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EQUIPMENT SPECIFICATIONS DOCUMENT

Twin screw extrusion equipment for compounding of batteries components

EOTP	A-INDIB-G0-4E-DD
OS	
Platform	Batteries
Ref Invest Plan	

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1. PURPOSED

The specifications set out the supply, on behalf of CEA, of an equipment of **twin-screw extruder** for compounding of small material quantities at laboratory scale. This equipment must allow the development of new batteries components such as electrolytes and electrodes. The equipment must be installed at the site CEA Grenoble in the building D2A.

Please note that this machine should be designed for **R&D applications**.

2. DEFINITION

In this document, the contractor is referred to as “the supplier”.

The instructing party is referred to as “CEA”.

3. GLOSSARY

- LITEN : Laboratoire d’Innovation pour les Technologies des Energies Nouvelles et les nanomatériaux
- PMAD : Prise en Main A Distance (Remote control access)
- MTBF : Mean Time Between Failure
- MTTR: Mean Time To Repair
- MTBI : Mean Time Between Interrupts
- FAT : Factory Acceptance Tests
- SAT : Site Acceptances Tests
- NMP : N-Methyl-2-pyrrolidone

4. APPLICABLE DOCUMENTS

The supplier shall comply with the documents and all procedures in force at CEA/GRENOBLE. Below is a non-exhaustive list:

- EQ/CS23-10: Règles applicables aux entreprises extérieures (French version)
- EQ/CS23-11: Applicable rules for outside companies (English version)

These documents shall be available for consultation upon request by the supplier.

5. INTERFACE CLIENT – PRESTATAIRE

The technical contact for the basic and additional services is:

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6. CONFIDENTIALITY

The supplier undertakes to keep confidential and shall refrain from disclosing to any third party, without written approval from CEA, the whole or part of information and/or knowledge belonging to CEA or any third party, that it may obtain or may have obtained during the service performed on behalf of CEA.

7. TECHNICAL SPECIFICATIONS

7.1. Description of the main function

The extrusion equipment will be used in the field of **battery cell manufacturing**, especially for **producing homogeneous compounds** that will be then shaped as strips or thin films (electrodes, electrolyte polymer membrane...).

Exemplary final compounds are composed of some or all of the following materials:

- one or several thermoplastic polymers (polyolefines, fluoropolymers,...).
- one or several inorganic powders (metal oxide, graphite...).
- one or several conductor additives (carbon black, carbon fibers, ...).
- one or several additives (inorganic salt, plasticizer, pore former, ...).
- one liquid phase (organic solvent, water, ...).

The polymers (in powdery or pellets form) must be able to melt in the first section of the extruder and then the other powders must be intimately distributed and dispersed along the screw profile with appropriate mixing elements.

After compounding, the mixture will be **directly shaped** out of extruder head by using a flat die.

Usage conditions:

- Installation of the equipment in a dry room with a dew point below -50°C. All components, particularly the electronic components, must be suitable for these conditions.
- Use by multiple trained operators, mainly 4 days by week, 50 weeks by year.

7.2. Sub-functions of the equipment

The equipment must be suitable for addressing the following sub-functions:

- Mixing the materials used in the battery components (electrodes, electrolyte polymer membrane...) in order to produce homogeneous compounds in continuous mode.
- Shaping the compounds into strips or flat films out of the extruder head by using a flat die.

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7.3. Expected performances

Expected performances of the equipment will be the compounding of **highly-filled mixtures** containing a large fraction of micron-sized and dense inorganic powders (**more than 60 %v./v.**). List of the inorganic powder used in the battery components is detailed in Table 1.

When needed, a **solvent fraction** could be advantageously added during the compound preparation in order to reduce the viscosity of the mixture. In this case, the **solid content of the mixtures will be in the range 70 - 100% (w./w.)**.

Table 1: List of representative inorganic powders used for compounding

Chemical formula	Theoretical specific mass (g/cm ³)	D50 (μm)	Website link for example
LiFePO ₄	3.6	~ 3.5	https://mtixtl.com/products/lib-lfpo?_pos=1&_sid=7ac75d52c&_ss=r
Li[Ni _x Mn _y Co _z]O ₂ (x+y+z=1)	4.7	~ 10	https://mtixtl.com/products/linicomno2-ni-co-mn-8-1-1-powder-for-li-ion-battery-200g-bag-eq-lib-lncm811?_pos=9&_sid=2269460da&_ss=r
Graphite (natural or synthetic)	2.2	~ 20	https://mtixtl.com/products/lib-mcmb?_pos=6&_sid=d811daf65&_ss=r
Li ₇ La ₃ Zr ₂ O ₁₂	5.5	~ 1to10	https://mtixtl.com/products/llzo-li7la3zr2o12-powder-for-solid-state-electrolyte-of-li-ion-battery-100g-bag-lib-llzo?_pos=1&_sid=f89c38f16&_ss=rhttps://www.mtixtl.com/EQ-Lib-LLZTO.aspx
Li ₆ PS ₅ Cl	1.6	~ 1to10	https://www.sigmaaldrich.com/FR/fr/product/aldrich/916137?srltid=AfmBOorFOldzAoXDxKk7DloDvkNm-yK39IS8STsmvSXCTeFuVEiBq2Bb

In addition, the equipment will be expected to shape the compound as strips or flat films out of the extruder head. Section of the strips or flat films is specified below:

Table 2: Section of the shaped strips or thin films.

	Width (mm)	Thickness (mm)
Minimum	20	0.5
Maximum	40	1.5

7.4. Specifications

7.4.1. General specifications

The equipment must be based on **twin-screw extrusion technology with parallel co-rotating axes**. For all the following equipment specifications the Supplier should prefer standard existing solutions. If

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equipment specifications should deviate from CEA ones the Supplier would precisely describe these deviations.

7.4.2. Extruder design

1) Barrel

The barrel length must be designed such that the ratio “length over diameter” (L/D) is equal or greater than 36 (**L/D ≥ 36**). Barrel with **segmented or modular design** will be highly preferred in order to adjust the configuration depending on the materials to be processed. A barrel configuration will be detailed by the Supplier (total length, port positioning, ...). Several inlets/outlets must be present along the total barrel length, with at least the following ones as required items:

- Solid dosing: **one port to feed from above the barrel.**
- liquid dosing: **one inlet above the barrel.**
- devolatilization: **one outlet for degassing.**

The Supplier is asked to provide **drawings of the barrel with relative ports positioning.**

The Supplier must provide all necessary plugs to easily close the ports when not used as well as connecting equipment with the feeders (see § 7.4.3.1).

Some parts of the barrel must be removable to easily have an access to the screws for cleaning steps, screw inspection or design modulation. The Supplier must detail the selected technology and its advantage (**clamshell opening, shaft extraction from the front, ...**). All necessary accessories needed or helping for the screw removal (mobile workplan, ...) must be provided by the Supplier.

Particular attention will have to be paid to the process using highly-filled mixtures and/or limited quantity of a solvent. Indeed, the inorganic powders with various morphologies and shapes (see § 7.3) could exhibit abrasive properties that could lead to **premature wear of the elements in contact with the mixture**. Besides solvents (deionised water, NMP, THF, acetone, ethylene carbonate, ...) could have **dissolving or corrosive effects** on soft parts such as gaskets or tubes.

In consequence, when selecting the appropriate barrel, **strong abrasion protection must be first considered**, with sufficient corrosion protection to be ensured in cases where inorganic salts and solvents are used.

The Supplier must propose appropriate **anti-abrasive treatment** for the barrel inner surface (direct coating or removable inner liner). A detailed description of the material(s) used for this treatment should be provided, as well as a rigorous comparison with “standard” materials in terms of hardness or “ratings” for the protection against abrasion. all parts of the barrel in contact with the product must be wear resistant for all considered component productions.

2) Screws

A set of two screws will be designed with **diameters between 10 mm and 13 mm**. A **modular design** would be preferred in order to adjust it to the products to be processed when necessary. Based on its own experience and CEA materials specifications, the Supplier is asked to provide a detailed screw configuration with the following items:

- Drawings of the screw design.
- List of the selected screw elements with detailed description (type, length, ...).

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In order to be able to process highly-filled blends, the screw parts in contact with the product must exhibit strong **wear resistance** (abrasion and corrosion). Based on its own experience and CEA materials specifications, the Supplier must propose appropriate **anti-abrasive treatment** for the screw elements. A detailed description of the material(s) used for this treatment must be provided, as well as a rigorous comparison with “standard” materials in terms of hardness or “ratings” for the protection against abrasion.

3) Heating and cooling systems

The twin-screw extruder must be equipped with **at least 5 electrical heating sections** along the barrel with separate temperature control in each section to make temperature profiles. **Maximum admissible temperature must be at least 300°C**. Each section must be equipped with thermocouples for precise measurement of temperature.

7.4.3. Ancillary equipment

1) Feeder for solid fraction introduction

A gravimetric feeder will be proposed for **solid fraction introduction above the extruder**. The feeder must be able to precisely introduce the solid with **flow rates from 0.1 to 1.5 Kg/h**. **Two sets of screws** will be proposed depending on the material to be processed and flow rate to be achieved (for example free-flowing polymer powder, polymer in pellets form, micrometric free-flowing carbon powder). A **hopper with volume between 0.5 and 1L** must be included with a lid. In addition, the extruder and the feeder must be controlled from the same interface.

2) Liquid dosing system

A **liquid feeding system** will be proposed to have the possibility to add small fractions of solvent in the compounded mixture. The dosing system must be able to precisely introduce liquid fractions with **flow rates between 0.5 and 10 mL/min**.

A volumetric dosing pump adapted for low viscosity fluids such as peristaltic pump could be advantageously proposed. Liquid dosing will be done at room temperature. The viscosities of the fluids that would be dosed are close to the one of water.

A global solution including a pump, piping, adaptors and all necessary accessories (specific support frame, hopper, ...) must be included. Tubing with Teflon, EPDM or silicone-based tubes will be preferred due to chemical compatibility considerations, especially with NMP solvent.

3) Output

For the considered application, the battery components will be shaped in the form of strips or flat films. A **flat die** outlet compatible with the single screw extruder must be provided. A design with adjustable

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die lips would be preferred with a **flexible gap between 0.5 and 1.5 mm, and a width between 20 and 40 mm**.

In addition to the flat-die, a **strand-die** with a **diameter of between 4 and 8 mm** should be provided. The dies must be equipped with a pressure sensor with maximum pressure of 100 bar and a controllable heating system with maximum temperature of 300°C. All parts of the die system should be easily removable to facilitate the cleaning steps.

7.4.4. Hardware specifications

The equipment must be equipped with a **control system** that enable to monitor all processing parameters (temperatures of each heating section of the extruder, pressure, rotational speed and torque). The **same interface** should also give the possibility to drive the rotational speed and the extruder temperatures during the process as well as integrate the parameters related to ancillary equipment (feeder operation via extruder control, flow rate of each feeder, ...). A **numeric HMI with touch panel** would be highly preferred.

A data recovery system would be provided to save the data and shall be compatible with Windows 11 Enterprise operating system (see § 7.5).

7.4.5. General technical specifications

The twin-screw extruder with these ancillaries must satisfy the specifications listed in

Table 3:

Specifications have different rating:

- **F0** = mandatory minimum requirement, must be quoted in the main offer, not negotiable;
- **F0*** = mandatory, must be quoted in the main offer, can be negotiated during the negotiation phase;
- **F1** = Mandatory type of Option: The supplier must obligatorily include an offer with the specified option, otherwise the offer will be considered irregular and eliminated. The CEA reserves the right to decide whether to exercise this option or not, but the price of the option must be clearly stated in the offer. The price of mandatory options will be included in the overall budget for the comparison of offers.
- **F2** = Non Mandatory type of Option: The supplier has the discretion to propose or not propose the specified option. If the option is not proposed, the supplier will not necessarily be disqualified. The CEA reserves the right to decide whether to exercise the option or not.

Table 3: general technical specifications of the extruder.

Specification designation	Minimum acceptance	Maximum acceptance	Significance level
Barrel length (L/D)	36:1	43:1	F0*
Screws diameter	10 mm	13 mm	F0*

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Screws rotational speed	10 rpm	500 rpm	F0
Torque by shaft	6 Nm	10 Nm	F0*
Barrel heating sections	5	10	F0
Achievable temperature	300°C	400°C	F0
Admissible pressure	100 bars	150 bars	F0
Flat die	Flat die with adjustable die lips		F0
Flat die width	20 mm	40 mm	F0
Flat die gap	0.5 mm	1.5 mm	F0
Powder feeding system	Gravimetric feeder		F0*
Powder feeding throughput	0.1 Kg/h	1.5 Kg/h	F0
Accuracy of the powder feeding	+/- 1%	+/- 5%	F0
Liquid feeding throughput	0.5 mL/min	10 mL/min	F0
Accuracy of the liquid feeding	+/- 1%	+/- 5%	F0
Hardware control system	Numeric HMI with touch panel		F0*
Data recovery system			F0
Advanced-level maintenance training for 2 people (see § 15.3)			F2

The Supplier must provide a detailed specification list of the extruder. In particular the **admissible pressure** within the barrel should be mentioned.

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Table 4: Specifications and tests conditions for the equipment

TEST #	SPECIFICATIONS			PROPOSED TEST CONDITIONS				
	Acceptance Criteria	Equipment Expected Target	Equipment Target Tolerance	Test Condition	Sample Type/Format (Specify who provide them)	Number of Test Samples	FAT ou SAT	Test medium (specify who provides it)
E-1	Heating temperature	300°C	5°C	Setting the temperature of the heating sections	-	-	SAT	Reading on the HMI and confirmed by thermocouples provided by CEA
E-2	Screw rotation speed	10 – 500 rpm	-	Setting the screw rotation speed	-	-	SAT	Reading on the HMI
E-3	Powder feeding throughput	0.1 – 1.5 Kg/h	1 – 5%	Dosing tests at 0.1, 0.5 and 1 Kg/h for 10 min	Powder mix of LiFePO ₄ / carbon black / PVDF provided by CEA	3	SAT	Reading on the HMI and controlled by weight fraction
E-4	Liquid feeding throughput	0.5 – 10 mL/min	1 – 5%	Dosing tests at 0.5, 2 and 5 mL/min for 5 min	Solvent (EC/PC)	3	SAT	Reading on the HMI and controlled by volume or weight fraction

PUBLIC**7.4.6. Process specifications****Process 1**

If the test conditions proposed by the CEA are not acceptable or sufficient for the equipment manufacturer, the manufacturer may propose alternative test conditions. These alternatives should be clearly documented and agreed upon by both parties to ensure a comprehensive and fair evaluation of the equipment.

Table 5: Specifications and test conditions for [process 1](#)

	SPECIFICATIONS			PROPOSED TEST CONDITIONS				
TEST #	Acceptance Criteria	Equipement Expected Target	Equipment Target Tolerance	Test Condition	Sample Type/Format (Specify who provide them)	Number of Test Samples	FAT ou SAT	Test medium (specify who provides it)
P1-1	Production of a cohesive film with regular shape	Torque by shaft of 6 Nm		Extrusion test with using the flat die, the powder feeder and the liquid dosing system. Test will be carried out at 0.5 Kg/h of powder with the liquid dosing decreases from 1.5 mL/min to 0.5 mL/min, temperature profile below 100°C.	Powder mix of LiFePO ₄ / carbon black / PVDF and solvent (EC/PC) provided by CEA	1	SAT	Visual observation, thickness measurements
P1-2	...							

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7.5. Computer specifications

7.5.1. Computer Control

The equipment is controlled from a computer workstation, preferably running the Windows operating system.

7.5.2. Network Connection

The equipment is connected to the CEA network through this PC via a dedicated Ethernet connection. The equipment supplier must ensure that an additional network card is installed in the workstation in case the equipment is connected to the sole available network port.

7.5.3. Instrumentation network cloud

The equipment is connected to a dedicated instrumentation IP network cloud. It follows the principle showed in the following figure:

Main Characteristics of the instrumentation network cloud:

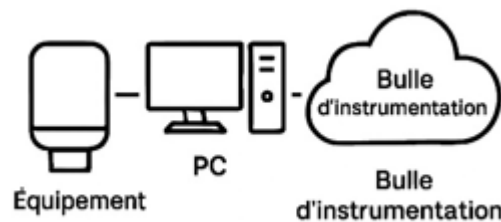


Figure 1 – CEA network connection diagram

- For IT security reasons, there is no internet access or email functionality.
- User session authentication is handled through a CEA Active Directory domain controller.
- Data is uploaded to a shared network storage system.
- Remote access is restricted to CEA's internal IT management service only.

7.5.4. Connection prerequisites

Prior to network connection, CEA requests that the equipment supplier evaluate the feasibility of:

- Installing CEA's specified antivirus software on the PC (reference available upon request).
- Implementing a process for regular Windows updates with two options:
 - Complete system updates (including all updates).
 - Security-only updates (critical security patches only).

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7.5.5. Documentation and procedure

The equipment supplier must document the IT configuration of the equipment for its connection to the CEA network (network interface configuration, protocols to be implemented, ports to be opened, data types, architecture diagram, etc.). The supplier will provide a network connection procedure.

7.5.6. Equipment Supplier IT Contact Availability

Availability of an IT contact from the equipment supplier is requested both prior to and during the network connection process.

7.5.7. Data Export

During operation, if the equipment serves as a data source, data should preferably be exported in flat file formats (TXT, CSV) or office document formats (XLSX, PDF) for deposit in the designated network storage (CEA infrastructure).

7.5.8. User Session Management

- Nominal phase:

The user session is either individual (named) or generic and authenticated through the CEA Active Directory domain controller.

- Maintenance phase:

The user session is local, has administrative privileges, and is named with the Equipment manager ID.

7.5.9. Hard Disk Drive Image

Subject to technical feasibility, CEA will create a disk image of the PC and store it on a network resource. In all cases, the equipment supplier must provide a complete system reinstallation procedure and all necessary source files or binary files (removable media, official download links, software licenses, etc.).

7.5.10. Administrator password

If the PC is running Windows, CEA requests that the equipment supplier provide the password for the ADMINISTRATOR account. This password will subsequently be managed by the IT service provider under CEA's outsourcing contract.

PUBLIC**8. WORK ENVIRONMENT, INSTALLATION LOCATION, LIMITS OF SERVICE****8.1. Limits of services**

The limits of Services between CEA and the supplier are the followings:

ITEM	CEA is responsible	Supplier is responsible
Metrology Equipments used for the SAT	X	
Installation and assembly of all materials on site		X
Electrical cabinet hook-up to the CEA power lines	X	

8.2. Environment, Facilities

The equipment will be installed in a laboratory with specifications linked to the facilities listed in Table 6.

Table 6: Specifications linked to facilities.

Main fluids distribution	Specification for Building D2A 101	Note
Electrical power supply	Voltage: 220 V or 380 V (3 phases)	All electrical installations must meet the European standard UTE18 510
	Frequency: 50 Hz	
Air conditioning	Dry air conditions: -50°C of dew point	All components of the equipment should be compatible with these conditions
	Temperature: 20°C	
Exhaust system	Air flow: 150 m ³ /h	Two adjustable extraction arms will be positioned by CEA above the equipment, in order to eliminate any fume during utilization

The supplier will submit with their offer the requirements for fluids, electrical power, and all other necessary interfaces, and will complete Appendix 2 provided with this specification document. If these elements are not known at the time of offer submission as they require further study, the supplier commits to providing this information no later than 16 weeks (in accordance with “Section 9 Timeline”).

The **neutral grounding system** of the installation (e.g., TT, TN-S, IT) must be explicitly stated in this document. This information must be clearly and unambiguously presented to ensure equipment compatibility and compliance with electrical safety regulations. The neutral grounding system typically used at CEA Grenoble is TN-S.

Important note:

Completing Appendix 2 will enable CEA to create Piping and Instrumentation Diagrams (PIDs) for fluids as well as the PID for electrical power supply. These PIDs will then be validated by the equipment

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supplier **before hook-up preparation work begins**. For simpler equipment, PIDs may not necessarily be required.

Communication Between Equipment and Facilities:

When the equipment relies on certain facilities (such as cooling water, ventilation, compressed air, etc.) for safe operation, the supplier must provide CEA with the following during the design phase:

The conditions required for proper equipment functioning.

An analysis of criticality in case of parameter deviations.

This analysis may take the form of an FMECA (Failure Modes, Effects, and Criticality Analysis) or an equivalent method.

Loose of Facility Failure Analysis:

Every potential facility failure—whether isolated or combined with others—must be studied. If a risk is identified, a dedicated section must be included in the documentation.

Safety Signal Integration:

If certain facility parameters could impact:

The safety of the equipment's process,

Safe operational mode,

Overall installation safety,

The supplier must integrate the necessary signals into the safety loop or automation system to enable emergency shutdown or controlled shutdown based on criticality level.

Communication Protocol:

Finally, if the equipment's operation could significantly disrupt the installation's facilities, the supplier must propose to CEA a communication protocol to anticipate and manage these impacts.

8.3. CEA on-site intervention rules

Access to the CEA site is strictly regulated. The applicable conditions are described in documents EQ/CS23-10 (Rules applicable for outside companies) and EQ/CS23-11 (Applicable rules for outside companies), provided with the bid documents. These terms also apply to the subcontractor of the supplier that will deliver the equipment.

Prevention plan:

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CEA will establish, in collaboration with the supplier and any subcontractors, a comprehensive prevention plan for the installation and commissioning of the equipment.

Safety Equipment:

As CEA prohibits the lending of equipment, including safety equipment, the supplier and any subcontractors must provide all necessary safety materials to prevent risks specific to their intervention (PPE, collective protective equipment, etc.). They will ensure the replacement and repair of this equipment and, if applicable, will ensure their personnel are properly trained and aware of its use in accordance with regulations. This equipment must comply with current regulations and have a certificate of conformity.

Collective Safety Equipment:

The supplier and any subcontractors must provide all collective safety equipment aimed at preventing accidents related to the work, such as:

- Marking of work areas.
- Marking of circulation areas.
- Marking of handling areas.
- Marking and installation of barriers around pits and level differences.

They will ensure the installation and removal of this equipment as soon as the service no longer requires the presence of markings.

Specific Access for Deliveries:

Given the access constraints to the CEA site, the supplier must provide a restricted list of individuals authorized to access the CEA:

For EU residents, 10 calendar days before delivery.

For non-EU residents, 25 calendar days before delivery.

8.4. Delivery

Delivery and Installation Organization

For the proper organization of delivery and installation at CEA, a packing list must be communicated to CEA at the kick-off meeting or at least 2 months before delivery. This list should include the following information:

- The total net weight of the shipment.
- The number of packages for transporting the equipment.
- The weight and dimensions (length × width × height) of each package.
- The number of support points (legs) and the weight supported by each.
- Any need for specific tools or a forklift for installation.

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- The unloading plans.

Whenever unloading requires lifting equipment (forklifts, cranes, etc.), a safety protocol supplementing the prevention plan must be established before the unloading operation.

All delivered materials must bear the order reference and the recipient's name on each item in the packing list.

Supplier Presence

The supplier must arrange for all necessary measures to unload and install the equipment (unloading plan and installation plan). **The supplier must be present during the unloading of any equipment requiring special monitoring due to its size, value, or complexity.**

Installation Location

The equipment will be installed at the CEA Grenoble site in the "Salle anhydre 2" of D2A building.

Logistical Constraints

The supplier must consider logistical constraints related to equipment placement (maximum space, weight, access through doors, ramps, stairs, elevators, maximum height, etc.). These details are specified in Section 7.4 and in Appendix 1.

Dimensional and Load Constraints:

Due to footprint constraints in the dry room, the main dimensions of the equipment (without the dosing system) should be as compact as possible with length inferior to 2000 mm and width inferior to 1200 mm. The total height including the dosing system and hopper must be less than 2200 mm.

Packaging and Waste Disposal

The equipment and all its peripherals must be delivered clean and properly packaged. Transport platforms, pallets, and packaging crates must be suitable for the weight and volume of the items to ensure safe transport and avoid any disputes related to improper packaging.

All transport platforms, pallets, and packaging crates must be removed by the supplier (waste disposal from packaging is not handled by CEA).

Delivery Hours

Deliveries will be made between 8:00 AM and 12:00 AM from Monday to Friday.

9. TIMELINE

All the deadlines mentioned below are indicative.

Step	Deadline
Equipment delivery at CEA site	$T_0 + 16$ weeks
Training	$T_0 + 17$ weeks

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Site Acceptance Test (SAT)	T ₀ + 17 weeks
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*T₀ refers to the date of order notification by CEA.

To facilitate compliance with delivery and acceptance deadlines, the supplier must promptly transmit all Appendixes required for equipment installation (fluid requirements, electrical power supply, and any other necessary interfaces (Appendix 2), hazard identification sheet (Appendix 3), equipment consumption data, etc.) or any other necessary elements.

10. QUALITY

For all its activities, the supplier must comply with the requirements of the ISO 9001 standard.

Significant and/or repeated deviations from this specification will be notified to the supplier (via email-anomaly or Improvement Sheet) for corrective action within a specified timeframe. In case of deviations or unperformed corrective actions, penalties will be applied to the supplier in accordance with the contract.

CEA Grenoble reserves the right to verify the effective operation of the system at any time through quality audits, which may be conducted at the supplier's premises and on the CEA Grenoble site.

Any measurements performed by the supplier for acceptance testing must comply with the requirements of Section 7.1.5 of ISO 9001 (Resources for Monitoring and Measurement). If the supplier subcontracts these measurements, they must be accompanied by a certificate of conformity.

11. SAFETY AND COMPLIANCE

As required in CEA's general purchasing conditions, the supplier commits to treating safety as an absolute priority in the design, preparation, and execution of the services covered by the contract.

The supplier acknowledges and applies the "rules applicable to external companies at the Grenoble center" provided with the tender dossier.

The supplier, as well as any subcontractors at any level, must comply with all applicable legislative and regulatory provisions regarding safety and environmental protection.

The equipment must comply with current regulations.

The equipment will be CE certified, bear the "CE marking," and be accompanied by a CE Declaration of Conformity (see § 13 Documentation).

The supplier is requested to seek assistance from a French certification body to verify regulatory compliance from the equipment's design phase.

11.1. Hazard identification

CEA may request the supplier to provide a description of the equipment's residual hazards, including the following information:

- Details about residual hazards for operators.

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- Interactions between the equipment and its environment (gas or chemical emissions, electromagnetic fields, noise, etc....).

If hazard identification is required, CEA will make this request no later than during the market launch meeting. The supplier will base this analysis on Appendix 3 of the Technical Specification Document: Identification of Residual Hazards.

The supplier must submit this analysis to CEA during the design phase (cf. § 12.1 Documentation).

11.2. Power supply disconnection and separation device

A power supply disconnection and separation device shall be provided on the equipment, for each source of energy of the machine.

11.3. Power supply lockout / tagout device

A power supply lockout / tagout device with dissipation of the residual energy shall be provided on the equipment, for each source of energy of the machine.

11.4. Emergency stop

Emergency stop buttons shall feature protection against unintentional operation. See the example on the side picture.



11.5. "Service" nitrogen or compressed air connection

When the equipment uses compressed air or nitrogen for controlling valves, actuators, and other systems, the machine must be equipped with a general shut-off valve.

This valve may be locked in the closed position using a padlock to allow for equipment isolation (maintenance).

There must be one or more purge devices to dissipate residual pneumatic energy stored in the machine after the main valve is closed. This dissipation must be performed without risk to exposed personnel.

11.6. Risks related to electricity

Generalities

The equipment shall comply with the regulations in force, in particular the following Directives:

- "Electrical Equipment" 2017/35/EU;
- "Electromagnetic compatibility" 2014/30/EU;
- "Restriction of the use of certain hazardous substances in electrical and electronic equipment" (2011/65/EU).

11.7. Presence of an uninterruptible power supply (UPS)

If the whole equipment must be supplied by an uninterruptible power supply (UPS), then this power supply shall be provided by CEA.

The supplier shall give all the required information for product definition (voltage, power, battery life).

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The supplier shall provide connection terminals on the equipment to connect the uninterruptible power supply.

In the event that only a portion of the equipment is powered by an internal UPS integrated by the manufacturer, the following rules shall be observed:

- An all-pole isolating device shall be installed downstream of the UPS in order to enable maintenance operations.
- If voltage still remains after the master switch of the machine has been turned off, such presence shall be indicated close to the switch.
- All circuits that remain live after switch off shall be marked in orange colour in accordance with standard 60-204.

11.8. Risks related to fire

The detectors integrated into the equipment will not be connected to the building's fire protection system by default, and will only act on the affected equipment and its associated peripherals, if applicable.

If the supplier deems it necessary to connect their fire protection system with the building's fire safety system, they must first consult with CEA to ensure the compatibility of the entire system.

11.9. Risks related to explosion

The equipment shall comply with the regulations in force, especially the "ATEX" Directive 2014/34/EU.

Whenever the equipment is likely to generate an explosive atmosphere, the supplier shall perform an ATEX risk assessment and substantiate the choice of the selected ATEX equipment. The ATEX zoning plan as well as the certificates of conformity of the ATEX items of equipment shall be supplied to CEA.

11.10. Risks related to Chemicals

When the equipment uses chemical products that pose health and safety risks to operators, the supplier must detail in the risk analysis the protective measures implemented during normal, degraded, or maintenance work phases.

- When chemical products (solid, gaseous, or liquid) are supplied by the supplier, they must provide the complete list of products, along with Material Safety Data Sheets in French (MSDS) for each product. CEA will be particularly vigilant about the content, pictograms, and classification used, as well as the provision of a version written in French.
- All equipment containing liquid chemicals must be organized to form a retention system to prevent the spread of these products outside the equipment without intentional action. These retention systems will be equipped with leak detectors reporting information to the equipment's control panel. The activation of a detector will interrupt the automatic power supply to the machine and the circulation of chemical fluids. The detectors will be tested before the equipment is put into operation.
- The operation of the equipment must be controlled by the proper functioning of the extraction system. The extraction level will be continuously monitored by one or more extraction controllers, which will trigger a visual alarm at the workstation (on the equipment, and if necessary on the affected peripherals).

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- Note: For automated equipment, this "extraction" alarm may be combined with other types of alarms on the equipment's control panels. The following must be placed under extraction: trays, work surfaces, and generally any location where a leak could occur: presence of fittings, valves, pumps, storage capacities (even closed), canisters, etc.
- The chemical product trays on the benches must be equipped with an automatic drain system with adjustable timing, so that solutions can be automatically directed to the drains in case of prolonged extraction failure.
- For certain process requirements, chemical products may need to be heated. At the end of the operation, these baths are drained to dedicated drains. For temperatures above 60°C and for discharges into the "solvents" drain, a study must be conducted to define the best solution: PVDF material, dilution module, heat exchanger, etc.
- If the solution chosen by the supplier involves the installation of a buffer tank to allow cooling of these effluents, it must be under retention and equipped with an adjustable timing drain system, as mentioned above.
- For equipment with process chambers, the supplier must provide the list of expected by-products in case of chamber opening, to facilitate maintenance operations.
- The supplier will provide CEA with the technical data sheets and SDS for the thermal insulators used, prioritizing the least hazardous thermal insulating products (non-CMR). The use of CMR Category 1a and 1b is PROHIBITED. The use of thermal insulating products classified as CMR Category 2 must be justified by the supplier and validated by CEA in advance.
- The supplier will provide CEA with the list of refrigerants used in the equipment and the associated SDS.
- If the equipment is likely to contain materials subject to regulations related to perfluoroalkyl and polyfluoroalkyl substances (Decree of June 20, 2023) and "Substances of Very High Concern" (SVHC) (under Regulation (EC) No 1907/2006), the supplier will inform CEA during the design phase.

11.11. Risks related to handling

For those parts of the equipment requiring handling (pumping units, chamber lids, covers, etc.), in particular during maintenance or installation operations, suitable lifting means shall be provided and described in the safety instructions of the equipment.

Systems integrated into the equipment shall be given preference over removable systems.

11.12. Risks related to pressure vessels

The equipment must comply with current regulations, including:

- Pressure Equipment Directive 2014/68/EU.
- The contract holder will provide the following elements with the supplied pressure equipment, at a minimum:
- The pressure equipment conformity declaration;
- The presence of a CE conformity plate on the affected equipment;

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- The service instruction manual;
- The maximum allowable pressure (PS) value;
- The maximum allowable temperature (TS) value;
- The useful volume for tanks;
- The diameters of the sections for pipelines, if applicable;
- The calibration certificates and safety accessories certificates.

11.13. Risks related to work at height

In the event that use, maintenance or installation operation of the equipment require access at height, the supplier shall give priority to the installation of collective protective equipment (e.g.: built-in work platform with handrail complying with the standards in force) or, failing that, provide personal protective equipment (e.g.: anchoring points or lifelines complying with the standards in force). In the latter case, the technical documents shall very clearly refer thereto, so that the associated regulatory checks can be implemented.

Where necessary, the associated personal protections may be required.

These shall have been validated by CEA.

11.14. Risks related to artificial optical radiation

These include visible, infrared, and ultraviolet radiation, whether coherent (such as lasers) or incoherent.

The design, implementation, and labeling of the affected equipment must comply with current regulations and standards.

The supplier must provide CEA with information about the artificial optical radiation used in the equipment during the design phase, particularly regarding the risks to users.

11.15. Risks related to noise

If the equipment falls under the definition of a machine, it must comply with current regulations, including Regulation EU 2023/1230.

11.16. Risks related to temperatures

If the equipment falls under the definition of a machine, it must comply with current regulations, including Regulation EU 2023/1230.

11.17. Signalling

If the equipment falls under the definition of a machine, it must comply with current regulations, including Regulation EU 2023/1230.

Residual risks shall be indicated on the machine by means of regulatory hazard pictograms (triangles with yellow background), accompanied by additional text when applicable. In this case, this text shall be written in French.

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11.18. Regulatory Inspection

CEA shall have the necessary regulatory inspections carried out by an authorized organization of its choice, in order to verify that the supplied equipment complies with the regulations.

The Supplier shall remedy any non-conformity in the shortest time possible without being able to claim any compensation. Depending on the severity of the detected anomalies, CEA may decide to suspend the commissioning operations until the problems have been solved (refer to Article 30 of chapter 11 of the General Purchasing Conditions).

11.19. Inspection of the work equipment

The equipment must comply with current regulations, particularly Regulation EU 2023/1230. It must be accompanied by:

- The CE marking of the machine;
- The Declaration of Conformity;
- The instruction manual **in French**, including all necessary plans, diagrams, and documents for installation, commissioning, operation, adjustment, assembly, and disassembly.

Refer to Chapter 0. CEA will arrange for a machine control inspection at the installation site. The report from this inspection must be free of any non-conformities. All remarks made by the certification body must be addressed by the contract holder, who will implement the necessary modifications without requesting any financial contribution from CEA.

CEA reserves the right to conduct a second inspection after the non-conformities have been resolved.

If the equipment meets the definition of a machine, the design of the safety-related control systems must be carried out in accordance with the EN ISO 13849-1 standard. The contract holder must provide CEA with:

- The list of safety-related control systems (SRP/CS);
- The reasoning followed during the design (e.g., the faults considered, the faults excluded);
- The result of the required performance level (PLr);
- The achieved performance level (PL);
- The calculation tool used (e.g., SISStema)

11.20. Regulatory electrical inspection

CEA is attentive to the proper sizing of electrical supplies for equipment connected to its electrical network.

To facilitate proper sizing of the power supply, the supplier must provide CEA with all electrical information for the equipment, including cumulative power ratings determined by calculation (e.g., using the ELIE BT tool).

Once the equipment is installed on-site, CEA will arrange for a regulatory electrical inspection before first commissioning by an accredited certification body of its choice.

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12. ENVIRONMENTAL CLAUSES

12.1. Material Durability/Facilitating Equipment Maintainability

The Contract Holder commits to implementing all the provisions described in their environmental proposal, which is an integral part of the contract.

In this context, and in accordance with these commitments, the Contract Holder implements all or part of the following environmental measures during the contract execution:

- To design equipment with robust materials and extended lifespan;
- To propose equipment offering scalability or adaptability (e.g., by adding frames);
- To ensure that the components of the equipment are easily disassembled and repairable;

The Contract Holder remains free to submit any alternative solution within the scope of this clause.

The Contract Holder commits to providing recommendations to extend the lifespan of the Equipment during the contract execution.

13. EQUIPMENT DOCUMENTATION

The equipment supplier commits to providing, no later than before the Site Acceptance Test (SAT), all technical and administrative documentation related to the equipment (non-exhaustive list).

This documentation will include at least:

- The instruction manual written in French including the CE Declaration of Conformity (in accordance with Regulation EU 2023/1230).
- Identification of hazard sources (see Appendix 3) and safety instructions. These documents will enable the development of a risk analysis for the equipment, co-constructed between CEA and the equipment supplier (no later than before the SAT) (see § 11.1).
- If applicable, technical and installation manuals for all commercial devices, accompanied by their calibration certificates, particularly for measurement sensors.
- The list of spare parts and consumables for routine maintenance, with costs and procurement lead times.

If applicable to the type of machine considered (prototype or custom-built with more or less CEA Intellectual Property), the supplier must provide:

- Process plans and diagrams (assembly, piping, and instrumentation).
- The final design file of the equipment.
- Sources of automation and supervision programs, documented and unprotected.
- The diagram of the IT architecture.
- The nomenclature of inputs/outputs (with tag numbers reported on electrical diagrams).
- The manufacturer's file, TQC (Piping, Quality, Control) plans, as well as the electrical and control-command file (including functional analysis and plans).

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- If applicable, the ATEX zoning plan of the equipment as well as the conformity certificates of ATEX materials.
- Any other documents required by applicable regulations.

14. ACCEPTANCE CONDITIONS

14.1. Acceptance breakdown

14.1.1. SAT Phase - Controls and Testing on CEA Site

The tests to be carried out on the CEA site must be defined by CEA and validated by the supplier.

If remarks were made during the factory reception (FAT), it will be necessary to verify that the corrective actions implemented meet the safety requirements.

The acceptance tests must cover all the specifications of paragraph § 7.4.

Each requirement must be evaluated (compliant/non-compliant/partially compliant), and the results must be recorded on

Before pronouncing the reception, the supplier must submit all the test and control reports carried out during the SAT.

14.2. Acceptance criteria

Acceptance will be granted if:

- The equipment complies with regulatory requirements (see § 11.18).
- The equipment meets all contractual technical requirements (see § 7).

14.3. Final Acceptance Pronouncement on Site

Final acceptance is pronounced when:

- The equipment has been delivered in full.
- Installation, commissioning and start-up are completed.
- Qualification controls and tests have been successfully passed.
- Regulatory compliance has been approved. If applicable, machine compliance according to EU 2023/1230, as per a report issued by a CEA-accredited body, with no non-conformities.
- If applicable, compliance with specific risks (ATEX, pressure equipment, etc.) validated by an accredited body (see § 11.9).
- The complete equipment documentation has been delivered (see §13).

A proceedings record following CEA's formalism is then drawn up and signed by both parties. This proceedings record allows the acceptance of the control file and, if necessary, the listing of reservations.

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15. TRAINING

The supplier commits to provide the following training sessions. A training certificate will be issued by the supplier, listing the trained personnel and their level of intervention.

15.1. Equipment Operation Training

The supplier commits to provide training on the use of the Equipment for 3 people. The supplier will indicate in their offer the number of training days required.

This training will cover, among other topics, equipment operation, automation, control system handling and the cleaning steps of the equipment.

15.2. First-Level Maintenance Training

The supplier commits to providing first-level maintenance training for 2 people. The supplier will indicate in their offer the number of training days required.

This training shall include the formation on regular maintenance operations to be held by CEA to ensure good service life of the equipment.

15.3. Advanced Maintenance Training

In their pricing offer, for informational purposes, the supplier will provide an advanced-level maintenance training for 2 people as a Non Mandatory type of Option. The supplier will indicate in their offer the number of training days required.

This training will include:

- Barrel replacement;
- Thermocouples and cartridge heaters replacement;

16. WARRANTY

The equipment is contractually guaranteed for 2 years from the date of acceptance against any defects in material, manufacturing, assembly, and operation, in compliance with the technical specifications of the tender document.

This warranty covers parts (excluding consumables), labor, transportation, and travel.

During the warranty period, the supplier commits to intervening for repairs within 10 days following receipt of an email request for intervention from CEA. These services are performed every day from Monday to Friday, 8 AM to 5 PM.

In case of unavailability, the warranty period is extended by an equivalent duration to the equipment's downtime.

17. MAINTENANCE

At the end of the warranty period, CEA could subscribe a preventive maintenance contract.

In their pricing offer, for informational purposes, the supplier will provide a preventive maintenance service quote which includes:

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- A list of spare parts and labor for preventive maintenance,
- An annual service visit.

Following adjustments to CEA's maintenance needs, the maintenance contract may be established after the warranty period through negotiations.

18. ELEMENTS TO PROVIDE IN RESPONSE TO THE CONSULTATION

- Comments from the Equipment Supplier on the Equipment Specification Document (named Appendix 1: "FOR_533_Annexe_1.xlsx").
- Completed characteristics of fluid requirements, electrical power supply, and all other necessary interfaces (named Appendix 2: "FOR_534_Annexe2.xlsx").
- Hazard identification sheet (see § 11.1 and Appendix 3: "FOR_535_Annexe_3.xlsx").
- The cost of preventive maintenance service must be specified
- Duration and descriptions of planned training sessions.
- Non Mandatory Option quotes

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APPENDIXES

FOR 533_Annexe_1.xlsx : Supplier's feedback on specifications document

FOR534_Annexe_2.xlsx : Specification Datasheet (GB spreadsheet) for tool installation

FOR535_Annexe_3.xlsx : Hazard Identification Sheet (GB Spreadsheet)