

Document title	Cryogenic probe station specifications
Réf. Chrono	DRT-LETI-DCOS-SCCS-LCEF-25-07-001559

**Protection des informations : Cocher la case :**

- ☒ Le présent cahier des charges ne contient aucune information de niveau « Diffusion Restreinte » ou « classifiées » ou relevant de la protection du potentiel scientifique et technique de la nation, ce qui permet la mise en ligne de ce document sur la plate-forme dématérialisée du CEA,
- ☐ Le présent cahier des charges contient des informations Diffusion Restreinte (DR) ou relevant de la Protection du Potentiel Scientifique et Technique de la Nation de ce fait la mise en ligne sur la plateforme dématérialisée du CEA de ce document **est possible via un conteneur chiffré ZED !**,
- ☐ Le présent cahier des charges contient des informations classifiées, de ce fait **la mise en ligne** sur la plate-forme dématérialisée du CEA de ce document **est strictement interdite.**"

## SUMMARY

<b>1</b>	<b>PURPOSE</b>	<b>4</b>
<b>2</b>	<b>EQUIPMENT TECHNICAL SPECIFICATIONS</b>	<b>5</b>
2.1	CRYOGENIC PROBE STATION	5
2.1.1	Core	5
2.1.2	Cryogenics	5
2.1.3	Sample stage	7
2.1.4	Vibration	7
2.1.5	Vacuum	7
2.1.6	Vision system	7
2.2	PROBE ARMS	7
2.2.1	Common specifications	8
2.2.2	DC arms assemblies	8
2.2.3	GSG arms assemblies	9
2.2.4	GSGSG arms assemblies	10
2.2.5	Optical fiber arm assemblies	11
2.3	ACCESSORIES	11
2.3.1	Basic tool kit	11
2.3.2	Grounded sample holder	11
2.3.3	GSGSG calibration kit	11
<b>3</b>	<b>GENERAL BUILDING, FLUIDS, ELECTRICITY, ENVIRONMENT SPECIFICATIONS</b>	<b>12</b>
3.1	ENVIRONMENT OF THE EQUIPMENT	12
3.1.1	Building specifications	12
3.1.2	Building fluids	12
3.1.3	Building power network specifications	12
3.1.4	Adaptation of the machine to the power network	12
3.1.5	Uninterruptible power supply (UPS)	13
3.2	MANAGEMENT OF THE ENVIRONMENT	13
<b>4</b>	<b>SAFETY</b>	<b>14</b>
4.1	EC CONFORMITY	14
4.2	RISKS CONNECTED WITH FACILITIES	15
4.3	RISKS CONNECTED WITH FIRE	16
4.4	RISKS CONNECTED WITH CHEMICAL PRODUCTS	16
4.5	RISKS CONNECTED WITH HANDLING	16
4.6	RISKS CONNECTED WITH AUTOMATIC LOADING OF FOUPS ONTO LOADPORTS	17
4.7	RISKS CONNECTED WITH PRESSURISED EQUIPMENT	17
4.8	RISKS CONNECTED WITH WORK AT HEIGHT	17
4.9	RISKS CONNECTED WITH LASER RADIATION	17
4.10	RISKS RELATED TO SOURCES OF IONIZING RADIATION (RADIOACTIVE SOURCES / ELECTRIC GENERATORS OF IONIZING RADIATION, ETC.)	17
4.11	RISKS CONNECTED WITH NOISE	17
4.12	RISKS CONNECTED WITH TEMPERATURE	17
4.13	SIGNALLING	18
4.14	INTERVENTION CONDITIONS ON THE CEA-LETI SITE	18
<b>5</b>	<b>SUSTAINABLE DEVELOPMENT</b>	<b>18</b>
5.1	CORPORATE SOCIAL RESPONSIBILITY (CSR)	18
5.2	SUSTAINABLE DEVELOPMENT AND DEVELOPMENT OF THE LOCAL ECONOMIC FABRIC	18
5.3	ENERGY PERFORMANCE	19
<b>6</b>	<b>EQUIPMENT DELIVERY CONDITIONS</b>	<b>19</b>

<b>7</b>	<b>CONDITIONS FOR INSTALLING EQUIPMENT</b>	<b>19</b>
<b>8</b>	<b>TRAINING &amp; LEARNING</b>	<b>19</b>
<b>9</b>	<b>DOCUMENTATION</b>	<b>19</b>
<b>10</b>	<b>WARRANTY</b>	<b>20</b>
10.1	WARRANTY CONDITIONS	20
10.2	SUPPORT DURING WARRANTY	20
<b>11</b>	<b>MAINTENANCE</b>	<b>20</b>
11.1	SPARE PARTS	20
11.1.1	List of spare parts	20
11.1.2	Process-kit	20
11.1.3	Storage area	20
11.2	MAINTENANCE CONTRACT	20
11.3	COST OF OWNERSHIP (COO)	21
<b>12</b>	<b>CHECKS &amp; TESTS</b>	<b>21</b>
12.1	CHECKS AND TESTS AT THE FACTORY (FACTORY ACCEPTANCE TESTS)	21
12.2	CHECK UPON DELIVERY & AT UNPACKING	21
<b>13</b>	<b>– INSTALLATION</b>	<b>21</b>
13.1	PREPARATION	21
13.2	INSTALLATION	22
13.2.1	System delivery & move in to final location:	22
13.2.2	Tiers 0 - System mechanical assembly, system start Up	22
13.2.3	Tiers 1 - Final Hook Up and system start Up after power up	23
13.2.4	Tiers 2 - Contractor Equipment qualification & handling test	24
13.2.5	Tiers 3 - CEA Process Qualification	24
13.3	ACCEPTANCE	24
13.4	END OF WARRANTY	24
<b>14</b>	<b>APPENDICES</b>	<b>26</b>
	APPENDIX A: Summary of Contractor's comments	26
	APPENDIX B: general fluids in building 51C	27
	APPENDIX C: Definition of Availability	28
	APPENDIX D: Specification for delivery of equipment subject to the European "machinery" Directive 2006/42/CE	30
	APPENDIX E: Specification relating to documents and manuals to be provided with the equipment	32
	APPENDIX H: Datasheet for tool installation	37
	APPENDIX I: Risk Identification Sheet	38
	APPENDIX K: Pedestal specification	39

# 1 PURPOSE

CEA-LETI is seeking to acquire a new cryogenic probe station, a highly specialized piece of equipment designed to enable precise electrical and optical characterization of materials and devices under a tightly controlled environment. This acquisition is critical for advancing our research in key technological fields, including quantum computing, superconductivity, and semiconductor physics. The station's unique ability to achieve and maintain a wide temperature range, from around 2 K up to 300 K, will allow our researchers to characterize the fundamental properties of novel materials and devices with unparalleled accuracy.

This document outlines the detailed specifications for the equipment. It is structured to provide potential suppliers with a clear understanding of our technical needs and operational requirements.

## Documents to be provided by the Contractor during the tender process

- ✓ The Contractor must complete and deliver to CEA-LETI **Appendix A: Summary of Contractor's comments** and put any comments in this section (the Contractor must not add any comments in the main text).
- ✓ The Contractor must deliver to CEA-LETI **Appendix H: Datasheet for Tool Installation.**
- ✓ The Contractor must deliver to CEA-LETI the system footprint and dimension of all systems or sub systems.
- ✓ The Contractor must deliver to CEA-LETI pre installation manual.
- ✓ The Contractor must complete and deliver to CEA-LETI **Appendix I: Risk Identification Sheet.**
- ✓ The Contractor must complete and deliver to CEA-LETI **Appendix K: pedestal specification.**

## 2 EQUIPMENT TECHNICAL SPECIFICATIONS

The equipment technical specifications are organized into three main sections. The first section details the station base, including the stand, vacuum chamber, cryogenics, thermometry, sample stage, and vision system. The second part focuses on the requirements for the probe arms and probes, which are essential for making direct contact with the sample. Finally, the third section details the accessories essential for the immediate and continued operation of the equipment.

### 2.1 Cryogenic probe station

This section provides detailed specifications for the cryogenic probe station base, which encompasses all of the system's components except the probe arms. This includes the stand, vacuum chamber, cryogenics, thermometry, sample stage mechanics, and vision system.

To guide CEA-LETI in its supplier choice, detailed mechanical drawings, schematics, and footprints of the following parts must be supplied.

#### 2.1.1 Core

The probe station must be built on a heavy-duty stand capable of supporting the entire system, including the prober body, the probe arms, and the vision system. The stand must incorporate a freestanding table with vibration dampening, as detailed in the [vibration](#) section.

A dedicated rack or console is required to house all control electronics. This includes controllers for thermometers, heaters, pressure gauges, and the vision system monitor. The supplier must provide a complete, integrated solution including all necessary furniture to properly house and manage the supplied equipment in a clean, organized, and accessible manner. All cabling must be neatly managed and clearly labeled to facilitate maintenance and troubleshooting.

The vacuum chamber of the prober will be constructed from high-quality welded stainless steel or machined aluminum to provide a clean, ultra-high vacuum environment. The chamber must be sized to fit all its internal components (shields, probes, samples, ...) in the most compact fashion to minimize black-body radiation. The chamber must also include a sufficient number of electrical feedthroughs for all necessary probes, thermometers, and heaters, as well as dedicated ports for cryogenics, vacuum pumping, and a pressure gauge. All vacuum seals should be made from low-outgassing materials suitable for cryogenic applications.

#### 2.1.2 Cryogenics

The cryogenic probe station must operate over a temperature range spanning from below 4 K to 300 K. It is designed to achieve a base temperature of approximately 4 K using a liquid helium (LHe) flow system. To reach lower temperatures, the system may employ evaporative cooling to cool down as low as 2 K. Solutions slightly above the targeted 2 K temperature will still be evaluated, provided they are well-justified.

CEA-LETI understands the complexities in such systems, including the distinctions between stage and sample temperatures and how much measurement conditions can affect the thermal environment. Therefore, the supplier is required to specify the precise temperatures achieved for the different thermometers and on actual probed samples for both scenarios: with and without evaporative cooling. This detailed information on measurement conditions and the specific probe configuration is crucial for guiding CEA-LETI's decision-making process.

#### Cryogenic fluids

The station utilizes a single liquid helium intake for its cool-down process. The transfer line must consist of two rods connected by a flexible hose. One end of this line must be compatible with the supplier's station inlet, while the other must be designed to connect with CEA-LETI's LHe dewars, featuring a 1/2-inch outside diameter and a minimum length of 150 cm. The transfer line must have a flow control valve to help to minimize LHe consumption. This transfer line must be robust and sturdy, featuring double-walled, vacuum-jacketed hoses to ensure efficient LHe transfer. A vacuum port is required for regular checks and maintenance of the vacuum pressure within the transfer line's double walls. Any specialized tools needed for this must be provided.

---

## **Cryogenic probe station specifications**

### **DRT-LETI-DCOS-SCCS-LCEF-25-07-001559**

---

To prevent any loss of cryogenic fluid, the circulation system must be completely leak-tight from the equipment inlet to its outlets. This is essential to ensure that all gas can be recovered at the station's output. The supplier must specify the type of output fittings so that CEA-LETI can prepare an appropriate recovery line.

The system is expected to cool down to 4 K in less than 75 minutes. A split-flow design is preferred for cryogenic fluid circulation to cool the outer elements of the chamber first, such as the outer radiation shield, before the sample stage and probes. This sequential cooling helps prevent the condensation of residual gases onto the samples and probes, which is critical for maintaining good quality electrical contacts. Once the station has reached its base temperature, the liquid helium flow rate should not exceed 2 LHe/hr.

After reaching 4 K, the system must be capable of reducing the sample temperature to below 2 K in less than 30 minutes using an evaporative cooling subsystem. This component must have its own independent exhaust port and flow control, allowing for fine-tuning without affecting the radiation shields' temperature. The supplier is responsible for providing the necessary pump, piping, and fittings for this subsystem and must specify the minimum temperatures reached by both the sample stage and a probed sample under the associated measurement conditions. Estimates for the liquid helium flow rate while evaporative cooling is active must also be provided.

The temperature stability at the sample stage is a key requirement, with a target better than 100 mK across the whole temperature range using the temperature control system described below.

The station must also be compatible with liquid nitrogen (LN<sub>2</sub>) for operation at 77K and maintain a temperature stability of around 200mK across the whole temperature range using the temperature control system described below.

#### **Heat and radiation shielding**

To effectively reach and maintain low temperatures, the system must be constructed with multiple thermal stages. These stages are strategically designed to balance blackbody radiation shielding with the available cooling power, ensuring each successive stage gets progressively colder towards the center.

At least one complete radiation shield, with a base and a lid, is required. This shield, anchored to an intermediate temperature stage, must include a viewport that effectively blocks radiation from the 300 K chamber while permitting optical observation. Additionally, there must be at least one partial radiation shield at the 4K-stage, covering the area from the bottom of the stage up to the sample level.

The inclusion of additional radiation shields at intermediate temperatures is highly preferred and will be considered a significant factor in our decision-making. These extra stages significantly reduce the heat that reaches the coldest point, thereby improving both the base temperature and the overall efficiency of the cryogenic system. These supplementary shields can be either fully enclosed with a base, lid, and viewport or be partial with only a base.

The system's viewports are crucial for allowing a clear view of the entire sample stage. This is essential for using a microscope to monitor probe positions and landings with precision. The main chamber and radiation shields windows must be made from materials that effectively block infrared radiation while maintaining a clear view for optical observation.

#### **Thermometry**

The system will be equipped with a comprehensive thermometry setup featuring at least four thermometers. These will be strategically placed on the main radiation shield stage, the 4K-stage, the sample stage, and one of the probe arms.

Heaters will be installed on both the radiation shield and the sample stage to achieve a total warmup time of less than 3 hours. These heaters must have safety limits linked to the thermometers to prevent any potential damage to the station.

The system requires a dedicated temperature controller to precisely adjust the temperature at the sample stage, ensuring an accuracy of 100 mK across the entire operational range. To achieve this precision, the parameters of the closed-loop control must be specifically tailored to the equipment. This controller will be equipped with both physical buttons and a screen for direct user interaction. Additionally, it must include a driver and remote-control capability, allowing for seamless integration with a Windows-based PC. This will enable researchers to monitor temperatures and manage the heaters remotely, which is crucial for automated experiments and data acquisition.

### **2.1.3 Sample stage**

The sample stage must accommodate samples up to 50 mm x 50 mm. To facilitate RF and multi-needle probing, the stage must have a rotation capability of at least  $\pm 5$  degrees. This rotation is critical to fine-tune the probe-pad alignment.

Additionally, the sample stage must be designed to securely mount various sample holders using a screw mechanism. These holders, which are detailed in the accessories section, must be well-thermalized to the sample stage. This ensures efficient heat transfer and accurate temperature control for the sample. This feature provides the flexibility needed to support our diverse user base and their wide range of experimental setups.

### **2.1.4 Vibration**

To ensure precise measurements, the system must include a robust vibration isolation system. The targeted vibrations along the X, Y, and Z axes should be below 100 nm of amplitude. A regulated source of compressed air or nitrogen ( $< 3$  bar) is available for active dampening systems. The supplier must communicate any required fittings or specifications for this system.

### **2.1.5 Vacuum**

The station must have a vacuum enclosure compatible with low vacuum and rapid pump-down times. The chamber must be airtight and will be leak-tested to be below  $1 \times 10^{-8}$  mbar·L/s when all vacuum ports, probe arms, and fittings are connected.

The complete system must include a full-range gauge mounted to the vacuum chamber, a dry scroll backing pump, and a turbopump with its controller integrated into the electronics console. A pressure of  $< 1 \times 10^{-3}$  mbar must be reached in under 10 minutes at 300 K.

To prevent pump line vibrations from being transmitted to the station, the pump line must be isolated from the stand. This can be achieved via a dedicated isolator, such as piping sealed into a stiff support independent of the main stand. All necessary clamps and fittings must be included. A gas injection port is also required to vent the chamber and allow for a rapid warm-up.

The chamber must be equipped with an overpressure safety feature, such as a relief valve, set to activate at a pressure of approximately 30 mbar. This safety device must be carefully dimensioned to effectively and rapidly prevent dangerous overpressure conditions that could arise from the abrupt sublimation of residual ice within the chamber.

### **2.1.6 Vision system**

A high-performance vision system is essential for accurately positioning the micron-sized probe tips onto the sample. The system must include a microscope with a zoom ratio of at least 12:1. This microscope must achieve a resolution of  $< 3$  microns at the sample level once associated to its high-resolution camera.

The lighting system is also critical and must provide uniform illumination. A dedicated XYZ manipulator and a robust mounting stand for the microscope are required to ensure smooth and precise positioning. The camera view must be displayed either directly on a screen provided by the contractor or on a Windows-based PC owned by CEA-LETI using imaging software supplied by the contractor.

## **2.2 Probe arms**

This chapter details the technical specifications for the eight probe arms ordered for the cryogenic prober. The system accommodates up to six arms simultaneously, with the additional two arms serving as swappable replacements. This allows for flexible experimental configurations by enabling the rotation of different arm types into the six available positions.

The eight probes are categorized into four distinct types to enable a wide range of precise electrical and optical measurements at low temperatures: two DC arms, two GSG (Ground-Signal-Ground) RF arms, two GSGSG (Ground-Signal-Ground-Signal-Ground) RF arms, and two optical fiber arms.



All eight arms share a set of common specifications related to movement, thermal management, and ease of use. This chapter is organized to first outline these common specifications, followed by the specific requirements for each of the four probe arm types.

## **2.2.1 Common specifications**

This section describes the common requirements for all probe arm assemblies.

The probe arms must be compatible with a probing area of 50 mm x 50 mm. Each arm's radial travel must be 50mm, its lateral travel 25 mm, and its vertical travel 12 mm, all with a sensitivity below 5  $\mu$ m. These displacement capabilities must be maintained over the full temperature range of the prober.

To minimize the heat load on the cryogenic system and maintain the sample's low temperatures required for measurements, each probe arm assembly includes a multi-stage thermalization scheme. Heat is transferred from the room-temperature cables and feedthroughs to two distinct stages: the radiation shield first and then to the sample stage. The probe arm tip itself must be directly thermalized to the sample stage. The thermalization braids used must be flexible enough to avoid hindering the arm's movement. They will not impede the arm's precise radial, lateral, or vertical travel, ensuring that the necessary displacement capabilities are maintained across the entire temperature range of the prober. Furthermore, the thermalization braids must have a flexible insulation coating to prevent thermal short-circuits between the different stages for all arm positions. The probe arm itself must be made out of low thermal conductivity material.

In its offer, the supplier must detail the material used and its thermalization scheme with a clear explanation, supported by schematics and pictures. The CEA considers this component of the cryogenic environment to be a critical factor in the supplier selection process, as it has a significant impact on both performance and future evolution.

Each probe arm assembly is designed to be easily swappable, allowing for quick reconfiguration of the cryogenic system. The entire process of removing and installing an arm should be completed in less than one hour, minimizing downtime and maximizing experimental flexibility. This rapid exchange capability is essential for adapting the prober to different measurement types without a lengthy and complicated teardown.

At least one arm must be equipped with a thermometer, located either at the probe tip or on the part thermalized to the radiation shield. The thermometer must be compatible with the prober's temperature monitoring system and be calibrated to an absolute error of less than 1 K over the prober's full temperature range.

## **2.2.2 DC arms assemblies**

This section outlines the requirements for two DC probe arm assemblies, including the probe arms themselves and the corresponding probes for DC measurements in a cryogenic environment. The probes can be designed with two mounting options: a needle that screws directly onto the probe arm tip, or a needle mounted on a body (like a PCB) with an SMA connector.

### **2.2.2.1 DC probe arms**

In addition to the [common specifications](#), the following are specific requirements for each of the two DC arms.

For probes that use a connectorized PCB, the probe arm end must have an SMA plug. The cabling needs to be flexible enough to accommodate probes from various manufacturers, as the position of the SMA sockets may differ between models. This flexibility is also critical for allowing frequent probe changes. Specifically, the SMA connector at the probe end must be durable enough to withstand hundreds of connection and disconnection cycles.

Regardless of the mounting type, the cabling on the chamber side must terminate via a 3-lug triaxial feedthrough. This feedthrough must be leak-tight and compatible with the cryogenic operation of the station. Each station must have a bandwidth from DC to 50MHz with a leakage current less than 50 fA for a 1 V bias over the whole temperature range.



### **2.2.2.2 DC probes & adapter**

We require four DC probes with tungsten needles, each having a tip radius of less than 10  $\mu\text{m}$ . These probes must be compatible with the DC probe arms described above and attach firmly to the arm to ensure good mechanical stability and thermalization. If the probe arm tip is not thermalized to the 4K-stage, each probe must include a way to be anchored to the 4K or sample stage. The probes must also be removable without requiring the disassembly of the probe arm.

The probes, including both the body and the needle, must be made from durable materials that can withstand repeated contact and cryogenic cycling without any degradation in performance or physical integrity. Electrically, they must demonstrate low contact resistance and minimal leakage current, which is essential for high-precision DC measurements in a cryogenic environment. Each probe should have a bandwidth of at least 50 MHz and provide at least 100 M $\Omega$  isolation between the signal and ground.

### **2.2.3 GSG arms assemblies**

This section outlines the requirements for two Ground-Signal-Ground (GSG) probe arm assemblies, including the probe arms themselves and the probes for RF measurements in a cryogenic environment.

#### **2.2.3.1 GSG probe arms**

In addition to the [common specifications](#), we will now describe the specific requirements for each of the two GSG arms.

The base of each probe arm must allow for a rotation of up to  $\pm 5^\circ$  along the arm axis to ensure proper planarization of the GSG probe tip.

The cabling must be flexible enough to accommodate probes from various manufacturers such as Picoprobe, Z-probe or equivalent; which may have different socket positions. At the probe end, a 2.92 mm RF connector plug is required. The other end of the cabling will terminate with a 2.92 mm RF socket via a feedthrough. This feedthrough must be leak-tight and compatible with cryogenic operation. It must also be robust enough to withstand the stress from the stiff, high-bandwidth RF cables used at room-temperature while maintaining its airtightness. The cables' connectors must be durable enough to withstand hundreds of connection and disconnection cycles at both ends.

Each cable must have a bandwidth from DC to 40 GHz with less than 3 dB of attenuation across this range. Furthermore, the cross-talk between the two adjacent cables must remain below -60 dB across the entire frequency range.

In addition to the default thermalizations, we require at least one 0 dB attenuator along each cable, thermalized to either the radiation shield or the 4K-stage. These attenuators must be removable, allowing them to be replaced with components of a higher attenuation if an experiment requires it.

#### **2.2.3.2 GSG probes & adapter**

We require the supplier to provide pricing and technical details for two mandatory options regarding the GSG probes: option 1, providing their own compliant GSG probes; and option 2, providing the necessary adapters to integrate FormFactor Z-probes (already own by CEA-LETI).

##### **Mandatory option 1: GSG probes from the supplier**

We require four GSG probes with a 150  $\mu\text{m}$  pitch to transition from a coaxial cable to a coplanar waveguide. These probes must be compatible with the GSG probe arms described previously. They must attach firmly to the arm to ensure good mechanical stability and thermalization. If the probe arm tip is not thermalized to the 4K-stage, each probe must include a way to be anchored to the sample stage. The probes must be removable without disassembling the probe arm.

The probes must be made from durable materials that can withstand repeated contact and cryogenic cycling without any degradation. Electrically, they must have low contact resistance and minimal leakage current, which is critical for high-precision RF measurements in a cryogenic environment. Each probe should have a bandwidth of at least 40 GHz, a characteristic impedance of 50  $\Omega$ , and the three tips of the GSG probe must be coplanar.

**Mandatory option 2: Adaptors to fit GSG Z-probes from FormFactor (or equivalent)**

The two GSG RF arms will be used with FormFactor Z-probes, already own by CEA-LETI. The entire probe arm assembly must be fully compatible with these probes. If an adapter kit is necessary, the supplier must provide a detailed list of its parts. Once installed, this adapter kit must not physically or functionally impede the use of other probe arm types on the station. It should also not affect the probing area or the sample's base temperature, ensuring consistent and reliable test conditions. The adapter kit must securely mount the Z-probes to the probe arm, and the probe must be thermalized to the sample-stage through the provided mount. The contractor must supply schematics or pictures of the adaptor parts in its offer.

**2.2.4 GSGSG arms assemblies**

This section outlines the requirements for two Ground-Signal-Ground-Signal-Ground (GSGSG) probe arm assemblies, including the probe arms themselves and the corresponding probes for cryogenic RF measurements.

**2.2.4.1 GSGSG probe arms**

In addition to the [common specifications](#), the following are the specific requirements for each of the two GSGSG arms.

The base of each probe arm must allow for a rotation of up to  $\pm 5^\circ$  along the arm axis to ensure proper planarization of the GSGSG probe tip.

The cabling must be flexible enough to accommodate probes from various manufacturers such as Picoprobe, Z-probe or equivalent; which may have different socket positions. At the probe end, two 2.92 mm RF connector plugs are required. The other end of the cabling will terminate with two 2.92 mm RF sockets via one or two feedthroughs. These feedthroughs must be leak-tight and compatible with cryogenic operation. They must also be robust enough to withstand the stress from the stiff, high-bandwidth RF cables used at room-temperature while maintaining their airtightness. The cables' connectors must be durable enough to withstand hundreds of connection and disconnection cycles at both ends.

Each cable must have a bandwidth from DC to 40 GHz with less than 3 dB of attenuation across this range. Furthermore, the cross-talk between the two adjacent cables must remain below -60 dB across the entire frequency range.

In addition to the default thermalizations, we require at least one 0 dB attenuator along each cable, thermalized to either the radiation shield or the 4K-stage. These attenuators must be removable, allowing them to be replaced with components of a higher attenuation if an experiment requires it.

**2.2.4.2 GSGSG probes & adapter**

We require the supplier to provide pricing and technical details for two mandatory options regarding the GSGSG probes: option 3, providing their own compliant GSGSG probes; and option 4, providing the necessary adaptors to integrate FormFactor Z-probes (already own by CEA-LETI).

**Mandatory option 3: GSGSG probes from the supplier**

We require four GSGSG probes with a 150  $\mu\text{m}$  pitch to transition from the two coaxial cables to a coplanar waveguide. These probes must be compatible with the GSGSG probe arms described above and attach firmly to the arm to ensure good mechanical stability and thermalization. If the probe arm tip is not thermalized to the 4K-stage, each probe must include a way to be anchored to the sample stage.

The probes, including both the body and the needle, must be made from durable materials that can withstand repeated contact and cryogenic cycling without any degradation. Electrically, they must exhibit low contact resistance and minimal leakage current, which is essential for high-precision RF measurements in a cryogenic environment. For each RF signal pair (GSG), a bandwidth of at least 40 GHz is expected, a characteristic impedance of 50  $\Omega$ , and all five tips of the GSGSG probe must be coplanar.

**Mandatory option 4: Adaptors to fit GSGSG Z-probes from FormFactor (or equivalent)**

The two GSGSG RF arms will be used with FormFactor Z-probes, already own by CEA-LETI. The entire probe arm assembly must be fully compatible with these probes. If an adapter kit is necessary, the supplier must provide a detailed list of its parts. Once installed, this adapter kit must not physically or functionally impede the use of other

probe arm types on the station. It should also not affect the probing area or the sample's base temperature, ensuring consistent and reliable test conditions. The adapter kit must securely mount the Z-probes to the probe arm, and the probe must be thermalized to the sample-stage through the provided mount. The contractor must supply schematics or pictures of the adaptor parts in its offer.

### **2.2.5 Optical fiber arm assemblies**

This section outlines the specific requirements for two probe arm assemblies equipped with fiber optics, in addition to the common specifications.

Each assembly must have a continuous length of fiber that runs from the probe end all the way to the outside of the equipment, passing through a vacuum-sealed feedthrough. Outside the chamber, the fiber needs to be at least 2 meters long and terminate with a fiber optic FC connector.

Inside the probe station, the fiber should be a coated length without a jacket. This internal fiber must terminate with a flat-cleaved end, which will be integrated into a fiber holder specifically designed to minimize breakage from accidental contact with the substrate. A crucial feature of this design is the ability to easily strip and re-cleave the fiber end if it gets damaged or dirty.

The fibers must be single-mode and compatible with wavelengths ranging from 1290 nm to 1650 nm, making them suitable for illumination from a coherent light source.

## **2.3 Accessories**

This section details the various parts, consumables, and optional components required to ensure the functionality and flexibility of the cryogenic probe station.

### **2.3.1 Basic tool kit**

The supplier must provide a comprehensive tool kit containing all specialized tools necessary for standard operation, routine maintenance, and assembly/disassembly of the station. This ensures that on-site personnel can perform essential tasks without requiring external support. Additionally, a spares kit containing common consumable items, such as O-rings, vacuum seals, and fasteners, must be included to allow for quick replacement and minimize downtime during maintenance cycles.

### **2.3.2 Grounded sample holder**

#### **Mandatory option 5: grounded sample holder**

The tender requires four grounded sample holders. These holders must be designed for direct thermal and electrical contact with the sample stage to minimize thermal gradients and ensure accurate temperature readings at the sample. They should be electrically grounded to the station's chassis to provide a stable electrical reference for measurements. The surface of these holders must be compatible with standard silver paste for securely mounting samples with good thermal and electrical anchoring. To this end, we recommend that the design features grooves on the top surface. These grooves improve thermal contact by trapping the silver paste and will also facilitate the repeatable mounting and easy removal of samples.

### **2.3.3 GSGSG calibration kit**

#### **Facultative option 6: GSGSG calibration kit**

As an optional component, the supplier may provide a GSGSG (Ground-Signal-Ground-Signal-Ground) calibration substrate. This kit must be specifically designed for calibrating microwave probes with a 150 µm pitch. The substrate should be compatible with standard calibration protocols, including SOLT (Short-Open-Load-Thru), LRL (Line-Reflect-Line), and LRM (Line-Reflect-Match). A crucial requirement for this kit is its compatibility with calibrations at the station's lowest temperatures, ensuring accurate high-frequency measurements across the entire operational range.

### 3 GENERAL BUILDING, FLUIDS, ELECTRICITY, ENVIRONMENT SPECIFICATIONS

#### 3.1 *Environment of the equipment*

##### 3.1.1 Building specifications

###### Features of the location of the equipment:

- Environment: laboratory.
- Cleanliness class according to **ISO 14-644-1**:  
**ISO 4 to 7** depending on the location in the building
- Environmental Conditions and tolerances (temperature and humidity)  
**22 +/- 1°C** or **23 +/- 5°C** depending on the location in the building.

##### 3.1.2 Building fluids

See **Appendix B**: General fluids building 51C.

##### 3.1.3 Building power network specifications

**CAUTION:**

The equipment covered by these specifications must be connected to an electrical distribution main with earthed neutral system (TN –S diagram).

If necessary, refer to CEI 60364 standard.

###### Electrical features

Power supply voltages available on main:

- Single-phase: 1 phase + neutral + earth,  
Phase/Neutral voltage: 230 V +/- 10%.

Main frequency: 50 Hz.

##### 3.1.4 Adaptation of the machine to the power network

**CAUTION:**

When the neutral lead is distributed in the machine, a cut-off device must be placed on the neutral lead, at the equipment item's general switch.

###### Neutral lead colour in machine:

Inside the equipment, the neutral lead shall be of light blue colour (EN 60204 standard) or clearly identified otherwise (colour ring, marker).

###### Protection lead colour in machine:

Inside the equipment, the protection lead (earth) shall be of green and yellow colour.

###### Power supply transformer (general machine)

Should a transformer be necessary:

- Contractor shall estimate this supply as an option, indicating all electrical features (power, primary and secondary voltages, etc.).
- A dry transformer (without liquid dielectric medium) is preferable;  
For transformers or other devices, containing a liquid dielectric medium:
  - Pyralene is prohibited;
  - Installation conditions in machine shall meet Decree of January 17, 1989 establishing prevention steps against fire hazard introduced by dispersion and ignition of flammable liquid dielectric media. In this case, mandatorily consult us.
- Characteristics of the transformer:
  - It shall be compliant with the "low voltage" directive **2014/35/EC** and affixed with the CE marking for this purpose,
  - case of a three-phase transformer:  
Secondary windings must be bridge connection so that there is a neutral point  
This provision applies even if the neutral is not used by the machine in order to enable protection against indirect contacts (ground connection if necessary)
- For "dry" transformers, the applicable construction standards are:
  - **NF EN 61558** standard, for powers of less than 25 KVA single-phase, or 40 KVA three-phase
  - **NF EN 60076** standard, for powers in excess of 25 KVA single-phase and 40 KVA three-phase

### 3.1.5 Uninterruptible power supply (UPS)

Should all the equipment be powered by an emergency power supply (UPS), this power supply shall be provided by CEA.

Contractor shall provide all the necessary information for defining the product (voltage, power, autonomy).

Contractor shall provide lock terminals on the equipment to connect the emergency power supply.

If only a section of the equipment is powered by an internal UPS incorporated by the manufacturer (IT section for example), the following rules shall be complied with:

- An omnipolar separation mechanism shall be installed downstream of the UPS in order to allow maintenance operations.
- The presence of voltage after shutoff of the machine master switch shall be signalled on same.
- The circuits still powered after cut-off must be identified in orange inside the equipment as per standard **NF EN 60204**.

## 3.2 Management of the environment

In reference to its "Sustainable Development" initiative, CEA-LETI is working on improving its environmental performance and would like understand what its service providers and Contractors' contributions are to this regard.

Contractor shall therefore list in its offer all the initiatives that it has undertaken and / or is planning to undertake to make its business more sustainable from an environmental and social perspective. It will provide details about:

- its efforts regarding reduction in:
  - consumption of electrical and heat energy, and fluids;
  - exhaust flows through careful design of covers and exhaust points;
  - cooling water flow rates using an optimized calculation for heat exchangers.
- proposed fluid recycling.

The equipment must be designed so as to limit polluting emissions in the environment in particular by implementing clean technologies, segregation and treatment of effluents and waste depending on their characteristics, and reduction of the discharged quantities.

## 4 SAFETY

### 4.1 EC conformity

The supplied equipment or service shall meet the regulations in force in France.  
Said regulations include the European directives transposed into French Law.

#### European Directives:

Compliance with the European directives applicable to the equipment is mandatory.

In particular (if applicable) :

- “Machinery” directive **2006/42/EC**  
See **Appendix D**: Specifications for delivering work equipment (Compliance with European machinery directive **2006/42/EC**).
- “Electromagnetic compatibility EMC” directive **2014/30/EU**
- “Low voltage” directive **2014/35/EU**
- “ATEX” directive **2014/34/EU**
- “Pressure” directive **2014/68/EU**

The equipment shall be EC certified, a “CE marking” shall be affixed thereon and it shall be accompanied by an EC/EU declaration of conformity.

#### Construction standards

Compliance with harmonized European Standards (NF EN or NF EN ISO) will be favored, the application of these standards giving a presumption of conformity on the subjects concerned.

- **Risk analysis**

The various risks (mechanical, electrical, thermal, gas, chemical, radiation) shall be clearly mentioned by Contractor in its proposal.

The risk analysis will be made according to the applicable reference standard: **NF EN ISO 12100** : "Safety of machinery - General principles of design - Risk assessment and risk reduction"

These risks shall be handled:

- in accordance with the instructions of the applicable directives:
- in accordance with the recommendations of Paragraphs 5.2 to 5.12

- **Design of safety related parts:**

The safety functions will be designed in accordance with standard NF EN ISO 13849-1 "**Safety of machinery - Safety-related parts of control systems - Part 1: general principles of design**" for each type of hazard (mechanical / gas / thermal...)

- **Electrical equipment of machines**

The electrical equipment of machines will be designed in accordance with standard **NF EN 60204**

#### Reminder of technical points in relation with the regulations:

**Warning:**

This paragraph is aimed at attracting the manufacturers' attention to a few specific technical points which may lead to noncompliance if they're not completed.

- **Energy separation device**



The equipment will be fitted with an isolation device on each energy source (electricity, pneumatic, nitrogen, etc.) that can be locked in the off position.

- **Electrical cabinets**

Electrical cabinets will have an IP2X protection index and it will only be possible to open them with a tool or a key ; the inside of the cabinet will also have an IP2X protection rating so as to avoid any risk of direct contact during maintenance operations (components / wiring)

- **Guards design**

- Protection panels:

Protection panels (guards) will be strictly designed in compliance with Machinery Directive **2006/42/EC** (See appendix F: 1.3.8 to 1.4.3)

Moreover, the following conditions shall be complied with for selecting guards:

Fixed guards:

**The installation of fixed guards by manufacturer will be accepted if:**

- Frequent disassembly for maintenance is not necessary
- Removal of guard is exclusively reserved to maintenance personnel by following a written instruction drawn up by manufacturer (lock out tag out of affected moving elements for example).

Moving guards:

**Moving guards will be considered as all types of guards installed on hinges (doors) or not complying with the criteria of fixed guards.**

- The opening of the movable protectors will have to stop the risks present behind these protectors, by means of a safety system designed in accordance with the applicable European standards.
- The opening detectors installed on movable guards will be safety components in accordance with **NF EN ISO14119**

- **Maintenance modes**

If the machinery is equipped with "maintenance" or "service" mode in which the safety systems are neutralised, these modes will be strictly designed in compliance with Directive 2006/42/EC "Selection of control or operating modes"

**(See: appendix F point 1.2.5)**

Consequently:

- The maintenance of the equipment should not require the direct neutralization of the detection components (interlock doors). If this neutralization is necessary, it should be done via a maintenance mode accessible via a code or a key and simultaneously cause the reduction of risks (reduction of speeds, permanent control of the movements ...)
- The maintained action required to validate the movements will be of the pedal type or "dead man" safety handle.  
In particular, this system will be present on the control modules ("teach pendant ") for teaching robots.

- **Fume cupboards**

In case of fume cupboards, the applicable standards are:

**NF EN 14175-1, NF EN 14175-2, NF EN 14175-3, NF EN 14175-4, NF EN 14175-6, NF EN 14175-7.**

Factory and onsite "type tests" shall be subject to a conformance certificate or Contractor declaration. The Contractor shall anticipate all exhaust surveillance devices, associated servomechanisms and operator information devices on equipment operating state.

## **4.2 Risks connected with facilities**

Power supply sectioning:

A power supply-sectioning device must be designed on the equipment for each energy source of the machine



Electrical supply cut-off device:

The accessories enabling the electrical supply of all or part of the machine to be immobilised shall be supplied with the equipment (locking circuit breakers in off position).

Compressed air connection or "service" nitrogen:

When the equipment uses compressed air or nitrogen for valve, actuator and other system control, the machine must be equipped with a general shut-off valve.

This valve must include a locking system, by means of a padlock, in order to make the facilities safe for maintenance. One or more drain/purge systems must be available to dissipate the residual pneumatic energy stored in the machine after general valve shutting-off. Energy dissipation must be harmless to any exposed personnel or operators.

Presence of an uninterruptible power supply (UPS):

The instructions of Paragraph 4.1.5 shall be complied with.

The cut-off component at UPS output may be locked in "off" position.

### **4.3 Risks connected with fire**

Automatic fire extinction system for equipment using solvents:

Equipment implementing solvents in open tray (pans, most often) must have an automatic CO2 extinction system. This system will be connected to the operation of detectors (smoke, flame, temperature, etc.) installed above open trays, but also at equipment retention trays.

DESAUTEL (or equivalent) type automatic extinction systems certified and validated by qualified authorities shall be installed with approval of the facilities department. Dry contacts shall be supplied in the building in order to report each of the following elements of information:

- System disturbance
- Fire detection (1 detector giving alarm)
- Confirmed fire detection (2 detectors giving alarm, extinction triggered)

Intrinsic equipment fire detection system:

When fire detectors are supplied with the equipment, they must be accompanied by the risk analysis leading to their installation, in such a way that the LETI is able to make decisions on the grounds for doubling said detection using existing systems in the building which are compatible with the fire systems in place. Detectors integrated into equipment shall not be connected with the fire system of the building and shall only have an action on the equipment in question and its related peripheral devices, if required.

The Contractor will specify and provide the necessary documentation relating to:

- Periodic calibration of sensors: frequency, operating mode, calibration gas used, parts to change in preventive and corrective maintenance, and any information necessary to maintain the detectors in good working order.
- Connections required on the equipment, in case of:
  - Detection alarms for different thresholds
  - Malfunctions

A list of these interlocks with the corresponding wiring diagrams will be provided.

### **4.4 Risks connected with chemical products**

Not applicable.

### **4.5 Risks connected with handling**

For the parts of equipment requiring handling: pumping units, chamber lids, covers, etc., notably during maintenance or installation operations, lifting means must be foreseen and described in the equipment safety notice.

Systems integrated into the equipment will be favoured over mobile systems.

In the case of a mobile system, it must be marked "CE", be the subject of an EC declaration of conformity and an instruction manual in French.

#### **4.6 Risks connected with automatic loading of Foups onto LoadPorts**

Not applicable.

#### **4.7 Risks connected with pressurised equipment**

Not applicable.

#### **4.8 Risks connected with work at height**

Not applicable.

#### **4.9 Risks connected with laser radiation**

Not applicable.

#### **4.10 Risks related to sources of ionizing radiation (radioactive sources / electric generators of ionizing radiation, etc.)**

Not applicable.

#### **4.11 Risks connected with noise**

In reference to machinery directive **2006/42**:

"Machinery must be so designed and constructed that risks resulting from the emission of airborne noise are reduced to the lowest level taking account of technical progress and the availability of means of reducing noise in particular at source.

The level of noise emission may be assessed with reference to comparative emission data for similar machinery."

The noise level measurements will be performed and mentioned in the instruction manual in compliance 2006/42

The noise level generated by the equipment in its installation environment should be less than 70 dB (A).

If noise level is likely to exceed 70 dB (A), the Contractor will suggest quoted technical solutions of reduction: silent hardware, soundproof materials, soundproof covers on noise sources...

#### **4.12 Risks connected with temperature**

**Hot surfaces:** the temperatures of directly accessible hot surfaces must comply with standard requirements **NF EN ISO 13732-1**

**Cold surfaces:** The temperatures of cold surfaces directly accessible shall comply with the requirements of standard **NF EN ISO 13732-3** of 2008

**WARNING:** In the case of heating systems embedded in the machine

- The manufacturer must foresee the consequences of a malfunction of the control unit by installing a completely independent overheating safety device (sensor / regulator ...). This safety system will shut down the power and will require manual reset for restart (after fault clearing). The reliability of the cut-off system will be defined according to **EN 13849-1**
- The manufacturer must be able to define the consequences of a sudden and simultaneous complete interruption of the machine's "facilities": water / electricity / extraction hot air / nitrogen service ... when the system is at nominal temperature.

The equipment will have to support this scenario without generating a fire risk internal to the machine, nor any other risk (explosion ...)

In this scenario, if the temperature of the external enclosure of the equipment exceeds that of the equipment in normal mode, the Contractor will give the estimated temperature values and will consider them in the installation instructions (safety distances from the walls and other equipment).

## 4.13 Signalling

Signalling: risks shall be indicated on the machine using danger pictograms such as described in European regulations, accompanied as the case may be by an additional text;

In this case, the text must be labelled in French.

## 4.14 Intervention conditions on the CEA-LETI site

In collaboration with the Contractor and its possible sub-contractors, the CEA-LETI shall draft an overall prevention plan for installation, start-up and possibly development (JDP) services on equipment.

As loaning material is prohibited at the CEA, the Contractor and any subcontractors must provide safety materials needed to prevent specific risks generated by its intervention: PPE, CPE, breathing apparatuses, etc. It shall be responsible for replacement and repairs and, if required (without compensation on the part of CEA), it shall promote awareness and train its staff for use of equipment as per regulations. This material shall comply with regulations in force and shall be accompanied by a certificate of conformity.

The Contractor and its possible sub-contractors must provide all collective safety equipment used to prevent accidents due to works (marking work areas, marking traffic areas, marking handling and flyby areas, marking and installation of barriers around pits, level differences, etc.). It shall carry out and ensure removal of them as soon as the service no longer requires the presence of marking.

# 5 SUSTAINABLE DEVELOPMENT

## 5.1 Corporate Social Responsibility (CSR)

With an amount representing nearly 2.7 billion euros, CEA purchases are an integral part of societal and environmental issues.

The CEA monitors the quality and diversity of relations with its suppliers. It conducts a responsible purchasing policy based on three priority commitments:

- Create and maintain confidence-inspiring relations with its suppliers,
- Take into account the responsible dimension of its purchases,
- Contribute to the development of Small and Medium Enterprises (SMEs) and innovation.

Since 2004, it has been a signatory of the “responsible supplier relationship” charter and adheres to the SME Pact, a national support scheme for innovative SMEs.

The CEA's commitment to developing responsible purchasing cannot be made without taking this dimension into account by its suppliers.

The CEA is therefore counting on your proposals within the framework of this consultation to optimize the environmental impact of your services and develop the integration of people who are excluded from employment and the protected sector.

## 5.2 Sustainable development and development of the local economic fabric

As part of the “Sustainable Development” approach, CEA Grenoble is striving to improve its environmental performance and requires the cooperation of its suppliers in this respect.



In its proposal, the service provider shall present its corporate strategy as regards sustainable development and its specific improvement proposals concerning the work that covered by these Specifications.

Furthermore, as part of its “Plan Déplacement Entreprise” (“Corporate travel plan”), CEA Grenoble undertakes to reduce its environmental footprint.

The service provider shall cooperate with CEA Grenoble and undertakes to use zero emission vehicles as much as possible to meet the requirements mentioned in these Specifications.

Furthermore, LETI MINATEC is a pedestrian area, with regulated vehicular access.

Vehicles identified by the company's name may access the pedestrian area subject to CEA Grenoble's approval. All other vehicles shall be parked in the dedicated car park.

The recovery or disposal of waste created during the performance of the services is the responsibility of the supplier during the duration of the contract.

The supplier shall ensure that any operations, collection, transport, storage, sorting and disposal of waste created by the services subject to the contract are carried out to the sites likely to receive them, in accordance with the regulations in force.

### **5.3 Energy performance**

As part of its ISO50001 "energy management" initiative, CEA Grenoble is working to improve its energy performance, and would like to be supported in this by its suppliers.



In its offer, the service provider presents its proposals for improvement specific to the services detailed in the present specifications.

CEA Leti asks the service provider to propose all equipment and solutions enabling to optimize and reduce as much as possible the energy consumption of the entire project, and to propose in its offer the energy saving certificates related to the project. »

## **6 EQUIPMENT DELIVERY CONDITIONS**

The equipment and all the peripherals will be delivered clean and packaged in a serious and appropriate way.

The transport platforms, pallets and packaging cases must be adapted to the weight and volumes of the elements in order to ensure safe a transport and avoid any dispute connected with improper packaging.

## **7 CONDITIONS FOR INSTALLING EQUIPMENT**

Contractor shall enclose with its technical proposal the pre-installation document defined in **Appendix E**, then an installation file at the time of the installation.

It shall include all the installation conditions in particular the elements required in Paragraph 2: "instruction manual /installation" of Appendix E: Specifications pertaining to documents and manual to be provided with the equipment.

## **8 TRAINING & LEARNING**

The supplier must provide comprehensive on-site training for at least two (2) CEA-LETI personnel immediately following the successful installation and acceptance test.

The training must cover all aspects of the system's operation, starting with detailed procedures for powering on and off the equipment. It should also include safe procedures for handling cryogenic fluids like liquid helium and liquid nitrogen and connecting the transfer lines. Trainees will receive a thorough walkthrough of the control software, including data acquisition, temperature control, and scripting. Hands-on training will be provided for basic maintenance tasks, such as replacing O-rings, re-sealing vacuum flanges, and troubleshooting common issues. Finally, the session must include an overview of all safety features and emergency protocols.

The training is expected to last a minimum of half a working day to ensure that our team is fully proficient in operating and maintaining the system.

## **9 DOCUMENTATION**

See **Appendix E**: "Specifications relating to the documents and manuals to be supplied jointly with the equipment".

Each manual must be available in two paper version plus possible CD-ROM version

Two sets of each manual shall be provided, one of the two sets shall be on clean room compatible paper.

From a statutory standpoint, the delivery of a document or publication in CD-ROM format only (no hardcopy version) is construed as non-conformity.

## 10 WARRANTY

### 10.1 Warranty conditions

Warranty shall start at the date of equipment acceptance for a duration of one year.

Warranty shall include corrective maintenance operations and cover all related costs: labour, spare parts, travels, shipments etc...

### 10.2 Support during warranty

During the warranty period, the Contractor agrees to provide on-site support within a maximum timeframe of 8 business days after receiving an e-mail or a call from CEA-LETI.

Support shall be available for on-site intervention from 8am-6pm on weekdays.

## 11 MAINTENANCE

### 11.1 Spare parts

#### 11.1.1 List of spare parts

In its bid, the Contractor shall include:

- A comprehensive list of spare parts;
- A comprehensive list of consumables needed to operate the equipment, with the functions, reference and price for each component.

These lists may be used as a basis for drawing up an agreement for the supply of spare parts and consumables.

The Contractor shall specify the standard delivery timeframe as well as the timeframe for an emergency situation.

#### 11.1.2 Process-kit

Not applicable.

#### 11.1.3 Storage area

The Contractor must specify in appendix A the floor space necessary for the storage of specific maintenance materials supplied with the equipment, including spare parts, tools, handling means etc:

- 1- Floor space required during installation phase
- 2- Floor space required during normal use of the equipment

### 11.2 Maintenance contract

At the end of the warranty period, the CEA-LETI shall have the possibility of subscribing a maintenance contract.

The Contractor shall commit to be able to perform preventive and corrective maintenance for each piece of Equipment after the warranty period has expired and for a minimum period of 10 years.

In the commercial proposal, the Contractor shall calculate the price of optional maintenance services, taking the following requirement levels into account:

- Full service including preventative maintenance, unlimited corrective maintenance, and all required spare parts. The Contractor should also commit to a defined up-time of the tool during this period. Unless otherwise stated, the performance of the tool during the Full Service contract will be that defined in the current « EQUIPMENT SPECIFICATIONS FORM ».
- Preventive maintenance plus corrective maintenance on request (hourly rates) complying with intervention and repair deadlines.

Further to the adjustment of CEA's needs with respect to maintenance, the maintenance contract may be implemented after the warranty period has expired further to negotiations.

### **11.3 Cost of ownership (COO)**

Not applicable.

## **12 CHECKS & TESTS**

The tests and checks of conformity for equipment subject of these specifications are broken down into six groups:

- ✓ At the factory
- ✓ Delivery
- ✓ Installation and commissioning
- ✓ Qualification
- ✓ Acceptance
- ✓ End of warranty

### **12.1 Checks and tests at the factory (Factory acceptance tests)**

Not applicable

### **12.2 Check upon delivery & at unpacking**

Contractor shall submit the packing procedure for CEA-LETI acceptance. It shall at least specify breakdown of the packages, space requirement and associated instrumentation (example: accelerometer indicator).

The Contractor will ensure proper following of this procedure. If the delivery occurs in the presence of the Contractor (or his representative), the Contractor will check the integrity of the various packages, analyse the associated instrumentation and draft a "delivery" report (using their own documentation). Otherwise, the delivery countersigned by CEA-LETI shall be considered as the delivery report.

The Contractor shall ensure that the equipment is correctly unpacked.

## **13 – Installation**

The following chapters describes the main steps for installation preparation

### **13.1 Preparation**

Contractor should be available at all time to assist CEA LETI in the preparation of the system installation

#### Part 1:

No later than 1 week after PO notification, Contractor must provide:

- System footprint - Dimension of all systems or sub systems
- Pre installation Manual

2 months after Po notification:

- Contractor must assist CEA LETI teams in order to validate definitive Appendix H and Footprint/layout.

#### Part 2:

2 months after PO notification:

- Contractor must validate Appendix I with the CEA LETI safety officer be compliant with CEA risk management policy (Appendix I, Fire suppression analysis, extra safety detections common validation)
- Consolidate the need of sub assembly which might be supplied by CEA LETI

#### Part3:

6 months before system delivery Contractor must assist CEA LETI:

- for chassis conception (formal Contractor dimension and cut off validation is requested)
- for PIDs (fluids & electric) conception (same)
- commissioning planning

## **13.2 Installation**

### Basic Rules:

During the installation and as soon as possible, the Contractor will remove all waste and parts from the installation which are no longer required

All along the installation, Contractor must follow CEA-LETI team safety policy and must not open or start any fluid or source of energy without specific approval.

The supplier is responsible for the full on-site installation of the cryogenic probe station at the CEA-LETI facility in Grenoble, France. This includes all necessary assembly, vacuum connections, electrical wiring, and cryogenic plumbing. A certified technician from the supplier's team must perform the installation and ensure that the system is fully operational and meets all specifications as detailed in this tender. The installation must be concluded with a formal acceptance test, witnessed by CEA-LETI personnel, to verify all performance metrics, including base temperature, cool-down time, and vacuum integrity. This part details the installation procedure and its different steps.

### **13.2.1 System delivery & move in to final location:**

Not applicable.

### **13.2.2 Tiers 0 - System mechanical assembly, system start Up**

#### Basic Rules:

The Contractor shall use its own tools to perform equipment assembly, including handling and lifting tools that may be necessary.

During this phase, the Contractor will perform the equipment assembly, levelling.  
Interconnections will be managed according to contract specification specified in the Appendix H

No energy will be present during this phase.

#### At the end of the Tier0:

- The machine and sub system will be energized.
- The Contractor must be present to acknowledge the power supply is meeting its specification.



### 13.2.3 Tiers 1 - Final Hook Up and system start Up after power up

#### Basic Rules:

The Contractor must:

- Attend all the operations to install and connect the equipment to the facilities (fluids, extractions, etc.) and shall make sure that the latter are compliant with the Contractor's specifications. The contractor has the responsibility of the final connection from facilities to its equipment's
- Contractor must follow CEA safety policy and must not open or start any fluid or source of energy without specific approval.
- Make sure that the connections are compliant with the Contractor's specifications.
- For all the fluid connections (including effluents) or gas inter equipment or modules provided by the Contractor, the latter will carry out the marking and direction of these networks in accordance with European standard NF X 08-100 including pictograms SGH informing of the danger by printed solvent resistant laminated polyester adhesive stickers.  
The valves will be equipped with color labels engraved out of PVC 8/10e fixed by adapted collars indicating their function.
- At the end of the installation, the Contractor will remove all waste and parts from the installation which are no longer required.

At the beginning of this phase, the system will be able to be powered Up.

The connection to Gas, Fluid, air extraction and Drain will be performed during this phase

The final gas connection to the system will be supervised by the contractor

The contractor will then:

- Perform the required hardware adjustment and calibration (robotics etc.) according to its system specification.
- Carry out checks on facilities which includes checking the various safety controls.
- Provide an "hardware report" commissioning which summarizes the progress of the above step and the result of the various controls. This report will confirm that the connection by the Contractor and standard safety tests are completed. The main safety elements concerned are: emergency stops, the extraction detection, leakage or gas detection, door contacts ... (Operation and connections)

#### Note:

The fluid connections to the equipment (process or chemical gases) will be made by CEA-LETI after receiving the "hardware report" described above from the Contractor and after the safety compliance inspection (described below) has been successfully completed.

#### At the end of the Tiers 1:

CEA-LETI will perform a safety compliance inspection (EC requirements).

The Contractor must be present during this inspection and will make all necessary documents available for the assessment of the equipment.

Depending on the anomalies, CEA-LETI may decide to suspend the commissioning operations pending remediation of the problems. Non-conformities noted correspond to non-compliance with the regulatory points.

Any non-compliance must be resolved before the acceptance report can be signed.

All Anomalies and malfunctions will be promptly corrected by the Contractor no additional costs.

### **13.2.4 Tiers 2 - Contractor Equipment qualification & handling test**

This qualification procedure shall be performed in the presence of CEA-LETI authorised representatives. The summary of these tests shall be countersigned by CEA-LETI (qualification summary report). During this step,

- The contractor will make the handling test according to specification
- The contractor will make its own system qualification according to system specification. A summary report might be provided and countersigned by CEA Leti at the end of the contractor test

In the case it is not under specification, the contractor will take the proper actions to get the systems under CEA LETI specification.

#### **At the end of the Tiers 2:**

The equipment is meeting the contractor specification test and the equipment is available for the CEA LETI process qualification.

The Contractor will remove all waste and parts from the installation which are no longer required.

### **13.2.5 Tiers 3 - CEA Process Qualification**

During this phase, CEA-LETI ensures that the expected specifications for each process are met.

If these specifications are not met, even after the equipment supplier's intervention, it may result in the CEA-LETI refusing to accept the equipment or recording reservations in the CEA Equipment Acceptance Report.

In particular, CEA-LETI will check that the sample temperature achieved in various conditions are in accordance with the specifications.

Note: the contractor must be present during the test of the equipment

## **13.3 Acceptance**

This acceptance recognises conformity of the equipment and transfer of ownership. The equipment warranty period shall start once the acceptance has been confirmed.

Acceptance shall be pronounced after:

- ✓ **Full delivery of the equipment**
- ✓ **The end of the installation and commissioning operations**
- ✓ **The qualification checks and tests successfully passed**
- ✓ **EC conformity approval given by the body accredited by CEA.**
- ✓ **Authorisation from the installation manager at the home site**
- ✓ **Delivery of the documentation (see make up in APPENDIX E: Specifications pertaining to documents and manuals to be supplied with the equipment)**

A reception document without qualifications (\*) will be signed between CEA-LETI and Contractor.

(\*) A concession may possibly be granted for a reserve forming the subject of a detailed action plan for restoring compliance to the specifications subject of this document. If so, acceptance will be pronounced "with reservations"

Note: Only the report in CEA-LETI format, shall prevail to assert the associated payments with this stage and launch the warranty period.

## **13.4 End of warranty**

The completion of the guarantee is pronounced at the end of the guarantee period under the following conditions:

- ✓ **Total removal of all qualifications noted during the acceptance**
- ✓ **No abnormalities detected**
- ✓ **Compliance of the equipment with the specifications during this period.**

---

**Cryogenic probe station specifications**  
**DRT-LETI-DCOS-SCCS-LCEF-25-07-001559**


---

In case of any abnormality, the Contractor will perform any work required to ensure the compliance of the equipment. If the functioning of the equipment is not satisfactory, the warranty period is automatically extended by a period described in the contract.

## 14 APPENDICES

### APPENDIX A: Summary of Contractor's comments

Please ensure you complete the provided template file, "Appendix\_A.xlsx", with all required information and return it as a mandatory part of your final offer submission.

APPENDIX A : contractor feedback to specifications										
			Specifications title		Lakeshore cryogenic probe station upgrade specifications					
			Specifications reference		DRT-LETI-DCOS-SCCS-LCEF-25-07-001561					
			Contractor company name							
			Quotation reference							
			Contractor reply Please add "X" in relevant column			If Contractor reply involves change to specification --> Specification discussion between				
Item number	Item title	LETI owner	Fully accepted	Accepted with modification	Not applicable	Contractor comment #1 + date	CEA-Leti comment #1 + date	Contractor comment #2 + date	CEA-Leti comment #2 + date	Contractor comment #3
1	<b>PURPOSE</b>	RE								
	Appendix A									
	Appendix I									
	Footprint and dimension of all systems									
	Pre-installation manual									
2.1	<b>New probe arm assemblies</b>	RE								
2.1.1	Common specification									
2.1.2	Multi-contact DC assemblies									
2.1.3	Multi-contact DC assemblies									
2.2	<b>Spare parts</b>	RE								
2.2.1	General purpose DC cables									
2.2.2	Low current leakage measurements cables									
2.2.3	Grounded sample holder									
2.2.4	Option - Cernox reference substrate									
3.1.1	<b>Building specifications</b>									
3.1.2	<b>Building power network specifications</b>									
3.2	<b>Management of the environment</b>									

## APPENDIX B: general fluids in building 51C

General fluid distribution	Building 51C characteristics	Specific observations
<b>"Service" gas nitrogen</b> (Recommended dimensioning velocity: 20 m/s)	Material: stainless steel 316L Ra 0.8	Service nitrogen replaces compressed air for all pneumatic uses; it is also used for vacuum pump ballasting.
	Relative pressure: 8 bar	
	O <sub>2</sub> < 1 PPM	
	CO + CO <sub>2</sub> + CnHm < 2 PPM	
	H <sub>2</sub> O < 1 PPM	
	H <sub>2</sub> < 1 PPM	

## **APPENDIX C: Definition of Availability**

### **1. Planned time**

The total planned time corresponds to the total hours of use for a reference period: 5 shifts - 7 days (168h/week).

### **2. Up-time definition**

The basic formula for calculating the up-time is:

- Up-time (%) = 100 - Equipment down-time (%)

### **3. Down-time definition**

The equipment down-time is the time during which the machine cannot be used for production according to the process specifications.

The equipment down-time is divided into:

- Scheduled down-time
- Unscheduled down-time

#### **A) SCHEDULED DOWN-TIME**

The scheduled down-time is the equipment shut-down time scheduled by the maintenance and production for preventive maintenance, for operations involving cleaning, modification, improvement, changing location, etc...

#### **B) UNSCHEDULED DOWN-TIME**

The unscheduled down-time is an unscheduled period during which the machine cannot be used for production. Down-time must result from a failure proper to the equipment and not result from external elements (fluids, building, etc...).

This time does not take the user's imperfections into account:

- malfunctioning after incorrect use of the equipment (non-compliance with operating procedures),
- malfunctions resulting from the user's installations or structural or social problems.

### **4. Measuring up-time**

Due to the up-time definition given above, measuring the up-time simply involves measuring the down-time.

### **5. Measuring down-time**

#### **A) START**

Down-time starts from stoppage of production due to stopping of the machine, either deliberate or not, and from the agreement between the production and maintenance teams that production can no longer be performed with the specifications.

This moment is recorded on a document or in a file and is immediately notified to the Contractor (in case of failure) by telephone with confirmation by MAIL within 24h.

#### **B) DURATION**

Down-time covers:

- The initial period during which the operator performs troubleshooting to locate the cause of error, plus the waiting time of a maintenance person after a call to the Contractor's departments (in the case of a failure).
- The duration of the maintenance operation (repair / improvement / modification).
- The repair time resulting from waiting for spare parts.
- The time, after repair, to burn-in and check the equipment.
- The maintenance and process qualification time.

These different times must be noted and recorded accurately.

#### **C) END**

The end of equipment down-time takes place after the process has been qualified again. At this moment the machine is again in compliance with the specifications and can be used for production in agreement with the maintenance and process teams.

The different down-time states and times are consultable and can be supplied to the equipment Contractor on request from him.

MTBF definition

The MTBF is the mean up-time value in hours between two failures (the interrupt can be scheduled or unscheduled down-time). This mean value is calculated over 13 weeks and is the number of hours of up-time divided by the number of interrupts.

$MTBF = \text{Up-time (in hours)} / \text{number of interrupts}$ .

MTTR definition

Mean time to recover: mean time to put the machine back into a state of compliance, this state takes account of scheduled and unscheduled down-time and is averaged over 13 weeks.

$MTTR = \text{number of hours of down-time} / \text{number of interrupts}$



## APPENDIX D: Specification for delivery of equipment subject to the European “machinery” Directive 2006/42/CE

**Purpose:** The aim of this document is to recall the application conditions of this directive as well as certain important technical points

### **1/ Reminder of the applicable regulation**

The “machinery” directive is a European text transposed into the French law.

### **2/ Definition of a machine**

A machine is “an assembly fitted with or intended to be fitted with a drive system other than directly applied human or animal effort consisting of linked parts or components, at least one of which move and which are joined together for a specific application...”

Consequently:

Any equipment complying with the definition will be designed and built-in application with the “machinery” directive 2006/42.

A machine is considered as “placed on the market for the first time”, “new” or “in the new condition” if it has not been used in a member state of the European Economic Community (EEC).

Consequently:

A second-hand machine from a non-EC country will be considered as new upon its entry into the EC.  
The applicable regulation will be that in force at its date of entry.

### **3/ Reference standards**

The presumption of conformity with regulatory requirements is provided by compliance with the provisions described in the harmonised standards mentioned above and circulated by AFNOR Tour de l'Europe 92049 Paris Cedex 7, France:

- specific standards to machinery
- general safety standards,
- standards pertaining to electrical equipment of machinery NF EN 60-204

**Note: Compliance with standard 61010-1 does not give a presumption of compliance to the machinery directive**

**4/ Documents to be provided with the equipment subject to directive 2006/42**

➤ **EC declaration of conformity**

**2006/42 annex II:**

**“EC DECLARATION OF CONFORMITY OF THE MACHINERY**

The declaration and translation thereof must be drawn up under the same conditions as the instructions

[See Annexe I, Section 1.7.4.1, points a) and b)] and must be typewritten or else handwritten in capitals.

This declaration relates exclusively to the machinery in the state in which it was placed on the market and excludes components which are added and/or operations carried out subsequently by the final user.

The EC declaration of conformity must contain the following particulars:

- 1) business name and full address of the manufacturer and, where appropriate, its authorised representative;
- 2) the name and address of the person authorised to compile the technical file, who must be established in the community;
- 3) description and identification of the machinery, including generic denomination, function, model, type, serial number and commercial name;
- 4) a sentence expressly declaring that the machinery fulfilled all the relevant provisions of this directive and where appropriate a similar sentence declaring the conformity with other directives and/or relevant provisions with which the machinery complies. These references must be those of the text published in the official journal of the European Union;
- 5) where appropriate, the name, address and identification number of the notified body which carried out the EC type-examination referred to in Annexe IX and the number of the EC type-examination certificate;
- 6) where appropriate, the name, address and identification number of the notified body which approved the full quality assurance system referred to in Annexe X;
- 7) where appropriate, a reference to the harmonised standard used as referred to in Article 7, Paragraph 2;
- 8) where appropriate, the reference to other technical standards and specifications used;
- 9) the place and date of the declaration;
- 10) identification and signature of the person empowered to draw up the declaration on behalf of the manufacturer or his authorised representative.”

➤ **An instruction manual**

An instruction manual shall be drawn up in compliance with Paragraph 1.7.4 of Directive 2006/42; see our Appendix E

**5/ Marking on the equipment (2006/42 – 1.7.3)**

“I. – Each machinery must be marked visibly, legibly and indelibly with the following minimum particulars:

- a) The business and full address of the manufacturer;
  - b) Designation of the machinery;
  - c) The CE marking;
  - d) The designation of series or type;
  - e) The serial number if any;
  - f) The year of construction, that is, the year in which the manufacturing process is completed. It is prohibited to predate or postdate the machinery when affixing the CE marking.
- Furthermore, machinery designed and constructed for use in a potentially explosive atmosphere must be marked accordingly.

II. – Machinery must bear full information relevant to its type and essential for safe use. Such information is subject to the requirement set out in Section 1.7.1.

III. – Where a machine part must be handled during use with lifting equipment, it must be indicated legibly, indelibly and unambiguously.”

## **APPENDIX E: Specification relating to documents and manuals to be provided with the equipment**

### **1. Purpose**

This appendix is intended to define the documentation to be delivered by the Contractor with the equipment (content, language, delivery schedule).

The documentation to be delivered by the equipment must meet current regulations.

The CEA-LETI / LETI specifications include the statutory requirements.

These obligations depend on whether the equipment is subject to the machine directive 2006/42 / EC.

### **2. Supply of an equipment item subject to machinery directive 2006/42/EC (e.g. 98/37/EC)**

#### **2.1. Regulatory obligations**

##### **2.1.1. Instruction manuals**

The regulations describe all the elements relating to the instructions that must be supplied with the equipment (content, language etc.).

This information is included in Annex I to Directive 2006/42 transposed into French law (Annex I of Book II of the Labour Code)

##### **Content**

The instruction manual will be drafted in compliance with Paragraph 1.7.4. of this appendix and where applicable Paragraphs 3.6.3 (moving machines) and 4.4 (lifting systems).

**2006/42 - 1.7.4 .2:** Content of the instruction manual:

“Each instruction manual must contain, where applicable at least the following information:

- a) The business name and full addresses of the manufacturer;
- b) The designation of the machinery as marked on the machinery itself except for the serial number in compliance with Paragraph 1.7.3;
- c) The EC declaration of conformity or a document setting out the contents of the EC declaration of conformity, showing the particulars of the machinery, not necessarily including the serial number and the signature;
- d) General description of the machinery;
- e) The drawings, diagrams, descriptions and explanations necessary for the use, maintenance and repair of the machinery and for checking its correct functioning;
- f) A description of the workstation(s) likely to be occupied by operator;
- g) A description of the intended use of the machinery;
- h) Warnings concerning ways in which machinery must not be used that experience has shown might occur;
- i) Assembly, installation and connection instructions, including drawings, diagrams and the means of attachment and the designation of the chassis or installation on which the machinery is to be mounted;
- j) The instructions relating to installation and assembly for reducing noise or vibration;
- k) The instructions for putting into service and use of the machinery and, if necessary instructions for the training of operator;
- l) The information about the residual risks that remain despite the inherent safe design measures, safe-guarding and complementary protective measures adopted;

- m) Instructions on the protective measures to be taken by the users, including, where appropriate, the personal protective equipment to be provided;
- n) The essential characteristics of tools which may be fitted to the machinery;
- o) The conditions in which the machinery meets the requirement of stability during use, transportation, assembly, dismantling when out of service, testing or foreseeable breakdown;
- p) Instructions with a view to ensuring that transport, handling and storage operations can be made safely, giving the mass of the machinery and of its various parts where these are regularly to be transported separately;
- q) The operating method to be followed in the event of accident or breakdown; if a blockage is likely to occur, the operating method to be followed so as to enable the equipment to be safely unblocked;
- r) The description of the adjustment and maintenance operations that should be carried out by the user and the preventive maintenance measures that should be observed;
- s) Instructions designed to enable adjustment and maintenance to be carried out safely, including the protective measures that should be taken during these operations;
- t) The specifications of the spare parts to be used, when these affect the health and safety of operators;
- u) The following information on airborne noise emissions:
  - the A – weighted emission sound pressure level at workstations, where this exceeds 70 dB (A); if this level is less than or equal to 70 dB (A), this fact must be indicated;
  - the peak C - weighted instantaneous sound pressure value at workstations where this exceeds 63 Pa (130 dB in relation to 20 µPa);
  - the A – weighted sound power level emitted by the machinery, where the A – weighted emission sound pressure level at workstations exceeds 80 dB (A)."

#### **Language**

"All machinery must be accompanied by instructions in French.

The instructions manual accompanying the machinery must be either an original instruction manual or a translation of the original manual in which case, the translation must be accompanied by the original instruction manual."

#### **(Transposition of 2006/42 1.7.4)**

"The instruction manual is drafted in French and may be in one or more official Community languages. The word original instruction manual must appear on the language version(s) verified by the manufacturer. Where no original instruction manual exists in French, a translation into this language must be provided by the manufacturer or by the person bringing the machinery into France. This translation must bear the words translation of the original instruction manual." **(Transposition of 2006/42 1.7.4.1)**

Consequently, the following will be provided:

- The instruction manual in its original version drafted in one of the EC languages, in any case
- The instruction manual translated in French (if the original version was drafted in another language than French) in the case where this obligation is incumbent upon the Contractor.

### **2.1.2. Maintenance manual**

"By way of exception, the maintenance instructions intended for use by specialised personnel mandated by the manufacturer may be supplied in only one community language which the specialised personnel understand."  
(2006/42- 1.7.4)

## **2.2. Specific specifications at CEA/LETI**

Contractor shall mandatorily provide:

- The instruction manual as described in 2.1.1 and specified in 2.2.1.
- The maintenance manual as described in 2.2.2.
- A file of all elements that were tested and validated during startup and adjustments made in connection with facilities for each fluid. This file will also include factory tests and calculation sheet for parts of the facility used for their selection during design (heat exchangers, flow rates, sections of pipes that are inside equipment).
- These instructions should be delivered with the equipment except the installation section of the instructions which should be received by CEA-LETI / LETI, together with the Contractor's offer.

### **2.2.1. Instruction manual**

The instruction manual shall correspond to the machine delivered and contain in particular the following chapters:

- Handling
- Assembly – Disassembly
- Installation
- Commissioning
- Adjustment
- Use
- Maintenance (1st level)

#### Handling

This chapter shall deal with the conditions for handling the equipment: lifting or bearing points, miscellaneous precautions to be taken during handling. It shall give indispensable information such as the weight in kilograms. It shall highlight the counter-indications such as for example shocks, tilting etc...

If the equipment is comprised of different parts, the same information shall be given for handling each part.

#### Assembly - Disassembly

This chapter shall specify if applicable the order of the operations, the precautions to be taken, and the tooling required.

#### Installation

This part shall contain all the specifications necessary for installation and connection of the machine on the CEA-LETI premises. A copy of this part shall be sent to the CEA/LETI/Department concerned, before the equipment is delivered. This chapter shall contain in particular the following information :

- For the equipment and its sub-assemblies: dimensions in mm, weight (in kg), dimensional drawing mentioning the connection points to the different networks.
- Environment required: dust content, hygrometry, vibrations, sensitivity to vibrations and electromagnetic radiation, extractions to be provided etc...
- Nature of the floor: resistance required with respect to the weight of the machine, flatness.
- Electricity: Voltage, Power, features of the power supply transformer if applicable.
- Pneumatics (compressed air): pressure, quality.
- Fluids: Type, pressure, flowrate, temperature, characteristics.
- Gas: Type, pressure, quality.
- Counter-indications for installation, nuisances introduced by the equipment.

All these parameters shall be accompanied by a tolerance.

### Commissioning

Even if commissioning is performed by the Contractor, this chapter shall set out the procedure to be followed for commissioning of the equipment (prior checks, start-up procedure etc.).

### Adjustments

A procedure shall be provided to perform tuning/adjustments within the scope of normal everyday use of the machine.

### Use

This chapter shall contain:

- The conditions of use scheduled by the manufacturer.
- The definition of the workstation(s) occupied by the operator(s).
- A presentation of the equipment enabling identification of the different parts (photos, diagrams) explaining the function of each part, particularly of the control and safety means.
- A description of the running sequence of the operations performed by the equipment. All the processes available on the equipment shall be described along with the nature and influence of each "process" parameter.
- An operating mode describing the details of the operations to be performed to process a sample, a batch (for example). It shall contain the learning instructions.

### **CAUTION**

In the case of an automatic machine, the operation mode shall not be limited to necessarily succinct description of loading/unloading of a sample or a batch (for example) but shall enable the parameters of the standard functions to be adjusted and the alarm messages to be understood.

In the case where man/machine dialogue takes place via keyboard + monitor or touch-sensitive screen, the following information provided by the manual shall enable:

- the general software architecture (maintenance part / engineering part / operator part for example) to be understood,
- navigation between the different parts,
- the parameters of a task performed by the machine and influencing the "process" (for example: speed, time, pressure, power etc.) to be adjusted, these operations falling within the scope of normal use of the machine in a research environment,
- the results or "process" running monitoring tables to be accessed,
- the alarm messages to be understood and interpreted.

To achieve this result, the manual shall reproduce the main tables displayed on the monitor. Each table shall be accompanied by comments on the actions to be performed, on the nature of the information given.

### Maintenance

The object of this chapter is to enable troubleshooting to be performed and certain problems of low complexity to be resolved. It involves 1st level maintenance.

### **CAUTION**

All the chapters of this manual shall be drafted integrating the safety warnings so that the operations described can be carried out without any risks.

This appendix is fully applicable even if supply of the equipment is accompanied by personnel training.

The potential users of this manual are technicians or engineers in charge of tuning the "processes". This shall be taken into account in the choice of the information supplied.

The equipment shall only be accepted after a detailed examination of the documents provided.

#### **2.2.2. Maintenance manual**

It shall contain :

- a presentation of the machine enabling the component parts to be located (photos),
- the interconnection diagrams between the different sub-assemblies,

- the electrical power diagrams, control diagrams, and interconnection diagrams between the different parts, the printed circuit board diagrams,
- the diagrams of the pneumatic and hydraulic circuits,
- the mechanical construction drawings (exploded views),
- the spare parts list,
- the specific documentation of apparatuses integrated in the machine such as automatic controllers, regulators, RF and micro-wave generators.
- the programs and programming tools associated to automatic controllers,
- the list of periodic checks to be performed,
- the list of preventive maintenance operations to be performed with the list of consumables associated with the operation,
- a troubleshooting guide,
- the access modes to the software maintenance parts, if applicable, and the back-up procedures.

### **3. Supply of equipment not subject to the machinery directive: Specifications of CEA/LETI**

The supplier must provide a comprehensive set of technical documentation upon delivery of the system. This documentation is critical for installation, maintenance, and future modifications. The required documents must include, but are not limited to:

#### **Detailed mechanical drawings**

Provide a complete set of mechanical drawings in an industry-standard format (e.g., CAD files like DWG, DXF, or STEP). These drawings must include precise dimensions, a complete parts list, and an exploded view of all major components, including the stand, vacuum chamber, and sample stage assembly. The documentation should also include a clear footprint of the entire system, detailing its precise dimensions and weight to facilitate facility planning and placement within the laboratory.

#### **Electrical and cryogenic schematics**

Supply a full set of electrical schematics detailing all wiring, connectors, feedthroughs, and control electronics. Similarly, provide schematics for the cryogenic fluid and vacuum lines, including all valves, pressure gauges, and plumbing connections. This will be invaluable for troubleshooting and for integrating the system with existing laboratory infrastructure, such as gas recovery lines and electrical networks.

#### **Operating and maintenance manuals**

Provide comprehensive manuals in both digital and physical formats. The operating manual must include detailed instructions for all procedures, from initial setup and cool-down to sample loading and temperature control. The maintenance manual must outline a clear schedule for routine service, a troubleshooting guide for common issues, and procedures for replacing key components.

#### **Software documentation**

For any supplied software, provide a user manual and a technical guide detailing the software architecture, remote control protocols, and scripting capabilities. This will enable CEA-LETI to automate experiments and integrate the system into its data acquisition environment.



## APPENDIX H: Datasheet for tool installation

The supplier must furnish a detailed Site Preparation Document summarizing all necessary requirements for the equipment's installation. This document must explicitly specify the demands for utilities, including, but not limited to, electrical power supply (voltage, phase, current, and required connectors), compressed air/nitrogen (pressure, flow rate, and connection fittings), and any other necessary supplies (e.g., cryogen venting line specifications). This information is mandatory to allow CEA-LETI to accurately design and install the required piping and utilities prior to the tool's scheduled delivery and installation.




## APPENDIX I: Risk Identification Sheet

Please ensure you complete the provided template file, "Appendix\_I.xlsx", with all required information and return it as a mandatory part of your final offer submission.

cea leti		DPFT					
APPENDIX I : Risk Identification Sheet							
EQUIPEMENT REFERENCE & NAME :							
REFERENCE OF SAFETY DOCUMENTS PROVIDED							
EC Compliance certificate		<input type="checkbox"/>		Safety information and requirements in French		<input type="checkbox"/>	
RISK IDENTIFICATION							
Chemical risk : <input type="checkbox"/>							
Product name	Physical state (solid, liquid, gas)	DANGEROUSNESS				Usage concentration	Usage temperature
		Flammable	Combustive	Irritant / Harmful	Sensitizer / Toxic / CMR		
Explosion risk : <input type="checkbox"/>							
Under-pressure elements (bulb, pressure tank, ...) :				Pressure :		Volume :	
Thermal risk : <input type="checkbox"/>							
Heating elements :				Temperature :			
Electrical risk : <input type="checkbox"/>							
Maximum voltage :				AC :		DC:	
Risk from ionising radiations : <input type="checkbox"/>							
Sealed radioactive material <input type="checkbox"/>		Presence of X-rays <input type="checkbox"/>		Open source radioactive material <input type="checkbox"/>			
Risk from non-ionising radiations : <input type="checkbox"/>							
UV <input type="checkbox"/>		Infrared <input type="checkbox"/>		High frequency <input type="checkbox"/>		Electromagnetic <input type="checkbox"/>	
Microwaves <input type="checkbox"/>		Permanent magnet <input type="checkbox"/>		Laser <input type="checkbox"/> Category (1-2-3-4) :			
Risk from handling during maintenance: <input type="checkbox"/>							
Manual handling <input type="checkbox"/>		Mechanical handling <input type="checkbox"/>		Handling device :			
Other risks :							
Equipment internal detections :							
Fire detection <input type="checkbox"/>				Leak detection <input type="checkbox"/>			
Gas detection <input type="checkbox"/>				Extraction control <input type="checkbox"/>			
Comments :							

## APPENDIX K: Pedestal specification

Please ensure you complete the provided template file, "Appendix\_K.xlsx", with all required information and return it as a mandatory part of your final offer submission along the different requested documents.

 		
APPENDIX K : Template and Footprint		
EQUIPEMENT REFERENCE & NAME :		
Tool characteristics		
Dimensions (mm)		
Weight (Kg)		
Footprint/drawings file name Has to be provided at T0 including subeq		
Chassis specifications		
Template file name (.DWG) Has to be provided at T1-6 months (with weight repartition and all cut-off locations)		
Seismic brackets installation requested	Yes <input type="checkbox"/>	No <input type="checkbox"/>
Vibrations specifications		
Specific request		
Comments :		