



THEIX SITE

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MODTHEIX 2 PROJECT FUNCTIONAL PROGRAM CONTROLLED ENVIRONMENT METABOLIC ROOMS FOR LARGE RUMINANTS

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0. GÉNÉRALITÉS

0.1 SUBJECT

As part of the extension of its range of services, the Herbipôle Experimental Unit (1414) would like to purchase itself with a metabolic rooms devices with a controlled environment for large ruminants, necessary for research and experimentation on ruminants.

The purpose of this program is to define the functional requirements, constraints, prerequisites and specific features of the expected equipment.

0.2 CONSULTATION FRAMEWORK

The equipment, which is the subject of this consultation, will be installed in the area CH4 of the MODTHEIX2 project currently under construction. Delivery of the building is scheduled for the end of July 2025.



The present contract is subject to a competitive dialogue (cf. administrative files of the requirement n°0.01 and 0.02).

French version will be the opposable reference in the event of any misunderstanding and/or conflicts

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0.3 REVISIONS HISTROY

Review	Purpose of the revision	Date	Author	Control
DRAFT 0	DOC CREATION	11/27/24	G. BUSSON	M. DELBERT
DRAFT 1	FOR MEETING ON 05/12/24	12/04/24	G. BUSSON	M. DELBERT
DRAFT 2	FOR MEETING ON 16/12/24	12/16/24	G. BUSSON	M. DELBERT
DRAFT 3	FOR MEETING ON 09/01/25	01/06/25	G. BUSSON	M. DELBERT
REVISION A	INITIAL CONTROL EDITION	01/13/25	G. BUSSON	M. DELBERT
REVISION B	REQUIREMENT EDITION	03/17/25	G. BUSSON	M. DELBERT
REVISION C	EDITING FOR PUBLICATION	07/07/25	G. BUSSON	M. DELBERT

0.4 LIST OF ABBREVIATIONS

ENGLISH		FRENCH	
Abbreviations	Designation	Abbreviations	Designation
RW	Raw water	AEP	Alimentation Eau Potable
HVAC	Handle Ventilation Air Conditioning	CVC	Chauffage Ventilation Conditionnement d'air
QC	Quality Control	CQ	Contrôle Qualité
RS	Requirement Specifications	PROG	PROGramme
DS	Design Specifications	ST	Spécifications Techniques
URS	Users Requirement Specification	SBU	Spécification Besoin Utilisateur
PUW	PURificated Water	EPU	Eau PURifiée
EXE	EXEcution	EXE	EXEcution
FAT	Factory Acceptance Tests	RU	Réception Usine
FDS	Functional Design Specification	AFB	Analyse Fonctionnelle de Base
HSE	Health Safety Environment	HSE	Hygiène Sécurité Environnement
DQ	Design Qualification	QC	Qualification de Conception
IQ	Installation Qualification	QI	Qualification de L'installation
OQ	Operational Qualification	QO	Qualification Opérationnelle
PQ	Process Qualification	QP	Qualification de Performances
SAT	Site Acceptance Test	RS	Réception sur Site
AB	As Built	TQC	Tel Que Construit
SPHC	Safety Prevention Health Coordinator	CSPS	Coordinateur Sécurité Prévention Santé
GCM	General Coordination Master	PGC	Plan générale de coordination
ES	emergency stop	AU	Arrêt d'urgence
GWP	Global warming potential	GWP	Potentiel de réchauffement
ATP	Air treatment plant	CTA	Centrale de traitement d'air
THI	Temperature Humidity Index	THI	Indice de Température et d'Humidité
PID	Piping and Instrumentation Diagram	PID	Schéma tuyauterie et instrumentation
POE	Power Over Ethernet	POE	Power Over Ethernet
CSV	Comma Separated Values	CSV	Valeurs Séparées par des Virgules

0.5 PARTICIPANTS & FUNCTIONS

NAME/FIRST NAME	VISA	QUALITY / FUNCTION
Phillipe PRADEL	PPL	Head Manager HERBIPOLE
Baptiste TERSIN	BTN	Site Works Manager
Arnaud HUART	AHT	Project leader
Mathieu SILBERBERG	MSG	Scientific Engineer
Frédéric ANGLARD	FAD	User
Christian PICHON	CPN	User
Cecile MARTIN	CMN	Researcher
Guillaume BUSSON	GBN	INAUV Project Leader
Maurice DELBERT	MDT	INAUV Ing Quality / HSE lab pole

0.6 LIST OF PROJECT APPLICABLE DOCUMENTATION

Please refer to Exhibit n°0.00_Liste des pièces du DCE, listing all written and graphic documents applicable and enforceable to this project, and included in the tender documents.

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1. USER REQUIREMENTS SPECIFICATION

1.1 PROJECT GOALS / SCOPE

1.1.1 *Background and general presentation*

Livestock farming systems face a major challenge on a global scale for each such as:

Respond to the growing demand for animal products while limiting their environmental impact and competition for resources for human consumption. In this general context, ruminant livestock systems pose challenges, insofar as they are both major producers of pollutant emissions (greenhouse gases, in particular enteric methane (CH₄), nitrogen emissions) and less efficient processors of food resources they consume than monogastric livestock, as well as irreplaceable users of the lands and fodder areas they farm.

This challenge poses several questions for research, which are at the heart of INRAE's scientific priorities.

One of these objectives is to combine reducing the environmental impact of ruminants with obtaining animal products that are safe and accepted by consumers and the general citizens.

At the same time, many operators involved at different levels of the animal production chain are seeking to make progress along the same lines, with the ultimate aim of proposing operational solutions to reduce these emissions, in order to maintain a high level of production and therefore preserve the competitiveness of farms.

The UE Herbipôle is an experimental facility that provides research teams with the equipment they need to carry out the experiments they require. The new premises to be built in 2024-2025 will be equipped with these controlled-atmospheric metabolic rooms for large ruminants, completing the experimental offer of the UE Herbivore (<https://www.inrae.fr/actualites/comment-mesurer-methane-enterique-emis-ruminants>).

1.1.2 *Objectives*

The scientific strategy for methanogenesis is organized around different areas of research, involving animal experiments to acquire new data and the integration of existing data. This research covers both fundamental and applied fields, and is structured around 3 key words: UNDERSTAND, PREDICT, QUANTIFY

UNDERSTAND: by studying the mechanisms (microbial or otherwise) of methanogenesis in the rumen of the different reduction strategies tested, in order to *in fine* imagine new ones.

PREDICT: by seeking non-invasive indicators of methanogenesis in order to propose equations for predicting CH₄ emissions. This line of research is a scientific front and offers interesting intellectual property potential if one or more relevant peripheral markers can be identified.

QUANTIFY: this 3rd key word is the keystone of the project, since reliable and precise quantitative CH₄ emission balances enable us to test the relevance of the proposed reduction strategies and the non-invasive predictors identified. The metabolic chamber technique is considered the Gold Standard Method in the international scientific community. Among other things, it enables kinetic measurements to be taken of daily gas production (including CH₄), makes ideal for studying the mechanisms of action of the various anti-methanogenic foods or dietary supplements tested. This system will therefore be extremely useful in meeting the growing demand from players in the industry for nutritional solutions to limit pollutant emissions (greenhouse gases, nitrogen emissions) from ruminants, including enteric CH₄ emissions.

Each metabolic chamber will be equipped with a system for collecting the animal's faeces and urine for digestive and nitrogen (nitrogen, ammonia) balances, which will complement the flows of enteric CH₄, carbon dioxide (CO₂) and hydrogen (H₂) emitted by the animal. Finally, other gas flows of interest will be quantified via the acquisition of dedicated sensors: oxygen (O₂) flows consumed by the animal for energy metabolism studies; nitrous oxide (N₂O) flows, released by effluents, etc... It is also planned to install animal behavior sensors (camera, heart rate) to monitor the animal's response in terms of well-being, health and adaptability to different feed conditions (including water availability) and environmental conditions (temperature, hygrometry; THI index) that will be simulated within the controlled environment chambers. This equipment will enable comprehensive studies of the animal's ingestive, digestive, metabolic, zootechnical and health functions on an individual scale as a function of different treatments related to climate change (new food resources, thermal and water stress, etc.).

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1.2 PROJECT LOCALIZATION

This unit will be installed in the extension to the "Les Intrabois" barn at the INRAE Theix site, created as part of the MODTHEIX 2 real estate project (Restructuring and modernization of the Herbipôle unit's experimental facilities). This ground-floor extension is currently under construction.

Exhibits 2.02 to 2.11 specify the environment, the positioning of the rooms, the utilities to be installed, and the maximum area and/or right-of-way available for the equipment. Exhibit 2.01 shows the position of the smoke extraction skylights.

Exhibits 2.02 and 2.03 show the volume available installation.

Exhibits 2.04 and 2.09 detail the level clearances provided to enable flows to be managed (animals, feeds, animals, faeces bin).

1.3 GENERAL REGULATORY REFERENCES

The services covered by this document will be carried out in compliance with the Standards, Decrees, Regulations and Unified Technical Documents in force in France at the date of this document.

- LABOR CODE CATEGORY I ;
- CODE OF PUBLIC CONTRACTS
- DIRECTIVE 2010/63/UE
- REFERENTIALS EXPERIMENTATION FRENCH DEPARTEMENT DDPP / EUROPEAN DEPARTEMENT ;
- ISO 50001 ENERGY MANAGEMENT;
- DIN 18910 Thermal insulation of closed livestock buildings - Thermal insulation and ventilation - Planning and calculation basis for closed, forced-ventilated barns.

1.4 PLANIFICATION

See the provisional schedule attached to this requirement (cf. exhibit n°0.04).

1.5 TERMS AND CONDITIONS

See consultation regulations (cf. exhibit n°0.01).

1.6 REQUIREMENT DESCRIPTION

Glossary of CRITICITIES:

- REGulatory rules / PV classification → REG.
- IMperative / MAndatory (Intangible according to the public procurement code) → IM/MA
- Optional Part → OP
- Acceptance according to Qualification Protocol Framework (QI / QO / QP) → QUALIF
- WISHES (Tangible according to public contracts rules) → WIS
- For Information → FI.

X-TITLE DETAILED REQUIREMENT		
ITEM	TITLE Description	CRITICITY
1-ACTIVITIES		
1.01	SPECIES TYPOLOGY Nursing and dairy cattle from 100 to 900 kg.	IM/MA
1.02	USE Each of these rooms will be housing a single large ruminant. This new facility is designed to accommodate one bovine per room for short-term stays, following established protocols. Cycles duration of stalling can vary in length (continuous 24/24H) from 4 to 14 days. Global annual accommodation is 9 months average.	IM/MA IM/MA IM/MA

	<p>The occupancy of each enclosure is independent / simultaneous occupancy can be 2, 3 or 4 rooms.</p> <p>There can be only one room in test/control procedure.</p>	<p>IM/MA</p> <p>FI</p>
1.03	<p>DIMENSIONAL & TECHNICAL CHARACTERISTICS (for each speaker)</p> <p><u>Installation in room CH4 :</u> See Master plan in appendix to file part n°2.02.</p> <p><u>Size internal dimensions :</u> See Master plan in appendix to file, part n°1.14. Minimum clear interior ceiling height → 2,40 m.</p> <p><u>Design layout :</u> Inside each room, a walkway around the animal's restraint area will be provided, with a minimum width of 0,60m. There must be at least one passageway of 0,60 wide between the feed trough and the door side zootechnician</p> <p><u>Clearance dimensions of door : Animal-side :</u> Minimum clear width → 160 cm. Minimum clear height → 220 cm. Opening technology → reinforced leaf with air-tightness 180° opening. Adaptation with the concrete level differences according to 3D level difference's part n°2.09.</p> <p><u>Clearance dimension s of door :zootechnician side :</u> Minimum width → depending on trough dimensions/handling. Minimum clearance → 210 cm. Opening technology → with reinforced leaf with air-tightness. Opening angle 120° minimum.</p>	<p>IM/MA</p> <p>IM/MA</p> <p>IM/MA</p> <p>IM/MA</p> <p>IM/MA</p> <p>IM/MA</p> <p>IM/MA</p> <p>IM/MA</p> <p>IM/MA</p> <p>IM/MA</p> <p>IM/MA</p>
1.04	<p>DESIGN REQUIREMENTS (Constructive features)</p> <p><u>Partitions / ceilings / doors / glazing :</u> Waterproof → maintains ambient (depressurization gradient). Finishes → Smooth, easy-to wash. Rot-proof / non-releasing. Hot-cleanable at 50°C+ disinfectant / diluted detergent. Dismountable / Repairable. Chemical resistance: <ul style="list-style-type: none"> ➤ Resistance to urine. ➤ Product pH range: 2 à 12. </p> <p><u>Floors :</u> Floor finish → Epoxy resin. Slip index R12 / PTV 36+. Ruminant bedding → carpet supplied by INRAE.</p> <p><u>Glazing :</u> Each room must have a maximum amount of glazing for external observation and animal welfare. Particular attention will be paid to ensuring that experimental animals can see each other between rooms. Each room will have a minimum of 2 windows. They will take into account the risks of possible shocks.</p> <p><u>Doors :</u> Reinforced airtightness <50m³/h at 15Pa.</p> <p><u>Terminal devices :</u> Semi-recessed only for sockets and recessed for lights and air vents for easy cleaning.</p> <p><u>Ceiling accessibility :</u> Walkable ceiling with overload of 125kg/m².</p>	<p>IM/MA</p> <p>IM/MA</p> <p>IM/MA</p> <p>IM/MA</p> <p>WIS</p> <p>IM/MA</p> <p>WIS</p> <p>IM/MA</p> <p>FI</p> <p>IM/MA</p> <p>IM/MA</p> <p>QUALIF</p> <p>IM/MA</p> <p>IM/MA</p>

1.05	<p>REQUIRED AMBIENT CONDITIONS</p> <p>See PHYSCHOMETRIC TABLE THI part n°1.11.</p> <p><u>Temperature:</u></p> <ul style="list-style-type: none"> • <u>Temperature range</u> : between +10 and +35°Celsius ; • <u>Accuracy température</u> : +/- 1°C ; • <u>Homogeneous</u>: +/-1°C. <p><u>Hygrometry :</u></p> <ul style="list-style-type: none"> • <u>Humidity range</u> : between 35 and 75% ; • <u>Humidity accuracy</u> : +/-5% ; • <u>Homogeneous</u> : +/-3%. <p><u>Water weight :</u></p> <ul style="list-style-type: none"> • <u>Water weight range</u> : between 5.4 and 20.8 g/kgas measured at chamber air intake and outlet (like ammonia, to prevent passage over cold batteries) ; • <u>Measurement sensitivity/repeatability</u> : < 0.1 g ; • <u>Device response time</u> : < 10 min. <p><u>TCI Thermal comfort indicator</u> : Animals should within the values given in the table in the FDS chapter on HVAC chapter .</p> <p><u>Maximum permissible CO2 concentration</u>: 5000 ppm in qualification and 3000 ppm in normal operation.</p> <p><u>Pressure</u>: -15 Pa +/-5 (delta with CH4 room to allow 100% recovery of gases emitted into the room).</p> <p><u>Incoming air filtration</u> : G4 (90% efficiency on 10µm particles) / F7 efficiency.</p> <p><u>Particle control</u> : Not applicable.</p> <p><u>Operating mode</u>: 100% fresh air.</p> <p><u>Dimmable illuminance</u>: 0 to 400 Lux / T°C 4000K / DALI function (adjustable) / programmable NYCTHEMERAL CYCLE.</p> <p><u>Noise level</u>: below NR 50 in the chamber under maximum brewing conditions.</p> <p><u>Vibration</u>: To be avoided as harmful.</p> <p><u>Acoustics</u>: Interior walls that can be cleaned and decontaminated should minimize interior noise reverberation wherever possible.</p>	<p>QUALIF QUALIF QUALIF</p> <p>QUALIF QUALIF QUALIF</p> <p>QUALIF QUALIF QUALIF</p> <p>QUALIF</p> <p>QUALIF</p> <p>QUALIF</p> <p>IM/MA</p> <p>IM/MA</p> <p>QUALIF</p> <p>QUALIF</p> <p>WIS</p> <p>WIS</p>
1.06	<p>INTERNAL FITTINGS & EQUIPMENT</p> <p><u>Cow's drinkingtrough :</u> Quantity: 1 per room. Characteristics: See general specification § 3.1. Each drinking trough will be continuously recording water's consumption .</p> <p><u>Feeding troughs with load cells:</u> Quantity : <ul style="list-style-type: none"> • 1 per room; • 1 additional per room (Optional Part.) Features: See général specification § 3.1. Each trough will be continuously weighed record ingestion kinetics. will be recorded.</p> <p><u>Internal protective barriers :</u> Quantity : <ul style="list-style-type: none"> - 1 on each side of the belt. Type: See general specification § 3.1.</p>	<p>IM/MA IM/MA QUALIF</p> <p>IM/MA OP 02 IM/MA QUALIF</p> <p>IM/MA IM/MA</p>

	<p>They allow passage and protection for the operator and facilitate animal entrance.</p> <p><u>Animal alter system :</u> A system for restraining the animal (chains/halters allowing freedom of movement and securing people and property) will be supplied. The sturdiness of the anchoring must be considered.</p> <p><u>Faeces collection tray :</u> Quantity: 1 set of 2 bins per room. Type : See general specification § 3.1. Siphon at bottom of pit (out of scope). They will allow faeces to be collected directly outside for weighing and analysis. A removable stainless-steel grating above the faeces trays supports the load of an animal will be provided.</p> <p><u>Vacuum connection for milking jar:</u> 1 smooth-ended manual tap per room, connected by flexible hose from the mains, position to be validated in the volume. Milking jar supplied by INRAE.</p> <p><u>Voice Data Images :</u> 2 RJ45 PC sockets are required per enclosure (in front and behind the animal). 1 camera with sound recording is required per enclosure for remote behavior monitoring (on additional RJ45 POE socket). A total of 3 RJ 45 surface-mounted sockets. Accepted video format : ✓ MP4 demultiplexer ; ✓ MPEG demultiplexer ; ✓ H264/AVC video decoder ; ✓ MPEG-2 video decoder ; ✓ MPEG-4 video decoder ; ✓ AAC audio decoder. 1 loudspeaker is required for individual sound distribution from PCs supervision.</p>	IM/MA IM/MA IM/MA IM/MA FI FI IM/MA IM/MA FI IM/MA IM/MA IM/MA WIS WIS WIS WIS WIS WIS IM/MA																				
1.07	<p>GAZ ANALYZERS</p> <p>Quantity: There will be 2 (common to the 4 rooms) and purpose in Optional Part as follows :</p> <ul style="list-style-type: none">Analyzer 1 (Animal).Analyzer 2 (Animal and Effluent). <p>Special features: See general specification § 3.1. Each gas analyzer meets the following requirements:</p> <p>1- <u>Analyzer 1 (Animal)</u></p> <table><thead><tr><th>Gases OP be analyzed</th><th>Measurement range</th><th>Measurement sensitivity /repeatability</th><th>Device response time</th></tr></thead><tbody><tr><td>CO2 =carbon dioxide</td><td>0-10000 ppm</td><td>1 ppm</td><td>1 min for 90% of gap 500-3000 ppm</td></tr><tr><td>CH4= Methane</td><td>100-1000 ppm</td><td>0,3 ppm (or <1% : 30 ppm à 1000 ppm)</td><td>1 min for 90% of gap 1-10 ppm</td></tr></tbody></table> <p>2- <u>Analyzer 2 (Animal and Effluent)</u></p> <table><thead><tr><th>Gaz à analyser</th><th>Measurement range</th><th>Measurement sensitivity /repeatability</th><th>Device response time</th></tr></thead><tbody><tr><td>CH4= Méthane</td><td>0-100 ppm</td><td>10 ppb</td><td></td></tr></tbody></table>	Gases OP be analyzed	Measurement range	Measurement sensitivity /repeatability	Device response time	CO2 =carbon dioxide	0-10000 ppm	1 ppm	1 min for 90% of gap 500-3000 ppm	CH4= Methane	100-1000 ppm	0,3 ppm (or <1% : 30 ppm à 1000 ppm)	1 min for 90% of gap 1-10 ppm	Gaz à analyser	Measurement range	Measurement sensitivity /repeatability	Device response time	CH4= Méthane	0-100 ppm	10 ppb		IM/OB OP 01 IM/MA IM/MA /QUALIF
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	<table><tr><td>O2=Oxygen</td><td>0-25%</td><td>0,0025 % (ce qui correspond à 100 ppm de gradient de CO2)</td><td></td></tr><tr><td>H2= Hydrogen</td><td>0-0.5 %</td><td></td><td></td></tr><tr><td>NH3= Ammonia</td><td>0-50 ppm</td><td>1 ppb</td><td>< 20 min</td></tr><tr><td>N2O=Nitrogen</td><td>0-50 ppm</td><td>1 ppb</td><td>< 20 min</td></tr></table>	O2=Oxygen	0-25%	0,0025 % (ce qui correspond à 100 ppm de gradient de CO2)		H2= Hydrogen	0-0.5 %			NH3= Ammonia	0-50 ppm	1 ppb	< 20 min	N2O=Nitrogen	0-50 ppm	1 ppb	< 20 min	
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1.08	FOOD PARAMETERS <ul style="list-style-type: none"><u>Dynamic measurement of water intake quantities</u> : By totalizing flowmeter Accuracy of measurements 1% / Time- stamping.<u>Dynamic measurement of food intake:</u> Weighing scales or weighing trays, range 0/100kg, accuracy 0.5% / Time- stamping.	QUALIF QUALIF																
2-QUALITY ASSURANCE																		
2.01	SUPERVISION /MONITORING AMBIENT CONDITIONS Data integration. Page screen architecture for data on gas analysis, ambient monitoring, VDI, food parameters. Audit trail → following 21CFR part 11. SCADA type supervision. Terminal under WINDOWS.	IM/MA IM/MA IM/MA WIS QUALIF																
2.02	RECORDING / BACKUP (raw data) Capacity / autonomy 72H min. in buffer memory on analyzer alone. UPS to be provided by supplier for continuity of measurements.	IM/MA IM/MA																
2.03	PROBE/SENSOR CALIBRATION Factory calibration before on start-up commissioning or on user request.	QUALIF																
2.04	SERVICE CONTINUITY Site Power generator with manual reset (effective restart 1h30 after shutdown).	FI																
2.05	CONTROL ACCESS Room CH4 only (out of scope) Provide contacts on all doors (2 contacts per room) with monitoring/alarm status report.	FI QUALIF																
2.06	MATERIALS The use of wood or wood derivatives is prohibited. Promote the use of stainless-steel materials.	IM/MA WIS																
3-ASPECT HSE																		
3.01	FIRE HAZARD No detection in the enclosures Action on fire detection in room CH4 : <ul style="list-style-type: none">Stop ventilation room CH4→ natural ventilation by triggering opening smoke extraction Skydome + manual opening of access door exterior.Shut down ventilation of each enclosure and vent to open air automated.	FI FI IM/MA /QUALIF																

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3.02	ANOXIA RISK CO2 concentration detector in the environment of each enclosure+ detection on socket (external pollution control). Action on individual CO2 detection: <ul style="list-style-type: none"> > 3000 ppm → visual and audible alarm. > 5000 ppm → Central shutdown, automatic natural ventilation of the enclosure and open the vents to create a natural air flow. Scale or limits can be modified only under login 	IM/MA IM/MA IM/MA WIS
3.03	CHEMICAL CORROSION RESISTANCE Resistant to animal excrement splashes (urine, faeces). Resistant to cleaning solutions with diluted detergent/disinfectant. Resistant to cleaning solutions with max. T°C of 70°C.	IM/MA IM/MA IM/MA
3.04	AIR/WATER/WASTE POLLUTION RISK No particular risk identified.	FI
3.05	WORKSTATION / ERGONOMICS POSTURES No threshold for faeces trays, part no. 1.13. All human intervention on components, removable materials and equipment must comply with the requirements of the French Labour Code.	IM/MA REG
3.06	VOC RANKING Avoid any material that could affect gas measurements. Use class A+ materials (e.g. silicone) wherever possible.	IM/MA IM/MA
3.07	PERSONAL SAFETY The interior layout of the room must allow personnel to evacuate and/or emergency services to enter. Outward-opening door for emergency exit. A standardized guardrail will prevent any risk of falling at the ceiling limit of the rooms and on all elevated access points, in compliance with the French Labour Code. Circulation around animals in each room.	IM/MA IM/MA REG IM/MA
3.08	SITE SAFETY The project will be subject to a safety plan (see Exhibit 1.05) drawn up by the Group between INRAE and the contractor. The requirements of this plan will be submitted to all those working on site, including contractors and subcontractors. INRAE reserves the right to appoint a Health and Safety Manager , in which case the company's work will be subject to these requirements .	REG REG
4- MAINTENANCE ASPECT		
4.01	ACCESS TO LOCAL CEILING Once accessible, all ceilings must be "walkable" with a minimum overload of 125kg/m². Access must be provided under normal safety conditions.	IM/MA IM/MA
4.02	ORIGIN OF MATERIALS All supplies must be CE marked or equivalent.	WIS
4.03	EQUIPMENT ACCESSIBILITY All sensors, regulators, filters and motors must be accessible under normal safety and/or handling conditions. The design must include provision for maintenance operations outside the speakers whenever possible.	IM/MA IM/MA
4.04	MAINTENANCE /ASS (AFTER SALES SERVICE List of components and/or consumables maintenance, wear and tear, and critical repairs will have to be established, planned and estimated. All operating, maintenance and troubleshooting instructions will be in French.	IM/MA IM/MA

2. BASIC FUNCTIONAL ANALYSIS

2.1 BASIC DATA

2.1.1 Site climatic conditions

- ✓ Altitude : 851m.
- ✓ Wind: Region 2 - Terrain category IIIb (according to Eurocode 1).
- ✓ Snow classification: Region A2 altitude 850 m (according to Eurocode 1).
- ✓ Wind/rain concordance: Zone III.
- ✓ Earthquake: seismic zone 3 moderate hazard.
- ✓ Reference outdoor temperatures: -7°C in winter / +32°C in summer.

2.1.2 Climatic conditions room CH4

- ✓ Temperature : 18°C+/-3 %.
- ✓ Humidity : < 90% HR (uncontrolled).

2.1.3 reference values

Table 6 – Livestock Buildings – Mass Flow Rate of Water Vapor and Carbon Dioxide and Heat Flux

Colonne	1	2	3	4	5	6	7	8
Ligne			En hiver					En été, à θ_i 30 °C
	Masse de l'animal individuel	Production laitière chez les vaches	Température ambiante (valeur calculée)	humidité relative de l'air (valeur calculée)	Débit massique de vapeur d'eau	Flux massique de dioxyde de carbone	Courant de chaleur sensible	Courant de chaleur sensible
	m kg	kg/an	θ_i °C	ϕ_i %	\dot{M}_{ST} g h ⁻¹	\dot{K}_{ST} g h ⁻¹	$\dot{\Phi}_{ST,W}$ W	$\dot{\Phi}_{ST,S}$ W
	Veaux à l'engrais							
1	60		18	70	135,0	67,4	126,2	118,8
2	90		17	80	162,4	84,3	161,2	151,3
3	120		16	80	185,7	100,0	195,2	182,6
4	150		16	80	212,1	114,3	223,0	208,6
	Bovins à l'engrais							
5	150		16	80	212,1	114,3	223,0	208,6
6	200		16	80	264,4	142,5	277,9	260,0
7	300		16	80	343,7	185,2	361,3	338,0
8	400		14	80	427,0	290,8	498,4	463,4
9	500		12	80	473,6	344,6	606,2	560,2
10	600		10	80	515,5	398,1	714,2	656,0
11	700		10	80	576,2	445,0	798,3	733,3
12	800		10	80	635,3	490,7	880,2	808,6
	Élevage de veaux (descendance)							
13	30		20	70	82,1	37,8	67,4	63,9
14	45		19	70	95,6	45,8	83,8	79,2
15	60		18	70	106,8	53,3	99,8	94,0
	Génisses (jeunes femelles)							
16	350		14	80	331,4	191,8	386,8	359,6
17	400		14	80	360,7	208,9	421,1	391,5
18	450		12	80	369,7	228,7	473,2	437,4
19	500		10	80	378,8	248,6	524,7	482,0
	Vaches laitières							
20	400	6 000	14	80	521,5	355,2	608,8	566,0
21	450	6 000	12	80	519,7	378,2	665,2	614,8
22	500	6 000	12	80	543,4	395,5	695,6	642,8
23	500	8 000	12	80	612,9	446,0	784,5	725,0
24	600	8 000	12	80	658,6	479,3	843,0	779,1
25	700	8 000	12	80	702,4	511,2	899,1	830,9
26	500	10 000	12	80	682,4	496,6	873,5	807,2
27	600	10 000	12	80	728,1	529,9	932,0	861,3
28	700	10 000	12	80	771,9	561,7	988,0	913,1
29	500	12 000	12	80	751,9	547,2	962,4	889,4
30	600	12 000	12	80	797,6	580,4	1 020,9	943,5
31	700	12 000	12	80	841,4	612,3	1 077,0	995,3
	Taureaux reproducteurs							
32	500		12	80	334,0	243,1	427,6	395,1
33	750		12	80	452,8	329,5	579,5	535,6
34	1 000		12	80	561,8	408,8	719,1	664,6

Table taken from DIN 18910 AOUT 2024 Thermal insulation of closed livestock buildings - Thermal insulation and ventilation - Planning and calculation basis for closed, forced-ventilated barns.

2.1.4 Climatic reference conditions for METABOLIC ROOM

2.1.4.1 Limiting outdoor climatic parameters

The maximum reference temperatures and humidity outside the building are as follows:

	Temperature	Relative humidity	Water weight
Winter	-10°C	100 %HR	1,6 g/kgas
Summer	40°C	30 %HR	13,9 g/kgas

2.1.4.2 Limit indoor climatic parameters

The maximum reference temperatures and humidity **outside the building** are as follows:

	Temperature	Relative humidity
Mini	10°C	35 %HR
Maxi	35°C	75 %HR

The initial **reference climate field** is shown in the psychrometric diagram on page 17.

2.1.4.3 Adjustment of reference climate domain

Influence du THI

INRAE would like to vary climatic conditions in order study the consequences of more or less moderate stress on animals following the Thermal Comfort Indicator (THI).

The aim is to avoid climatic conditions that could lead to the death of the animal, so the THI must remain in place. strictly less than value 84.

Consequently, **the reference climatic range** must be limited so that at no time does the THI reach or exceed the value :

THI limit value before death of the
animal

84

See the THI=84 curve on the psychrometric diagram on the following page and the resulting exclusion zone on the initial **reference climate field**.

Influence of dehumidification method

For economic reasons, it was decided to dehumidify the air entering the chamber using a condensing system on hydraulic cold coils. To achieve the required minimum air temperature point of 10°C (75%RH), dehumidification must be lowered as much as possible (floor water weight). The low temperature of cold-water network is set at +2°C, because at a lower temperature, there's a risk of frosting the cold coil and obstructing the air stream. This is a physical limit.

At this cooling water temperature, the temperature of air stream is assumed to be attainable given the

The heat exchanger's pinch point is at least +5°C at saturation (100%RH), which means floor water weight of :

Floor water weight due to
dehumidification method

5,4 g/kgas (dry air)

The straight line of this water shown on the psychrometric diagram on page 16 defines a new zone of exclusion from the initial **reference climate field**.

Conclusion

The **reference climatic range** for the ambient atmosphere of each enclosure will be delimited by the following 6 points :

Reference Area	Temperature	Hygrometry Relative	Water weight
	10°C	71 %HR	5,4 g/kgas
	21°C	35% HR	5,4 g/kgas
	35°C	35 %HR	12,3 g/kgas
	35°C	43 %HR	15,2 g/kgas
	30,5°C	75 %HR	20,8 g/kgas
	10°C	75 %HR	5,7 g/kgas

It is divided into three distinct zones according to the THI index:

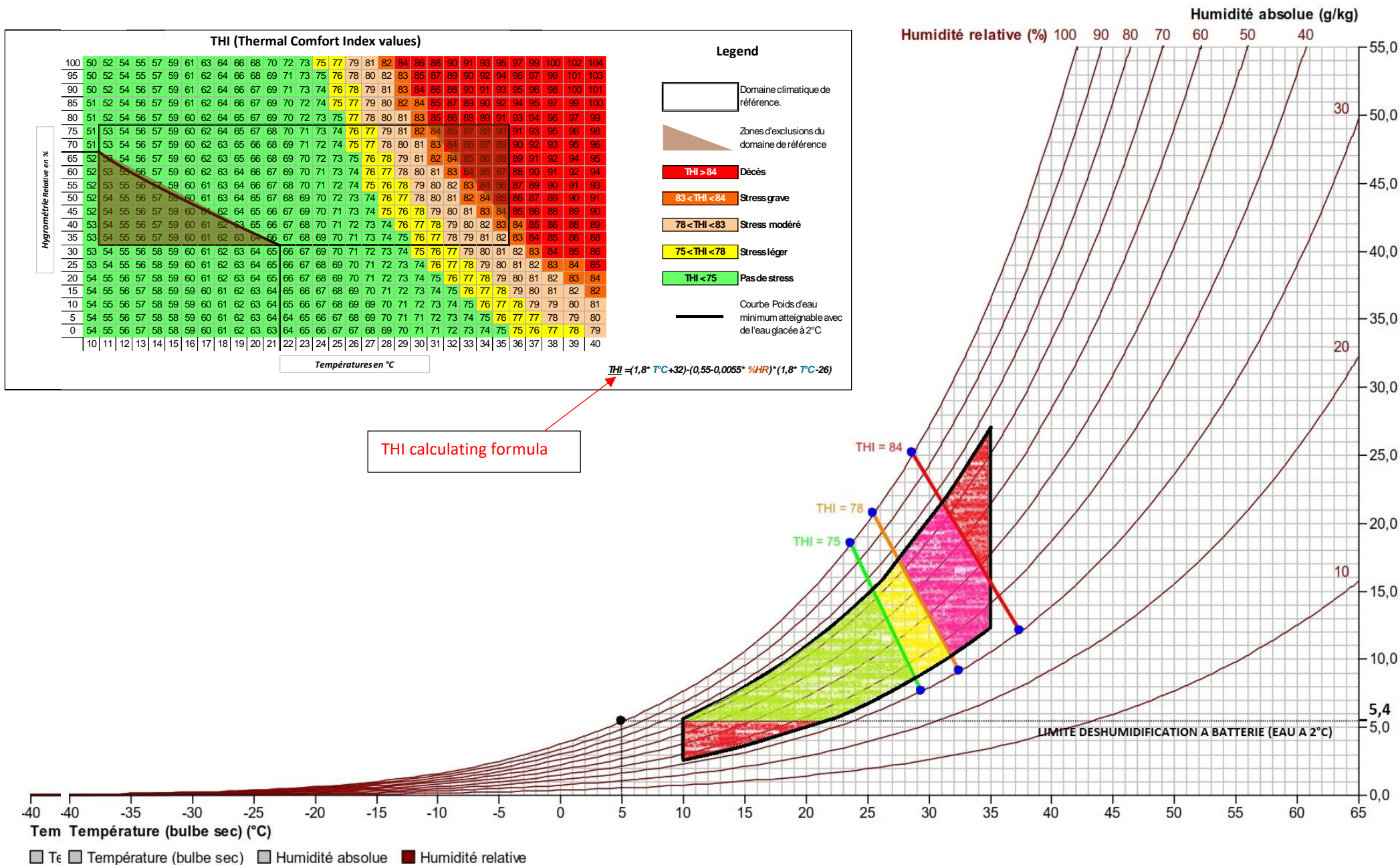
- ✓ A stress-free zone for the animal with a THI of less than 75.
- ✓ An area with light stress for $75 < \text{THI} < 78$.
- ✓ An area with moderate stress for $78 < \text{THI} < 83$.

The purpose of treating fresh air blown into the enclosure is:

1. Guarantee an ambient atmosphere within the defined range.
2. To be able to vary climatic parameters at will in this same area.

In view of these objectives, atmosphere in the metabolic room must be controlled by two means parameters:

- ✓ Either the THI with the desired temperature.
- ✓ Either the THI with desired relative humidity.



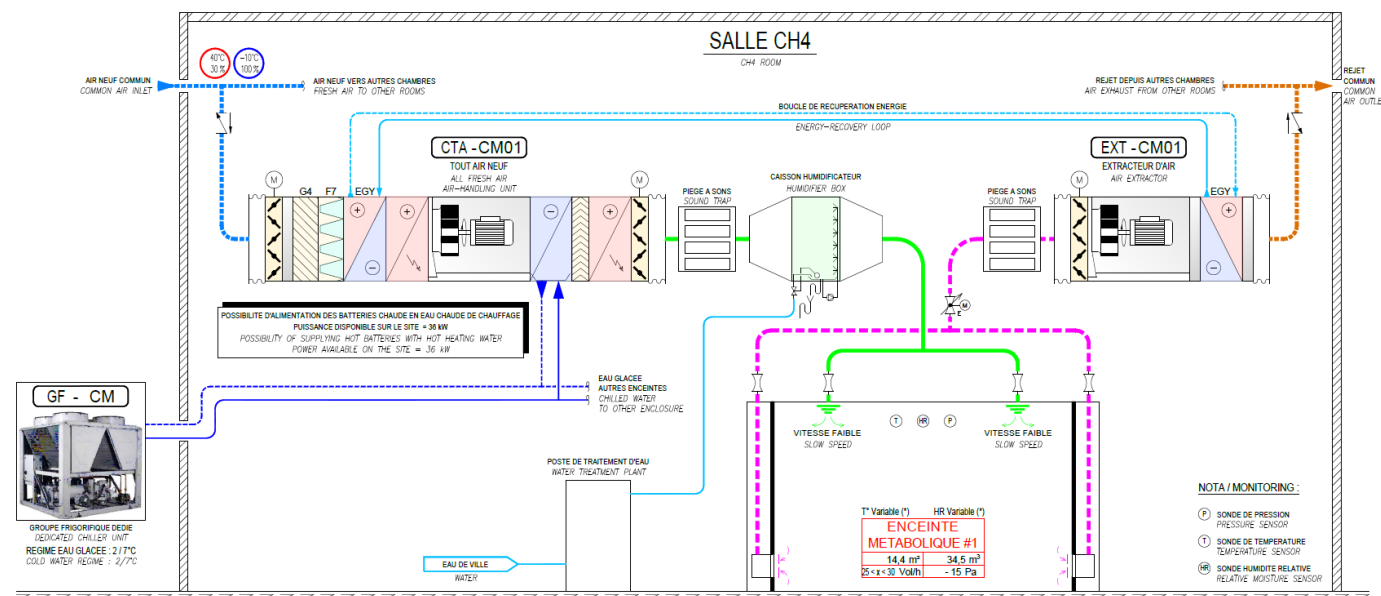
2.2 RUNNING

2.2.1 Preamble

The installation must be all fresh air, and the required ambiances can be programmed specifically for each enclosure.

2.2.2 Installation principle

PID diagram of the ventilation guide, part no. 1.09, summarizes the desired functional principles.



Extract from part no. 1.09 PID diagram of guide ventilations

2.2.3 Running modes

2.2.3.1 Normal mode

Normal operation" means the following:

- ✓ Independent room control for each of the 4 rooms ;
- ✓ Unit ventilation shutdown outside experimentation ;
- ✓ Monitoring indicators on lighting columns (2 per room above doors +1 synthesis in room CH4) :
 - Green: Conditions within expected range,
 - Orange: Limits (min/max) exceeded,
 - Red : Installation stop / safety devices active,
 - Off : out of order.

Safety

- ✓ Power supply to generator set on site outside the scope of this contract.

Safety features

- ✓ Ventilation stop on SSI detection (from room CH4) / Vent function
- ✓ FIRE FIGHTER stop on cut-off action
- ✓ Ventilation stop when THI setpoints exceeded
- ✓ Ventilation stop on 2nd high level CO2 concentration → Air inlet opening/ air vent function
- ✓ Stop ENCEINTES on proximity Emergency Bottom → audible alarm
- ✓ Stop on outdoor temperature thermostat to prevent batteries from freezing

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2.2.3.2 Maintenance mode

The maintenance mode will individually access all or part of the equipment, sensors and installation. It will be operated in a non-experimental mode.

This mode inhibits the aerodynamic drives to enable analyzer's calibration phase an increase in CO2 concentration above threshold levels.

2.3 BUSINESS CONTINUITY

2.3.1 Emergency

In the event of a power cut, a power generator (site) will take over. Switchover and return to normal will be tested.

However, the supply and connection of a general inverter is included in the present contract. This must ensure continuity of service (including data logging) and security for a minimum of 4 hours:

- ✓ Maintain program / control / indicator / alarm functions.
- ✓ Maintaining monitoring and analyzers.
- ✓ Lighting maintenance ;
- ✓ Maintain drinking water flowmeter.
- ✓ Maintain CO2 detection.
- ✓ Maintain drives/ operating doors.

2.4 AIR

2.4.1 Interface with existing installation

Input/output will consider the planned environment in room CH4.

2.4.2 Air diffusion

Under no circumstances should air velocity at discharge generate hot or cold draughts that are detrimental to the animals' comfort during prolonged stabling (<1m/s in all cases).

All fans will be installed with frequency inverters to enable flow/pressure adjustments. Particular attention will be paid to the **positioning of supply/return outlets:**

- ✓ Create a homogeneous ambience.
- ✓ Ensure efficient sweeping of the volume (minimized dead zones);
- ✓ Allow measurements to be taken at maximum value.

2.4.3 Heat production

Heating will be provided by the electrical batteries in the plant, under the required temperature conditions. The electrical power per enclosure will be specified. The contractor may, if he wishes, propose another source of energy, but all costs inherent in this proposal must be included in the bid.

In accordance with the PID note, and depending on the maximum calculated requirement, it will be possible to connect to an existing waiting area hot water heating system (uninterruptible power supply) in room CH4.

2.4.4 Cold production

It will be handled by a dedicated group enabling:

- ✓ Independent controls for each system, depending on requirements.
- ✓ Simultaneous operation of 1 to 4 rooms (25% to 100%);
- ✓ Maximum dehumidification capacity for THI maintenance according to programmed range.

It will be located on the ground outside (position to be validated with INRAE). If necessary, the installation will include shock protection.

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2.4.5 Hygrometry treatment

There will be one steam humidifier per enclosure. This will be combined with a common water treatment system to allow for any necessary adjustments. This installation will ensure that there is no risk of contamination of the insufflation air.

See raw water analysis, part 1.10, for water design.

2.4.6 Energy recovery

This recovery will enable the exchange of heat between the incoming fresh air and the exhaust air from each plant.

An energy recovery system is a prerequisite to minimize operating costs.

The proposed system will have a recovery rate of over 60% averaged over one year.

2.4.7 Monitoring

All ambient values are acquired via calibrated sensors independent of the control probes.

These values will be used to validate the experimentation.

The THI will be calculated according to the regulated formula shown at the foot of the legend on page 16.

2.4.8 Noise level

Sound traps will be installed to achieve the level of sound attenuation required to comply with required values.

2.5 GAS ANALYZER

2.5.1 Preamble

The installer will need to pay close attention to the analysis of new air coming from outside, but also from the CH₄ room. In fact, gas analysis in the chambers must be subtracted from the "background noise" coming from the air entering the chamber, or from negative pressure if there are leaks, to obtain the most accurate value possible for gas production by the animal.

It should be noted that the slurry pit under the barn is stirred 2 times a day, releasing a lot of odors into the barn and outside, and therefore potentially gases that could be analyzed as coming from the animals. Air flow prevailing winds should be considered to avoid any external pollution of the analysis.

2.5.2 Basic principle

The gas analyzers will be common to all 4 rooms and will also analyze the ambient air in the room housing the metabolic rooms, as well as fresh air from outside.

- ✓ The analyzers must have a minimum of 6 configurable channels or one channel capable of analyzing 6 gas inputs;
- ✓ They will operate at temperatures ranging from 10 to 40°C.
- ✓ A self-calibration would be appreciated by Users;
- ✓ The supplier will indicate the measurement mode(s) and associated technologies.
- ✓ The system, common to all enclosures, must allow measurements to be taken sequentially and according to the desired adjustable programming.
- ✓ It must indicate the times/frequencies per gas to ensure maximum measurement reliability/precision.
- ✓ The analyzers must be able to be coupled with a SCADA system for supervising the parameters of each metabolic chamber.

Gas and flow measurements should perform in 30-minutes cycles as follows:

Cycle start

- A *measurements at fresh air inlet for 5 minutes,*
- B *measurements taken in the room housing the metabolic chambers over a period of 5 minutes,*
- C *measurements chamber 1 for 5 minutes,*
- D *measurements chamber 2 for 5 minutes,*
- E *measurements chamber 3 for 5 minutes,*

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F measurements chamber 4 for 5 minutes,
End of cycle

It should be possible to independently modulate the number and order of channels, and the measurement time per channel, using simple, fast methods that are free of charge for the user.

Particular attention will be provided to:

- ✓ The guarantee in terms of power consumption, which must be as low as possible.
- ✓ Durability of materials and manufacturing techniques.
- ✓ Equipment service life.
- ✓ Upgrading equipment to support Windows operating systems, which are currently in the process of being rolled out, is a priority, constant evolution.

This equipment must be able to generate CSV files, according to the current CSV files given as an example in Exhibit 1.04.

2.5.3 Location

The system can be installed on a rack or in a cabinet, allowing easy access to all connections.
The system must be accessible via an IP address.

2.5.4 Auto-calibration

The supplier will indicate, if necessary, the purge and/or calibration gas requirements and their purity needed for the analysis.
Calibration frequencies and times are to be specified by the contractor.
Gas cylinders will be supplied by INRAE.
Automatic calibration of the various analyzer sensors would be appreciated

2.5.5 Recording

The system will store a minimum of 72 hours of raw data in the analyzer buffer.
This equipment must be able to generate a CSV file containing at least the fields indicated below:

Date Time
ANALYZER_FAULT
COOLING_GROUP_FAULT
CH4
CH4_raw_AA
CH4_raw_CHAMBER1
CH4_raw_CHAMBER2
CH4_raw_CHAMBER3
CH4_raw_CHAMBER4
Analyse_AA
Analyse_CHAMBER1
Analyse_CHAMBER2
Analyse_CHAMBER3
Analyse_CHAMBER4
CO2
CO2_raw_AA
CO2_raw_CHAMBER1
CO2_raw_CHAMBER2
CO2_raw_CHAMBER3
CO2_raw_CHAMBER4
FLOW_RAW_EXTRACTION_CHAMBER1
FLOW_RAW_EXTRACTION_CHAMBER2
FLOW_RAW_EXTRACTION_CHAMBER3
FLOW_RAW_EXTRACTION_CHAMBER4
TP_AIR_AMBIANT
TP_CHAMBER1
TP_CHAMBER2
TP_CHAMBER3
TP_CHAMBER4

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H2O_AIR_AMBIENT
 H2O_CHAMBER1
 H2O_CHAMBER2
 H2O_CHAMBER3
 H2O_CHAMBER4
 PRESSION_ATMOSPHERIC
 PRESSION_abs_CHAMBER1
 PRESSION_abs_CHAMBER2
 PRESSION_abs_CHAMBER3
 PRESSION_abs_CHAMBER4

2.5.6 Backup /archiving

Data backup and archiving will be automatic and will be handled by INRAE.

2.6 SUPERVISION

Supervision will be provided via a WINDOWS terminal package.

This package will include the server(s), acquisition software and an office PC with 20" screen.

The workstation supplied with this equipment will enable temporary storage of raw data, control applications, settings and parameters, as well as individual control of the 4 loudspeakers via a screen-based organization (to be proposed in the bid's technical brief, then validated during the execution phase).

The system must be accessible via an IP address.

This equipment must be able to generate the views shown below, for example see exhibit 1.08 and the extract below.



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2.7 POSTPONEMENTS/ALARMS

Technical alarm reports available on terminal blocks are :

- ✓ ELECTRICAL PANEL synthesis fault ;
- ✓ COLD GROUP synthesis fault ;
- ✓ Air handling unit synthesis faults according to enclosure;
- ✓ Open door faults according to enclosure.

Process alarm reports available are:

- ✓ Gas analyzer fault;
- ✓ Water supply fault ;
- ✓ Room monitoring fault.

Security alarm reports available are :


- ✓ Emergency stop ;
- ✓ CO2 concentration.

A communication interface will enable broadcasting and/or transfer to the various parties involved - users, on-call service, maintenance. Distribution and/or transfer is out of scope.

3. TECHNICAL SPECIFICATIONS

3.1 ROOM INSTALLATION

X-TITLE DETAILED ASPECT		
ITEM	TITLE Description	CRITICITY
5-ASPECT ENVELOPPE		
5.01	WALL/CEILING ENVELOPE They will be industrial modular panels. They will allow the integration of air distribution and other small equipment. All loudspeakers will be self-supporting, with no need to rebuild on upper structures. <u>General features :</u> <ul style="list-style-type: none"> ✓ Fire classification → M0. ✓ REI classification → NO RESEARCH ✓ Thermal conductivity → 0.041 W/m.K. ✓ Acoustic attenuation of enclosure → > 30dB(A). ✓ Minimum global leakage rate → < 30m³ /h sous 15Pa. The lower part of wall will be finished with skirting boards on the outside and flush with the resin floor, with a coved skirting board on the inside (height 10cm). To facilitate cleaning, angular fillets are provided at vertical and horizontal panel junctions.	WIS IM/MA IM/MA WIS WIS WIS WIS WIS IM/MA
5.02	GLASSES The glazing integrated into the panels will be flush with inside of the panels cells. They will be double, insulating, laminated, with STADIP PROTECT treatment in compliance with EN 356. In the Optional Part, integrated blinds will be proposed (for the following conditions different atmospheres)	IM/MA IM/MA OP 03
5.03	DOORS <u>Animal side</u> They will be of the hinged type or other technology; manual or controlled by CO2 detection for venting. The proposed solution is free to be chosen by the contractor; any different solution must be mentioned in the deviations section, part no. 1.03. 180° opening. The closure will allow a leakage rate of less than 2%, particularly when interfacing with a drip tray. A proximity contact is used to determine the status of each leaf of the doors. An oculus is required on each door at eye level, minimum dimensions 400x400 mm. A closing flap on the outside will provide privacy if required. <u>Note on the interface between the base and the door:</u> particular attention will be paid to the waterproofing treatment between door and trays , since as shown in Exhibit 2.09 the level of the threshold of this door will be lower than the level of the enclosure base to allow the exit of the enclosure's faeces tray positioned under the grating. <u>Zootechnician side</u> Dito animal-side door	QUALIF QUALIF IM/MA IM/MA OP 03 IM/MA DITO (Animal door)

5.04	CEILING It will be of the same design as the vertical panels to render seals the interior volume of the enclosure. It will allow the integration of air, lighting and other small functions equipment (e.g. CO2 sensors). Its design makes it walkable (see maintenance chapter).	QUALIF IM/MA IM/MA
5.05	INTEGRATION / EMBEDDING All penetrations must be watertight and sealed. finishing closure (interior / exterior). The use of silicone sealants must have a VOC rating of A+. Reservations greater than 100mm are factory-made and perfectly sealed.	IM/MA IM/MA WIS
6-ASPECT AMENAGEMENTS / EQUIPEMENTS		
6.01	DRINKING TROUGH <u>Type:</u> Anti-lapage F30A TUBE PO 3/4 LAITON in Cast iron or equivalent, see photo opposite. <u>They must meet the following minimum requirements:</u> <ul style="list-style-type: none"> ✓ Easy to clean; ✓ Sturdy mounting; ✓ Enabling the tracking of the water consumption (in liters) 	IM/MA IM/MA IM/MA IM/MA
6.02	FEEDING TROUGHS / WEIGHING LOAD CELLS AUGE <u>Type :</u> removable on wheels. <u>They will have the following characteristics:</u> <ul style="list-style-type: none"> ✓ Minimum dimensions: 105 x 55 x 40 (under passageway) see examples of troughs part n°1.07 ; ✓ Material: 304L stainless steel or other proposal ; ✓ Fast, secure gripping system; ✓ Mobility mode on wheels or other proposal ; ✓ Easy to clean ; ✓ Continuous weighing for monitoring feed consumption in kinetics. WEIGHING LOAD CELLS <u>Type :</u> fixed per rooms frame <u>They will have the following characteristics :</u> <ul style="list-style-type: none"> ✓ The location/position of the load cells will be proposed in relation to the trough transfer principle. The principle of fixed load cells at residence is desired. ✓ These weighing systems will be connected to the supervision system. ✓ The load cells will have a calibration certificate and must be calibrated before commissioning. 	IM/MA IM/MA IM/MA IM/MA IM/MA IM/MA IM/MA IM/MA IM/MA
6.03	INTERNAL PROTECTIVE BARRIERS <u>Type :</u> removable side panels <u>They will have the following characteristics:</u> <ul style="list-style-type: none"> ✓ Positioned on 3 sides: sides and front of the animal; ✓ Shaping for trough's introduction on the front of part; ✓ Material: 304L stainless steel tubular profiles. ✓ Dismantling design ; ✓ Adjustable spacing for animal infeed / outfeed guidance 	IM/MA IM/MA IM/MA IM/MA IM/MA

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6.04	<p>FEACES TRAYS</p> <p><u>Type</u> : removable trays on wheels</p> <p><u>They will have the following characteristics</u> :</p> <ul style="list-style-type: none"> ✓ Pit dimensions: 1.50 x 1.65 x height variable from 0.25 to 0.30 m ; ✓ Ergonomic handling to be considered (handles, etc.) retractable, hook/transfer support) ; ✓ Mobile / easily removable and washable / no floor threshold; ✓ Design according to 3D faeces trays as per part no. 1.13 ; ✓ Estimated weight of faeces+ urine to be recovered:> 80 kg /day; ✓ Non-corrosive materials with the following chemical resistances: <ul style="list-style-type: none"> ➤ Resistance to urine ; ➤ Product pH range : 2 to 12. 	IM/MA IM/MA IM/MA IM/MA IM/MA IM/MA IM/MA
6.05	<p>ON-LINE GAS ANALYZERS</p> <p><u>General features</u> :</p> <ul style="list-style-type: none"> ✓ Auto-calibration function ; ✓ Operating temperature: 10/40°C ; ✓ Ambient conditions → see HVAC section; ✓ Pressure regulation ; ✓ Integrated gas connections as per URS chapter requirements; ✓ ATEX (CH4/H2) ; ✓ CH4 and CO2 recovery rates from 97 to 103%; ✓ CE marking certification ; ✓ Minimum buffer capacity: 72h ; ✓ Degreasing of contact surfaces (suitable for measuring Oxygen) <p><u>Location</u> :</p> <ul style="list-style-type: none"> ✓ According to plan part n° 2.02 subject to recommendations suppliers. <p><u>Measuring</u> :</p> <ul style="list-style-type: none"> ✓ The material used for the measuring channels must be VOC-free (TEFLON). ✓ Perfect seal trough partition/ceiling <p><u>Performance</u> (to be completed by contractor) :</p> <ul style="list-style-type: none"> ✓ Measurement repeatability/linearity (FULL SCALE) ; ✓ Response time. <p><u>Audit trial on connections</u> :</p> <ul style="list-style-type: none"> ✓ Programming changes and system connections will be recorded (as per 21 CFR Part 11). <p><u>Connectivity interfaces</u> :</p> <ul style="list-style-type: none"> ✓ Data transmission via RJ45 ; ✓ USB port for local printer. 	IM/MA & OP 01 QUALIF QUALIF QUALIF QUALIF QUALIF QUALIF IM/MA QUALIF QUALIF WIS IM/MA IM/MA QUALIF QUALIF QUALIF QUALIF QUALIF
7-ASPECT HIGH/LOW VOLTAGE ELECTRICITY		
7.01	<p>SOCKETS</p> <p>A minimum of 4 sockets will be provided per room (2 per side), position to be validated during EXE STUDIES .</p> <p>They will be watertight IP 65 IK 08 with shutter, 240V 16A+T.</p>	WIS IM/MA
7.02	<p>NORMAL LIGHTING</p> <p>It will be fitted with extra-flat LED luminaires with recessed mounting, GROUP 0 to NF EN 62471, IP 65, T°C 4000 K. Their number will be specified in the offer, and their position will be validated by the EXE according to the lighting study.</p> <p>They will be of the DALI type (IEC 62386.) for intensity control.</p>	IM/MA IM/MA

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	<p>Individual nycthemeral cycle programming per enclosure will be included in the supervision.</p> <p>An external switch on the animal door side will allow forced lighting at a pre-programmed intensity.</p>	IM/MA
7.03	<p>EMERGENCY LIGHTING</p> <p>NO SUBJECT</p>	
7.04	<p>EARTHING</p> <p>All metallic parts of installation will be earthed as follows IEC 60364-5-54 requirements.</p> <p>Equipotentiality of earth with equipment is required</p>	REG REG
7.05	<p>ELECTRICAL CABINETS (all specialities)</p> <p>They must be made of lacquered plate metal Classification IP65 IK 08.</p> <p>It (or they) will include, as a minimum, switchgear, Emergency Bottom, indicators and fault indicators.</p> <p>Their locations will be proposed according to the wishes of the contractor and agreed by EXE studies in the CH4 room volume.</p>	REG IM/MA WIS
7.06	<p>CABLES / CABLE TRAYS</p> <p>They will meet standards.</p> <p>High and low voltage cable trays will be separate.</p> <p>They will be of the "CABLOFIL" type or similar, with a 30% reserve, and will not be covered.</p>	REG REG IM/MA
7.07	<p>CO2 DETECTION</p> <p>Each enclosure will have a CO2 measurement sensor, as well as one on the general air intake. They will be associated with a control / report unit connected to the supervision system.</p> <p>The probes will have calibration certificate and will have to be calibrated before the commissioning</p> <p>The location / position of the probes will be discussed during the EXE studies .</p>	IM/MA IM/MA IM/MA IM/MA
7.08	<p>DOOR MANAGEMENT</p> <p>Each room will be equipped with all locking and unlocking devices as well as leaf position detection on the 2 associated doors.</p> <p>They will be connected to the supervision system, enabling status and schedules to be tracked movements over the cycle.</p>	IM/MA IM/MA
7.09	<p>CAMERA</p> <p>Each room will be equipped with a wireless camera (or PEO) with a common 4-channel recording system offering FULL HD image quality, zoom, night vision and microphone.</p> <p>The system will need a free Smartphone application (iPhone / Android).</p> <p>Video surveillance management software will also be installed on the supervision system (live/recorded images).</p>	IM/MA IM/MA IM/MA
7.10	<p>SOUND BROADCASTING</p> <p>Each room will be equipped with an IP system loudspeaker (type HARMONYS from BODET or equivalent) with ringtones, calls, music diffusion, by manual triggering from the computer network or a smartphone.</p>	IM/MA
7.11	<p>VDI RJ45 NETWORK SOCKET</p> <p>Each enclosure will be fitted with 2 IP65 IK 08 waterproof RJ45 sockets (in front of and behind the animal) for connecting terminals such as PCs and recorders.</p> <p>Power cables and cores will be category 6A.</p> <p>All network outlets will be connected to the existing patch bay. The contractor will supply the cabling, connection via 19", frame mounting, multi-sockets including connectors, from the existing patch bay (see part no. 2.11).</p>	IM/MA IM/MA IM/MA

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	<p>All other network sockets for PC supervision / analyzer(s) / other equipment must also be considered.</p> <p>Validation with the INRAE IT department will be carried out.</p> <p>Installation acceptance testing is included.</p>	IM/MA
8-ASPECT HVAC		
8.01	<p>AIR CIRCULATION FROM EACH ROOM</p> <p>It will ensure homogeneous ambience such that "deviation over of 1°C" on mapping control points.</p> <p>Grids must be treated to prevent any risk of corrosion (in particular rework).</p> <p>To ensure the comfort and viability of the experiments, the following are not permitted preferential air affecting physiological well-being animals.</p>	<p>WIS</p> <p>IM/MA</p> <p>WIS</p>
8.02	<p>RESIDUAL NOISE LEVEL</p> <p>WISnd traps will be sized to meet the objectives noise level.</p>	IM/MA
8.03	<p>LIGHTING COLUMN</p> <p>Each loudspeaker will be fitted with a 3-colour lighting column to check the environmental status of each room (according to FDS) .</p> <p>They will be located above the animal-side door of each enclosure and at the control station level.</p>	<p>IM/MA</p> <p>WIS</p>
8.04	<p>COLD GROUP</p> <p>It will be equipped with 2 COMPRESSORS / 2 evaporator circuits providing 2/3 of rated power (back up).</p> <p>It will be selected with a GWP of less than 150 and will meet the requirements of development (F-Gas).</p> <p>An external chilled-water buffer tank allows for flexible and precise control avoid untimely cycle courses.</p>	<p>IM/MA</p> <p>WIS</p> <p>WIS</p>
8.05	<p>CTA</p> <p>They will be stand-alone by enclosure, from type all air new, with separate energy recovery box/compartiment.</p> <p>Their sizing and positioning will be the subject of a proposal requirements in terms of throughput, flexibility, accesibility and dimensional constraints of room CH4.</p> <p>Fresh air intake and distribution may be common to all AHUs.</p> <p>No particule class or air filtration requirements beyond that G4/F7 filtration. (Battery protection).</p> <p>The recovery motors will be frequency-controlled to adjust the flow.</p> <p>Corrosion-resistant battery (stainless steel will be provided.</p>	<p>IM/MA</p> <p>WIS</p> <p>IM/MA</p> <p>IM/MA</p> <p>IM/MA</p> <p>WIS</p>
8.06	<p>SUPPLY AIR DUCTS</p> <p><u>Blowing</u></p> <p>Permissible air speeds are 2m/s.</p> <p>Outlet speeds must be less than 1 m/s.</p> <p><u>Extract</u></p> <p>They must be resistant and long-lasting in the sometimes-harsh environments in which they are used aggressive.</p>	<p>IM/MA</p> <p>IM/MA</p> <p>IM/MA</p>
8.07	<p>CALORIFUGE</p> <p>General insulation such as kraft alu+ M0 insulation will prevent heat loss and will increase efficiency of the recovery system.</p>	IM/MA
8.08	<p>ADJUSTMENT/INSTRUMENTATION ACCESSORIES</p> <p>They will be carefully positioned to ensure easy access maintenance and metrology.</p> <p>All shutter motorizations and controllers should be selected from the rapid response ranges.</p>	<p>IM/MA</p> <p>WIS</p>

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8.09	ELECTRICAL CABINET Each enclosure will be electrically isolated independently of simultaneity/continuity of service. The choice of a cabinet for each enclosure or a general cabinet is left to the discretion of the installer.	IM/MA WIS
9- FLUIDS ASPECT		
9.01	DRINKING WATER It will be distributed in stainless steel tube (304L) from the specific waiting area in room CH4. Before connecting to the drinking trough, each enclosure will be fitted with a flowmeter/totalizer to collect the following information: <ul style="list-style-type: none"> ✓ Water flow and timestamp display. ✓ Global daily consumption. All this data will be sent to the supervision system Location: to be confirmed by EXE studies. The contractor will provide for the possibility of isolating trough in the event of a leak or malfunction.	IM/MA IM/MA IM/MA IM/MA IM/MA
9.02	COLD/HOT SANITARY WATER They will be distributed in stainless steel tube (304L) from the specific waits in room CH4. Each room will be fitted with a stainless-steel mixing valve for connecting hoses or a high-pressure cleaner. <u>Location</u> : to be confirmed by EXE studies.	IM/MA IM/MA IM/MA
9.03	WATER FOR STEAM AIR HUMIDIFICATION Depending on the nature of the domestic cold water (see analysis appended as Exhibit 1.10), the appropriate treatment will be provided to supply the dedicated humidifiers with the programmed ambient humidity values for each of the metabolic chambers. The supplier will ensure that the hardness and purity characteristics are compatible with the steam generators and fogging ramp associated with each of the enclosure AHUs, and with maintaining the sanitary status of the animals housed. In the technical brief, the supplier must specify the equipment provided for in the water treatment / steam production. <u>Location</u> : To be determined in accordance with maximum distance requirements between equipment, connection points, and water/condensate discharge points on waits provided in room CH4 (see parts no. 2.04 and 2.05).	IM/MA IM/MA IM/MA IM/MA
9.04	DRAIN EVACUATIONS The contractor will be responsible for the installation of all drip trays, pots, overhead drainage systems and condensate recovery systems. All requirements will be collected and brought back to the existing waits in room CH4.	IM/MA IM/MA
9.06	VACUUM TRANSFER Vacuum production and 2 waits in CH4 room will be provided by INRAE Service pressure 300 mbar DN25.	FI

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	From these expectations, a distribution network with manual valves DN20 inox304L at the point use (1 per enclosure) will be supplied and installed under present lot (positions to be seen in EXE studies).	IM/MA
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3.2 INSTALLATION SPECIFICATIONS

3.2.1 GENERAL IMPLEMENTATION RULES

3.2.1.1 Load transfer on existing structure

The roof and framework of the CH4 room volume do not allow permanent loads more than 5kg/m².

3.2.1.2 Locksmith

In the case of metal structures such as technical platforms, they will be of the mechanically welded type, with galvanized tubular sections. Peripheral fall protection will be provided by standardized galvanized guardrails.

At the very least, an aluminum climbing ladder will be provided for access to each platform(s).

3.2.1.3 Heating Ventilation Air Conditioning

The fresh air intakes and discharges will be laid out as shown on the plans and sections EXE Gros Œuvre de la salle CH4 pièce n°2.02. These have already been installed, see photo pièce n°2.10. No discharge will be closer than 10 meters from a fresh air intake.

The entire duct network will be accessible (inspection hatches) for maintenance, especially the return duct this.

The latter can be cleaned/disinfected if necessary.

Sheet metal thickness for all air-conditioning systems must not be less than 8/10.

3.2.1.4 Plumbing/fluids

All piping and associated fittings will be in 304L stainless steel. Supports and collars will be made of electro-galvanized steel outside the enclosure and stainless-steel inside (support every 1.00m for DN< to 15, every 1.5m for DN from 12 to 20, every 2.00m for DN >20 to 50.

Additional hot water lines will be insulated. All low points will be fitted with drain valves.

Each speaker can be isolated independently.

3.2.1.5 Electricity High current

All necessary cables (including brackets/fixings) will be provided (CABLOFIL type), without covers (not allowed).

All penetrations into enclosed spaces must **be sealed** silicone mastic

Ducting will only be authorized outside the enclosure volume.

3.2.1.6 Low-voltage electricity

The VDI network must meet the following requirements:

- ✓ Compliance with the standards EN50173 /EN50173/EN55022 and 802.3BT ;
- ✓ RJ45 sockets will be IP65 IK07 in the enclosures / IP55 in room CH4.
- ✓ The cabling will be CATEGORY 6A.
- ✓ This lot is responsible for acceptance testing.

3.2.2 GENERAL RULES FOR SPOTTING/LABELING

All components on the air, hydraulic and electrical networks must be marked and numbered in accordance with the drawings and diagrams drawn up in collaboration with INRAE.

Distribution directions and/or feeder quality in accordance with standardized colors will also be provided every 10m on each antenna and/or branch.

All statutory safety notices must also be installed.

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4. INTERFACES/PERFORMANCE LIMITS

4.1 SITE INTERFACES

4.1.1 *DELIVERY / STORAGE OF MATERIALS*

Packing/transport/unloading is the responsibility of the successful bidder.
On-site storage will be coordinated with INRAE so as not to interfere with site activities.
Appropriate transfer and handling equipment for assembly / installation is the responsibility of the contractor.

4.1.2 *WASTE MANAGEMENT*

All waste generated will be stored and evacuated by the contractor. Waste must be sorted according selective type (plastic/cardboard, wood, metal). The contractor must provide INRAE with all waste tracking slips, of all types, and hand over the site waste register at the end of the project. Exhibits 1.15.1 to 1.15.3 provide a classification table, a sample waste tracking slip and a sample waste register.

4.1.3 *LIFE SITE BUILDING*

INRAE will provide changing room/sanitary block and a catering room for site personnel (see PPIEE Exhibit 1.05).

4.2 ENERGY / UTILITIES

4.2.1 *EVACUATION / GROUND SHELTER*

All available channels, siphons and floor connections are shown on the structural drawings in part no. 2.04.

4.2.2 *ENERGY REQUIREMENTS*

4.2.2.1 *Fluids*

Flow/pressure/temperature requirements must be specified in the brief and compared with existing availability.

4.2.2.2 *High-voltage electricity*

The power available for entire installation is 80 kW.

4.2.2.3 *Low-voltage electricity*

FIRE CENTER → CATEGORY with type 1 alarm equipment.

BRASSAGE BAY → EXISTING bay see part no. 2.11. Bands and cores will be provided as required.

ALARM REPORTS → Via patch bay.

4.3 BENEFIT LIMITS

4.3.1 *VRD*

No interface a priori. The chiller base will be built directly by INRAE according to the contractor's recommendations.

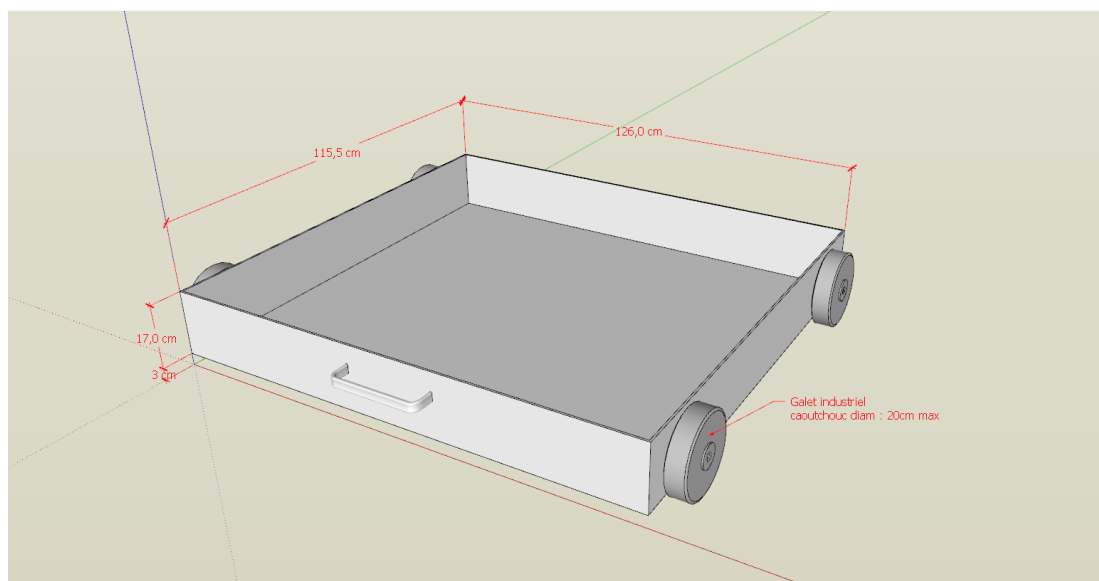
4.3.2 *STRUCTURAL WORKS*

Except for the exterior chiller block, where INRAE has laid a slab to anchor the chiller, no substantial work or modifications to the masonry inside the building should be required as part of the service. Should modifications prove necessary, they should be specified in the framework of the deviations, part no. 1.09 of a fine-tuning report (slopes, faeces tray reservations).

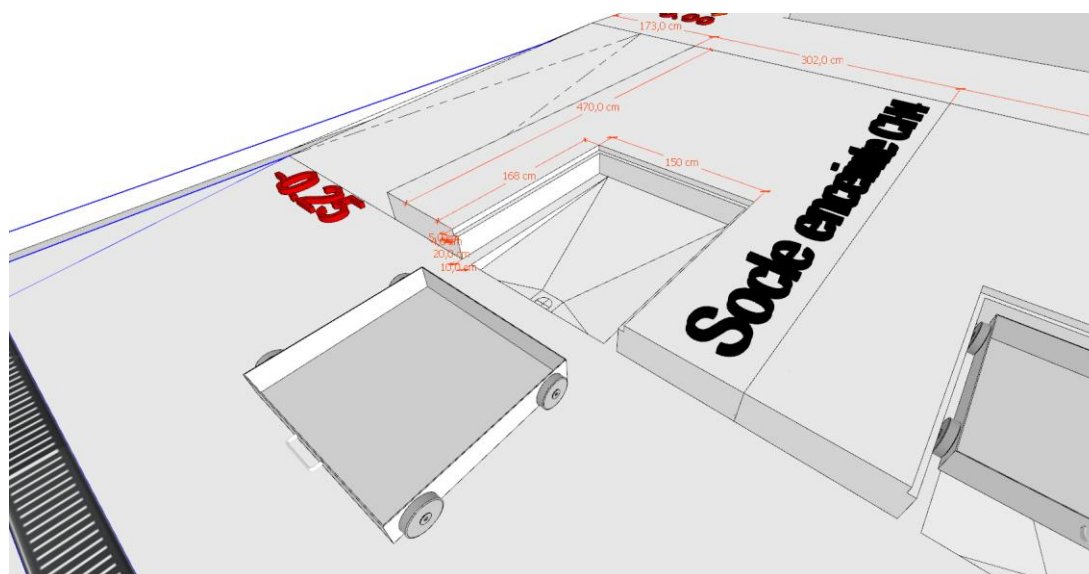
The quality of the flooring (flatness, finish) will be as observed during the site visit and will mainly be rough concrete with a float finish.

The operating live load of the CH4 slab is 1500kg/m². Overloads induced by the layout / organization of the installation must not generate massive reinforcements.

Faeces trays must fit into the spaces provided (see 3D below):



Faeces bin – Principle 3D modeling



3d modeling of the slab forming the base of the enclosures and the feces management pit

The tray can be compartmentalized to prevent spillage when being moved.
Any additional requirements must be specified in the table of deviations (Exhibit 1.03).

4.3.3 ENCLOSED BUILDING

4.3.3.1 PERMANENT LOAD TRANSFER

The existing structure of the building's framework and/or beams will not accept significant permanent loads > 25kg/m². Only fixings for ducts, pipes and cable trays are permitted.

4.3.3.2 ACCESS ROOM CH4

The clear passage available for the introduction of materials/handling equipment is 3.00 m wide x 3.00 m high (see exhibit no. 2.02).

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4.3.3.3 ZENITHAL LIGHTING/SMOKE CONTROL

The 4 skydomes must be left free of any obstruction, even partial (see part no. 2.01).

4.3.4 SECOND WORK

4.3.4.1 Floor coverings

Rough concrete floor.

4.3.4.2 Partitioning

Room CH4 will be lined with food-grade sandwich panels. All doors to the outside of room CH4 will be controlled by access. All networks in room CH4 will be visible.

The slope of the slab will be considered when installing the partitioning.

4.3.4.3 False ceiling

A ceiling will be installed between glued laminated wood beams and food-processing sandwich panels in the upper part of room CH4.

4.3.4.4 Painting/finishing

Not applicable.

4.3.5 PLUMBING FLUIDS

An empty network will be on standby in room CH4, as shown in drawing 2.05.

4.3.6 HVAC

Des percements de façades avec grille 950x950 ont été prédisposés sur 2 façades opposées permettant les raccordements des prises d'air neuf sur l'une et d'air rejeté sur l'autre. Voir positionnement suivant plan pièce n°2.04 et photo de la salle CH4 en construction pièce n°2.10.

4.4 ELECTRICITY

4.4.1.1 High current

The location of the LVBT is shown on drawings 2.01 and 2.02.

Grounding is available in the electrical distribution cabinet in room CH4.

4.4.1.2 Low voltage

The location of the patchbay is shown on drawings 2.01 and 2.02.

The fire station is located in another building, and there is only one distributor in the building, as shown on drawings 2.01 and 2.02.

A fire detection system is installed in room CH4.

4.5 OUT-OF-SCOPE EQUIPMENT

Below is a list of equipment and services not included in the project and/or provided by INRAE:

- Faeces / trough washing equipment;
- Additional cleaning equipment (karcher) ;
- Milking jar.
- Bedding carpet.
- Wet bench / hand wash CH4 room ;
- Neutral gas cylinders for calibration.

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5. COMMISSIONING

5.1 GENERAL CLEANING RULES

5.1.1 *HYDAULIC NETWORK CLEANING*

After leak/pressure test , all networks will be cleaned before commissioning.

5.1.2 *COLD WATER NETWORK DISINFECTION*

The network dedicated to animal watering will be disinfected and rinsed before being put into service.
This cleaning will be subject to potability control.

5.1.3 *AIR SYSTEM CLEANING*

The entire duct network will be accessible (inspection hatches) for maintenance, especially the return duct. This the latter can be cleaned/disinfected if necessary.

5.1.4 *SURFACE CLEANING*

All internal and external surfaces of the rooms must be agreed washed with additive detergent/disinfectant.

5.1.5 *CLEANING BEFORE COMMISSIONING*

Before acceptance/qualification, the contractor will be responsible for general cleaning by vacuuming and semi-wet washing(s) to remove any dust, traces or stains.

5.2 ACCEPTANCE OF EXISTING INSTALLATIONS

5.2.1 *BUILDING*

The contractor will be responsible for all dimensional and height checks in room CH4.

5.2.2 *UTILITIES*

Before, he will also check the energies/expectations made available to him (validated in the design phase).

5.3 INSTALLATION ACCEPTANCE

5.3.1.1 *Implementation compliance*

This first stage should validate the following points:

- EXECUTION drawings updated for any changes / modifications;
- Verification of required compliance certificates, self-tests. (Tightness, pressure, temperature, ...)
- Checks on actual attendance, positioning, numbers, ...
- Validation of visual aspects of finishes.

5.3.1.2 *Operating Qualifications compliance*

This acceptance will be subject to qualification. It will be carried out by means of test protocols and procedures mentioning the verification status and listing (PUNCH LIST) of non-conformities. This qualification will be carried out by a specialized company (under INRAE responsibility) which will be responsible for writing the protocols.

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5.4 TESTING / FUNCTIONAL ACCEPTANCE

5.4.1 SAFETY TESTS

No functional start-up test can be performed without the following prerequisites:

- Up-to-date wiring diagrams, validated without reservation by the Bureau de Contrôle Technique;
- Emergency Stop tests verified OK;
- Effective alarms when necessary.

5.4.2 START-UP INSTALLATION

Prior to any start-up, an operations planning protocol will be provided.

Prerequisites :

- Calibration of REGULATIONS /MONITORING probes ;
- Validated wire-to-wire tests ;
- Programming on PLCs and actual supervision software ;
- Effective data transfer, thresholds and servo-controls modeled.

If the optional tranche OP 01 is awarded. Gas analyzer tests can only begin once ambient conditions have been stabilized (to predefined values).

The contractor must supply all the measuring/control equipment and consumables required for commissioning, including the necessary calibration gases.

5.4.3 CRASH TESTS

In addition to the servo-controls and active safety devices, a series of tests simulating the following potential failures will also be carried out:

- Perte d'un équipement dans le cas de redondance / back up ;
- Loss of equipment in the case of redundancy / back-up ;
- Loss of normal power, switch to standby mode, return to normal;
- Loss on Emergency Bottom / "hot" restart ;
- Inverter loss;
- Wrong THI value.

For each test, initial conditions, effective alarm postponements and return-to-normal conditions are mentioned.

5.4.4 SETTINGS

A history of settings and any corrective actions will be recorded.

Verification of all physical values/measures when alarm thresholds are exceeded will be tested. Minimum/maximum ambient control tests will be carried out for each enclosure.

5.4.5 FUNCTIONAL ACCEPTANCE / COMMISSIONING

This reception will be done by means of a protocol mentioning :

- Compliance of expected/measured values and associated tolerances;
- Analyzer recordings / point mapping on T°C / RH /é clearly by rooms.
- Overall system behavior for simultaneous operation of 1 to 4 rooms.
- Verification PUNCH LIST (without any reserves)
- Reports and alarms.

Intervention will be specified according to the criticality of the process.

Commissioning can only take place once this stage has been completed.

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5.5 TRAINING

All INRAE staff will receive training in the use of the equipment from the contractor.

3 types of training are available:

- ARCHITECTURE / DATA USE (HARD) Nb person 2/3 ;
- PILOTAGE (SOFT)Nb of people 4/5 ;
- MAINTENANCE Nb person 2.

The program and time allocated to each training course will be specified in the technical brief attached to the offer.

The duration of these courses will be adapted to the technologies and software used, and more specifically to the analyzer(s). French-language operating, calibration and maintenance procedures must be supplied all materials offered.

5.6 ACCEPTANCE

In addition to the general acceptance requirements set out in the administrative documents, each enclosure will be deemed to have been definitively accepted once the contractor has responded to and/or remedied all non-conformities identified during the qualification phase (carried out by a third-party organization).

5.7 OTHERS WARRANTIES

5.7.1 *Duration (excluding analyzers) :*

1-year guarantee of perfect completion and 2-year guarantee of good working order: parts and labor on proven malfunctions or damage, hidden defects.

5.7.2 *Hotline assistance*

The contractor will provide HOT LINE assistance for a period of 12 months from acceptance.

5.7.3 *Interventions*

A commitment period for interventions during this period will be specified.

5.8 AFTER-SALES SERVICE

In all cases, the contractor must propose the conditions for monitoring the installations in "Pro Forma" form. The proposal must be in 2 parts:

PREVENTIVE aspect: During the warranty period / Outside the warranty period.

CURATIVE aspect: During the warranty period / Outside the warranty period.

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6. ENGINEERING

6.1 STUDIES AND EXECUTION

6.1.1 CALCULATION NOTES

The contractor will be required to provide all calculation notes supporting these dimensions.
The basic data/conditions must be systematically indicated.

6.1.2 FUNCTION/PID DIAGRAMS

All complex technical installations will be covered by a PID diagram.

6.1.3 ELECTRICAL/PNEUMATIC DIAGRAM

All cabinets must have a standard-compliant wiring diagram.

6.1.4 EXE PLANS

Before any fabrication, dimensional drawings of the installations will be supplied, as well the location/positioning of all terminals (vents, luminaires, sensor sockets, displays, etc.).

6.1.5 MATERIAL DOCUMENTATION

All manufactured materials will be the subject of a technical data sheet detailing specifications/constraints for .

6.2 PROJECT QUALITY

6.2.1 INTERFACES WITH EXISTING SYSTEMS

The contractor will contact the project managers Mr. HUART and Mr. TERSIN to validate all implementation hypotheses having an impact on completed, ongoing or future projects. Any additional dimensions required will be the responsibility of the contractor.

6.2.2 LOCATIONS

All dimensional layouts will be subject VISA by INRAE prior to execution.
All functional diagrams will be subject to VISA by INRAE prior to execution.

6.2.2.1 PV /certificates

They must be supplied whenever required.

6.2.2.2 Notices

All documents relating to installed equipment with functional specificities will be attached to the execution for validation.

6.2.2.3 Planning

The validation an EXECUTION schedule is a prerequisite, as is its .

6.2.2.4 Document management

A list of graphics and handwritten documents will be kept up to date as they are distributed. The contractor will use Indication of plans to make them easier to find in different versions.

6.2.3 CHANGE MANAGEMENT

Any qualitative, quantitative or functional modifications during EXE studies and/or implementation will be subject to :

- Indication with color marking.
- Distribution according to established protocol;

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- Validation if the modification affects the content of the contract.

7. QUALIFICATIONS PROTOCOL FRAMEWORK

7.1 QUALIFICATIONS CHART

All the protocol frames ticked below must be subject to measurement/control procedures to validate the compliance with required values and functions.

These protocols will be drawn up and carried out by a specialized company. The successful bidder will provide the assistance required to ensure that the qualification phases run smoothly (as part of the acceptance of works).

REP	PROTOCOL	IQ	OQ	PQ
1	ROOM MOUNTING / INSTALLATION	<u>X</u>		
2	FLUID FLOW CHECKS	<u>X</u>		
3	ELEC POWER CHECKS	<u>X</u>		
4	HVAC INSTALLATION CHECKS	<u>X</u>		
5	ANALYZER CONNECTION CHECKS	<u>X</u>		
6	DOOR SEALING		<u>X</u>	
7	LIGHTING		<u>X</u>	
8	SOUND LEVEL		<u>X</u>	
9	FLOW / PRESSURE ENCLOSURES		<u>X</u>	
10	DATA / ALARM REPORTS		<u>X</u>	
11	MAPPING T°C / HYGRO		<u>X</u>	
12	SAFETY DEVICES / CONTROLS		<u>X</u>	
13	ANALYZER CALIBRATION		<u>X</u>	
14	PRECISION / LINEARITY OF MEASUREMENTS		<u>X</u>	
14	AMBIENT MONITORING DATA VALIDATION			<u>X</u>
15	CRASH TESTS			<u>X</u>
16	ANALYZER DATA VALIDATION			<u>X</u>
17	SUPERVISION / CONTROL VALIDATION / CYCLE PROGRAMMING			<u>X</u>