technical parameters, leak tests, and safety interlocks at the manufacturer's site prior to shipment.
 - **SAT (Site Acceptance Test):** Verification of installation, calibration, safety functions, and execution of at least one full HIP cycle at agreed representative process parameters.
- **Services:** Installation supervision, commissioning, and on-site training for operating and maintenance personnel.

4. Customer Responsibilities and Site Requirements

Final site specifications shall be confirmed by the Contractor during the design/planning phase. The Customer will provide:

- **Cooling Water:** Standard industrial cooling water to interface points.
- **Gases:** Argon gas supply and compressed air supply (approx. 0.7 MPa, dry and oil-free).
- **Ventilation:** Exhaust/vent line from the system to a safe discharge point outside the building.
- **Power Supply:** 3 x 400 V, 50 Hz + N + PE (Installed power up to 60 kW to be confirmed by Contractor).
- **Space & Access:** Indoor installation area with adequate floor loading capacity and transport access. Unloading equipment (crane/forklift) can be provided upon prior coordination.

The Contractor shall define and confirm all required utilities, connection specifications, and tolerances prior to delivery.