European Organization for Nuclear Research
Organisation européenne pour la recherche nucléaire

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The HL-LHC Project

Price Enquiry

Technical Specification

Supply of two Fixed Systems with LN_2 Storage Tanks (600 Nm^3/h Gas Delivery Capacity each)

Abstract

This Technical Specification concerns the supply of two fixed systems, comprising each a vaporization system capable of delivering a flow of 600 Nm^3/h of gas and a liquid nitrogen tank of between 20 m^3 and 30 m^3 equipped with all the necessary equipment to operate, including its pressurization/depressurization system, set of piping, valves and instrumentation for industrial filling and operation.

The delivery is foreseen over 20 weeks from notification of award of the Contract.

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Table of Acronyms

Acronym	Definition
DDF	Detailed Design File
FAT	Factory Acceptance Tests
GN_2	Gas Nitrogen
HART	Highway Addressable Remote Transducer
HL-LHC	High Luminosity Large Hadron Collider
LHC	Large Hadron Collider
LN_2	Liquid Nitrogen
MAWP	Maximum Allowable Working Pressure
MIP	Manufacturing and Inspection Plan
PBU	Pressure Build-up Unit
QP	Quality Plan
SAT	Site Acceptance Tests
TIG	Tungsten Inert Gas

1. INTRODUCTION

The Contract will be performed in accordance with the General Conditions of CERN Contracts (CERN/FC/6674-II). However, this Technical Specification prevails over the General Conditions of CERN Contracts with regard to the particular provisions specified in this document, and this without prejudice to any other provision in the General Conditions of CERN Contracts.

Capitalised terms in the body text are defined either in the General Conditions of CERN Contracts or in the present document.

1.1 Introduction to CERN

CERN, the European Organization for Nuclear Research, is an intergovernmental organization with over 30 Member States[1]. Its seat is in Geneva but its premises are located on both sides of the French-Swiss border (https://maps.web.cern.ch/). CERN's mission is to enable international collaboration in the field of high-energy particle physics research and to this end it designs, builds and operates particle accelerators and the associated experimental areas. At present, more than 10 000 scientific users from research institutes all over the world are using CERN's installations for their experiments. Further information is available on the CERN website: http://cern.ch.

The accelerator complex at CERN is a succession of machines with increasingly higher energies. Each machine injects the beam into the next one, which takes over to bring the beam to an even higher energy, and so on. The flagship of this complex is the Large Hadron Collider (LHC) (see Figure 1).

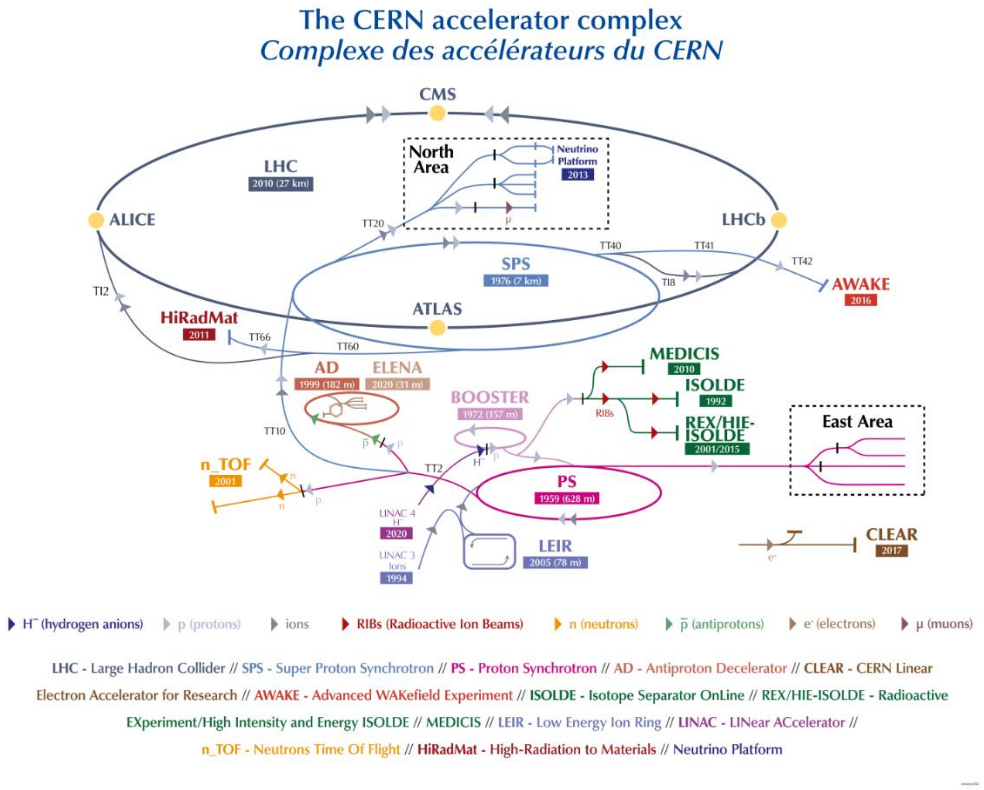

Figure 1: CERN Accelerator Complex

[1] http://home.web.cern.ch/about/member-states

1.2 Introduction to the High-Luminosity LHC Project

The Large Hadron Collider (LHC) is the most recent accelerator constructed on the CERN site. The LHC machine accelerates and collides proton beams but also heavier ions up to lead. It is installed in a 27 km circumference tunnel, about 100 m underground. The LHC design is based on superconducting twin-aperture cryo-magnets which operate in a superfluid helium bath at 1.9 K.

High Luminosity LHC (HL-LHC) is a project aiming to upgrade the LHC collider after 2020–2025 in order to maintain scientific progress and exploit its full capacity. By increasing its peak luminosity by a factor five over nominal value it will be able to reach a higher level of integrated luminosity, nearly ten times the initial LHC design target. To this aim, HL-LHC is exploring new beam configurations and new advanced technologies in the domain of superconductivity, cryogenics, rad-hard materials, electronics and remote handling.

1.3 Introduction to HL-LHC Helium Cryo Plants at LHC Point 1 and Point 5

In the context of HL-LHC project, the LHC cryogenic system will face a significant increase of dynamic heat loads, representing about 80 % of the total heat load at LHC P 1 and P 5. The cryogenic system will therefore be upgraded with two new additional HL-LHC cryo plants and adapted to operate efficiently at reduced capacity for long periods of time and to react quickly to high-capacity variations.

The two new HL-LHC helium cryo plants as well as the necessary warm helium vessels will be installed at LHC P 1 located in Switzerland, and at LHC P 5 located in France as shown in see Figure 2: Location of the new HL-LHC helium cryo Plants.Figure 2.

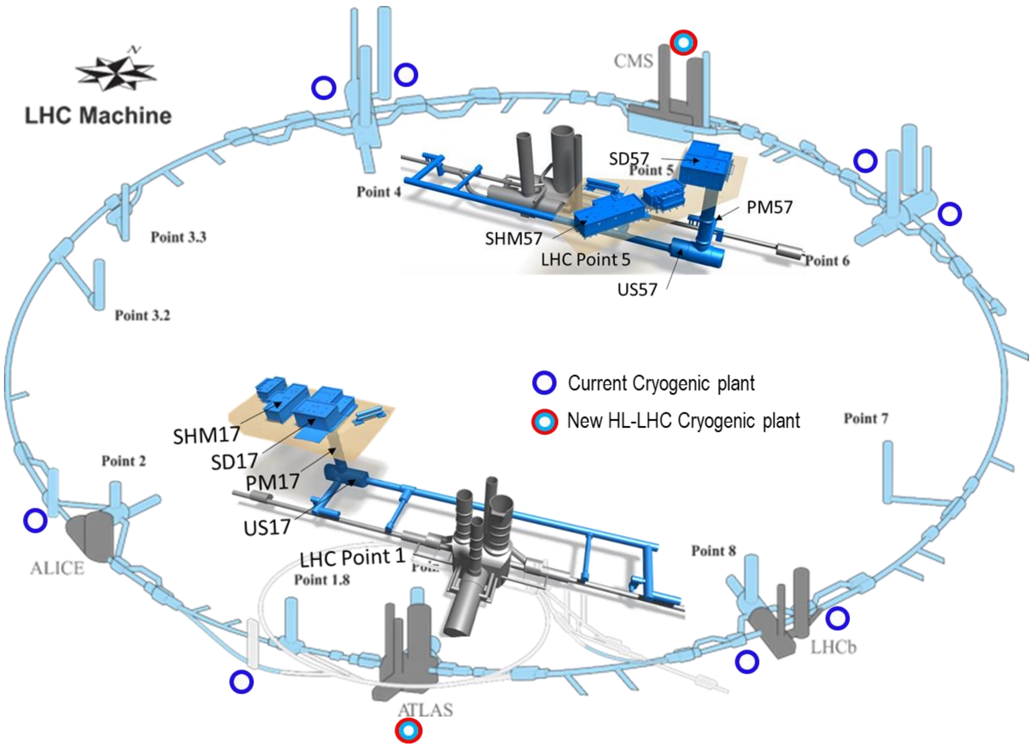

Figure 2: Location of the new HL-LHC helium cryo Plants.

2. SCOPE OF THE SUPPLY

CERN intends to place, to the single successful Bidder, two contracts (the "Contract(s)") for the supply of two fixed systems (the "System(s)" and, in whole or in part, the "Supply"; one System per Contract) comprising each a vaporization system capable of delivering 600 Nm^3/h of gas and a liquid nitrogen storage tank equipped with all the necessary equipment to operate, including its pressurization/depressurization system, set of piping, valves and instrumentation for industrial filling and operation, that CERN will install with the Contractor's supervision at LHC Point 1 (Switzerland) and LHC Point 5 (France).

The successful bidder (the "Contractor") shall provide the Supply as defined in this Technical Specification.

2.1 General Description

The Supply consists of two fixed Systems comprising each a liquid nitrogen storage tank equipped with its pressurization/depressurization system including the piping, valves and instrumentation for industrial filling and operation, and an ambient air vaporization system.

2.2 Content of the Supply

The Supply shall include:

- *Technical deliverables* or Systems, as specified in § 3 and each consisting of:
    - One industrial vacuum-insulated LN_2 storage tank with a volume between 20 and 30 m^3 and a design pressure of at least 16 bar;
    - One pressurization and depressurization system to allow the continuous withdrawal of LN_2 at a rate of 600 Nm^3/h for 16 h or 400 Nm^3/h for 36 h;
    - An ambient air vaporization system capable of delivering continuously nitrogen gas at ambient temperature at a rate of 600 Nm^3/h for 16 hours or 400 Nm^3/h for 36 hours at a pressure of 5 bar;
    - Piping and valves required to operate the tank including for filling and withdrawal;
    - Safety devices to protect the tank and its piping against overpressure;
    - Instrumentation required for monitoring and process control;
- *Activities* as specified in § 4:
    - On the Contractor's site:
        - Design (see § 4.1.1);
        - Manufacturing (see § 4.1.2);
        - Packing, and shipping (see § 4.1.3);
        - Factory Acceptance Tests (see § 4.3.1);
    - On the CERN site:
        - Supervision of the installation[2] of the Supply (see § 4.2);
        - Site Acceptance Tests (see § 4.3.2);
- *Documentation* as specified in § 5:

[2] The installation of the Supply will be done by CERN.

- Detailed Design File (see § 5.1.1);
- Manufacturing and Inspection Plan (see § 5.1.2);
- Factory Acceptance Test report (see § 5.1.3);
- Technical documentation (see § 5.1.4).

2.3 Equipment, Materials and Facilities Provided by CERN

CERN will provide the following equipment, materials and facilities for the purpose of the performance of the Contract:

- The concrete foundations for the systems, including the fixations;
- Handling equipment;
- Installation on CERN site including:
    - Fixation to the slab;
    - Assembly of the interconnecting piping between the tank and the vaporization system;
- Utilities such as electricity (400 V AC, 50 Hz) and compressed air;
- The control system including the cabling.

3. SPECIFICATION OF THE TECHNICAL DELIVERABLES

The Supply shall include the technical deliverables, the Systems, as specified in the present section.

3.1 Technical Requirements

3.1.1 Characteristics and Performances

Each System shall meet the requirements listed in Table 1.

Table 1: General design requirements

Section	Sub-section	Description / specification
General	Design codes and regulations	Mechanical: PED 2014/68/EU Electrical IEC- 60364 and EN IEC-60204 General: CE marking
Operation	Process fluid	Nitrogen
	Cycle 1 (once a month)	Production of nitrogen gas at ambient air temperature with a flow rate of at least 400 Nm^3/h for 36 hours at a pressure of 5 bar
	Cycle 2 (once a month, not the same as cycle 1)	Production of nitrogen gas at ambient air temperature with a flow rate of at least 600 Nm^3/h for 16 hours at a pressure of 5 bar
LN_2 storage tank	Tank orientation	Vertical
	Tank insulation	Vacuum insulated with perlite powder
	Capacity	Between 20 m^3 and 30 m^3
	Design pressure	16 bar or more
	Operational pressure	Between 5 bar and 18 bar

	Insulation performance	Maximum boil-off rate of saturated LN_2 at atmospheric pressure under steady conditions at full liquid storage capacity: 0.35 % per day
Vaporization system	Sizing parameter	The vaporization system shall be sized for a maximum temperature difference of 10 °C between outdoor conditions and the gas outlet temperature
	Outlet pressure	The pressure of the gas delivered at the outlet of the vaporization system shall be 5 bar
	Outlet interface (user)	PN16 flange according to EN-1092-1 type 11 with a surface roughness Ra 0.8
	Inlet interface (with tank)	Internal interface to be defined and supplied by the Contractor

3.1.2 Operational and Environmental Conditions

The Supply will be installed[3] outdoors and shall be able to operate in the temperature range of -30 ˚C to +60 ˚C and a humidity level ≥ 80%. All components in contact with nitrogen shall be suitable for operating in the temperature range of 77 K to 330 K.

3.1.3 Seismic Hazard at CERN

According to the "*Décret n° 2010-1255 du 22 octobre 2010 portant delimitation des zones de sismicité du territoir francais*", CERN sites are classified as seismic zone 3 (moderate seismicity), where the full scale goes from seismic zone 1 (low seismicity) to seismic zone 5 (strong seismicity).

The design of the Supply shall be compliant with EN 1998 (Eurocode 8): *Design of structures for earthquake resistance* using the parameters in Table **2** and Table **3** to calculate the design response spectrum. The behaviour factor shall be defined in line with Eurocode 8 and the ductility class justified.

Table 2: Seismic Loading - Eurocode 8 parameters

Parameter		**Unit**	**Value**
Peak Ground Acceleration	a_{gR}	m/s²	1.1
Importance Factor	γ	-	1.0
Spectrum Type	-	-	2
Ground Type	-	-	E
Damping (5 % viscous)	η	-	1

Table 3: Seismic Loading - Resulting Eurocode 8 spectra inputs

Direction	**S**	**a_{vg}**	**TB [s]**	**TC [s]**	**TD [s]**
Horizontal	1.8	-	0.08	0.45	1.25
Vertical	-	0.88	0.03	0.2	2.5

[3] By CERN, with the Contractor's supervision.

3.1.4 Dimensions and Interface Requirements

The Supply shall respect the minimum requirements shown in the process flow diagram in Figure **3**.

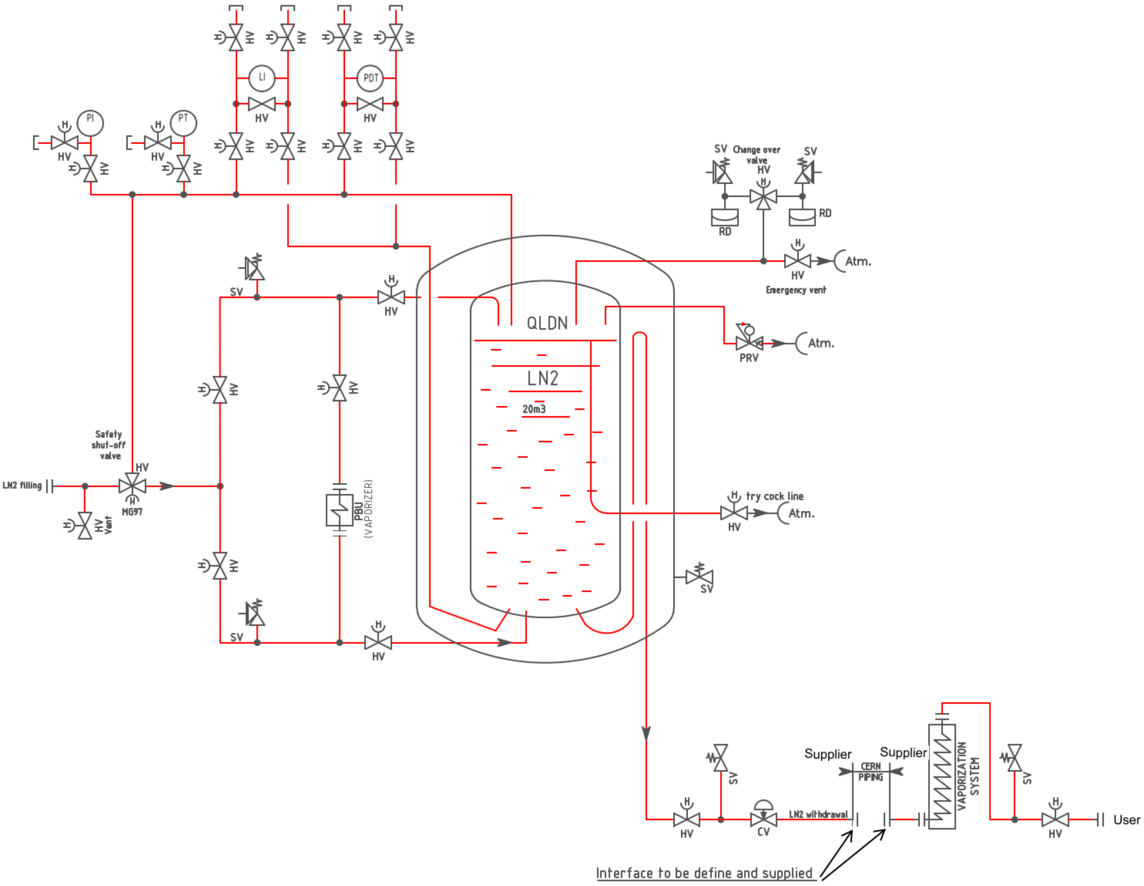

Figure 3: Process flow diagram for the LN_2 tank showing the minimum requirements

The Supply shall be equipped with the following lines and components:

- One filling line connecting to the bottom and one filling line connecting to the top of the inner vessel. Both lines shall be equipped with a manual shut-off valve. A safety shut-off device of type MG-97 shall be installed at the inlet as a protection against over-pressurization due to filling as well as one manual vent valve;
- One LN_2 withdrawal line equipped with a manual shut-off valve and a control valve to allow the control of the flow and/or of the pressure to the vaporization system;
- One GN_2 withdrawal line equipped with a manual shut-off valve connected to the top of the inner vessel;
- One try cock line equipped with an isolating manual shut-off valve;
- One Pressure Build-up Unit (PBU) with a vaporizer and a pressure regulator or a pneumatic control valve to regulate the pressure of the inner vessel. The vaporizer shall be sized to allow the operation and production of cycles specified in Table **1**. It shall be able to isolate the pressurization system from the inner vessel by manual shut-off valves;

- One depressurization line to vent the boiled-off GN_2 to atmosphere. A pressure regulator or pneumatic control valve shall be installed at the outlet to regulate the pressure of the inner vessel.
- An emergency vent line with an isolating manual shut-off valve for the depressurization of the tank in case of emergency;
- A safety block consisting of a changeover valve and two sets of one safety relief valve and one rupture disk installed in parallel to protect the inner vessel (see § 3.5.3);
- Instrumentation as defined in § 3.4;
- The vacuum tank shall be equipped with a vacuum pumping connection;
- The vent line and the emergency vent line shall be placed in such a way that freezing of the safety relief valves is avoided during nominal operation to eliminate the risk of blockage of the safety relief valves and that an operator can access the manual valves (in particular the emergency vent valve) safely in case of a release;
- The interface between the tank and the vaporization system to generate the gas at ambient temperature shall be defined and supplied by the Contractor. If piping is required, it will be procured and installed by CERN;
- The outlet of the vaporization system shall be equipped with a manual shut-off valve and a flange to connect the piping to the user (see Table **1** for the flange detailed characteristics).

Each supplied System (assembly including the tank and its necessary accessories, as well as the vaporization system) shall fit on a footprint area of 7×4 m^2 with a maximum height of 13 m, as indicated in Figure **4** and Figure **5**. The slab is sized for a maximum load of 50 kN/m^2 and local load of 187 kN/m^2. The final arrangement shall be subject to approval by CERN.

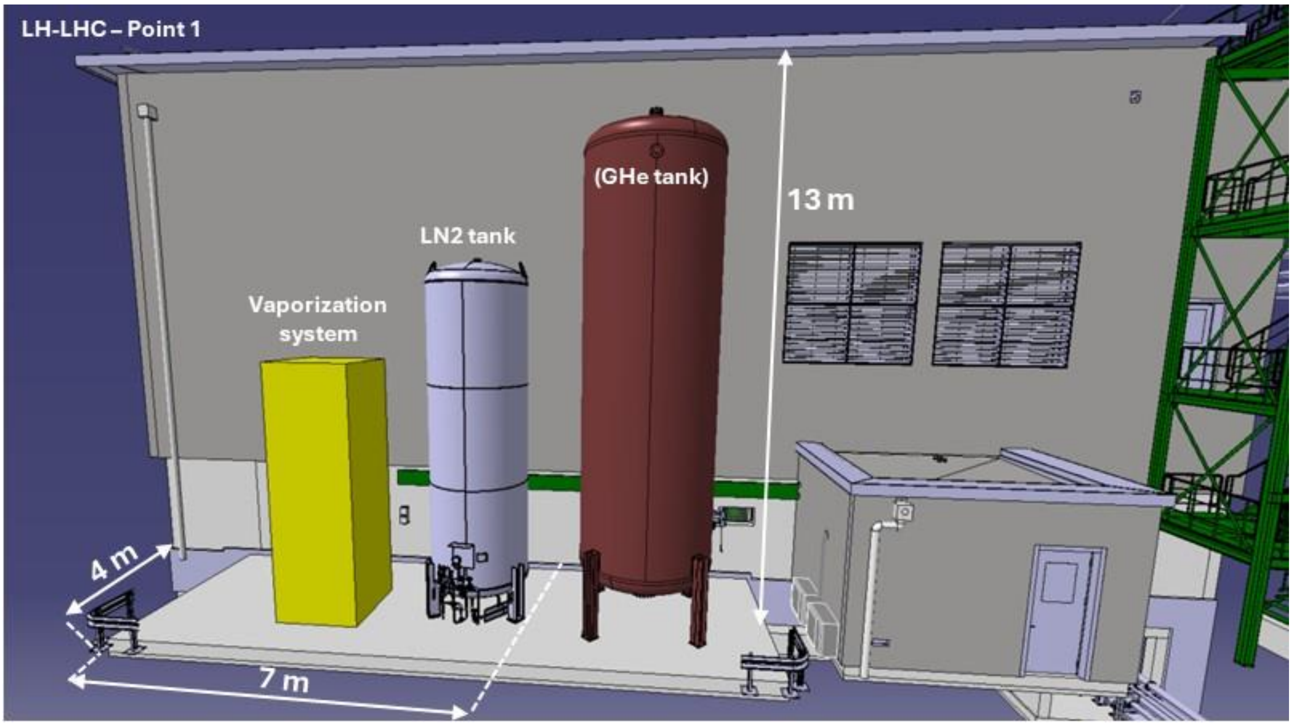

Figure 4: Layout for LN_2 tank and vaporization system at P1 (Switzerland)

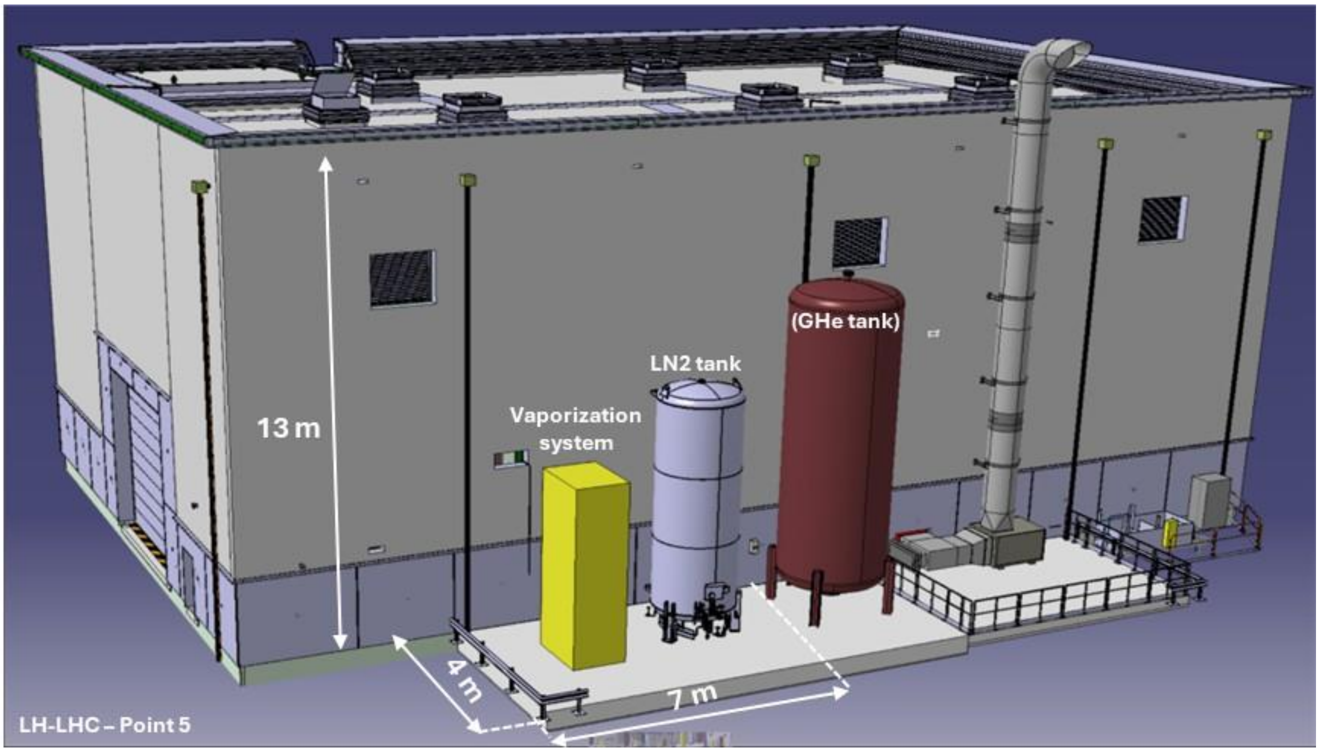

Figure 5: Layout for LN_2 tank and vaporization system at P5 (France)

3.1.5 Leak Rates

The maximum allowable helium leak rates for nitrogen and air leaks for all components operating in steady state of the Supply are summarized in Table **4**: .

Table 4: Maximum allowed helium leak rates at the design pressure at 293 K

Leak	**Leak rate [Pa m³/s]**
Global leak rate from the process circuits to the insulation vacuum	10^{-9}
Global leak rate from the atmosphere to the insulation vacuum	10^{-7}
Seat tightness of safety relief valves and valves	10^{-5}

3.2 Specific Material Requirements

The Contractor shall use certified materials for all components of the Supply. Material selection and specification are subject to approval by CERN.

All pipework in contact with cold fluids and the inner tank shall be made of low carbon austenitic stainless steel of EN grade 1.4404, 1.4306, 1.4307, 1.4435 or equivalent. For the external tank, if parts are made in mild steel, they shall be protected against corrosion by an appropriate coating with a minimum corrosion lifetime of 20 years.

Materials known to become brittle at low temperature shall not be used for components that may become cold in operation or during an accidental scenario.

3.2.1 Sealing O-rings

The material of O-rings shall be fluor elastomer (FPM). The correct compression of the O-rings shall be ensured by the geometry of the related flanges. This geometry shall also protect the rings against

UV. The O-rings shall be installed in such a way that they are accessible for replacement. The surface finish of flanges for static O-ring seals shall have a maximum surface roughness of $R_a = 0.8$ µm to avoid leaks.

3.2.2 Ferrule Fittings

Dismountable joints for instrument capillaries (maximum outer diameter of 14 mm) shall be Gyrolok®, Sagana® or Swagelok® ferrule fittings.

3.2.3 Bimetallic Transitions

In case that bimetallic transitions are used, only industrial certificated products shall be used that are subject to approval by CERN.

3.3 Identification, Markings and Labelling

Each Supply shall be identified with an appropriate permanent identification plate attached mechanically to it. For equipment submitted to regulation as mentioned in § 6.1, the marking and the labelling shall be done in accordance with Laws (CE-marked).

Each part of the Supply shall bear the test mark of the certified inspection body in the manufacturer's country and must be marked with a non-reusable identification plate with at least the following graved indication:

- MAWP of the inner vessel (bara);
- MAWP of the outer jacket (bara);
- Hydrostatic pressure test (bara);
- Min/Max working temperature of the inner vessel (°C);
- Min/Max working temperature of the outer jacket (°C);
- Volume of the vessel (m^3);
- Pressure test (bara)
- Type of fluid;
- Mass of the vessel (kg);
- Name of the manufacturer;
- Year of manufacture;
- Serial Number.

The CE marking shall be affixed in an easily readable and indelible way. Two empty rows on this plate must be left available for other information.

3.4 Instrumentation and Electrical Requirements

The Supply shall be equipped with at least:

- One absolute pressure indicator (mechanical analog) for the gas space for local use;
- One differential pressure indicator (mechanical analog) for the level measurement indicating the level of LN_2 in kilograms, for local use;
- One absolute pressure transmitter for the gas space;
- One differential pressure transmitter for the level measurement indicating the level of LN_2 in kilograms;

- The absolute pressure transmitter and indicator shall be equipped with a valve manifold allowing for periodic calibration, containing at least two isolation valves: one between the process and the transmitter, another connecting to the transmitter, closed with a ferrule union;
- The differential pressure transmitter and indicator shall be equipped with a valve manifold for periodic calibration containing at least five isolation valves: one between the process and each side of the transmitter (two valves), one connecting to each side of the transmitter, closed with a ferrule union (two valves) and one bypassing the transmitter;
- The transmitters shall be supplied with 24 V DC, provide a 4 - 20 mA output signal, a M12 connector for the cabling and include the HART® protocol.
- All instrumentation shall be delivered with an EU declaration of conformity and shall be labelled in a permanent way conforming to the equipment tag code system that will be given to the Contractor after the Contract award;
- Monitoring and control instruments shall comply with Directive 2011/65/EC;
- The Contractor shall provide to CERN details on the instrumentation and associated conditioners, if any, as well as on the wiring from the instruments to the CERN control system, including the intermediate connectors. The proposed solution is subject to approval by CERN;
- All instrumentation and electrical equipment of the Supply shall comply with the document *Cryogenics Electrical Equipment*, available at https://edms.cern.ch/document/1210688/1.0;
- Local cabling will be executed by CERN.

3.5 Valves

The selection of valves, including the choice of manufacturer, is subject to approval by CERN. Valves in contact with the cold fluid shall be suitable for operation from 77 K to 320 K.

Leak rates of the valves including all cryogenic valves, at the maximum pressure difference occurring in operation, shall not exceed the values given in Table **4**: .

3.5.1 Pneumatic and Manual Valves

Pneumatic valves shall be spindling valves sealed by a metallic bellow. Manual valves shall be spindling valves.

Control valves shall be equipped with standard plugs and the following flow characteristics: “equal percentage” and rangeability minimum of 1:100.

The actuator of each control valve shall be equipped with a side-mounted intelligent electro-pneumatic positioner SIEMENS SIPART PS2 with a 4-20 mA output signal, type 6DR5310-0NG00-0AA0.

All pneumatic shut-off valves shall be equipped with two inductive end-position switches of the IFM® type, reference IN5224 corresponding to the “fully open” and “fully closed” positions.

3.5.2 Solenoid Valves

Solenoid valves shall be equipped with coils for 24 V DC excitation, local status display by LED and DIN 43650 connectors. The connectors shall integrate the protection diode. The replacement of the solenoid shall be possible without opening the fluid circuit.

Solenoid valves shall be chosen powerful enough to remain tight (when they are not energized) if the maximum allowable pressure is applied on one side of the valve with atmosphere on the other side.

3.5.3 Safety Relief Valves and Rupture Disc

The safety relief valves shall be sized according to the European Norms (see § 6). Each part of process pipe in between two valves shall be protected by a safety relief device capable of keeping the pressure inside the process pipe below the maximum allowable pressure.

The vacuum vessel shall be protected by a safety device capable of keeping the pressure inside this vessel below 0.5 bar gauge.

The inner tank shall be equipped with two sets of safety devices, each consisting of a safety relief valve and rupture disk mounted in parallel, connected to the inner tank via a changeover valve to allow permutation between the two sets for maintenance. The changeover valve shall never be able to be in a closed position, i.e. one set of safety devices shall always be connected to the inner tank.

The exhaust of the safety relief valves shall be installed such that an operator can access the manual valves safely in case of release. The exhaust shall be protected against insects and rain entering the outlet.

All safety relief valves shall be removable for periodical calibration. Therefore, each safety relief valve shall be installed in an easily accessible position and the surrounding pipework shall be designed to ensure an easy removal of the safety relief valves by disconnecting flanges only.

CERN will check the setting of the safety relief valves in accordance with the CERN safety codes (see § 6). Malfunctioning safety relief valves shall be replaced immediately by the Contractor without any additional costs for CERN.

3.6 Lifting and Handling Equipment

All equipment for lifting and handling delivered with the Supply shall comply with the CERN General Safety Instruction GSI-M-1 - *Lifting equipment accessories*[4] and shall remain at CERN.

4. SPECIFICATION OF THE ACTIVITIES

4.1 Activities at the Contractor’s Premises

During the Contract, CERN shall have free access, during normal working hours, to the Contractor’s premises, including manufacturing and assembly sites and Subcontractor’s premises. The change of manufacturing place is subject to prior written approval by CERN.

4.1.1 Design Activities

The Contractor shall perform the design activities according to the following requirements:

- Design of the Supply according to EN or ISO standards;
- Manufacturing drawings according to ISO GPS standards.

4.1.2 Manufacturing Activities

The Contractor shall manufacture the Supply specified in § 2.1 according to the requirement specified in § 3. They shall be tested in accordance with § 4.3.

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[4] Available in English https://edms.cern.ch/ui/file/875606/LAST_RELEASED/SR-M_EN.pdf or French https://edms.cern.ch/ui/file/875606/LAST_RELEASED/SR-M_FR.pdf

4.1.2.1 Welding technique

All structural joints shall be tungsten inert gas (TIG) welded protected with argon gas. A penetration of 100 % is required for the butt welds. Welding shall be performed according to the European Directives and Standards (see § 6). At least 10 % of the welds shall be checked by X-ray inspection. The radiographs shall be evaluated in accordance with the ISO-5817 standard, requirement B. CERN reserves the right to request an X-ray inspection of any weld.

4.1.2.2 Cleanliness

The Contractor shall assess the cleanliness in compliance with ISO 23208– Cryogenic vessels – Cleanliness for cryogenic service.

Particular attention shall be provided to cleaning throughout the complete manufacturing and transport process to prevent contamination of the vessel internal surface from water, hydrocarbon, dust, particles, metal chips, welding scale, and other debris. Humidity shall not exceed a concentration of 5 ppm of H_2O.

4.1.2.3 Conditioning

The Contractor shall keep the Supply correctly conditioned and sealed until its acceptance by CERN, including the warehousing of items (secure area, identification, safety, protection and preservation).

Specifically, the Contractor shall ensure that all fabricated components are conditioned and sealed with nitrogen gas after performing the final pressure and leak tests (see § 4.1.3).

4.1.3 Packing and Shipping

The Contractor shall be responsible for the packing and, if requested by CERN for the transport to CERN. In this case, the Contractor shall take up a dedicated all-risk transport insurance for each of the Systems of the Supply concerned in accordance with the provisions of DAP Incoterms 2020 conditions:

- For the System to be delivered to LHC Point 1: DAP CERN Meyrin (CH);
- For the System to be delivered to LHC Point 5: DAP CERN Cessy (FR) (the Supply must be declared at CERN's reception service in Prévessin (FR) before the delivery to Cessy (FR)).

In all cases, the Contractor shall comply with the packing and shipping instructions available under: https://procurement.web.cern.ch/system/files/document/packing-and-shipping-instructions_0.pdf and, in particular, ensure that the Supply is packed in a way that guarantees the absence of any contamination and that no damage or any possible deterioration in performance due to transport conditions can occur.

In addition, the Contractor shall comply with the relevant applicable standards in matters of packing and shipping. In particular, the vessels shall be filled with dry nitrogen gas with at least 0.15 barg pressure to avoid any corrosion by exposure to air during storage and transport.

4.2 Activities on the CERN site

The Contractor shall execute the following activities on both the French (Point 5) and Swiss (Point 1) territory of the CERN:

- Inspection of the elements of the Supply after shipment (see § 4.2.1);

- Supervision of the installation[5] of the Supply;
- Site Acceptance Tests (SAT) (see § 4.3.2).

4.2.1 Inspection Upon Arrival at CERN

The Contractor shall perform an inspection (jointly with CERN) of all transported elements following their delivery to CERN sites. The site inspections shall comprise the verification that:

- No external damages occurred during the transport;
- The Supply is free of any internal contamination;
- The quality assurance documentation is complete;
- No leaks have developed during the transport.

4.3 Tests

The Contractor shall carry out the tests as specified below.

4.3.1 Tests Carried Outside the CERN site - Factory Acceptance Tests (FAT)

The Contractor shall carry out the following FAT:

- Pressure test of the Supply;
- Leak test of the Supply (see maximum leak rates in Table 4:).

The Contractor shall compile the FAT results in a FAT report (see § 5.1.3) to be submitted to CERN for written approval prior to shipment of the Supply.

CERN, or a representative of its choice, may attend any tests carried out outside the CERN site (including those performed at subcontractor's premises, if any). The Contractor shall notify CERN in writing at least ten working days before the proposed date for any such tests.

All testing shall be made in accordance with written procedures prepared by the Contractor and approved by CERN, specifically the test procedure which shall be described in the Detailed Design File.

4.3.2 Tests Carried Out at CERN - Site Acceptance Tests (SAT)

CERN, or a representative of its choice, will carry out the following SAT on its site. The Contractor may attend such tests:

- Filling of the tank;
- Functional test of the valves;
- Leak test under operating conditions of the System (see maximum leak rates in Table 4:);
- Performance tests:
  - Boil-off test: measurement of the evaporation rate of the LN_2 tank;
  - Vaporization system test: continuous delivery of nitrogen gas at ambient temperature at a rate of 600 Nm^3/h for 16 hours or 400 Nm^3/h for 36 hours at a pressure of 5 bar.

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[5] CERN will perform the installation.

4.4 Tooling

The Contractor shall have available all the necessary tooling and material for the proper execution of the Contract.

5. SPECIFICATION OF THE DOCUMENTATION

The Supply shall include the documentation related to the Supply (§ 5.1) and the Quality Plan (§ 5.2). This documentation shall comply with the requirements specified below.

5.1 Documentation Related to the Supply

The documentation related to the Supply shall include:

- Detailed Design File (DDF) (see § 5.1.1);
- Manufacturing and Inspection Plan (MIP) (see § 5.1.2);
- Factory Acceptance Test report (see § 5.1.3);
- Technical Documentation (see § 5.1.4).

5.1.1 Detailed Design File (DDF)

The Contractor shall submit a DDF including:

- List of applicable codes and standards;
- General layout drawings of the Supply showing the dimensions, weights, supports and pipework of the main components;
- Mechanical, thermal and hydraulic sizing calculations of the Supply and its components;
- Justification of the design and choice of the vaporization system;
- 3D models;
- Detailed design and manufacturing drawings of the Supply and all of its components including the location of panels, valves, pumping ports, safety flanges and instrumentation flanges;
- Design of the labels for instrumentation and valves;
- Process flow diagrams and piping and instrumentation diagram;
- Leak testing procedure;
- Manufacturing and testing schedules.

The procurement of components and the performance of the manufacturing activities by the Contractor shall be subject to prior written approval of the DDF by CERN.

5.1.2 Manufacturing and Inspection Plan (MIP)

The Contractor shall submit a MIP in accordance with the schedule defined in § 7.1, including:

- Manufacturing procedures;
- Detailed fabrication and assembly drawings;
- Fabrication, factory acceptance, inspection and control procedures;
- Welding plan;
- Cleanness plan and procedures.

5.1.3 Factory Acceptance Test report

The Contractor shall submit a FAT report in accordance with the schedule defined in § 7.1, including:

- All tests performed;
- All test results;
- All non-conformities;
- All modifications performed;
- Anything else of interest for CERN.

5.1.4 Technical Documentation

The Contractor shall submit the documentation written in English in electronic format. This documentation shall be supplied at the same time as the equipment and shall contain:

- Mechanical, thermal and hydraulic calculations of the Supply and its components;
- Final assembly and manufacturing drawings of the Supply and its components with part lists indicating the material used, main dimensions and weight;
- Process flow diagrams and piping and instrumentation diagrams of the Supply;
- Certificates of all components and materials;
- Test reports of all factory and acceptance tests;
- Technical description and operating manuals of the Supply and its components;
- EC Declaration of Conformity (CE) and CE marking.

5.2 Quality Plan

The Contractor shall submit a Quality Plan in accordance with the schedule defined in § 7.1. The Quality Plan (QP) shall be prepared along the guidelines stated in ISO 10005:2018, *Quality management – Guidelines for quality plans*.

The Quality Plan shall include:

- The description of the operational quality system;
- The identification of the key individuals responsible for ensuring the activities performed during the Contract;
- The allocation of resources, duties, responsibilities and authority;
- Details of all sub-contractors and how interfaces shall be managed if any;
- The procedures, methods and work instructions to be implemented;
- The procedures for inspection and testing;
- The methods of communication and documentation.

5.3 Creation, Updating and Control of Documents

The Contractor shall apply professional standards and codes in matters of document editing, design/drawing process, design reviews and approval, naming conventions and tagging, quality assurance/control.

All documentation delivered in the framework of the Contract (including all drawings and technical notes) shall be in English.

The Contractor shall submit all documents produced exclusively in the following electronic formats:

- 3D models in CATIA® or STEP format;
- Drawings in CATIA® or AUTOCAD® or PDF® format;
- Text documents in Microsoft Word® or PDF® format;
- Cost breakdowns and equipment lists in Microsoft Excel® and CSV format;
- Schedules in Microsoft Project® or PDF® format.

6. APPLICABLE RULES, NORMS AND STANDARDS

The Supply shall comply with Laws. For the purpose of the Contract, Laws shall include all relevant rules, norms and standards and, and in particular:

6.1 Rules

- CERN Safety rules, available under: http://cern.ch/safety-rules, and specifically:
  - Safety Regulation SR-M: Mechanical Equipment[6];
- General Safety Instruction:
  - General Safety Instruction GSI-M-1 – Standard Lifting Equipment[7]
  - General Safety Instruction GSI-M-2: Standard Pressure Equipment[8];
  - General Safety Instruction GSI-M-4 – Cryogenic Equipment[9];
- Swiss, European and French rules;
- European Directive 2014/68/EU: Pressure Equipment Directive (PED);
- European Directive 2011/65/EC: Restriction of the use of certain hazardous substances in electric and electronic equipment.
- EN IEC 60204-1: 2016 – Safety for machinery – Electrical equipment of machines;
- EN IEC 60364-1: 2005 – Low-voltage electrical installation.

6.2 Norms and Standards

The Supply shall comply with all relevant professional and CERN standards and codes including, but not limited to:

- EN 764: *Pressure equipment*;
- EN 1092-1: *Flanges and their joints – Circular flanges for pipes, valves, fittings and accessories, PN designated – Part 1: Steel flanges*;
- EN 1779: *Non-destructive testing – Leak testing. Criteria for method and technique selection*;
- EN 1993: *Eurocode 3: Design of steel structures*;
- EN 1998: *Eurocode 8: Design of structures for earthquake resistance*;
- EN 10088-1: *Stainless steels – Part 1: List of stainless steels*;
- ISO 23208: *Cryogenic vessels – Cleanliness for cryogenic service*;

[6] Available in English https://edms.cern.ch/ui/file/875606/LAST_RELEASED/SR-M_EN.pdf or French https://edms.cern.ch/ui/file/875606/LAST_RELEASED/SR-M_FR.pdf

[7] Available in English https://edms.cern.ch/ui/file/875611/LAST_RELEASED/SR-M_EN.pdf or French https://edms.cern.ch/ui/file/875606/LAST_RELEASED/SR-M_FR.pdf

[8] Available in English https://edms.cern.ch/ui/file/875610/LAST_RELEASED/GSI-M-2_EN.pdf or French https://edms.cern.ch/ui/file/875610/LAST_RELEASED/GSI-M-2_FR.pdf

[9] Available in English https://edms.cern.ch/ui/file/1327191/LAST_RELEASED/GSI-M-4_EN.pdf or French https://edms.cern.ch/ui/file/1327191/LAST_RELEASED/GSI-M-4_FR.pdf

- EN 13445: *Unfired pressure vessels*;
- EN 13458: *Cryogenic vessels – Static vacuum insulated vessels*;
- EN 13480: *Metallic industrial piping*;
- ISO 228-1: *Pipe threads where pressure-tight joints are not made on the threads – Part 1: Dimensions, tolerances and designation*;
- ISO 1127: *Stainless steel tubes – Dimensions, tolerances, and conventional masses per unit length*;
- ISO 1609: *Vacuum technology – Flange dimensions*;
- ISO 2861: *Vacuum technology – Dimensions of clamped-type quick-release couplings*;
- ISO 9606-1: *Qualification testing of welders*;
- ISO 14732: *Welding personnel – Approval testing of welders for fusion welding and resistance weld setters for mechanized and automatic welding*;
- ISO 15614-1: *Specification and qualification of welding procedures for metallic materials – Welding procedure test – Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys;*
- ISO 21013: *Cryogenic vessels – Pressure relief accessories for cryogenic service.*

All the directives and standards are intended in their latest published version.

The Bidder may propose[10] other internationally recognized standards, subject to prior written approval by CERN. In such cases, the Bidder shall submit to CERN all the necessary documentation (in English or French) for CERN approval in an annex to the Tender Form. CERN reserves the right to veto the use of certain codes or norms if it is considered that their application will not ensure compliance with this Technical Specification.

7. PERFORMANCE OF THE CONTRACT

All deliverables and activities that are not explicitly mentioned in this Technical Specification but are essential for the execution of the Contract shall be considered an integral part of the Technical Specification and therefore subject to clause 3.1 of *General Conditions of CERN Contracts*.

7.1 Schedule

The Contractor shall deliver the Supply in accordance with the following schedule, starting from the date of notification of award of the Contract to the Contractor:

Table 5: Schedule

	Milestones	Weeks	Indicative Date
T_0	Notification of award of the Contract to the Contractor		April 2025

[10] The Bidder is encouraged to propose the alternative standards for CERN's approval during the tendering process.

	Milestones	Weeks	Indicative Date
	Delivery of the DDF, MIP, Technical Documentation and Quality Plan as defined in § 5	$T_0 + 4$	May 2025
T_1	Delivery of the Supply at CERN including remaining documentation as defined in § 5	$T_0 + 20$	October 2025
	End of installation of the Supply at CERN	$T_1 + 12$	December 2025
	End of acceptance test at CERN		March 2026

CERN reserves the right to amend this delivery schedule before the start of the installation works. In such case, CERN will inform the Contractor in writing about the definitive date to start the on-site installation two weeks before such date.

CERN and its representatives shall have free access during normal working hours to the manufacturing or assembly sites, including any subcontractor's premises, during the Contract period. The place of manufacture may only be changed after written approval by CERN.

The schedule shall make provision for CERN's official holidays and take into account weather and other conditions related to the execution of the Contract.

7.2 Contractor's Personnel

The Contractor shall assign an appropriate number of qualified personnel for the performance of the Contract. The personnel assigned by the Contractor shall at all times remain under the sole direction and responsibility of the Contractor.

The Contractor shall forthwith replace, if so requested by CERN, any member of its personnel assigned to the Contract whose conduct or whose administrative situation affects or threatens to affect the proper performance of the Contract or any other activities on the CERN site.

The Contractor shall, at its own expense, ensure that its personnel assigned to the Contract has suitable training to comply with the requirements of the Contract.

7.3 Contract Follow-Up and Progress Monitoring

The Contractor shall assign a person responsible for the technical execution of the Contract and its follow-up, as well as a person responsible for the commercial follow-up, throughout the duration of the Contract. They shall be able to communicate in one of the official languages of CERN (English or French).

The Contractor shall send a written progress report to CERN every month until completion of the Contract. All communications and documents shall be in English or French.

This report shall include all the necessary information, in particular:

- Actual progress in comparison to scheduled progress;
- Updates of Safety documents;
- Major manufacturing problems or any difficulty likely to affect the delivery schedule shall be reported immediately to CERN.

7.4 Working on the CERN Site

For any intervention on the CERN site, the Contractor shall take into account and implement the rules and provisions defined in the document *Working on the CERN Site* available under: https://procurement.web.cern.ch/document-category/key-reference-documents

The Contractor shall take into account the following features of the CERN site:

- One Contract for one System will involve onsite activities on CERN Swiss territory (LHC Point 1), and another Contract for the other System will involve onsite activities on CERN French territory (LHC Point 5);
- Extent of the territory and distances between sites.

7.5 Acceptance of the Supply by CERN

7.5.1 Acceptance of the DDF, MIP, Technical Documentation and QP

The Contractor shall submit to CERN for written acceptance the DDF, MIP, Technical Documentation and QP as specified in §§ 5.1 and 5.2 and according to the schedule defined in § 7.1.

CERN will, within two weeks, verify the conformity of the DDF, MIP, Technical Documentation and QP in accordance with Article 22 of the General Conditions of CERN Contracts.

The ordering of components and the start of the production of the Supply shall be subject to CERN's prior written approval of the DDF, MIP, Technical Documentation and QP.

7.5.2 Acceptance of the Supply

Acceptance of the Supply will be subject to the successful completion of the FAT by the Contractor and the submission and written approval by CERN of all the Documentation (see § 5), including the FAT report (see § 5.1.3), and all compliant tests results or other certificates requested by CERN; and the successful completion of the installation of the Supply as well as the SAT by CERN on its site (§ 4.3.2).

7.6 Warranty

The warranty period shall be of two years from the date of acceptance (see § 7.5).

In case of warranty repairs for component(s), the Contractor shall repair or replace this/these component(s) within maximum five working days after CERN's announcement to the Contractor.

8. CERN REPRESENTATIVES

All commercial and technical correspondence concerning the Price Enquiry shall be communicated to the CERN Procurement officer and in copy to the Technical officer. Any communication by or to any other person than the CERN Procurement Service shall not be valid and have no effect.

Procurement officer	Tel	Email
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