

Document title	Low Temperature Epitaxy Cluster tool - RPCVD
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1 PURPOSE

For its research activities targeted at developing 10nm and beyond fully-depleted SOI technologies, CEA-LETI is willing to purchase a new epitaxy cluster tool to address the coming challenges of the technology.

This RPCVD low temperature epitaxy cluster tool must be able of performing IV-IV intrinsic and in-situ doped, non-selective and selective (N&P type) epitaxial growth of group IV semiconductors at high and low temperatures (from 1100°C down to 300°C) on 300 mm silicon wafers.

Documents to be provided by the Contractor during the tender process

- ✓ The Contractor must complete and deliver to CEA-LETI **Appendix A: Summary of Contractor's comments** and put any comments in this section (the Contractor must not add any comments in the main text).
- ✓ The Contractor must complete and deliver to CEA-LETI **Appendix H: Datasheet for Tool Installation**.
NB: The datasheet information allows CEA-LETI to design the fluid PID* and the electrical PID*. These PIDs are then sent for verification and approval to the equipment Contractor. Hook Up and Fit Up will start after the official validation of PIDs by the equipment Contractor. (* Piping and Instrumentation Diagram)
- ✓ The Contractor must complete and deliver to CEA-LETI **Appendix I: Risk Identification Sheet**
- ✓ The Contractor must complete and deliver to CEA-LETI **Appendix J: SECS/GEM Compliance**
- ✓ A forecast packing list

2 PROCESS OR MEASUREMENT SPECIFICATIONS

The Contractor will have to demonstrate its capacity to achieve the specifications to which he complies, by presenting results obtained on the proposed tool.

2.1 Process 1: High Temperature SiGe 30% (Chamber A & Chamber B)

30 nm thick SiGe 30% layers will be grown at 650°C, 20 Torr with SiH₂Cl₂ + GeH₄ on Si(001) substrates *after the dedicated low temperature surface preparation and a 650°C, 2 minutes H₂ bake only*. Such layers should be seen as smooth in X-Ray Reflectivity (e.g. with definite thickness fringes up to 4°), haze measurements (< 1 ppm), low roughness by atomic force microscopy (Root-Mean Square value lower than 0.2 nm) and high crystalline quality in X-Ray Diffraction (well defined, intense XRD peaks with thickness fringes on both sides). Repeatability test will be performed on 10 wafers with less than 1% variability wafer to wafer on the 10 wafers tested.

Test n°	Test name	Method	Result to pass
Test 1.1	Layer quality 1	XRR	Well-defined thickness fringes up to 4°
Test 1.2	Layer quality 2	XRD	Well-defined layer peak with thickness fringes on each side well rendered by the RADS software from Bruker
Test 1.3	Layer quality 3	DW and DN Haze	< 1 ppm
Test 1.4	Layer quality 4	AFM	1x1 μm <0.2nm RSM and 2nm range.
Test 1.5	Thickness and composition	Spectroscopic Ellipsometry	Polarmaps, 49points, 3mm edge exclusion: thickness 1 sigma variations $\leq 1\%$, thickness range $\leq 3\%$; Ge content range $\leq 1\%$.
Test 1.6	Particle density	Surface scan	<10 parts <120 μm .

2.2 Process 2: High Temperature Si (Chamber A & Chamber B)

Interfacial C, O, N and F contamination between 100 nm thick Si layers (grown at 650°C, 20 Torr with SiH₄) on Si(001) substrates underneath will be quantified with SIMS for the following surface preparations: "HF-Last" wet cleaning OR the *appropriate low temperature surface preparation* then in-situ H₂ bakes for 2 minutes at 20 Torr at 650°C, 750°C, 775°C, 800°C and 825°C. The sheet concentrations of contaminants after a dedicated *low temperature surface preparation* should be inferior or equal to those obtained after a "HF-Last" wet cleaning. For bake temperatures 800°C and above, C and O interfacial contamination peaks should not be present anymore and haze should be lower than 1 ppm. Typical Lower Limits of Detection of O, C, N and F in Si are the following ones with the SIMS apparatus we use: O $\Rightarrow 5 \times 10^{17} \text{ cm}^{-3}$, C $\Rightarrow 10^{17} \text{ cm}^{-3}$, N $\Rightarrow 5 \times 10^{15} \text{ cm}^{-3}$ and F $\Rightarrow 10^{15} \text{ cm}^{-3}$. Repeatability test will be performed on 5 wafers with less than 1% variability wafer to wafer on the 5 wafers tested.

Test n°	Test name	Method	Result to pass
Test 2.1	Sheet interface contamination	SIMS	No interfacial contamination peaks for H ₂ bakes temperatures 800°C and above.
Test 2.2	Layer quality 1	DW and DN Haze	< 1 ppm for H ₂ bake temperatures $\geq 800^\circ\text{C}$
Test 2.3	Particle density	Surface scan	<10 parts <120 μm .

2.3 Process 3: Low Temperature SiP (in the n-type Chamber A)

60 nm thick Si:P >5% layers will be grown at 500°C with a cyclic process on Si(001) substrates *after the dedicated low temperature surface preparation and a 500°C 2 min bake only*. Such layers should be seen as smooth in X-Ray Reflectivity (e.g. with definite thickness fringes up to 4° when grown on SiGe marker layer) or haze measurements (< 1 ppm) and high crystalline quality in X-Ray Diffraction (well defined, intense XRD peaks with thickness fringes on both sides). Repeatability test will be performed on 10 wafers with less than 1% variability wafer to wafer on the 5 wafers tested.

Test n°	Test name	Method	Result to pass
Test 3.1	Layer quality 2	XRD	Well-defined layer peak with thickness fringes on each side well rendered by the RADS software from Bruker. P%>5%. With P variation P_content range $\leq 0.2\%$.
Test 3.2	Layer quality 3	DW and DN Haze	< 1 ppm
Test 3.3	Layer quality 4	AFM	1x1 μm <0.2nm RMS roughness and 2 nm Z range.
Test 3.4	Thickness	Spectroscopic Ellipsometry	Polar maps, 49 points, 3mm edge exclusion: thickness 1sigma variations $\leq 1\%$, thickness range $\leq 3\%$;
Test 3.5	Layer quality 5 O conta in SiP	Tof-SIMS	The oxygen concentration must be low in the CDE SiP films (<1E19 atm.cm ³).
Test 3.6	Metal contamination Post LT_SiP	VDP-ICPMS	All metal contamination* Front & back side
Test 3.7	Resistivity	4PP	Layer resistivity < 2.5×10^{-4} Ohm.cm
Test 3.8	Particle density	Surface scan	<10 parts <120 μm .

*Data concerning metallic contamination must then be provided. It must be within LETI's specifications (e.g. front side (backside) metallic contamination < lower limits of detections or 5×10^{10} atm.cm⁻², whichever is the highest).

2.4 Process 4: Si:As (in the n-type Chamber A)

60 nm thick Si:As with As>2% ($>1E21$ atm/cm³) layers will be grown at <650°C on Si(001) substrates. Such layers should be seen as smooth in X-Ray Reflectivity (e.g. with definite thickness fringes up to 4° when grown on SiGe marker layer) or haze measurements (< 1 ppm) and high crystalline quality in X-Ray Diffraction (well defined, intense XRD peaks with thickness fringes on both sides). Repeatability test will be performed on 10 wafers with less than 1% variability wafer to wafer on the 5 wafers tested.

Test n°	Test name	Method	Result to pass
Test 4.1	Layer quality 2	XRD	Well-defined layer peak with thickness fringes on each side well rendered by the RADS software from Bruker. As%>2%. With as variation As_content range $\leq 0.2\%$.
Test 4.2	Layer quality 3	DW and DN Haze	< 1 ppm
Test 4.3	Layer quality 4	AFM	1x1 μm <0.2nm RMS roughness and 2 nm Z range.
Test 4.4	Thickness	Spectroscopic Ellipsometry	Polar maps, 49 points, 3mm edge exclusion: thickness 1sigma variations $\leq 1\%$, thickness range $\leq 3\%$;
Test 4.5	As contamination 1 Post SiAs and clean	TXRF	As contamination Front & back side (<2E10 atm.cm2)
Test 4.6	Metal contamination 2 Post SiAs and clean	VDP-ICPMS	As contamination Front & back side (<1E9 atm.cm2)
Test 4.7	Resistivity	4PP	Layer resistivity <0.7 mOhm.cm
Test 4.8	Particle density	Surface scan	<10 parts <120 μm .

2.5 Process 5: Low Temperature SiGe:B (the p-type chamber B)

30 nm (± 1 nm) nm thick, heavily in-situ boron doped SiGe30% layers will be grown at 400°C on slightly n-type doped Si(001) substrates *after the dedicated low temperature surface preparation and a 500°C 2 min bake only*. Such layers must be seen as smooth in X-Ray Reflectivity (e.g. with definite thickness fringes up to 4°) and high crystalline quality in X-Ray Diffraction (well defined, intense XRD peaks with thickness fringes on both sides). Layer resistivity must be as low as <2.5x10⁻⁴ Ohm. cm. Repeatability test will be performed on 10 wafers with less than 1% variability wafer to wafer on the 10 wafers tested.

Test n°	Test name	Method	Result to pass
Test 5.1	Layer quality 1	XRR	Well-defined thickness fringes up to 4°
Test 5.2	Layer quality 2	XRD	Well-defined layer peak with thickness fringes on each side well rendered by the RADS software from Bruker
Test 5.3	Layer quality 3	DW and DN Haze	< 1 ppm
Test 5.4	Layer quality 4	AFM	1x1 μm <0.2nm RSM and 2nm range.
Test 5.5	Thickness and composition	Spectroscopic Ellipsometry	Polar maps, 49 points, 3mm edge exclusion: thickness 1 sigma variations $\leq 1\%$, thickness range $\leq 3\%$; Ge content range $\leq 1\%$.
Test 5.6	Resistivity	4PP	< 2.5x10 ⁻⁴ Ohm.cm
Test 5.7	Particle density	Surface scan	<10 parts <120 μm .

2.6 Process 6: Pre-clean chamber

For the pre-clean chamber, we defined also acceptances tests.

A 300 mm single wafer low temperature surface preparation chamber that must be able to convert native oxide on Si, SiGe or Ge surfaces into a salt that evaporates at temperatures lower than 300°C. This chamber shall be able to remove (etch) SiO₂ based oxides layers leaving the underneath silicon or silicon-germanium surface free of contamination elements (O,C,F) see below elements contamination allowed). Tests will be conducted on thermal SiO₂ films, Nitride films, and on Silicon bare wafers and on SiGe films. 30A and 50A etch based recipes (BKM) will be provided by the manufacturer to evaluate its capacity to remove at least 30A and 50A of SiO₂. The selectivity will be evaluated on SiN and on nitride based low-k films. Repeatability test will be performed on 10 wafers with less than 1% variability wafer to wafer on the 10 wafers tested.

Test n°	Test name	Method	Result to pass
Test 6.1	Thickness etched	Spectroscopic Ellipsometry	50A SiO ₂ etched
Test 6.2	Uniformity Thickness etched	Spectroscopic Ellipsometry	Etch Uniformity of 50A SiO ₂ Polar maps, 49points, 3mm edge exclusion < 1% STDEV and range <4%
Test 6.3	Etch Selectivity 1 SiN	Spectroscopic Ellipsometry	Selectivity ratio SiN/ SiO ₂ >100
Test 6.4	Etch Selectivity 2 Low-k	Spectroscopic Ellipsometry	Selectivity ratio Low-k Nitride / SiO ₂ >40
Test 6.5	Si Layer quality	AFM	Post 50A SiO ₂ Etch. Si surface: 1x1 µm <0.2nm RMS roughness and 2nm Z range.
Test 6.6	Interface contamination	SIMS (a 100 nm thick Si layers (grown at 650°C, 20 Torr with SiH ₄ on Si (100) substrate) will be used to evaluate the interfacial contamination)	SiGe/Si film with : "O" Interface conta <5E17 atm/cm ³ "C" Interface conta <1E17 atm/cm ³ "N" Interface conta <5E15 atm/cm ³ "F" Interface conta <1E15 atm/cm ³
Test 6.7	Particle density	Surface scan	<10 parts <120µm.
Test 6.8	HT SiGe layer quality after surface cleaning and H ₂ bake	XRR , Haze, XRD (30 nm thick SiGe 30% layers will be grown at 650°C, 20 Torr with SiH ₂ Cl ₂ + GeH ₄ on Si(001) substrates in the epitaxy chamber <i>after the dedicated low temperature surface preparation and a 650°C, 2 minutes H₂ bake only.</i>)	<ul style="list-style-type: none"> - XRR: definite thickness fringes up to 4° - Haze measurements (< 1 ppm) - HRXRD: high crystalline quality in X-Ray Diffraction (well defined, intense XRD peaks with thickness fringes on both sides)

2.7 Process 7: in-situ etch chamber for contact optimization [mandatory option]:

An etch chamber for contact optimization (in-situ cavity shaping)

A 300 mm single-wafer Inductively Coupled Plasma Reactive-Ion Etching (ICP-RIE) etching chamber capable of preferentially etching specific crystal orientations of Si-based materials (Si, Si:P, Si:B) and SiGe-based materials (SiGe:B, SiGe:P), with priority given to (111) surfaces to form V-shape etching. This chamber must also be able to shape cavities on epitaxial materials. It must be able to remove materials while leaving the underlying silicon or silicon-germanium surface free of contaminants (O, C, F, Cl); see allowable contamination levels below.

Test 7.1	Cavity shaping on (111) orientation	TEM	Etch at least 10nm of SiGe:B Epitaxy layer forming a V shape on (111) planes.
Test 7.2	Interface contamination	SIMS	Interface post etch must be free of contamination (O,C,F,Cl,N) "O" Interface conta <5E17 atm/cm ³ "C" Interface conta <1E17 atm/cm ³ "N" Interface conta <5E15 atm/cm ³ "F" Interface conta <1E15 atm/cm ³ after a 100 nm thick Si layers grown at 650°C, 20 Torr post etch

2.8 Process 8: in-situ etch chamber for lateral recess [mandatory option]

An etch chamber for junction optimization (in-situ lateral recess for Source and Drain): a 300 mm single wafer etching chamber that must be able to etch laterally (110) Silicon and SiGe surfaces with a high selectivity toward (100) surfaces. This chamber shall be able to remove materials leaving the underneath silicon or silicon-germanium surface free of contaminants (O,C,F) see below elements contamination allowed) .

Test 8.1	Lateral recess of an Si cavity	TEM	Etch selectively the Silicon layer on (110) planes toward (100) planes.
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3 EQUIPMENT TECHNICAL SPECIFICATIONS

3.1 Equipment description

The epitaxy cluster tool must have with the following features:

- Two reduced pressure load-locks with up to 25 wafers stored in each. (see §3.1.1)
- Two reduced pressure buffer/transfer chambers (see §3.1.2)
- A dedicated surface preparation chamber to remove native oxide, with reduced etching of low-k nitrides materials, reduced process temperature (lower than 300°C). (see §3.1.4)
- Two Reduced Pressure – Chemical Vapour Deposition (RP-CVD) epitaxy chambers (A & B) dedicated to the low temperature selective epitaxial growth of several tens of nm thick SiGeC:B and Si:P layers (300°C – 800 °C for deposition; capable of going to 1100 °C for bakes and etchings) (see §3.1.3)
- An etch chamber for contact optimization (in-situ cavity shaping) (quoted as a mandatory option) (see §3.1.5)
- An etch chamber for junction optimization (in-situ lateral recess for Sources and Drains) quoted as a mandatory option) (see §3.1.6)

3.1.1 Factory Interface (FI)

The equipment will have a factory interface (FI) system to load and unload automatically wafers in a very clean environment. This part will include: at least 2 loadports accepting Front Opening Unified Pods (FOUPs) with N₂ purge and a transfer chamber with a clean environment to transfer wafers from FOUPs to the load-locks.

Pressure in those load-locks, which will be under ultra-pure N₂, must be between 10 and 100 Torr, typically. A configurable cycling between atmospheric pressure (and the air) and Reduced Pressure (in ultra-pure N₂) will yield very low residual partial pressures of O₂, H₂O, organics (at most a few parts per billion) etc. The resulting surfaces must be fit for epitaxy after a “HF-Last” wet cleaning and a regular H₂ bake (> 650°C and above) in one of the epitaxy chambers without any additional surface preparation procedures.

3.1.2 Mainframe

The new cluster tool must consist in a mainframe made of two single wafer load-locks and two transfer chambers. All chambers (process chamber, surface cleaning chamber and in-situ etch chamber) will be mounted to the mainframe maintaining a clean and inert environment when transferring wafers between transfer chambers and the other chambers.

These buffer/transfer chambers, which will be under ultra-pure N₂, must be able to operate between 10 and 100 Torr.

3.1.3 Process chambers: low temperature epitaxy chambers

Two low temperature epitaxy chambers, named chamber A and chamber B will be mounted to the mainframe. These chambers will handle 300mm wafers and will provide controlled environment for epitaxial processing.

These chambers are single wafer Reduced Pressure - Chemical Vapour Deposition chambers in which “Low Temperature” intrinsic or in-situ doped SiGe:B, SiGeC, Si:P epitaxial growths will be carried out (called thereafter the “NEW LOW TEMPERATURE RP-CVD chambers”).

These chambers must at all cost be neutral in terms of particular and metallic contamination.

By “Low Temperature” epitaxy, we mean the following, typically:

(i) Several nm to two hundreds nm thick Si/SiGeC multilayers (thickening of SOI substrates, fabrication of suspended nanowires and so on), Si, SiGe:B, SiGeSn:B, SiGeSn:Ga, SiC:P, Si:P, Si:As raised sources and drains etc. N-type and p-type doping levels will typically be in the 10¹⁸ - 10²¹ cm⁻³ range, Ge contents in the 1% - 100% range, C contents in the 0% - 3% range, B, Ga, P, As and Sn contents in the 0%-15% range. Growth will be either non selective or selective. The preferred approach in order to have selectivity on patterned wafers will be to add HCl to gaseous precursors (e.g. the “co-flow” approach). “Regular” Cyclic Deposition/Etch (CDE) processes with HCl as the etchant gas will be used as well. Growth temperature will be in the 400°C – 750°C range.

(ii) Several nm to several tens of nm thick intrinsic or in-situ doped Si/SiGeC, Si:P, SiC:P, Si:As, SiGe:B, SiGeSn:B and SiGeSn:Ga multilayers selectively grown on patterned wafers thanks to "Advanced" Cyclic Deposition/Etch (CDE) processes with gaseous or liquid precursors for growth and Cl₂ as etchant gas. Growth temperature will then be in the 300°C – 600°C range.

To sum up, N₂, H₂ bakes and epitaxial growths at temperatures between 300°C and 1100°C of layers or stacks several tens of nanometers thick must be feasible in this chamber, this at pressures between 5 and 600 Torr, (>700 Torr ideally). Chamber quartz wall cleaning will occur both at high pressure (several hundreds of Torr, typically), at 1000°C – 1100°C using HCl or at 300-400°C* using Cl₂.

The following gases must be available for delivery in the chamber. The total of 14 gases must be available on each epitaxy growth as described below:

- Ultra-high purity H₂ carrier gas and N₂ purge gas
- Pure SiH₄
- Pure SiH₂Cl₂
- Pure Si₂H₆
- Two bubblers for Liquid precursors. A dedicated bubbler with purified H₂ and N₂ as the push and pull gases will be supplied to that end.
- GeH₄
- SiH₃CH₃
- PH₃ and B₂H₆. H₂ or N₂ injection into mixers must occur. Meanwhile, injection of diluted PH₃ or B₂H₆ coming out of mixers into the epitaxy chamber must occur.
- High purity HCl, low flow
- High purity HCl high flow
- High purity Cl₂, low flow
- High purity Cl₂, high flow
- The chamber must be able to run Cl₂ and P in process mode.
- The rotation speed must be tunable up to 100 rpm.
- 2 liquid distribution systems have to be as close as possible to the chamber (distance from canister to the chamber as to be < 2 meters).
- Injectors have to be able to flow small to high carrier flows (250 sccm- 20 slm).
- The temperature monitoring will be performed on several points over the wafers (over a radius from center to edge).
- The chamber has to be able to grow uniform films both at (i) high and (ii) very low carrier flows (from 40 slm down to 0.5 slm) with decent uniformity (i.e uniformity specifications)

(*) the supplier will specify the gas that he uses for chamber etch between growth. Cl₂ at temperatures <400°C is acceptable; data concerning metallic contamination must then be provided. It must be within LETI's specifications (e.g. front side (backside) metallic contamination < lower limits of detections or 5x10⁹ (10¹⁰) cm⁻², whichever is the highest).

It must not be possible for mass-flow bypasses to be in open position if the equipment is in "gas demand" (gas input valve open), so as to prevent any excessive discharge flow incompatible with the extraction systems (example: dilution by a neutral gas for flammable gases).

3.1.4 Surface cleaning chamber

This chamber for surface preparation will be a dedicated chamber added to the mainframe, allowing wafer transfer without air exposure from the surface preparation chamber to the low-temperature chamber. This chamber will remove all oxides (e.g., native SiO_x) present on silicon, germanium, or silicon-germanium-based surfaces with a very high selectivity ratio (> 40) against nitride-based dielectric materials (SiN, Low-k spacers: SiBCN, SiOCN, SiCO, etc.). This process has to be performed <300°C.

3.1.5 In-situ etch chamber for contact optimization (quoted as mandatory option)

This chamber for surface preparation will be a dedicated chamber added to the mainframe, allowing wafer transfer without air exposure from the surface preparation chamber to the low-temperature chamber. This chamber will etch silicon, Silicon-germanium based materials following (111) crystal planes and form a V-shape cavity on crystal materials.

Etch gases must be compatible with FEOL CMOS integration leaving the Surface free of contamination (O,C,F,Cl).

3.1.6 In-situ etch chamber for lateral recess (quoted as an option)

This chamber for surface preparation will be a dedicated chamber added to the mainframe, allowing wafer transfer without air exposure from the surface preparation chamber to the low-temperature chamber. This chamber will etch selectively and laterally a Si cavity flowing (110) planes versus (100) planes. The (110) etch rate must be higher than the (100) etch planes. Etch gases must be compatible with FEOL CMOS integration leaving the Surface free of contamination (O,C,F,Cl).

3.2 Hardware

3.2.1 Pumping system

The supplier shall price the pumping system as an optional item. **The supplier shall draft his recommendations for pumping according to specifications provided by CEA just below and his own specifications.**

The Contractor shall draft his recommendations for pumping according to the specifications indicated by the CEA-LETI and his own specifications.

Parameters	Specifications
Basic pressure: RPCVD process chambers	Between 5 and 600 Torr (ideally, 700Torr)
Pumping rate Chamber	$\leq 60s$
Pressure Stabilization time Pressure/calibrated gauge deviation	$\leq 10s$ $\leq 2\%$
Leakage test Transfer air lock: RPCVD process chamber Gas lines	$\leq 10mTorr/min$ $\leq 2mTorr/min$ $\leq 0.1mTorr/min$

3.2.2 Gas/chemical lines

The machine shall be equipped with the gas/chemical lines necessary for the processes and for the required performances. Each line shall be equipped with a filter compatible with the corresponding active gas/chemistry. Each gas/chemical line shall be clearly identified and equipped with a manual shutdown valve up-line from the flowmeter (line isolation).

Each gas line (or chemical line) shall be equipped with a digital flowmeter, and the information of instant flow as well as total gas / chemical volume shall be reported to the facilities. Alternatively, the information of the valve status will be reported to the facilities in order to calculate the total gas or chemical consumption.

Each gas or chemical line shall be identifiable on the control monitor of the machine, the name of the line shall indicate the name of the gas/chemistry used.

The gas/chemistry panel and the lines internal to the machine shall be manufactured and assembled using welded pipe (orbital type welding) or pipes assembled by "VCR" type joint techniques. The stainless steel used for the piping, bellows, and other parts shall be electro-polished ANSI316L steel (0.25 μm Ra).

All gas lines coming out from liquid canisters should have on each line a molar mass meter (gas concentration) in order to monitor the exact gas concentration coming out of the bubblers.

Parameters	Specifications
Mass flow calibration:	MFC configurable
Flow control	3 % linearity between 5 and 95 % of the full range ± 1 % repeatability

The following gases should be available for delivery in the epitaxy chambers; numbers between brackets are the maximum flows deliverable by each Mass-Flow Controller (MFC).

Low temperature Epitaxy chamber A: NMOS Chamber:

- Ultra-high purity H₂ carrier gas / N₂ purge gas
- Pure SiH₄
- Pure SiH₂Cl₂
- Pure Si₂H₆
- GeH₄
- SiCH₄
- AsH₃
- Mixers that can deliver diluted PH₃ and B₂H₆ into the growth chamber. H₂ or N₂ injection into mixers should occur. Meanwhile, injection of diluted PH₃ or B₂H₆ coming out of mixers into the epitaxy chamber should occur.
- High purity HCl, low flow
- High purity HCl, high flow
- Two liquid precursors must be pluggable in the chamber. A dedicated bubbler with purified H₂ and N₂ as the push and pull gases will be used to that end.
- High purity Cl₂, low flow
- High purity Cl₂, high flow
- 2 liquid distribution systems have to be as close as possible to the chamber (distance from canister to the chamber as to be <2meters).
- Injectors have to be able to flow small to high carrier flows (0.2slm to 20slm)
- In the CDE approach, the chamber have to be built with dedicated and separated inlet/injection lines for deposition and etch.
- The chamber has to be able to grow uniform films both at (i) high and (ii) very low carrier flows (from 40 slm down to 0.5 slm) with decent uniformity (i.e. see specification)
- The chamber shall be able to operate up to 600 T (700 T ideally) using controlled distribution gas flow system in its full range for each MFC.

Low Epitaxy chamber B: PMOS Chamber:

- Ultra-high purity H₂ carrier gas / N₂ purge ga
- Pure SiH₄
- Pure SiH₂Cl₂
- Pure Si₂H₆
- GeH₄
- Ge₂H₆
- SiCH₄
- Mixers that can deliver diluted PH₃ and B₂H₆ in gas bottles into the growth chamber. The injection of those n-type or p-type dopants into mixers .H₂ or N₂ injection into mixers should occur. Meanwhile, injection of diluted PH₃ or B₂H₆ coming out of mixers into the epitaxy chamber should occur.
- High purity HCl, low flow
- Two liquid precursors must be pluggable in the chamber. A dedicated bubbler with purified H₂ and N₂ as the push and pull gases will be used to that end.
- High purity Cl₂, low flow (2 slm) => co-flow selectivity

- High purity Cl_2 , high flow (20 slm) => low temperature chamber quartz wall cleaning between each epitaxial growth, advanced CDE (*).
- High purity HCl , high flow => high temperature chamber quartz wall cleaning between each epitaxial growth (*).
- 2 liquid distribution systems have to be as close as possible to the chamber (distance from canister to the chamber as to be < 2 meters).
- Injectors have to be able to flow small to high carrier flows (0.2- 20slm).
- The chamber has to be able to grow uniform films both at (i) high and (ii) very low carrier flows (from 40 slm down to 0.5 slm) with decent uniformity.
- The chamber shall be able to operate up to 600 T (700 T ideally) using controlled distribution gas flow system in its full range for each MFC.

(*) The supplier will specify the gas that he uses for chamber etching between growths. Cl_2 at temperatures close to <700°C is acceptable; data regarding metallic contamination should then be provided. It should be within LETI's specifications (e.g. front side (backside) metallic contamination < lower limits of detections or 5×10^9 (10^{10}) cm^{-2} , whichever is the highest).

It must not be possible for mass-flow bypasses to be in open position if the equipment is on "gas demand" (gas input valve open), in order to prevent any excessive discharge flow incompatible with the extraction systems (example: dilution by a neutral gas for flammable gases).

3.2.3 Equipment consumption monitoring

All fluids that are controlled in flowrate through Mass Flow Controllers shall be monitored by equipment software and their consumptions shall be recorded. This shall include at least process gases, chemicals and de-ionized water. Fluid consumption data shall be accessible on equipment user interface for viewing and shall be readily exportable to cleanroom IT network through SECS/GEM protocol in dedicated SVIDs.

Molar flow monitoring system for liquid precursors will be installed and monitored through software and recorded for all liquid sources.

3.2.4 Idle mode management and interface with peripheral sub-equipments

The equipment shall be able to detect idle time and trigger relevant actions aimed at decreasing power and fluid consumptions (for instance: temperature decrease, purge flowrate decrease...). Idle time threshold to trigger these actions shall be setttable through equipment user interface. Upon restart all equipment process parameters setpoints shall be automatically restored and process launch shall be inhibited until parameters have reached their setpoints.

The equipment shall embed an interface box to manage communication with peripheral sub-equipments (pumps, abatement systems...). Communication with sub-equipments shall rely either on dry contacts or on Ethernet connection. The interface module shall be able to collect information from sub-equipments (status, alarms, warnings) and trigger relevant actions on the equipment (process aborts, process inhibits...). Such actions shall be setttable on equipment user interface. The interface module shall also be able to send standby commands to sub-equipments in order to decrease their power and fluid consumptions during idle times, which commands shall also be setttable on equipment user interface (pump speed decrease, abatement burner shutdown...). Upon restart nominal sub-equipment operation shall be automatically restored and process launch shall be inhibited until nominal operation level of all sub-equipments is reached.

3.2.5 Flammable gas management

The flammable gases, particularly pure or mixed silane and hydrogen, will be diluted by pump ballast nitrogen at vacuum pump outlet, so that the concentration is < LIE (LEL) /2. Ballast flowrate shall be monitored by the equipment and flammable gas dispensing shall be inhibited if it is below dilution requirement. Required nitrogen flowrate will be calculated based on the maximum flowrate that can be delivered by the MFC.

3.2.6 Temperature control

Chamber	Specifications of wafer temperature
RPCVD chambers	As close as possible
Chamber surface preparation	+/-0.5°C compared with setpoint
Chamber etch 1	+/-0.5°C compared with setpoint
Chamber etch 2	+/-0.5°C compared with setpoint

Heat exchangers / Chillers

The Contractor shall price the chillers as an optional item.

The Contractor shall draft his recommendations for heat exchangers and chillers according to the specifications indicated by the CEA-LETI and his own specifications.

3.2.7 Vibrations

The Contractor will provide the vibration emissivity specifications (amplitude and frequency) of the equipment and its sub-elements.

The Contractor will provide the vibration sensitivity specifications (amplitude and frequency) of the equipment and its sub-components.

3.2.8 Other

The chamber quotation should include spare part kit for a one full PM (o-rings, quartzs...)

A solution to treat and manage PH₃ as well as AsH₃ gases will be provided.

Parameters	Specifications
Chamber pressure	+/- 0.5 Torr compared to setpoint
Power supply/voltage	No voltage anywhere
Re-initialization	< 30min
Wafer removal	In automatic mode
Data/equipment status	Full storage
Programs	Full storage

3.3 Software

3.3.1 IT configuration

Contractor shall describe the configuration and possibilities of the equipment management IT system (PC, OS safeguard device, etc.)

Connection to the external network

Equipment shall have all features installed to enable remote maintenance capabilities. Contractor shall provide all necessary information relating to protocols, infrastructure and tools used in this regard to allow CEA-LETI to verify compatibility with its own cleanroom IT network.

CEA-LETI will study the request for connection to the internet network for remote maintenance on a case by case basis.

If the connection is accepted, it won't be achieved through the CEA-LETI network but by means of an independent CEA network (Sophos Network). It will be established on a one-off basis by means of a manual switching box which will be activated during the remote handling operations.

Connection to the internal network (intranet)

The equipment should enable connection to the CEA-LETI intranet for process management and data recovery purposes. The protocol used shall be SECS / GEM.

Contractor shall provide the CEA-LETI with:

- The software and licenses required to operate the SECS / GEM interface
- The peripheral hardware required for the SECS / GEM interface (ex: network interface, etc.)
- Documentation (in English) associated with the SECS / GEM interface

The equipment shall implement the following mandatory standards:

- SEMI E5 (SECS-II)
- SEMI E30 (Generic Equipment Model)
- SEMI E37 (HSMS)
- SEMI E37.1 (HSMS-SS)
- SEMI E37.2 (HSMS-GS)
- SEMI E39 (Object Services)
- SEMI E40 (Process Job Management)
- SEMI E84 (Carrier Handoff Parallel IO Interface)
- SEMI E87 (Carrier Management)
- SEMI E90 (Substrate Tracking)
- SEMI E94 (Control Job Management)

The equipment shall implement the following optional standards:

- SEMI E41 (Exception Management)
- SEMI E42 (Recipe Management)
- SEMI E53 (Event Reporting)
- SEMI E54 (Sensor/Actuator Network)
- SEMI E58 (Availability, Reliability, Maintainability)
- SEMI E95 (Human Interface)
- SEMI E98 (Object Base Equipment Model)
- SEMI E99 (Carrier ID Reader/Writer)
- SEMI E109 (Reticle and Pod Management)
- SEMI E116 (Equipment Performance Tracking)
- SEMI E120 (Common Equipment Model)
- SEMI E125 (Equipment Self Description)
- SEMI E126 (Equipment Quality Information Parameters)
- SEMI E128 (XML Message Structure)
- SEMI E132 (Client Authentication and Authorization)
- SEMI E134 (Data Collection Management)
- SEMI E138 (XML Semiconductor Common Components)
- SEMI E139 (Recipe and Parameter Management)

The Contractor must complete and deliver to CEA-LETI **Appendix J « SECS/GEM Compliance »**.

It should be noted that, during the equipment acceptance, a total of 5 working days will be needed for automation tests. During these 5 days, the support of a field support engineer will be required on site. A software automation engineer should also be available for remote support (mail, online conference, phone, etc...)

Restoration of the system:

Contractor agrees to provide CEA-LETI with:

- the procedure enabling complete backup of the embedded hard drives
- the hardware required for correct application thereof

It will train the CEA-LETI maintenance staff in proper application of this procedure

A backup will be performed for tool acceptance.

Licenses

Contractor agrees to deliver the equipment with all the operating licenses enabling it to be used by CEA-LETI.

Software update and upgrade

Contractor shall systematically provide the CEA-LETI with update (bug correction, etc.), upgrade and the latest version of the software as soon as it becomes available and shall install them free of charge during the warranty period. After the warranty has expired, the Contractor will keep CEA-LETI informed of any upgrade or new version that improves the functionality and provide the price conditions if the CEA-LETI request them.

Notwithstanding the warranty expiration, the Contractor will perform the software modifications needed to fix any bugs and therefore maintain the original functionality of the software at no cost to the CEA-LETI. The modifications connected with a correction (bugs, etc.) shall be supplied and installed free of charge.

"The contractor must ensure the installation of software updates necessary for maintaining system performance. Software upgrades include hardware modifications necessary for proper functioning. During these updates, the contractor must provide a document describing the corrections and improvements made compared to the previous version.

The contractor will provide the White Room IT with the data backup procedure, allowing for the quickest possible restart of equipment following a hardware failure of the data support(s) and will assist the CEA during the first backup and restoration to validate the proper execution of the procedure.

The contractor must intervene, if necessary, with a PC that is up-to-date in terms of its OS and antivirus and ensure that it is free of any viruses. If a USB key must be used, the contractor must also ensure beforehand that it contains no viruses. It must be scanned on one of our white stations (TOTEM KUB) positioned at the entrances to our clean rooms before any connection to equipment and at the end of the intervention. If a virus is detected by a KUB, a log file will be written on the concerned USB key. The concerned USB key must be handed over to the RSSI of DPFT and, in their absence, to the White Room IT team. In case a virus spreads to equipment during their intervention, the equipment provider will be held solely responsible."

Through-the-wall installation

If the equipment is installed in through-the-wall mode, user interface stations shall be available in both white and grey areas. The two control stations shall not be active at the same time.

3.3.2 Antivirus and data back-up

Antivirus :

- **Only required for computers running with Windows type of Operating System, and directly connected to CEA-LETI network.**

There are 3 Antivirus solutions provided by CEA-LETI:

- Symantec EndPoint Protection, version 14 or above
- McAfee OfficeScan v8.8 or above
- TrendMicro Apex One

If none of those antiviruses are compatible with the equipment, Contractor must provide a qualified antivirus.

In all cases, Contractor must specify a qualified configuration of antivirus, including:

- List of exclusions required for real time control (Symantec EndPoint Protection)
 - List of executables usually used during equipment operation (McAfee Application Control)
- **Required for all computers connected to CEA-LETI network, whatever the Operating System is**

Provider must specify in his technical proposal if a qualified local firewall is available on the computer connected to CEA-LETI network.

Data back-up:

CEA-LETI performs back-up copy of all data stored on all computers and associated peripheral devices of the equipment.

This is achieved doing both:

- a snapshot of all storage disks, with a tool like "Symantec Ghost"
- an automatic data copy, capturing (on a periodic basis) data updates during equipment operation

In case the equipment complies with such methodology, the Contractor must specify in his technical proposal the process to generate files dedicated to the periodic back-up.

If the equipment is not compatible with this methodology, the Contractor must specify in his technical proposal the way to create back-up material, in order to enable a complete computer reboot on a clean/brand-new disk. Any extra material (such as server or software) that would be required to perform these back-up (except basic file copy with standard protocols such as CIFS/SMB, FTP, CP/SFTP, NFS) must be provided by the Contractor. This is especially the case if a tool/software different from Symantec Ghost is recommended.

If the software has a protection mechanism that could interfere with an equipment disk replacement, then the Contractor must provide to CEA-LETI the way to reactivate the software. In Particular, this is mandatory if a new User License Key is required by the software after a hard drive change.

3.4 Transfer and handling of wafers [mandatory option]

This section deals with the relationship between machine, wafer carriers and wafers.

The tool should have an option to allow to transfer a wafer into a remote box plugged on a free facet to allow to keep a wafer under controlled atmosphere. This box should be removable from the cluster tool to be plugged into other equipment.

3.4.1 Wafers specifications

Characteristics	Spécifications
Wafer circulaire	
Size	300 mm
Material:	silicon, SOI, bonding Silicon wafers
Thickness:	standard wafer (775 +/- 25 µm), thin wafer (between 300 µm and 750 µm), bonding wafers (between 750 and 1500 µm)
Weight: standard:	128 g, Min: 49 g, Max: 256 g
Profile of the edge:	could be damaged after deep etching
Bow et warp maximum:	500 µm

3.4.2 Load ports

Load ports must be compliant with SEMI standards referenced in appendix G.

FOUPs will need a N2 purge.

INFOPAD configuration:

INFOPAD settings shall be configurable in order to meet CEA-LETI requirements. CEA-LETI uses different INFOPAD configurations based on wafers metallic contamination grade (FEOL, BEOL, packaging) to prevent processing on improper equipment. Loading of a FOUP with INFOPAD configuration not matching the equipment contamination level shall inhibit process launch and generate relevant alarms. INFOPAD configuration details corresponding to equipment metal contamination category will be given during installation and proper operation with respect to CEA-LETI rules shall be verified as part of acceptance tests.

3.4.3 Handling and contact surfaces

- Authorized contact surfaces: edge gripping, back side, exclusion area of 1mm
- materials : all part should be coated SiC, and avoid thermal shift at surface contact
- handling techniques : mechanical

3.4.4 References of wafer carriers used on equipment

FOUP 300 mm :

- F300 Autopod Wafercarrier- or equivalent
- SF 300. 02 Version V or equivalent
- Spectra S - or equivalent

3.4.5 Handling system reliability

The handling system reliability will be checked through a “marathon test” - 1000 transfers without failures. All the loading stations, loadlocks, buffers, process modules or chambers will be checked.

No wafer rubbing.

No move potentially inducing particle on the wafers.

3.5 Mini environment

This section is only relevant for equipments operating, at least partly, under atmospheric pressure.

Parameters	Specification
Overpressure of the mini-environment with respect to the clean room	> 1 Pa
Blowing speed at 10 cm under filters	Between 30 and 40 cm/s
Blowing speed at the level of the wafers	Between 20 and 40 cm/s
Integrity of filters	Visual check

3.5.1 Check of the physical characteristic of the air

In no event shall any necessary slight overpressure of the environmental chamber compared with the room affect to the confinement with odors nor cause a risk of spreading aerosols nor other vapors in the operator environment. During in situ tests, the Contractor shall be responsible for adjusting air speed of fan filter units (FFUs).

The service includes all equipment, auxiliary modules (air conditioning units (ACUs), fans, and filter housing) and systems necessary for maintaining temperature and humidity conditions and controlling particulate contamination (and molecular if necessary) in the equipment.

3.5.2 ESD (Electrostatic Discharge)

The equipment must be made of dissipative materials in particular, in so-called sensitive areas (< 25 cm from devices):

- Carrier loading/unloading plates,
- Plant unit transfer arm/shovel,
- Chuck/support plates.
- Casing.

For surfaces located at less than 25 cm from the wafers, the electrostatic discharge must be less than 100 V/inch (circuit breakdown voltage).

If the machine is equipped with ionising bars:

Measurements of ionising bar efficiency at the level of the plates	<ul style="list-style-type: none">• Time of the positive discharge from + 1000V to + 100V < 20s• Time of negative discharge from – 1000V to –100V < 20s
Contamination check on the tips of ionising bars	<ul style="list-style-type: none">• Whitish deposit (to be cleaned)

3.5.3 Particle checks

This section refers to particle counts in air flowing through the mini-environment.

Particle check in static mode

The sampling probe of the particle counter is placed at the location representing passage of the plates.
The mini-environment will be checked at 7 sampling points with a sampling time of 1 minute per point.
The maximum number of particles allowed will be 35 particles per m³ of size > 0.1µm (or 1 particle per ft³).

Particle check in dynamic mode

The probe is placed close to the various moving elements.
Specific attention will be paid to parts which may present friction.
The mini-environment will be checked at one sampling point per site in motion with a sampling time of 1 minute per point.
The maximum number of particles allowed will be 3,500 particles per m³ of size > 0.1µm (or 100 particle per ft³).

3.6 Interface with the rest of the clean room and its organisation.

The equipment must be compatible with the environment for which it is intended.
It should not degrade the environmental conditions of the room according to the following constraints (see the environmental conditions in Annex B):

- The cleanliness class (It should respect the cleanliness class according to ISO 14-644-1)
- Temperature
- The relative humidity
- The VOC (Volatile organic compounds) content: VOC <50ppb
- The air contamination (Any parts likely to release particles or other contaminants should have an appropriate extraction)

The Contractor should respect ISO 3 to ISO 8 clean concept rules.

The provider must follow the rules of "clean concept" imposed in accordance with quality documents mentioned in this specification.

Regarding the personnel involved in clean rooms, the service provider provides the CEA-LETI with a proof of a registered training in "Clean environment concept in micro and nanotechnology" for both himself and his possible subcontractors.

3.7 Contamination

3.7.1 Particle contamination

Following particle contamination specifications shall be achieved by the equipment and equipment performances shall be verified as part of acceptance tests. Equipment shall also consistently achieve these performances over the course of the warranty, which will be verified through tests carried out by CEA-LETI on a regular basis.

Test #	Test name	Method	Result to pass
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C1	Frontside particle contamination: handling	<p>Silicon monitors</p> <p>Handling (mechanical only) in and out of process chambers</p> <p>Pre and post-handling particle measurements with unpatterned wafer defect inspection system</p>	<p>< 10 particles @ 40-90nm minimum particle size</p> <p>3 consecutive wafers within specification</p>
C2	Frontside particle contamination: process	<p>Silicon monitors</p> <p>Representative process to be agreed upon between CEA-LETI and Contractor</p> <p>Pre and post-process particle measurements with unpatterned wafer defect inspection system</p>	<p>< 20 particles @ 40-90nm minimum particle size</p> <p>And</p> <p>< 10 particles @ 120nm particle size</p> <p>3 consecutive wafers within specification</p>
C3	Backside surface condition	<p>Silicon monitors</p> <p>Handling (mechanical only) in and out of process chambers</p> <p>Backside measurements with unpatterned wafer defect inspection system</p>	<p>No scratch signature on defect map</p> <p>3 consecutive wafers within specification</p> <p>No result drift: total defect count for backside measurement of wafer ID #3 must not exceed total defect count for backside measurement of wafer ID #1 by more than 10%</p>

3.7.2 Metallic contamination

The metal contamination specifications are those that the equipment must have when it enters the cleanroom.

This control is a handling test. It reports on the level of metal contamination at the end of installation, before the equipment acceptance tests are started and before any process tests.

The test wafers must be handled throughout all the equipment modules.

The process acceptance tests are mentioned in section 2 of the specifications document.

Test C4 : Use Monitor quality silicon substrates.

Loading/unloading (handling) in **all equipment modules**.

Test C5 : Use Monitor quality silicon substrates

Loading/unloading (handling) in **all equipment modules**

NB: For equipment handling wafers with a diameter of 200mm or less, the wafers will be handled upside down (polished side in contact with robots, chucks, etc.).

Test #	Test name	Analysis method	Result to be achieved
C4	Metal contamination Front side	TXRF measurement analysis with mapping AND VPD-ICPMS measurement	TXRF results: For all the elements measured ⁽¹⁾ : Average : < 5 ^E 10 at/cm ² or LLD (for LLD > 5 ^E 10 at/cm ²) VPD-ICPMS results: « CONTA 1 » ⁽²⁾ list: < 5 ^E 10 at/cm ² Noble metals : < LLD Lithium : < LLD
C5	Metal contamination Back side	TXRF measurement analysis with mapping AND VPD-ICPMS measurement	TXRF results: For all the elements measured ⁽¹⁾ : Average : < 5 ^E 10 at/cm ² or LLD (for LLD > 5 ^E 10 at/cm ²) VPD-ICPMS results : « CONTA 1 » ⁽²⁾ list: < 5 ^E 10 at/cm ² Noble metals: < LLD Lithium: < LLD

⁽¹⁾ List of elements measured in TXRF : Na, Mg, Al K, Ca, Ti, Cr, Fe, V, Mn, Co, Ni, Cu, Zn, Ga, Ge, As, Sr, Y, Zr, Nb, Mo, Ru, Pd, Ag, Cd, In, Sn, Sb, Te, Ba, La, Hf, Ta, W, Ir, Pt, Au, Pb, Ce, Gd, Dy, Er, Yb, (this list of elements may be modified at the discretion of LETI)

⁽²⁾ List of elements « CONTA 1 » : Al, As, B, Ca, Co, Cr, Cu, Fe, Ga, Ge, Hf, K, In, Li, Mg, Mn, Mo, Na, Nb, Ni, P, Pb, Sb, Sn, Ta, Te, Ti, V, W, Y, Zn, Zr, (list of elements which may be modified at the discretion of LETI)

4 GENERAL BUILDING, FLUIDS, ELECTRICITY, ENVIRONMENT SPECIFICATIONS

4.1 Environment of the equipment

4.1.1 Building specifications

Features of the location of the equipment:

- Environment: [cleanroom, lab, etc.](#)
- Cleanliness class according to **ISO 14-644-1**:
 - [41](#): **ISO 3-6** depending on the installation site in the building
- Environmental Conditions and tolerances (temperature and humidity)
 - [41](#): **21 +/- 1 ° C // 45 +/- 5% RH**
- Mounting: [Passwork walls](#)
- Location of devices: [basement, gray fingers](#)

The Contractor must ensure that the Equipment installed in a clean room will not have to disturb modify the characteristics of the zone.

In case a furnace needs to be installed in our facilities, the Contractor must provide the equivalent thermal power.

4.1.2 Building fluids

See **Appendix B**: General fluids building [41-03](#)

4.1.3 Building power network specifications

CAUTION:

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

If necessary, refer to CEI 60364 standard

Electrical features

Power supply voltages available on main:

- Single-phase: 1 phase + neutral + earth
Phase/Neutral voltage: 230 V +/- 10 %
- Three-phase: 3 phases + neutral + earth
Phase/Phase voltage = 400 V +/- 10 %;
Phase/Neutral voltage = 230 V +/- 10 %

Main frequency: 50 Hz

4.1.4 Adaptation of the machine to the power network

CAUTION:

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

Neutral lead colour in machine:

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

Protection lead colour in machine:

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

Power supply transformer (general machine)

Should a transformer be necessary :

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

4.1.5 Uninterruptible power supply (UPS)

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

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

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

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

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

4.2 Management of the environment

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

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

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

- proposed fluid recycling.

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

The Contractor will provide emissions evaluation:

- vapour/gaz emissions rate and liquid chemical wastes
- Actives wastes mass and volume of if possible, pollutants rate in rinsing wastes.
-

4.2.1 Process Cooling Water

Contractor will provide design calculations for heat exchangers to be connected to the buildings process cooling water supply system (allow for delta T of at least 5°C). If necessary, it will also justify pressure relief valves on the valve console. In the event flexible pipes are used in the equipment or for links with auxiliary modules, connections using a single Swagelock rubber series PB from-end or the equivalent with a central tube in Buna N, braided-fiber reinforcement and covered with abrasion-resistant, nonflammable Buta N. End-pieces will be the push-on type and/or double-ring in 316 stainless steel adapted for the required pressure (Serflex or similar collars are prohibited). Color of flexible piping: blue for "inlet" into the equipment and red for "outlet".

4.2.2 Exhaust and other internal equipment air systems

The Contractor will provide design reports or tests used to define air flow rate required to comply with current regulations. It will select the sections of adapted systems in order to limit resistance (air speed < 8m/s for exhaust and < 6m/s for supply). It will study optimal routing inside the equipment, particularly by limiting the number of specific head losses. If flexible piping is used, they shall be classified M1 for fire and be of the smooth interior type adapted to the fluid being carried.

Drawings will be provided before construction to indicate routing of air systems (exhaust and supply), design inside the equipment and its auxiliary modules.

In the case of extracting calories from power box cabinets or electrical bays located in the clean room, an extraction fan must be integrated into the cabinet or electrical bay: the "hot air flow" will be extracted from the cabinets or electrical bay and it will be redirected directly into the false floor of the clean room.

4.2.3 Segregation of liquid effluents

Depending on their composition, liquid effluents shall be directed to dedicated drains.

Fluorinated effluents whose concentration is more than or equal to 1% fluoride, as well as phosphorus effluents must be directed to the drain for fluorinated / Phosphorus effluents. Temperature shall not exceed 50°C

Solvent effluents must be directed towards the solvents drain.

If the process involves using heavy metals (copper, nickel, gold, cadmium, etc.), a specific collection drain as well as interfacing with the dedicated recovery system for these effluents shall be provided for by Contractor. The HSE cell shall validate the collection and treatment mode for these effluents.

The means for transporting dangerous or unsanitary fluids and for the collection of effluents which are polluted or are likely to be so are sealed and resist the physical and chemical action of products which they are likely to contain.

4.2.4 Case of DI return or recycling of ultrapure water

Contractor will provide DI flow evaluation (for mainframe and all sub-systems):

- process flow
- idle flow

Reclaim drains collecting non-polluted ultrapure waters used for maintaining the quality of equipment is available in building 4102 and BHT, in an initiative for rationalising and saving processed water.

Where possible, Contractor shall provide for a "DI return" outlet collecting all the water used to preserve the quality of the equipment, guaranteed without contact with the process chemicals (recirculation loop, recirculated bath, etc.). This "DI Return" outlet shall be equipped with an adjustable flow meter. The Contractor will provide data showing the minimum necessary water flow to keep the process / equipment quality.

In the case of wet bench or similar equipment using ultra-pure water, the quality of water is maintained through a programmable flush rather than permanent leak flow.

Moreover, in the case of rinsing containers or equivalent process, it will propose the possibility of recovering rinsing water excluding raw sewage for a collection in a "reclaim" drain and reuse of this water in the facilities water.

4.2.5 Gaseous effluents

Depending on the process and the operation mode of the equipment, the installation of a gaseous effluents treatment system will be decided by CEA-LETI.

Contractor shall provide the information required for the needed analysis: gas quantities of the standard process recipe, sub-products of the reaction, etc.

Contractor will provide information and advice regarding the abatement of ($N_2 + PH_3 + Si_2H_6$) based process as well as $Cl_2 + N_2$ based process.

The Contractor must be pro-active regarding the nature and conditions for setting up a reduction system which is compatible with its equipment.

CEA-LETI reserves the right to refuse the proposal of the abatement system recommended by Contractor.

4.2.6 Odours

The required steps must be taken in order to limit odours from effluent processing. The Contractor will carry out the studies and the design of its equipment for an effective capture at source of aerosols, chemical vapors and other gas effluents to ensure the personnel 'safety against the risk of inhalation and the protection of the process in the environment of the equipment. Before delivering the equipment, it will perform factory testing to demonstrate that the level of risk is acceptable and provide associated reports. In the event of failing extraction, he will do the necessary modifications until obtaining the requested results.

All the equipment will be equipped with covers adapted to the activity. These protections will have to allow reduction of the air flows to put in place for rationalizing energy and better efficiency without bringing ergonomic constraints which can endanger the operator.

The Contractor will integrate in the design of its equipment protections and other points of catchment considered necessary at the time as of maintenance operations.

5 SAFETY

5.1 EC conformity

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

European Directives:

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

In particular (if applicable) :

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

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

Construction standards

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

- **Risk analysis**
The various risks (mechanical, electrical, thermal, gas, chemical, radiation) shall be clearly mentioned by Contractor in its proposal.
The risk analysis will be made according to the applicable reference standard: **NF EN ISO 12100** : "Safety of machinery - General principles of design - Risk assessment and risk reduction"

These risks shall be handled :
 - in accordance with the instructions of the applicable directives:
 - in accordance with the recommendations of Paragraphs 5.2 to 5.12
- **Design of safety related parts :**
The safety functions will be designed in accordance with standard NF EN ISO 13849-1 "**Safety of machinery - Safety-related parts of control systems - Part 1: general principles of design**" for each type of hazard (mechanical / gas / thermal...)
- **Electrical equipment of machines**
The electrical equipment of machines will be designed in accordance with standard **NF EN 60204**

Reminder of technical points in relation with the regulations:

Warning:

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

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

- **Electrical cabinets**

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

- **Guards design**

- Protection panels:

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

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

Fixed guards:

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

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

Moving guards:

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

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

- **Maintenance modes**

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

(See: appendix F point 1.2.5)

Consequently:

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

- **Fume cupboards**

In case of fume cupboards, the applicable standards are:

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

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

5.2 Risks connected with facilities

Power supply sectioning:

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

Electrical supply cut-off device:

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

Compressed air connection or "service" nitrogen:

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

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

Presence of an uninterruptible power supply (UPS):

The instructions of Paragraph 4.1.5 shall be complied with.

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

5.3 Risks connected with fire

Automatic fire extinction system for equipment using solvents:

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

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

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

Intrinsic equipment fire detection system:

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

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

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

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

5.4 Risks connected with chemical products

- When chemical products (solid, gaseous or liquid) are supplied by the Contractor within the framework of installing equipment, testing or any other operation, it must comply with **EC regulation 1907/2006**. It must also supply the full list of products as well as safety information sheets in French for each product. These documents must comply with European directive CLP.

The CEA-LETI shall be particularly vigilant with regard to compliance with content, pictograms and classification used, as well as the provision of a version drafted in French.

- Product classified as noxious, toxic, extremely toxic, corrosive, etc. (e.g., fluorhydric acid with a concentration greater than 7%, gas, etc.) supplied by an outside source to the equipment shall be distributed with double-walled pipe up to the equipment intake. Pipes connecting dangerous chemical fluids between the equipment and auxiliary modules will also be double-walled.

- If there is a risk in a chemical containment of the equipment during a maintenance operation, a safety device in the system shall be able to cut power supply of devices that may present a risk to personnel.

All equipment containing liquid chemicals must be organised in such a way as to create a retention system aiming at preventing the accidental spread of said products outside the equipment without voluntary action. All elements of the installation in the equipment that could be a source of leaks (fittings, valves, filters, etc ...) will be placed on the retention and under extraction.

- These retention systems shall be fitted with leak detectors reporting the information to the equipment control console. Alarm enabling of a detector shall interrupt automatic supply to the machine and the chemical fluid circulation.

The detectors shall be tested before activating the equipment.

- The operation of equipment shall be connected with the proper operation of the extraction. The extraction level shall be permanently controlled by one or several extraction controllers which will drive a visual alarm per stack light (code green, orange and red) and a sound alarm on the working station and if necessary on the concerned sub equipment). These sensors will give an indication of current negative pressure level and shall also ensure equipment safety servo mechanisms in the event of an alarm. It must be possible to recalibrate the sensors on site to correct drifts over time. A calibration certificate shall be provided upon installation.

For each type of control sensor used on the exhaust a spare sensor will be delivered with the equipment to be kept as a spare part.

- NB: for automated equipment, this "extraction" alarm may be linked with the other types of alarms on the equipment control consoles.
All equipment modules and devices (reactor, chemical vat, stove, coater, gas or chemical storage cabinet including the lower cabinets of the benches, canisters, etc.) and, more generally, any compartment where a leak may occur including those housing connections, valves, pumps, etc., that present a risk to operators shall be included in the exhaust system.
- In order to ensure efficient exhaust, the mobile front should have no rim.
Ideally, the bench should have 2 exhaust strips: a first one on the worktop level and a second one located on the top of the bench, in order to promote the exhaust of chemical vapours.
If the bench includes bulky elements (ultrasonic tank, oven, etc.), these elements must be embedded in the worktop and not on the top of it in order to prevent any perturbation of exhaust and aerolics performance.
- Chemical product trays of pans must be equipped with an adjustable time delay automatic drainage system in such a way that solutions may be automatically directed towards drains in the event of a prolonged shut-down of extraction.
- For the requirements of certain processes, chemical products will need to be heated. At the end of operation, these baths may only be evacuated to designated drains if the temperature of the bath does not reach 60°C. For higher temperatures and for drainage in the "solvent" drain, a study must be conducted in order to determine the best solution: PVDF material, dilution module, thermal exchanger, etc.

If the solution selected by the Contractor consists in installing a buffer tank to enable these effluents to cool, it must be located under retention and be equipped with an adjustable time delay drainage system as stated previously.

- For equipment with processed chambers, the Contractor must provide the list of expected by-products in the event the chamber is opened, in order to facilitate maintenance operations.
- For equipment with gas detectors, The Contractor will specify and provide the necessary documentation relating to:

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

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

- For solid compounds used as insulating materials in furnaces, the Contractor will provide all relevant information on the nature and dangerousness of these materials: Material Safety Data Sheet (MSDS) should be provided. If one of these materials contains Refractory Ceramic Fibres (RCF), the Contractor must provide costed alternatives: substituents and less dangerous materials than RCF.

5.5 Risks connected with handling

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

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

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

5.6 Risks connected with pressurised equipment

For equipment subject to "Pressure" directive **2014/68/EU**, Contractor shall:

- Provide a complete file of the equipment in order to enable the commissioning inspection operations
- Update the roll where all the interventions will be recorded (inspections, requalification, and maintenance).

Contractor shall submit the periodicity of visit and controlled equipment requalification.

5.7 Risks connected with work at height

Should equipment use, maintenance or installation operations require elevated access, the Contractor shall provide protected access with guard rails in compliance with European standards **EN 14122-3**, if not, anchoring points compliant with European standards **EN 795**. In the latter case, technical documentation must make a very clear reference to it, in such a way as to implement related regulatory checks.

Where required, related personal protective equipment may be requested. They must be validated by the HSE Cell.

5.8 Risks connected with laser radiation

Lasers must have EC marking. The design, implementation and labelling of lasers must be compliant with standard **EN 60825**.

Should a risk exist beams must be automatically shut-off when the enclosure in which they are confined is opened (for example: opening of vacuum chamber, opening of mobile protectors, etc.).

Once completed by the Contractor, the following table should be inserted in Appendix A:

Type	Class	Continuous or pulse	Wave length	Power	Beam diameter before focusing	If pulsed laser		
						Energy	Length of pulses	Number of pulses

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

If the equipment contains radioactive sources, or if it embeds an Electric Ionizing Radiation Generator, a description must absolutely be provided: type of source / characteristics / radiation / activity / kV / mA /

Please note: In this area, certain design obligations result solely from French regulations, including the decisions of the Nuclear Safety Authority (ASN)

The design of the device on the risk of ionizing radiation must meet an obligation of results, the specifications of which are given below.

Equipment design:

DECISION 2017-DC-591

The equipment must comply with DECISION 2017-DC-591 of the Nuclear Safety Authority "setting the minimum technical design rules to which the premises where electrical devices emitting X-rays are used must comply"

Full text available (in French) on request.

Warning: also applies to electrical devices emitting unwanted X-rays (for example: ion implanters, electron beam welding equipment, etc.)

In application of this decision:

- **Access restrictions**
When access is possible (door / hatch) :
 - Door open = X-ray emission not possible
 - Opening of the door = shutdown of X-ray production
- **Emergency stops**
An emergency stop button will be present near the control device and will cause:
 - A shutdown of X-ray production upon triggering
 - Holding of the stop order until it is rearmed
- **Risk light signalling:**
 - A light sign will be installed on each access
 - Power-on signalling
 - Radiation emission signalling
 - If several devices are installed: identification of the one in operation
 - In application of this criterion, a specific light tower will be installed outside the equipment at each access (doors);
 - orange color will indicate power on;
 - red color will indicate emission
- **Shutter**
 - The X-ray emission signalling will operate in connection with the position of the shutter and will flag the shutter open position.
 - In addition, a light signal will be present at the shutter level

Construction and test rules

FRENCH STANDARD NFC 74-100

Any equipment equipped with one or more X-ray generators must comply with the French standard **NFC 74-100 "RADIOLOGY EQUIPMENT X-Ray Apparatus Construction and tests REQUIREMENTS "**

The application of this standard is mandatory in France.

Certification assessment will be planned by the manufacturer on his site before delivery

If necessary please contact us to obtain the address of an accredited organization able to do this assessment.

The certificate of conformity regarding NFC 74-100 will be provided at delivery.

Radiation flux :

The manufacturer will certify that the emission measured at any point 10 cm from the equipment is less than 1µ Sv / hour (1 micro Sievert per hour)

5.10 Risks connected with noise

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

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

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

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

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

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

5.11 Risks connected with temperature

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

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

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

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

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

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

5.12 Signaling

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

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

5.13 Intervention conditions on the CEA-LETI site

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

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

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

6 SUSTAINABLE DEVELOPMENT

6.1 Corporate Social Responsibility (CSR)

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

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

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

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

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

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

6.2 Sustainable development and development of the local economic fabric

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



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

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

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

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

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

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

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

6.3 Energy performance

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



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

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

7 EQUIPMENT DELIVERY CONDITIONS

The equipment and all the peripherals will be delivered clean and packaged in a serious and appropriate way. The transport platforms, pallets and packaging cases must be adapted to the weight and volumes of the elements in order to ensure safe a transport and avoid any dispute connected with improper packaging.

The following cleanliness requirements shall be fulfilled for the specific case of equipment intended to be installed in the clean rooms:

- very careful cleaning of all the subassemblies before shipment in order to remove any trace of shavings, hydrocarbons, grease or any other potential contaminant.
- packaging of the parts intended to be installed in the clean room under double film in order to perform progressive unwrapping while allowing a minimum amount of particles to contaminate the clean room. Peripherals intended to be installed in the basement may be packaged in single skin.
- likewise, all packages containing cable works, spare parts, various accessories required for assembling the equipment must be compatible with the clean rooms; wood, cardboard or traditional paper-type materials are prohibited; Contractor shall provide plastic-based non-contaminating wafer carriers (rigid or corrugated plastic cases for example).
- Filters of the environmental chambers and **FFUs shall not be delivered mounted on the equipment at delivery** to avoid any risk of particulate contamination and deterioration during handling and installation. Mounting remains the responsibility of the Contractor.

8 CONDITIONS FOR INSTALLING EQUIPMENT

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

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

9 TRAINING & LEARNING

The Contractor undertakes to provide at no additional cost training covering the use of the equipment (operation and process development), and safety. Trainings for maintenance (hardware and software) will have to be proposed and quoted as an option. These trainings will be provided by a trainer of the Contractor and will end with a training certificate given to the trained personnel and the maintenance manager.

- Training for use of the equipment

After commissioning of the equipment, user training shall be provided on site during 1 week, for at least 5 people. This training shall cover use of the equipment in production mode and in engineering mode.

- Safety training

Contractor shall provide a complete safety training of the staff which will be appointed to operate the equipment.

In particular, this training must include:

- ✓ Training on the use conditions and contraindications of use,
- ✓ Information on the prevention devices implemented and residual risks,
- ✓ Training on the specific precautions and procedures to be complied with during adjustment and maintenance interventions,
- ✓ Training on the periodic functional check operations of the safety systems.

- Level 1 maintenance training to be quoted as an option

First level maintenance training will be provided during 1 week, for at least 5 people at CEA-LETI or on the Contractor's premises for maintenance and/or process staff upon acceptance.

The Contractor will provide a list and description of first level maintenance operations to be carried out on the equipment.

- Advanced maintenance training to be quoted as an option

The Contractor shall provide "advanced maintenance" training during the warranty period which will be carried out at the Contractor's training center. Training for at least 2 people.

10 DOCUMENTATION

See **Appendix E**: "Specifications relating to the documents and manuals to be supplied jointly with the equipment".
Each manual must be available in two paper version plus possible CD-ROM version
Two sets of each manual shall be provided, one of the two sets shall be on clean room compatible paper.
From a statutory standpoint, the delivery of a document or publication in CD-ROM format only (no hardcopy version) is construed as non-conformity.

11 WARRANTY

11.1 Warranty conditions

Warranty shall start at the date of equipment acceptance for a duration of one year. An additional year of warranty must be quoted as an option.

Warranty shall include corrective and preventive maintenance operations, with at least one preventive maintenance per process chamber and per year.

All costs related to maintenance operations during warranty period shall be borne by the Contractor: labour, spare parts, consumables, travels, shipments etc...

11.2 Support during warranty

During the warranty period, the Contractor agrees to provide on-site support within a maximum timeframe of 2 business hours after receiving an e-mail or a call from CEA-LETI.

Support shall be available for on-site intervention from 5am-9pm on weekdays and from 8am-5pm on week-ends.

11.3 Equipment performance indicators

- A) The definition of the down-time calculation used by the CEA-LETI is set out in Appendix C.

Up-time (%) = $100 - \text{Down-time (\%)}$

- B) During the warranty period:

Uptime > 90%

MTBF¹ > 1000h

MTTR² < 4h.

- C) Penalties during the warranty period

The up-time (see **Appendix C** "up-time definition") shall be assessed on a three-monthly basis.

Should one of the 2 parameters (Uptime or MTBF), recorded during the warranty period, not comply with specifications: the warranty period shall be automatically extended by a period of 3 MONTHS.

During this extension, the Contractor shall perform all the corrective actions necessary to meet the specifications.

If, at the end of this warranty extension period, the specifications are still not met: the warranty shall be further extended by periods of 3 MONTHS until the specifications are met.

¹ Mean Time Between Failure

² Mean Time To Repair

12 MAINTENANCE

12.1 Spare parts

12.1.1 List of spare parts:

In its bid, the Contractor shall include:

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

These lists may be used as a basis for drawing up an agreement for the supply of spare parts and consumables. The Contractor shall specify the standard delivery timeframe as well as the timeframe for an emergency situation.

12.1.2 Process-kit :

The equipment must be delivered with an additional process-kit per chamber to allow continuity of service after maintenance.

12.1.3 Storage area

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

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

12.2 Maintenance contract

At the end of the warranty period, the CEA-LETI shall have the possibility of subscribing a maintenance contract. The Contractor shall commit to be able to perform preventive and corrective maintenance for each piece of Equipment after the warranty period has expired and for a minimum period of 10 years.

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

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

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

12.3 Cost of ownership (COO)

Contractor shall provide the cost of ownership of system, including:

- Facilities consumption (gases, water -flows and required cooling capacity-, electricity, thermal load)
- Idle condition (includes consumables costs)
- Wafer move based (additional cost when tool is in production mode)
- Scheduled maintenance program and associated parts costs.

13 CHECKS & TESTS

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

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

13.1 Checks and tests at the factory (Factory acceptance tests)

Several factory acceptance tests shall be performed at the Contractor's site based on the procedure defined beforehand and submitted for CEA-LETI approval. The Contractor will carry out the control in factory using its own wafers and carriers according to the references provided by the CEA. Tests of security devices shall be mandatorily included in factory acceptance: exhaust controllers, EMOs, door or panel switches...

A "Factory acceptance" report shall be drafted by CEA-LETI and signed by both parties to accept the Equipment and mention any restrictions. Contractor shall not be authorised to ship the equipment without signature of factory acceptance and solving restrictions before shipment.

Test numbers 3.1, 3.4, 3.5, 3.6, 3.7 as well as 4.1,4.4,4.7 should be evaluated during factory acceptance

13.2 Check upon delivery & at unpacking

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

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

The packages destination must be indicated on boxes: basement or clean room.

The Contractor shall ensure that the equipment is correctly unpacked.

13.3 Installation & commissioning

After uncrating completion, the equipment will be moved to its final location in the cleanroom by CEA-LETI or its subcontractor. The Contractor shall then take care of equipment final assembly and interconnections. The Contractor shall use its own tools to perform equipment assembly, including handling and lifting tools that may be necessary.

The Contractor shall attend all the operations to install and connect the equipment to the facilities (fluids, extractions, etc.) and shall make sure that the latter are compliant with the Contractor's specifications.

Prior to powering up the equipment, CEA-LETI has programmed a compliance check of the applicable safety regulations (EC instructions), this check shall be performed by an independent approved body. The Contractor must be present and provide the required documents for the assessment of the equipment.

After powering on the equipment, the Contractor will perform the startup and adjust hardware settings (robotics etc.). The Contractor will carry out checks on facilities which includes checking the various safety controls.

The Contractor shall prepare and provide a "hardware report" commissioning which summarizes the progress of this step and the result of the various controls. This report will confirm that the connection by the Contractor and standard

safety tests are completed. The main safety elements concerned are: emergency stops, the extraction detection, leakage or gas detection, door contacts ... (Operation and connections)

At this stage, the CEA-LETI will arrange for a safety compliance inspection by the applicable regulatory compliance body (EC requirements). This check is performed by an independent accredited body. The Contractor will be present during this inspection and will make all necessary documents available for the assessment of the equipment.

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

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

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

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

The CEA-LETI also employs a firm that tests exhaust efficiency and air flow (FFUs) and takes ESD measurements.

For all the fluid connections (including effluents) or gas inter equipment or modules provided by the Contractor, the latter will carry out the marking and direction of these networks in accordance with European standard NF X 08-100 including pictograms SGH informing of the danger by printed solvent resistant laminated polyester adhesive stickers. The valves will be equipped with color labels engraved out of PVC 8/10e fixed by adapted collars indicating their function.

At the end of the installation, the Contractor will remove all waste and parts from the installation which are no longer required.

13.4 Qualification

Contractor shall submit the qualification procedure to CEA-LETI for acceptance. It shall check all the functional specifications described in Paragraph 2.

This qualification procedure shall be performed in the presence of CEA-LETI authorised representatives.

The summary of these tests shall be countersigned by CEA-LETI (qualification summary report).

13.5 Acceptance

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

Acceptance shall be pronounced after:

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

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

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

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

13.6 End of warranty

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

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

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

14 INSTALLATION PREPARATION SCHEDULE

The schedule below includes the key stages of the contract. For some the date is stipulated by CEA-LETI relatively with respect to the contract starting date (T0) or the delivery date (TL), for others, the contractual date will be specified in the Manufacturer's offer.

Note: For equipment delivered in several stages, a schedule per subassembly shall be drawn up (one subassembly per delivery).

1	Starting Date The start date of the contract ("T0") is date of the acknowledgment of receiving the contract if the latter does not exceed 10 days after the date of signature of the contract by CEA. In the case of an acknowledgment received after this period the "T0" is arbitrarily set at the date of dispatch of the contract by CEA-LETI (the date of the covering letter) plus 10 days. Appendix H (v0) including information related to the equipment and sub-equipement (to be provided by the contractor) Delivery the installation manual and foot print	T0
2	Preparation file of equipment installation (Made up at least from the "installation" chapter of the instruction manual defined in Appendix E)	T0 + 0.5 months
3	Kick-off meeting at the latest 1 month calendar after notification of the order to the service provider	T0 + 1 months
4	PID (Piping and Instrumentation Diagram) approval by the Contractor. Hook Up and Fit Up will start after the official validation of PID by the Contractor	T0 + 1.5 months
5	Appendix H (v1) with definitive information including related to the equipment and sub-equipement (to be provided by the contractor)	At the latest T0 + 2 months
6	Preparation file for equipment installation for approval; composed at least of: <ul style="list-style-type: none"> ✓ "Handling", "assembly", "commissioning and adjustments" chapters of the instruction manual defined in Appendix E. ✓ Transport specifications ✓ "Factory acceptance" and "Qualification" procedures 	TL - 2 months
7	Factory acceptance (on Contractor's site) (Prior written call of CEA-LETI representatives three weeks before). The factory acceptance file recording the checks and tests performed shall be forwarded to CEA-LETI within 10 days after the end of factory acceptance and at least 15 days before delivery.	At the latest TL - 1 month
8	Project maintenance manual in electronic format (composition of a file as per Appendix E)	TL - 0.5 months
9	Detailed programming of delivery (date, time, carriers, civil status of the workers on-site, etc). Note: Drafting of a prevention plan as per French regulation with a CEA-LETI engineer must be taken into account in the delivery schedule. The complete or simplified prevention plan (depending on the number of companies and the number of hours) must integrate commissioning of the equipment	TL - 0.5 months
10	Delivery	TL
11	Installation and assembly of the equipment and connection to the various networks Note: Given that at this stage the equipment is still the property of the Contractor (under CEA-LETI responsibility) the presence of one of its representative is mandatory during the handling and connection operations.	
12	Commissioning. This phase will be finalised with acceptance by CEA-LETI of the equipment filed formalised on a report with safety inspection of the installation.	

Document title : Low Temperature Epitaxy chamber - RPCVD

N° Chrono : LETI/DPFT/SSURF24-55

13	Qualification of the equipment	
14	Final equipment file (in electronic format and in two hard copies of which at least one in clean room compatible paper composed as per Appendix E)	15 days before acceptance
15	Acceptance of the equipment (This stage notifies transfer of ownership of equipment to CEA, the warranty period starts at this date)	
16	End of warranty (this stage notifies end of the equipment warranty and start of any maintenance contracts)	At the end of the warranty period and after lifting of reservation

15 APPENDICES

APPENDIX A: Summary of Contractor's comments

Use the following template and ask the Contractor to fill it:

[APPENDIX A Equipment specification.dotx](#)

Appendix B: GENERAL FLUIDS IN BUILDING 41-03

Distribution fluides généraux	Caractéristiques	Remarques particulières
Eau de refroidissement Réseau ERP_301 (production P1) Réseau ERP_302 (production P2) ID : ER-A / ER-R	Matériau : Inox 304 - PPH Pression aller : 6 bars / retour ~0 bar Température aller : 18 ou 19°C Conductivité : 200 microS/cm pH : 7 Produits de traitement : régulation pH, inhibiteur de corrosion, biocide	Circuits d'eau recyclée en boucles fermées → consommation en eau perdue interdite.
Eau Ultra Pure Réseau EUP ID : EUP-A/EUP-R	Matériau : PVDF haute pureté Pression : 4 +/- 0.5 bars Température : 20 +/- 1 °C Résistivité : ~ 18,2 Mohm.cm TOC < 2 ppb Fiche complète disponible SFETN	
Eau Désionisée Réseau EDI15 ID : EDI-A/ EDI-R	Matériau : PPH Pression : 4 +/- 0,5 bars	Usages vers CTA, Humidificateurs et appoints ERP
Eau de ville EdV_Pro (Process) EdV_Fac (Facilités) EdV_San (Sanitaires) EdV_Sec (douches sécurité) EdV_Spk (incendie/sprinkler)	Matériau : PVC Pression : 6 bars	Réservé aux fonctions techniques, sécurité, process, sanitaires, incendie
Eau Adoucie EAd_Pro (Process) EAd_Fac (Facilités)	Matériau : PVC Pression : 6 bars Prévoir dilatoflex	Réservé au lavage de gaz et fonctions techniques.
Vide procédé Réseau VPE	Matériau : INOX 304L Pression relative : ~ -880 mbar	
Air comprimé Réseau ACS	Matériau : acier inox 304L Pression : 7 ± 0.3 bars	Usage Transport et pneumatiques
Air comprimé Réseau ACP	Classe 1-1-0 selon la norme ISO8573-1 Matériau : acier inox 316L Ra 0,18 Pression : 10 ± 0.3 bars	Usage process (dont scanner)
Azote gaz "service" Réseau N2S	Matériau : inox 316L Ra 0,4 Pression relative : 7 ± 0.5 bars	Réservé aux usages pneumatiques et ballast de pompes
Azote gaz "process" Réseau N2P	Matériau : inox 316L Ra 0,18 Pression relative : 7 ± 0.5 bars	Réservé aux procédés, purges chambres et purges tank chimie
Argon réseau Réseau Ar	Matériau : inox 316L Ra 0,18 Pression relative : 7 ± 0.5 bars	
Oxygène Process Réseau O2P	Matériau : inox 316L Ra 0,18 Pression relative : 7 ± 0.5 bars	
Oxygène Industriel Réseau O2-Ind	Matériau : inox 316L Ra 0,18 Pression relative : 7 ± 0.5 bars 99,5%	Utilisation pour brûleurs et scrubbers

Hélium réseau Réseau He	Matériau : inox 316L Ra 0,18 Pression relative : $5,5 \pm 0.5$ bars	
Hydrogène Réseau H2	Matériau : inox 316L Ra 0,18 Pression relative : 8 ± 0.5 bars	
Gaz de Ville Réseau GdV	INOX 304L, repérage selon la chartre universelle	Utilisation pour brûleurs et scrubbers
Gaz spéciaux		Réservation de place
Chimie		Réservation de place
Collectes d'effluents	Caractéristiques bâtiment	Remarques particulières
Drain ESAD effluents acido-basiques dilués	Matériau : PPH	Relevage vers PUS
Drain ESAF effluents fluorés	Matériau : PPH Joints EPDM / revêtus Teflon	Relevage vers PUS
Drain ESS effluents solvants	Matériau : INOX Points de curage	Collectés en cuve et dépotage pour retraitement hors site
Drain ESAC Effluents acido-basiques concentrés	Matériau : PPH	Relevage vers PUS
Drain ESCU Effluents Cuivre et métaux lourds	Matériau : PPH	Relevage vers PUS
Drain Re-Use Récupération eau propre	Matériau : PVC Pression	Vers cuve Eau Adoucie
Drain ES_BF/CTAAN Récupération condensats	Matériau : PVC Pression	Vers cuve Eau Adoucie
Drain ESLA Effluents Laveurs Acides	Matériau : PVC pression en intérieur et adapté aux UV en extérieur	Rejoint drain ESAD en amont du préleveur réglementaire.
Drain ESCMP Récupération Silice Prévision	Matériau : PPH	Relevage vers PUS
Drain ESA_Sulf Récupération acide sulfurique Prévision	Matériau : PPH	Relevage vers futur laveur base (voir Extractions)
Drain ESLB Effluents Laveurs Basiques Prévision	Matériau : PVC pression en intérieur et adapté aux UV en extérieur	Evacuation vers PUS
Ventilation / Extractions	Caractéristiques bâtiment 41.03	Remarques particulières
Réseau extraction Chaleur EXCH	Matériau : Inox 304L. type JACOB, ou techniquement équivalent avec joints FKM Dépression disponible : de -400 à -600Pa entrée équipement suivant la localisation	Raccordement des équipements en salle blanche par le haut.

		Dimensionnement réseaux aérauliques dans équipement pour vitesse d'air $\leq 8\text{m/s}$;
Réseau extraction ACIDE EXA	Matériau : inox revêtu Halar ou équivalent roulé soudé bord bombé. Dépression disponible : de -500 à -800Pa entrée équipement suivant la localisation	Raccordement des équipements en salle blanche par le bas. Dimensionnement réseaux aérauliques dans équipement pour vitesse d'air $\leq 8\text{m/s}$ gaine flexible M1 en utilisation limitée tolérée (<1ml). Alu interdit. Pour les pompes à vide , réseaux démontables par colliers rapides type Pneurop pour nettoyage
Réseau extraction BASIQUE EXB	Matériau : inox revêtu Halar ou équivalent roulé soudé Dépression disponible : de -500 à -800Pa entrée équipement suivant la localisation	Raccordement des équipements salle blanche par le bas. Dimensionnement réseaux aérauliques dans équipement pour vitesse d'air $\leq 8\text{m/s}$ gaine flexible M1 en utilisation limitée tolérée (<1ml). Alu interdit. Pour les pompes à vide , réseaux démontables par colliers rapides type Pneurop pour nettoyage
Réseau extraction Solvant EXSV	Matériau : Inox 304L. type JACOB, ou techniquement équivalent à bord bombé et joint EPDM entre bride. Dépression disponible : de -500 à -800Pa entrée équipement suivant la localisation	Dimensionnement réseaux aérauliques dans équipement pour vitesse d'air $\leq 8\text{m/s}$
Flux laminaire pour soufflage dans équipement	Fan Filter Unit à prévoir par équipementier	Installation devant respecter la norme EN ISO 14644 avec filtres aisément démontables.
Air traité Salle blanche 41.03	Température: $21.5^{\circ}\text{C} \pm 1$ pour l'ensemble de la salle blanche 41.03 Hygrométrie : $45\% \pm 5$ pour l'ensemble de la salle blanche 41.03. Spécificité zone scanner : - Température: $21.5^{\circ}\text{C} \pm 0.5$ variation $< 1^{\circ}\text{C} / 1\text{h}$ - Hygrométrie: $45\% \pm 5\%$ variation $< 10\% / \text{h}$ et variation $0,5\% / 5\text{mn}$ sur cycle de 15mn	Limites de fonctionnement : Conditions extérieures climatiques Hiver : -11°C , HR = 90 % Été : $+38^{\circ}\text{C}$, HR = 40 %
Air traité Basement sub fab 41.03	Température: $21.5^{\circ}\text{C} \pm 2$ pour l'ensemble de la salle blanche 41.03 Hygrométrie : $45\% \pm 10$ pour l'ensemble de la salle blanche 41.03	Limites de fonctionnement : Conditions extérieures climatiques Hiver : -11°C , HR = 90 % Été : $+38^{\circ}\text{C}$, HR = 40 %

APPENDIX C: Definition of Availability

1. Planned time

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

2. Up-time definition

The basic formula for calculating the up-time is:

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

3. Down-time definition

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

The equipment down-time is divided into:

- Scheduled down-time
- Unscheduled down-time

A) SCHEDULED DOWN-TIME

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

B) UNSCHEDULED DOWN-TIME

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

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

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

4. Measuring up-time

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

5. Measuring down-time

A) START

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

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

B) DURATION

Down-time covers:

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

These different times must be noted and recorded accurately.

C) END

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

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

MTBF definition

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

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

MTTR definition

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

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

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

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

1/ Reminder of the applicable regulation

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

2/ Definition of a machine

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

Consequently:

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

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

Consequently:

A second-hand machine from a non-EC country will be considered as new upon its entry into the EC.

The applicable regulation will be that in force at its date of entry.

3/ Reference standards

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

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

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

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

➤ **EC declaration of conformity**

2006/42 annex II:

“EC DECLARATION OF CONFORMITY OF THE MACHINERY

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

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

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

The EC declaration of conformity must contain the following particulars:

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

➤ **An instruction manual**

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

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

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

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

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

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

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

1. Purpose

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

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

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

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

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

2.1. Regulatory obligations

2.1.1. Instruction manuals

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

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

Content

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

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

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

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

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

Language

"All machinery must be accompanied by instructions in French.

The instructions manual accompanying the machinery must be either an original instruction manual or a translation of the original manual in which case, the translation must be accompanied by the original instruction manual." **(Transposition of 2006/42 1.7.4)**

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

Consequently, the following will be provided:

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

2.1.2. Maintenance manual

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

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

Contractor shall mandatorily provide:

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

2.2.1. Instruction manual

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

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

Handling

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

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

Assembly - Disassembly

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

Installation

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

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

All these parameters shall be accompanied by a tolerance.

Commissioning

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

Adjustments

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

Use

This chapter shall contain:

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

CAUTION

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

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

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

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

Maintenance

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

CAUTION

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

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

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

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

2.2.2. Maintenance manual

It shall contain :

- a presentation of the machine enabling the component parts to be located (photos),

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

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

The special specifications of CEA/LETI [(§ 2.2)] of this document apply.

APPENDIX F: Selection of protection against risks connected with moving parts Characteristics required for guards and protective devices

Abstract of machinery directive 2006/42

1.2.5. Selection of control or operating modes

The control or operating mode selected must override all other control or operating modes, with the exception of the emergency stop.

If machinery has been designed and constructed to allow its use in several control or operating modes requiring different protective measures and/or work procedures, it must be fitted with a mode selector which can be locked in each position. Each position of the selector must be clearly identifiable and must correspond to a single operating or control mode.

The selector may be replaced by another selection method which restricts the use of certain functions of the machinery to certain categories of operator.

If, for certain operations, the machinery must be able to operate with a guard displaced or removed and/or a protective device disabled, the control or operating mode selector must simultaneously:

- disable all other control or operating modes,
- permit operation of hazardous functions only by control devices requiring sustained action,
- permit the operation of hazardous functions only in reduced risk conditions while preventing hazards from linked sequences,
- prevent any operation of hazardous functions by voluntary or involuntary action on the machine's sensors.

If these four conditions cannot be fulfilled simultaneously, the control or operating mode selector must activate other protective measures designed and constructed to ensure a safe intervention zone.

In addition, the operator must be able to control operation of the parts he is working on from the adjustment point.

1.3.8. Choice of protection against risks arising from moving parts

Guards or protective devices designed to protect against risks arising from moving parts must be selected on the basis of the type of risk. The following guidelines must be used to help to make the choice.

1.3.8.1. Moving transmission parts

Guards designed to protect persons against the hazards generated by moving transmission parts must be:

- either fixed guards as referred to in section 1.4.2.1, or
- interlocking movable guards as referred to in section 1.4.2.2.

Interlocking movable guards should be used where frequent access is envisaged.

1.3.8.2. Moving parts involved in the process.

Guards or protective devices designed to protect persons against the hazards generated by moving parts involved in the process must be:

- either fixed guards as refer to in Section 1.4.2.1, or
- interlocking movable guards as refer to in Section 1.4.2.2, or;
- protective devices as refer to in Section 1.4.3, or
- a combination of the above.

However, when certain moving parts directly involved in the process cannot be made completely inaccessible during operation owing to operations requiring operator intervention, such parts must be fitted with:

- fixed guards or interlocking movable guards preventing access to those sections of the parts that are not used in the work;

and

- adjustable guards as referred to in Section 1.4.2.3 restricting access to those sections of the moving parts where access is necessary.

1.3.9. Risks of uncontrolled movements.

When a part of the machinery has been stopped, any drift away from the stopping position, for whatever reason other than action on the control devices, must be prevented or must be such that it does not present a hazard.

1.4. Required characteristics of guards and protective devices.

1.4.1. General requirements.

Guards and protective devices must:

- be of robust construction;
- be securely held in place;
- not give rise to any additional hazard;
- not be easy to bypass or render non-operational;
- be located at an adequate distance from the danger zone;
- cause minimum obstruction to the view of the production process;
- enable essential work to be carried out on the installation and/or replacement of tools and for maintenance purposes by restricting access exclusively to the area where the work has to be done, if possible without the guard having to be removed or the protective device having to be disabled.

In addition, guards must, where possible protect against the ejection or falling of materials or objects and against emission generated by the machinery.

1.4.2 Special requirement for guards

1.4.2.1. Fixed guards.

Fixed guards must be fixed by systems that can be opened or removed only with tools.

Their firing systems must remain attached to the guards or to the machinery when the guards are removed.

Where possible, guards must be incapable of remaining in place without their attachment.

1.4.2.2. Interlocking movable guards.

1 Interlocking movable guards must be designed and constructed:

- to remain attached where possible to the machinery when opened;
- they can be adjusted only by means of an intentional action.

2 Interlocking movable guards must associated with an interlocking device that:

- prevents the start of hazardous machinery functions until they are closed,
And
- gives a stop command whenever they are no longer closed.

3 Where it is possible for an operator to reach the danger zone before the risk due to the hazardous machinery function has ceased, movable guards must be associated with a guard locking device in addition to an interlocking device that:

- prevents the start of hazardous machinery functions until the guard is closed and locked,
And
- keeps the guard closed and locked until the risk of injury from the hazardous machinery functions has ceased.

4 Interlocking movable guards must be designed in such a way that the absence or failure of one of their components prevent starting or stops the hazardous machinery functions.

1.4.2.3. Adjustable guards restricting access.

Adjustable guards restricting access to those areas of the moving parts strictly necessary for the work must be:

- adjustable manually or automatically, depending on the type of work involved;
- readily adjustable without the use of tools.

1.4.3. Special requirements for protective devices.

Protective devices must be designed and incorporated into the control system in such a way that:

- moving parts cannot start up while they are within the operator's reach;
- persons cannot reach moving parts while the parts are moving,
And
- the absence or failure of one of their components prevents starting or stops the moving parts.

Protective devices must be adjustable only by means of an intentional action.

APPENDIX G: Transfer and handling of wafers

1 – Applicable SEMI standards

Equipment must be compliant with following SEMI Standards:

	SEMI Standard
G1.1	SEMI E15.1 — Specification for 300 mm Tool Load Port
G1.2	SEMI E47.1 — Provisional Mechanical Specification for Boxes and Pods Used to Transport and Store 300 mm Wafers
G1.3	SEMI E57 — Mechanical Specification for Kinematic Couplings Used to Align and Support 300 mm Wafer Carriers
G1.4	SEMI E62 — Provisional Specification for 300 mm Front-Opening Interface Mechanical Standard (FIMS)
G1.5	SEMI E63 — Mechanical Specification for 300 mm Box Opener/Loader to Tool Standard (BOLTS-M) Interface
G1.6	SEMI E64 — Specification for 300 mm Cart to SEMI E15.1 Docking Interface Port
G1.7	SEMI E72 — Specification and Guide for 300 mm Equipment Footprint, Height, and Weight
G1.8	SEMI E103 — Provisional Mechanical Specification for a 300 mm Single-Wafer Box System that Emulates a FOUP
G1.9	SEMI E110 - Guideline for Indicator Placement Zone and Switch Placement Volume of Load Port Operation Interface for 300 mm Load Ports
G1.10	SEMI E111 - Provisional Mechanical Specification for a 150 mm Reticle SMIF Pod (RSP150) Used to Transport and Store a 6 Inch Reticle. (if applicable)

Other applicable standards

- Classification of air cleanliness: standard ISO 14644-1
- Metrology and test methods: standard ISO 14644-3
- Protection of electronic devices against electrostatic discharges: IEC 61340-5-1
- Mini-environment : IEST- RP-CC028.1
- Control of mini-environments: QM 07.08.011
- Check of mini-environments: QII 07.08.004
- Particle inspection of the air: QM 07.08.001
- Metrological inspections: QM 07.08.004

2. Handling Device

Loadport:

	<i>Loadport</i>	<i>Objective</i>
G2.1	Loadport Kinematic coupling pins ground resistivity value	< 100 kohm
G2.2	Maximum wafer insertion temperature in FOUP	< 100 °C
G2.3	Maximum FOUP environment continuous temperature	80°C
G2.4	Inserted wafers in FOUPs are dry	No droplet
G2.5	Maximum static charge during wafers FOUPs insertion	< 100V cm
G2.6	Maximum delay between docking request and end docking movement	< 10s
G2.8	A "load" push button (one position stable) is placed at the right front side of FOUP load as figure 1	Y

APPENDIX H: Datasheet for tool installation

Use the following template and ask the Contractor to fill it:



DPFT

ANNEXE H : Datasheet for tool installation

- 1) The datasheet informations allows CEA-LETI to design the fluid PID and the electrical PID.
- 2) These PIDs are then sent for verification and approval to the Contractor.
- 3) Hook Up and Fit Up will start after the official validation of PIDs by the Contractor.

Equipement Model :

List of Equipments & sub-equipments						
Name	Location (Fab or sub-fab)	Type (Chiller, pump...)	Model	Dimensions (L x w x h) in mm	Weight (Kg)	Supplied by
Chiller 1	Sub-Fab	Heat Exchanger	NESLAB HX-150	500 x 600 x 900	400	Contractor
Pump 1	Sub-Fab	Pump	iHx 600	300 x 900 x 800	200	CEA-LETI
Mainframe	Fab	Mainframe	xxx	2500 x 1300 x 2600	2500	Contractor

EXAMPLE

Facilities requirements				Connection		Consumption (e)				Pressure (bar) at the connection on the tool		Temp (° C)		Purity	Supplied by	Comments (ex. max length...) (f)
Fluid (a)	From	To	Description (b)	ID (c.)	Size (d)	Type	Min	Max	Average	Min	Max	Min	Max			
N2S	Facilities	Mainframe CH A	N2 Purge	G1	1/4"	VCRM	15	50	25	2.5	5	N/A	N/A	N/A	CEA-LETI	EXAMPLE
Glycol	Chiller 1	Mainframe CH A	Chilled Water	F1	3/8"	swg	10	20	12	2	3	15	18	N/A	Contractor	installed by CEA-LETI EXAMPLE
BCO	Facilities	Mainframe CH A	BCO proces	J2	1/4"	VCRM	1	2	1.2	1	1.3	N/A	N/A	N50	CEA-LETI	Purity : N50

The datasheet information allows CEA-LETI to design the fluid PID and the electrical PID (PID = Piping and Instrumentation Diagram).

These PIDs are then sent for verification and approval to the equipment Contractor.

Hook Up and Fit Up will start after the official validation of PIDs by the Contractor.

APPENDIX I: Risk Identification Sheet

Use the following template and ask the Contractor to fill it:

[Annexe I Fiche Identification Risques.xlsx](#)

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

Document title : Low Temperature Epitaxy chamber - RPCVD

N° Chrono : LETI/DPFT/SSURF24-55

APPENDIX J: SECS/GEM Compliance

Use the following template and ask the Contractor to fill it:

[Annexe J SECS/GEM Compliance Statement](#)