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EQUIPMENT SPECIFICATIONS DOCUMENT

High throughput automatic equipment for powder synthesis and blending

EOTP	A-ELORG-G0-5F-DD
OS	LOC5NPEROKET
Platform	Surface Fonctionnelle

	Name	Function	Signature / Date
Written by	Ferdinand LEDEE	Research Engineer	LEDEE Ferdinand Signature numérique de LEDEE Ferdinand Date : 2026.07.21 11:35:33 +02'00'
Checked by security	Benoit BELLEVILLE	Safety Engineer	
Checked by Quality	Hélène DUFOUR	Quality Engineer	
Checked by Installation	Pascal MORA	Installation Manager	
Checked by Management	Marilyne ROUMANIE	Head Of Laboratory	
Issued by	Richard LAUCOURNET	Head of Department	

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Purchasing Department - SMA Manager MANGIN 1 copy (email)
Anne/ANDRE Anthony

Department - Head of Department +Deputy 1 copy (email)
LAUCOURNET Richard / THERY 1 copy (email)
Jessica
- Safety Engineer: BELLEVILLE Benoit 1 copy (email)
- Quality Engineer: DUFOUR Hélène 1 copy (email)
- Facility Manager: ENTZMANN
Vincent

Division - Head of Division: MORA Pascal 1 copy (email)
- Installation Manager 1 copy (email)

Laboratory and platforms - Head of Laboratory: ROUMANIE 1 copy (email)
Marilyne 1 copy (email)
- Equipment Project Manager
CHATELIER Corentin/LEDEE
Ferdinand
- Platform Manager: GALLAIRE Didier 1 copy (email)
- Writer(s): CHATELIER Corentin, 1 copy (email)
LEDEE Ferdinand

CSOP 1 copy (email)
- Equipment purchasing coordinator:
BOHNKE Marc

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PUBLIC**1. PURPOSE**

This specification document defines the supply, on behalf of the CEA, of an equipment designated as "High throughput automatic equipment for powder synthesis and blending." The equipment must be installed at the site "GRENOBLE" in the building "D3".

The installation work for the equipment will be subject to analysis following the selection of the equipment.

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

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 contacts for the basic and additional services are:

Mr Ferdinand LEDEE

Tel : +33 (0)4 38 78 30.92

Email : Ferdinand.ledée@cea.fr

PUBLIC**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 equipment will enable high throughput automated powder synthesis by co-precipitation as well as powder and solvent dispensing, and powder and solvent blending.

It will specifically

- allow the reproducible synthesis of up to 1 g of powder from solid precursors and solvents
- allow reaction with temperature control, homogenization by stirring and orbital shaking and, optionally, reflux.
- enable washing/filtering of the resulting powder, mixing operations,
- and drying the powder under vacuum at controlled temperature in vials that can be sealed with caps or placed in a dedicated system suitable, for example, for off-line analysis.

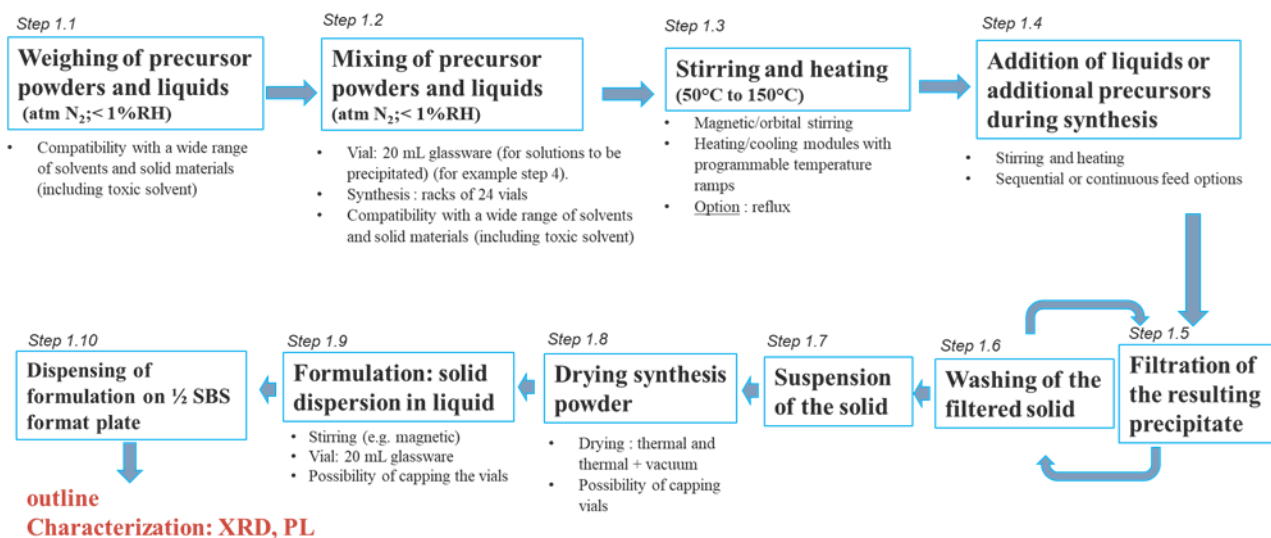
7.2. Sub-functions of the equipment

Figure 1. Flowchart example for synthesis of 1g per vial of powder by Co-precipitation/blending-formulation in the high throughput automatic equipment for powder synthesis and blending

The equipment consists of different elements, each addressing a sub-function

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- Limitation of humidity level
- Loading of consumables into the tool
- Automatic system for dispensing and weighing powders
- Automatic system for aspirating and dispensing liquid volumes
- System for synthesizing up to 1 g of powder per vial (20mL) by co-precipitation
- System for filtering and washing synthesized powders
- System for drying powders under vacuum
- System for drying powders
- System for liquid-to-viscous formulations
- Substrate holder for offline analysis
- Preventing electrostatic discharge from the powder
- Tool cleaning:
 - o Tool surfaces
 - o Cleaning of the liquid dispenser
 - o Cleaning of the solid dispenser
 - o Cleaning of the vials
- Modular software:
 - o Provision of an initial recipe for a standard co-precipitation synthesis
 - o Saving different recipes
 - o Setting the parameters
 - o Recording the process parameters
 - o Exporting the process parameters in format compatible with tier-party analysis tools (Excel, Python, etc.)
- Connecting the tool to the internal network

These sub functions are detailed in the next sections of this document.

7.3. Mandatory / non-mandatory types of requirements of the equipment

The equipment must meet a number of requirements listed below. These requirements are categorized into four levels of significance based on their mandatory or optional nature. Some of these requirements may be negotiable with the supplier. Further details on the listed requirements are provided in section 7.4.

- **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.

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Specification designation	Minimum acceptance	Maximum acceptance	Significance level
Limitation of humidity level	System embedded in a closed box		F0
Limitation of the humidity level during operation (weighing, liquid dispense, stirring)	<5%RH	<10%RH	F0
Recording and storage the humidity level data for each operation			F0*
Real-time display of the humidity level			F2
Dedicated locations for consumables, reactors and reactants	Vials: for at least 6 elements Powders: for at least 6 elements Liquids: for at least 6 elements Filtration: if applicable, for at least 6 elements Caps: for at least 6 elements		F0*
Powder weighing range	0.01 - 1 g	0.01 – 0.5 g	F0
Minimum weighing accuracy	±1 mg	±5 mg	F0
Prevention of powders cross-contamination	Accurate and careful handling of powders, no spilling of powders		F0
Calibration of the balance	Standards accredited by the COFRAC (French Accreditation Committee) or equivalent		F0*

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Handling of toxic solvents	Protection of the user: closed box connectable to an external exhaust system		F0
Dispensing viscous liquids	1 mPa.s	100 mPa.s	F0*
Liquid dispensing range	See Table 1 (part 7.4.4)	See Table 1 (part 7.4.4)	F0
Liquid dispensing accuracies	See Table 1 (part 7.4.4)	See Table 1 (part 7.4.4)	F0
Prevention of liquid cross-contamination	Accurate and careful handling of liquids, no spilling of liquids		F0
Handling of halogenated acids (HI, HCl, HBr)	Prevention of corrosion in the system		F2
Synthesize powders by co-precipitation in parallel	working volume of 20 mL, 1g of powder, at least 6 syntheses in parallel		F0*
Heating during synthesis	130°C	150°C	F0
Cooling during synthesis	0°C	10°C	F0*
Temperature ramping	±1°C / hour	±100°C / hour	F0*
Magnetic stirring	At least 100 rpm	At least 500 rpm	F0*
Orbital stirring	At least 100 rpm	At least 500 rpm	F0*
Reflux system during synthesis			F1
Filtration / washing of the powders	Compatible with particle sizes down to 1 µm		F0

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Drying the powders under vacuum while heating	Under vacuum (< 1 mbar) and at a maximum temperature of 150°C		F0*
Drying the powders under vacuum	the pumping system offers the capability to handle concentration halogenated acid solution.		F1
Drying the powders while heating	At a maximum temperature of 150°C		F0*
Sealing of the reactors	Reaction vials sealed with a screw cap or equivalent system		F0*
Custom substrate holder for offline analysis	At least 2 half-SBS standardized plates, further details in section 7.4.10		F0*
Prevention of electrostatic discharge	Powder deionizer		F1
Automatic cleaning of liquid dispenses			F0
Easy cleaning of the robot system			F0
Provision of standard recipes for co-precipitation	At least 1		F0*
Modular software and recipes			F0

Table 1 - List of Mandatory / non-Mandatory types of requirements.

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7.4. Expected performances

7.4.1. Limitation of humidity level

The equipment operation (weighting, dispensing, agitation) must be carried out under a neutral gas atmosphere (argon or nitrogen). For example, the equipment can be contained in closed box with continuous neutral gas supply (Ar or N₂) and exhaust.

Relative humidity levels within the box must be maintained below 5% ($\pm 2.5\%$).

Regeneration of the inner atmosphere, as in a glove box system, is not necessary.

Humidity levels, as well as temperature within the equipment, must be monitored.

The system must allow to record and store the humidity level and the temperature for each operation (e.g. liquid/ solid dispense, mixing, etc). The humidity levels and temperature may be displayed in any standard units (ppm, dew point, %RH, %, °C, etc.).

Option (non-mandatory type): the humidity levels and the temperature are displayed on a screen in real time.

7.4.2. Loading of consumables into the tool

Dedicated locations must be provided for powders, liquids (if stored within the machine), vials, caps, filtering system, and any other consumables required for system operation.

The equipment must be designed for easy and safe access, with no risk during opening and loading operations.

7.4.3. Automatic system for dispensing and weighing powders

The system must be compatible with salts powder (e.g. ionic solids), inorganic precursor powders (e.g. metal halides), metal oxide and hydroxides powders, as well as organic powders (e.g. polymers, fullerenes derivatives, etc).

The equipment must be capable of dispensing electrostatic powders with different morphologies, and particle sizes ranging from 1 μm to 100 μm .

The supplier must specify any limitations regarding powder properties, such as particle size, flowability, hygroscopicity, or electrostatic behaviour

Powder dispensing must be performed vertically from above directly into the target vial.

The weighed mass ranges between 0.01 and 1 g, with an accuracy of ± 1 mg.

The supplier must provide a dispensing and weighing solution suitable for such powders, ensuring accurate handling and preventing any cross-contamination between reaction/formulation vials (e.g. residual powder potentially falling into another vial and within the dispensing/weighing system).

The powders must be stored in vials/bottles or any container inside the closed box. The system must accommodate at least 6 different powders.

A certificate of conformity for the measurement equipment is required for the acceptance of the equipment. This certificate must specify the traceability to standards accredited by the COFRAC (French Accreditation Committee) or equivalent accreditation organization.

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The supplier must provide a protocol for the calibration of the weighting system.

7.4.4. Automatic system for aspirating and dispensing liquid volumes

The system must be compatible with a wide range of solvents including polar aprotic toxic solvents (example: DMSO, DMF, PEG...), high vapor pressure halogenated solvents (DCM, CB, etc.), apolar solvents (toluene, diethylether), concentrated basic aqueous solution (example KOH 5 mol/ L). Appropriate exhaust outlet must be available to plug to CEA extraction.

The solvents must be stored either in bottles outside the closed box (e.g. below the equipment) or inside the closed box, using an appropriate liquid handling system. The system must accommodate at least 6 different solvents.

The system must be capable to handle liquids with viscosities ranging between 1 mPa.s to 100 mPa.s.

The volume ranges and expected accuracies of liquid dispense are specified in the table below:

Volume (mL)	Accuracy (mL)
0.05 – 1	± 0.01
1 – 10	± 0.1
10 – 40	± 0.5

Table 2 - Volumes ranges and expected accuracies

The supplier must propose a system that presents no risk of cross-contamination between vials during pipetting or dispensing. This includes preventing residual droplets from falling into another vial, and washing / replacing the pipette tip between two pipetting operations.

Option (mandatory type): The equipment offers the capability to handle concentrated halogenated acidic solutions (e.g., HI, HCl, HBr).

7.4.5. Automatic system for synthesizing up to 1 g of powder per vial by co-precipitation

The system must use vials with a minimum working volume of 20 mL to enable the synthesis of up to 1 g of powder under the specified conditions.

The system must include a configurable capacity ranging from at least six (6) to thirty-six (36) vials in order to support multiple parallel syntheses.

The system must ensure homogenization of powder/solvent mixtures to enable uniform co-precipitation reactions. The system must be capable of operating within a temperature range from (20-30°C) up to 150°C. The system must be capable of cooling operations down to at least 0°C.

In addition, stirring must be performed under programmable heating and cooling ramps down to 1°C/hour.

Reaction must be carried out under inert atmosphere.

The equipment must have tools for both magnetic stirring and orbital shaking at a minimum speed of 100 rpm of the vials during heating/cooling. The equipment must enable the opening and closing of vials during synthesis operations to allow for the addition of liquids or powders.

Option (mandatory type): a reflux system is proposed.

PUBLIC**7.4.6. Automatic System for filtering and washing synthesized powders**

The synthesized powder must be filtered and washed multiple times. It must be possible to program between 0 and 40 washing/filtration cycles. The filtering system must be compatible with particle sizes down to 1 μm .

7.4.7. Automatic System for drying powders under vacuum

The equipment must be able to dry powders at a maximum temperature of 150°C under vacuum (< 1 mbar). The vacuum pumping system must be compatible with the solvents cited in section 7.3.4, including high vapor pressure halogenated solvents

Option (mandatory type): the pumping system offers the capability to handle concentration halogenated acid solution.

7.4.8. Automatic system for powder drying

The equipment must be able to dry powders at a maximum temperature of 150°C. The vial containing the dried powder must be sealed with a cap before being manually removed from the synthesis robot.

7.4.9. Automatic System for liquid to viscous formulations

This robot must be capable of performing formulations based on liquid or liquid/powder mixtures.

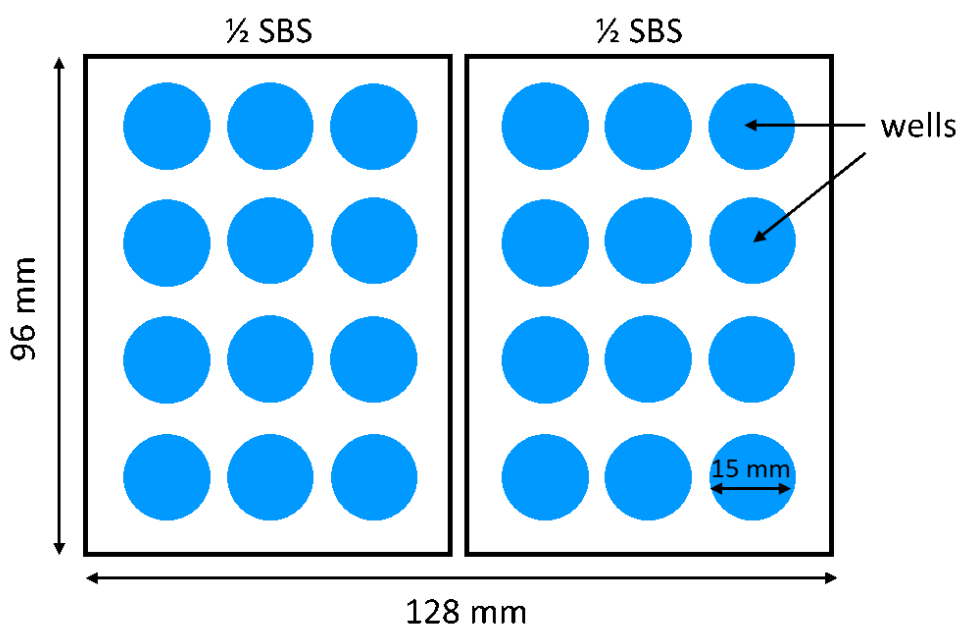
Target viscosities range from water-like viscosity ($\sim 1 \text{ mPa}\cdot\text{s}$) up to 100 $\text{mPa}\cdot\text{s}$.

For mixing these formulations, magnetic stirring must be provided.

The vials must be sealable with a cap.

7.4.10. Powder holder for offline analysis

The equipment must provide at least 2 and no more than 6 half-SBS standardized plates (SBS plates format being 96 x 128 mm^2 , half-SBS plates format being 96 x 64 mm^2), with 4x3 wells with 15 mm diameter each (2 mm deep) for the collection of dispensed suspensions. The equipment must provide



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a storage area for these plates. The equipment must allow the dispense of formulations in the aforementioned wells.

7.4.11. Preventing electrostatic discharge from the powder

Option (mandatory type): The equipment must prevent the electrostatic discharge from the powder, both in the powder containers (bottles, vials, others) and in the reaction vials.

7.4.12. Tool Cleaning**Tool surfaces**

A wide range of solvents and powders must be handled. All surfaces of the automated system shall be easily accessible and easy to clean using water and ethanol/isopropanol, in order to remove any residual traces of materials.

Cleaning of the liquid dispenser

The liquid dispensers must be automatically cleanable using an appropriate solvent to prevent any cross-contamination. They must also be easily manually replaceable if required.

Cleaning of the solid dispenser

The solid dispensers must be cleanable and must be easily replaceable with new ones.

Cleaning of the vials

Used vials must be removed manually after use and manually replaced with new ones.

7.4.13. Modular software**Provision of a standard co-precipitation recipe**

A standard recipe for the co-precipitation synthesis must be provided by the supplier, using the different tools of the equipment, with consistent parameters (weighting precision, masses, volumes, dispense speeds, etc.)

Saving different recipes

All the process parameters must be controlled, saved and recalled under an identified recipe.

Data that are acquired during the process must be stored and can be saved through network under a format that can be transferred into a database.

In each recipe, we can find all the parameters and the position of the vials. For example:

- Recipe X

- volume of liquid
- mass of solid
- identification of each vial position
- temperatures
- blending mode: stirring/shaking

.....

The operator must be capable of creating his own recipe by programming the number and sequence of the elemental operation cited above. The number of possible main recipe will be at least 150.

The software must give the operator a high degree of programming flexibility. For example:

Recipe X:

Synthesis 1 in vials 1, 10, and 4 with addition of solid 1 and liquid 3.

Synthesis 2 in vials 2, 3, and 8 with addition of solid 2 and liquid 3.

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Mixing in vials 12 and 16 with addition of solid 2 and liquid 1.

Recipe Z:

Recipe X followed by Recipe Y, or the reverse order.

In another level of programming flexibility, the operator must be capable of fine tuning the elemental operation parameters. For example:

- volume of liquid: collection speed, dispense speed, distance between the tip and the vial, etc.
- mass of solid: distance between the solid dispensing tool and the vial
- Distances between the tools and the different plates
- if applicable, gripping / holding system: gripper finger travel distance, gripper force, etc.

Setting the parameters

A GUI (Graphical User Interface) must be provided to monitor the equipment during its use and operation. Whatever the system proposed by the manufacturer it must have to be ergonomic:

- in terms of software management,
- its positioning outside the equipment will not disturb any task of the operator

The interface must gather all the functionalities to run the tool:

- All hardware positioning
- During process, all the parameters of the recipe (such as weighing of the solid, dispensed liquid volume, vials position, temperature,) must be managed through this interface. These parameters must be automatically stored inside the used recipes.
- the software must allow to display if the robot is running and the ongoing operation

Recording the process parameters

All the process parameters must be controlled, saved and recalled under an identified recipe.

During the process, collected data must be stored and can be saved on USB key or on the local network.

The format of the data must be compatible with common tier-party analysis tools (Excel, Python), for instance .csv, .txt, yaml, json, etc.

Dispensing in the SBS plate wells

The software must allow dispensing at programmable (x, y) locations and at programmable z distances between the liquid dispense opening and the SBS plate surface, as well as the solid dispense opening and the SBS plate top surface.

Collecting liquid

The software must allow for the collection of liquids at these programmable (x, y) locations and at a programmable z distance between the liquid dispense opening (e.g., needle eye) and the vial opening.

7.4.14. Connecting the tool to the internal network

If the equipment is delivered with a computer, it shall be set up with a Windows 11 Enterprise Operating System and shall be compatible with the SYMANTEC Endpoint Protection 12.1 RU6 MP6 at least (12.1 RU6 MP9 preferred) antivirus.

The hardware shall enable networking and shall feature at least wired (Ethernet) network.

CEA's facilities management shall be called on to configure the PC to the CEA standard before its networking.

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It must be possible to save the configuration and acquisition data in a repository of a network server. Therefore, the acquisition data shall be supplied as result files that can be transferred onto the network.

The system must have a remote supervisory system. This supervisory system shall feature a read only profile of the parameters. It shall not be possible to perform any action on the operation of the equipment.

Additional profiles will allow to make the following functions:

- User for the piloting of the equipment
- Maintenance technician for the configuration of the equipment
- Administrator (only for the system administrator staff)

Remote control access of the computer equipment from the Internet shall not be authorised for the maintenance or commissioning phases. Should, for technical reasons, remote control access from an Intranet be required, the supplier shall specify such requirement in its bid. It shall provide the list of all the remote actions that may occur on the equipment using the remote-control access. CEA will then carry out an analysis to determine whether or not CEA grants an exception, without this being constituted as a commitment. In any case, the implementation of remote-control access shall give rise to a reduction by the supplier which shall be specified in the bid. By default, the remote-control access shall then be implemented via RDP (Remote Desktop Protocol) software.

In case parameters of the system can be modified, the supplier will have to indicate in the offer the elements of **analysis of security of this system of supervision allowing to demonstrate that the security of the equipment remains mastered by technical means independent from the system of supervision**. If these elements are not briefly known at the time of the offer, the supply of these elements will constitute a deliverable in the putting into service.

7.5. Specifications

7.5.1. Hardware and equipment specifications

Small wheels must be mounted on the equipment to make its transfer easy in case of change of the floorplan in the cleanroom. However, these wheels will have to be disabled as soon as the equipment will be hooked up.

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Table 3 - Specifications and tests conditions for the equipment

	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)
E-1	Controlled humidity during operation (dispense, agitation, vial opening/closing)	H ₂ O < 5%RH	±2.5%	Box closed	NA	NA	FAT	Neutral gas (Ar, N ₂) supplied by the supplier
E-2	Heating	140°C	±3°C	In vial, temperature monitored inside the vial, under agitation (shaking or stirring)	NA	In 6 different vials	FAT	Vial (supplier), thermocouple (supplier or CEA), thermocouple reader (supplier or CEA), oil (supplier or CEA)
E-3	Cooling	0°C	±3°C	In vial, temperature monitored inside the vial, under agitation (shaking or stirring)	NA	In 6 different vials	FAT	Vial (supplier), thermocouple (supplier or CEA), thermocouple reader (supplier or CEA), oil (supplier or CEA)
E-4	Heating / cooling ramp	+ 1°C / hour (heating) - 1°C/ hour (cooling)	±0.5°C / hour	In vial, temperature monitored inside the vial, under agitation (shaking or stirring)	NA	In 6 different vials	FAT	Vial (supplier), thermocouple (supplier or CEA), thermocouple reader (supplier or CEA), oil (supplier or CEA)

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E-5	Vortex created in vial during agitation (stirring or shaking)	Vortex created (visual check)	NA	In vial, during heating at 40°C	NA	In 6 different vials	FAT	Vial (supplier), water
E-6	Filtration of a suspension <100 µm in ethanol	Evacuation of the supernatant (visual check) No clogging (visual check)	NA	In vial, solid powder <100 µm particle size dispersed in ethanol	NA	In 6 different vials	FAT	Vial (supplier), powder insoluble in ethanol (e.g. CaCO ₃ , KCl) provided by supplier or CEA, ethanol (supplier or CEA)
E-7	Dedicated locations for consumables	Present (visual check): Vials: for at least 6 elements Powders: for at least 6 elements Liquids: for at least 6 elements Filtration: if applicable, for at least 6 elements Caps: for at least 6 elements	NA	NA	NA	NA	FAT	NA
E-8	Agitation system (orbital shaking or magnetic stirring) with heating / cooling	Present (visual check): At least one of the mentioned options Ideally, both options are proposed	NA	Heating / cooling by calorific fluid and/or electric	NA	NA	FAT	NA
E-9	Vials capping / uncapping system	Present (visual check)	NA	NA	NA	NA	FAT	NA

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E-10	Powder dispense system	Present (visual check)	NA	Powder dispensed from above, directly in vial	NA	NA	FAT	NA
E-11	Washing / rinsing station for liquid dispense	Present (visual check)	NA	Evacuation of the rinsing solvent in waste bottle (closed or under extraction)	NA	NA	FAT	NA
E-12	Exhaust gas outlet	Present (visual check)	NA	NA	NA	NA	FAT	NA
E-13	Neutral gas inlet	Present (visual check)	NA	NA	NA	NA	FAT	NA
E-14	Filtration system	Present (visual check)	NA	Compatible with particle size down to 1 μm	NA	NA	FAT	NA
E-15	Pumping system to dry powders under vacuum	Present (visual check)	NA	NA	NA	NA	FAT	NA
E-16	Ionization module for both powder containers and reaction vials	Present (visual check)	NA	NA	NA	NA	FAT	NA
E-17	Standard recipe for co-precipitation	Delivered to CEA in any digital file format compatible with the equipment software	NA	Co-precipitation recipe using the different tools of the equipment: weighting, dispense, agitate, heal, filtrate, etc.	NA	NA	FAT	NA
O-1 (optional)	Option: pumping system compatible with concentrated halogenated acids (HCl, HBr, HI)	Present (visual check)	NA	NA	NA	NA	FAT	NA

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O-2 (optional)	Option: reflux system	Present (visual check)	NA	For vials, compatible with agitation	NA	NA	FAT	NA
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PUBLIC**7.5.2. Process specifications**

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.

PUBLIC**Process 1**Table 4 - Specifications and test conditions for [process 1: co-precipitation of](#) (FeMn)(OH)₃ with 0 at.% Mn, 5 at.% Mn, 10 at.% Mn

	SPECIFICATIONS			PROPOSED TEST CONDITIONS				
TEST#	Acceptance Criteria	Equipment Expected Target	Equipment Target Tolerance	Test Condition	Sample Type/Format (Specify who provide them)	Number of Test Samples	FAT or SAT	Test medium (specify who provides it)
P1-1-1	Dispense of iron nitrate	m ₁ = 3.795 g m ₂ = 3.607 g m ₃ = 3.419 g	+/- 1 mg	Weight appropriate amount of Fe nitrates.	N.A.	2 each (6 total)	SAT	Powder provided by CEA (iron nitrates)
P1-1-2	Dispense of manganese acetate	m ₁ = 0 g m ₂ = 0.173 g m ₃ = 0.346 g	+/- 1 mg	Weight appropriate amount of Mn acetate and dispense in the previously loaded (with Fe nitrate) vials.	N.A.	2 each (6 total)	SAT	Powder provided by CEA (manganese acetate)
P1-1-3	Dispense of water	V = 5 mL	+/- 10 µL	Dispense appropriate amount of water in the previously loaded (Fe/Mn) vials.	N.A.	2 each (6 total)	SAT	Liquid provided by CEA (water)
P1-2-1	Dispense of potassium hydroxide	m ₁ = 1.581 g m ₂ = 1.581 g m ₃ = 1.581 g	+/- 1 mg	Weight appropriate amount of KOH.	N.A.	2 each (6 total)	SAT	Powder provided by CEA (KOH),

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P1-2-2	Dispense of water	V = 6 mL	+/- 10 µL	Dispense appropriate amount of water in the previously loaded (KOH) vials.	N.A.	2 each (6 total)	SAT	Liquid provided by CEA (water)
P1-3	Precipitation	Precipitation of the hydroxide (visible solid in solution)	N.A.	Dispense the KOH solution into the vial (drop-by-drop, drop of 0.05 mL) during agitation, temperature of 70C	N.A.	9	SAT	N.A.
P1-4	Filtration and washing	Evacuation of the supernatant, No clogging	NA	Evacuate supernatant, wash the powder 4 times with water, evacuate wash solvent	N.A.	9	SAT	Liquid provided by CEA (water)
P1-5	Drying	Dried powder (visible)	NA	Dry the powder at T> 100°C under vacuum until it appears dry	NA	6	SAT	NA
P1-6	Resuspension	Well-dispersed (visible)	NA	Dispense appropriate amount of ethanol (e.g., 5 mL) to create suspension of the dried powder, agitation until particles are evenly distributed in ethanol	NA	6	SAT	Liquid provided by CEA (ethanol)
P1-7	Drop-cast	Drop-cast done (visible)	NA	Collect appropriate amount of suspension (e.g., 100 µL), drop-cast in vials, dry the powder under vacuum or by heating at T=60°C	NA	6	SAT	NA

PUBLIC**Process 2**Table 5 - Specifications and test conditions for process 3: Dispense of CsBr and PbBr₂

	SPECIFICATIONS			PROPOSED TEST CONDITIONS				
TEST #	Acceptance Criteria	Equipment Expected Target	Equipment Target Tolerance	Test Condition	Sample Type/Format (Specify who provide them)	Number of Test Samples	FAT or SAT	Test medium (specify who provides it)
P2-1	Dispense of CsBr	0.5 g	+/- 0.01 g	Weight and dispense CsBr in vial	N.A.	6	SAT	CsBr (CEA), vials (CEA)
P2-2	Dispense of PbBr ₂	0.5 g	+/- 0.01 g	Weight and dispense PbBr ₂ in vial	N.A.	6	SAT	PbBr ₂ (CEA), vials (CEA)

7.5.3. Measurement specifications

Table 6 – Measurement Specifications and associated test conditions

	SPECIFICATIONS	PROPOSED TEST CONDITIONS
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PUBLIC

TEST #	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)
M-1	Dispense of powders	10 mg	±1 mg	In a vial, repeated twice.	NA	In 6 different vials	FAT	Powder provided by the supplier or CEA (e.g. KCl, CaCO ₃), vial (supplier)
M-2	Dispense of powders	100 mg	±1 mg	In a vial, repeated twice.	NA	In 6 different vials	FAT	Powder provided by the supplier or CEA (e.g. KCl, CaCO ₃), vial (supplier)
M-3	Dispense of powders	1000 mg	±1 mg	In a vial, repeated twice.	NA	In 6 different vials	FAT	Powder provided by the supplier or CEA (e.g. KCl, CaCO ₃), vial (supplier)
M-4	Dispense of liquids	50 µL	±10 µL	In a vial, repeated twice.	NA	In 6 different vials	FAT	Liquid provided by the supplier or CEA (e.g. water), vial (supplier)
M-5	Dispense of liquids	500 µL	±10 µL	In a vial, repeated twice.	NA	In 6 different vials	FAT	Liquid provided by the supplier

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								or CEA (e.g. water), vial (supplier)
M-6	Dispense of liquids	5000 μ L	± 10 μ L	In a vial, repeated twice.	NA	In 6 different vials	FAT	Liquid provided by the supplier or CEA (e.g. water), vial (supplier)

PUBLIC**7.5.4. Maintenance specifications**

The components of the equipment required to meet the needs for each function and sub-function are listed to establish any potential conditions expected by the CEA regarding maintenance.

Examples include:

- Provision of a list of spare parts.
- Provision of the modalities of the annual maintenance plan.
- Internal training of the maintenance team.

Table 7. *Components and maintenance related specifications*

Component	Spec #	Maintenance Specifications	Significance level
Whole Equipment	MT-1	Provide an annual maintenance Plan	F1
	MT-2	Provide lead time and associated cost to establish maintenance training course for 4 people	F0*
	MT-3	Provide a list of spare parts	F1
Robot	MT-4	Provide a detailed procedure (within the technical documentation, see part 13) for: - Replacing all the components in the robot (e.g. syringes, tubes for liquid,...) - Provide a procedure to clean the robot - Provide a procedure to reinitialize the robot - Provide a procedure for re-calibration of weighting and liquid dispensing system.	F0*
Vacuum pump	MT-5	Provide a detailed maintenance plan	F1
	MT-6	Provide the replacement cost for the Vacuum pump	F1
Cooling / heating device	MT-7	Provide a detailed maintenance plan	F1
	MT-8	Provide the replacement cost for the cooling / heating device	F1
UI Control	MT-9	Indicate in the maintenance offer the cost of the UI control (software upgrades, ...)	F1
Automation	MT-10	Provide annual maintenance plan	F1

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The small maintenance must be easily done by the user of the equipment: This include cleaning, changing small spare parts of the equipment with one or two tools maximum; those must be removed and replaced easily and in safety. The maintenance mode has to be intuitive.

Note :

- **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.

7.6. Computer specifications

7.6.1. Computer Control

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

7.6.2. 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.

7.6.3. 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:

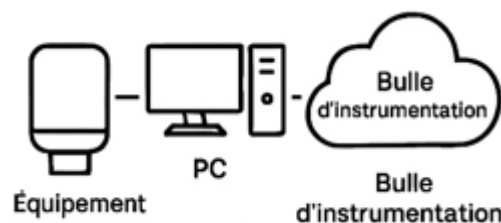


Figure 2 – CEA network connection diagram

- For IT security reasons, there is no internet access or email functionality.

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- 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.

7.6.4. 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).

7.6.5. 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.

7.6.6. 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.

7.6.7. 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).

7.6.8. 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.

7.6.9. 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.).

7.6.10. 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**7.6.11. Remote maintenance**

If requested by the equipment supplier and subject to technical feasibility, an external remote maintenance solution may be implemented based on CEA's service offering. For IT security reasons, consumer-grade remote maintenance software is not permitted. Remote maintenance sessions are scheduled and conducted under continuous supervision by CEA personnel. During these sessions, the equipment is physically disconnected from the instrumentation network cloud.

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
Transportation from supplier to CEA building		x
Hook up and equipment installation into the room		x
Extraction from the room to the exterior of the building	x	
Fluids, electrical power supply	x	
Prevention plans	x	

8.2. Environment, Facilities

The equipment will be installed in a clean room (class 10000) Temp 21°C, Hr 50%.

The equipment must fulfill criteria for being installed in this room.

The supplier must include in its bid the fluid requirements, electrical power supply and any other required interfaces. CEA provides a recycled cooling water closed-loop system with the specifications presented in Table . The supplier may connect to this loop instead of a chiller, provided that the specifications are compatible with the requirements.

Table 8 – Specifications linked to facilities

Main fluids distribution	Specification for Building D3	Note
Cooling water		Recycled cooling water in closed loop
	Inlet Pressure : 5 bar	
	Outlet Pressure : < 1 bar	
	Inlet Temperature : 19 to 24°C	
	Conductivity : 250-450 µS/cm	
	pH : 7.5-8.5	

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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 T0 + 8 weeks (in accordance with “Section 9 Timeline”) as T0 refers to the date of order notification by CEA.

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 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:

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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:

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.

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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.
- 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 must be installed at the GRENOBLE site in the D3 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 7.5 and in Appendix 1.

Dimensional and Load Constraints:

The crate must meet the following size requirements to enter the facilities (doorway):

Maximum width: 1400 mm

Maximum height: 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

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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
Factory Acceptance Test (FAT)	$T_0 + 24$ weeks
Equipment delivery at CEA site	$T_0 + 25$ weeks
Training	$T_0 + 26$ weeks
Site Acceptance Test (SAT)	$T_0 + 26$ weeks

* T_0 refers to the date of order notification by CEA.

o 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.

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

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.
- 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. § 0 Documentation).

11.2. Hazards related to facilities

NA

11.3. 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.

11.4. 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.

11.5. Emergency stop

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

**11.6. "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.

11.7. Risks related to electricity**Generalities**

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

- "Electrical Equipment" 2017/35/EU;

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

If the equipment is composed of electrical measurement, control and laboratory devices, it shall comply with Standard NF EN 61010-1.

11.8. 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).

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.

11.9. 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.

11.10. 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.

11.11. 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.

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- 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).
- 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.

11.12. 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.

PUBLIC**11.13. 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;
- 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.

11.14. 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.

11.15. 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.

11.16. 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.

PUBLIC**11.17. 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.

11.18. 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.

11.19. 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).

11.20. 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.

CEA may arrange for a machine control inspection at the manufacturing site by a certification body of its choice. The report from this manufacturing site 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.

In all cases, a second inspection must be conducted after the equipment is installed on-site.

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., SiStema)

PUBLIC**11.21. 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.

12. ENVIRONMENTAL CLAUSES***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 ;
- To propose training on the use of the Equipment in line with the implementation of the clause.

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). It must include:
 - Instructions for replacing all the consumables in the robot (e.g. syringes, tubes for liquid,...)
 - A procedure to clean the robot
 - A procedure to reinitialize the robot
- 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.

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- 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).

14. ACCEPTANCE CONDITIONS

14.1. Acceptance breakdown

14.1.1. FAT Phase - Factory Control and Testing

The supplier must propose a procedure for controlling and testing the equipment. This procedure must include the controls and tests requested by CEA (cf. § 7.5). The controls carried out at the supplier's site will follow this procedure, which must be submitted to CEA for approval beforehand. After approval of the procedure, CEA will indicate the tests it wishes to attend.

At the end of the FAT, a pre-acceptance proceedings record following CEA's formalism is drawn up and signed by both parties. This pre-acceptance proceedings record allows the acceptance of the factory control file and the listing of reservations. It includes a list of raw measurement data for the tests requested by CEA (cf. § 7.5).

14.1.2. 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 § 7.5.

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

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 § 11.19).

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- The equipment meets all contractual technical requirements (see § 7).

When verification of an acceptance criterion requires measurement, the means used must be control, measurement, and test equipment (ECME), as defined by ISO 9001 §7.5.3.

If CEA provides the measurement equipment: Verify the availability of suitable ECME with sufficient precision.

If the supplier provides the measurement equipment:

- Measurements must be performed using compliant ECME.
- The supplier must provide calibration certificates with COFRAC accreditation or equivalent.

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 § 11.10).
- 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.

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 4 people. The supplier will indicate in their offer the number of training days required.

This training will cover, among other topics, equipment operation, automation, and control system handling, recipe creation, data backup.

15.2. First-Level Maintenance Training

The supplier commits to providing first-level maintenance training for 4 people. The supplier will indicate in their offer the number of training days required.

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The supplier commits to providing first-level maintenance training for 4 people. The supplier will indicate in their offer the number of training days required.

16. WARRANTY

The equipment is contractually guaranteed for 1 year(s) 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 48 hours 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

The small maintenance must be easily done by the user of the equipment.

At the end of the warranty period, CEA will have the option to subscribe to a maintenance contract.

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

- Parts and labor for preventive maintenance,
- Corrective maintenance on demand (at hourly rates) with adherence to intervention and repair deadlines.

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.
- Separated Mandatory and non Mandatory Option quotes

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Mandatory and non Mandatory Options:

- **Mandatory Option:** The supplier must obligatorily include an offer with the option, otherwise the offer will be considered irregular. 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.
- **Non mandatory type Option:** The supplier has the choice to propose or not propose the option. If the option is not proposed, the supplier will not necessarily be disqualified. CEA reserves the right to decide whether to exercise the option or not.

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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)