Universitat Autònoma de Barcelona

TECHNICAL NOTE 94.31

WASTE PREPARATION UNIT, USER REQUIREMENTS AND TECHNICAL SPECIFICATIONS

Prepared by/Préparé par	Peiro, E. and Gòdia, F.
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List of acronyms

CI : compartment I

CII : compartment II

CIII : Compartment III

CIVa : Compartment IVa

CIVb : compartment IVb

CV : Compartment V

HPC: Higher Plant Chamber

MELiSSA: Micro-Ecological Life Support System Alternative

UAB: Universitat Autònoma de Barcelona

MPP: MELiSSA Pilot Plant

UPS: Uninterrupted Power Supply

NTU: Nephelometric turbidity units

CFU: colony-forming units

COD: Chemical oxygen demand

DM: Dry matter

WPU: Waste Preparation Unit

1. Context: the MELiSSA Project and the MELiSSA concept

1.1. The MELiSSA Project

Over the last 15 years several Space Agencies (i.e. NASA, JAXA, RSA, CSA, ESA) have been studying the regenerative life support systems needed to sustain long-term manned space missions.

Space exploration constraints dictate that the primary objective of the studies is to reduce the launched mass of metabolic consumables (i.e. water, oxygen, food) by increasing their recycling rates up to, ideally, closure of the gas, liquid and solid loops.

Within Europe, the main part of the work has been performed within the MELiSSA (Micro-Ecological Life Support System Alternative) project by a highly comprehensive European and Canadian scientific and technical network, coordinated by the European Space Agency (specifically the European Space Research and Technology Centre ESTEC).

Within MELiSSA, it is proposed to follow a global approach of Life Support requirements by addressing jointly the main Life Support functions, i.e.:

- Air revitalization,
- Water production,
- Waste management,
- Food production and preparation
- Quality Control and Safety issues
- Ergonomics and Habitability

With regards to the challenge of sustaining Human Life during long-term manned space missions, a stepwise engineering approach is followed in MELiSSA, starting from basic research and development studies, including preliminary flight experiments, up to a comprehensive ground demonstration of the technologies developed.

1.2. The MELiSSA concept

The MELiSSA concept is based on the duplication of the functions of the earth without benefiting from earth's large resources (i.e. oceans, atmosphere..) and from terrestrial comfort.

The goals of the MELiSSA loop are the recovery of food, water and oxygen from wastes, i.e. CO_2 and organic wastes, using light as a source of energy.

From the observation of a lake ecosystem (i.e. the identification of the elementary consumption, degradation and production functions composing this ecosystem), the MELiSSA loop is conceived as a closed regenerative system, based on five compartments duplicating the lake ecosystem's elementary functions (see below Figure 1, further information is available at http://www.estec.esa.int/ecls).

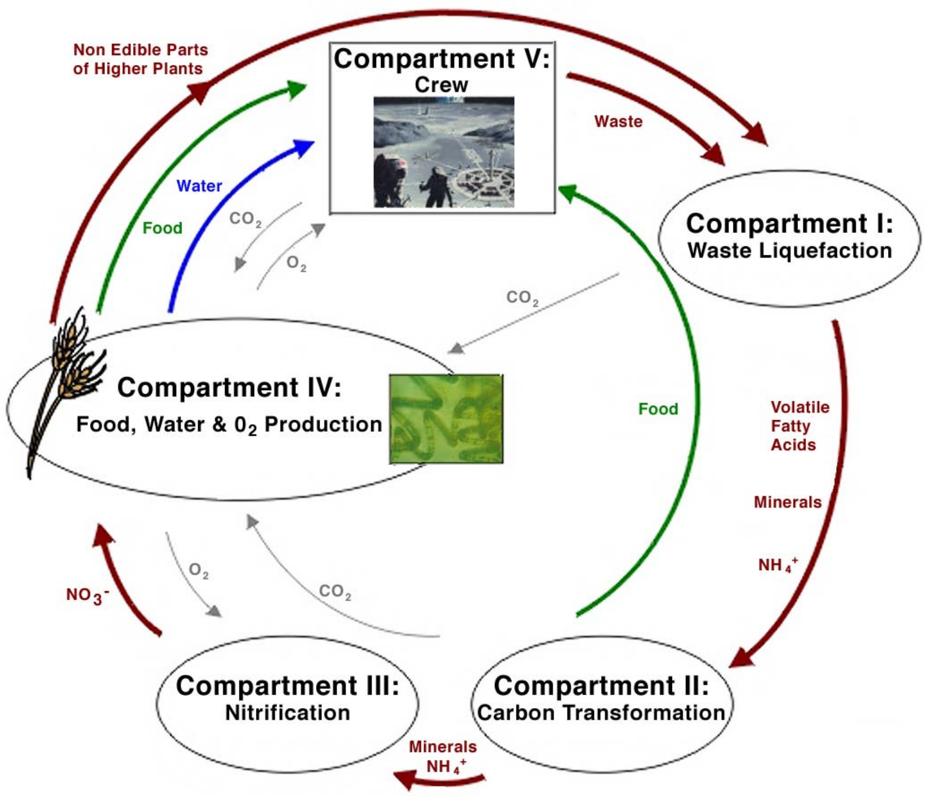


Figure 1: MELiSSA Advanced Loop Concept

Each compartment has a given objective within the complete biotransformation and connections with other compartments.

The basics are the followings:

- In Compartment I, the different waste sources are degraded in an anaerobic thermophilic bioreactor. The wastes include non edible material from plants, excess bacterial material from other compartments, fecal material, etc. The degradation yields a range of volatile fatty acids (VFA) that are transferred in Compartment II.
- Compartment II is photobioreactor where the VFA produced by Compartment I are further converted, basically to CO_2, by the photoheterotrophic growth of the bacteria *Rhodospirillum Rubrum*.

- Compartment III is responsible for the bioconversion of the nitrogen source, i.e. from ammonium NH_4^+, as produced in CI, into nitrate NO_3^-. Compartment III is a fixed-bed bioreactor, with a co-culture of *Nitrosomonas* and *Nitrobacter* bacteria immobilized onto a solid support (beads).
- The production compartments are Compartment IVa and IVb:
    - o Compartment IVa is devoted to the culture of the photoautotrophic cyano-bacteria *Arthrospira platensis* (*a.k.a. Spirulina platensis*), and is used mainly for the production of oxygen from CO_2,
    - o Compartment IVb is devoted to the culture of a number of selected higher plants (i.e. wheat, lettuce and beet), for the production of food and oxygen.
    - o These compartments are the closing steps for the loop, since they provide with the functions of atmospheric regeneration (converting the CO_2 generated by the crew and other bacterial compartments into O_2) and edible material generation. In addition, higher plants can also provide a way to biologically regenerate potable water through transpiration.
- Compartment V corresponds to the crew (i.e. consumer) compartment. For the first demonstration of the MELiSSA loop, it has been decided to work with laboratory animals.

The development of each individual compartment follows the same engineering logic:

- Technologies characterization in batch and continuous modes,
- Stoichiometry studies,
- Hydrodynamic characterization,
- Static Modeling,
- Dynamic Modeling,
- Control Model (for predictive control),
- Safety issues (chemical and microbiological),
- Maintenance and Dependability.

At the upper level of the complete loop (i.e. closed loop of interconnected compartments), a system approach is mandatory to achieve mass balance closure, a relevant safety of the complete system and its reliability for long term operation. This system approach is supported by a knowledge-based control leading to the development of a predictive control based management of the overall MELiSSA loop.

2. The MELiSSA Pilot Plant

2.1. Overall presentation

As expressed previously, the challenge of sustaining human life in frame of long-term missions is such that an extensive demonstration of MELiSSA on ground is a mandatory step in the process of its adaptation to space.

Owing to the state of the art at laboratory scale, the five MELiSSA compartments are progressively developed up to a pilot scale, according to a sizing scenario defined by the MELiSSA Consortium as representative of a full scale manned mission **(i.e. production of 1 eq-man oxygen, production of 20% of 1 eq-man daily diet)**.

The European Space Agency (ESA) has entrusted the implementation of the MELiSSA Pilot Plant to the Universitat Autonoma de Barcelona (UAB), with **the challenge to make it the primary European Facility for Life Support Ground-Demonstration.**

The MELiSSA pilot compartments will be integrated (i.e. connection of the gas, solid and liquid phases) within the MELiSSA Pilot Plant, with **the ultimate objective of a long-term demonstration (i.e. around 3 years of continuous operation) of the MELiSSA loop (i.e. 5 compartments interconnected).**

A new MELiSSA Pilot Plant facility has been built by the Universitat Autònoma de Barcelona., in the Departament d'Enginyeria Química, Escola Tècnica Superior d'Enginyeria (ETSE). This new facility of 214 m^2 will be devoted to the location of:

- compartments I, II, III and IVa, three Higher Plants Chambers composing CIVb, the animal compartment (i.e. CV),
- a human waste collection unit,
- a control room,
- Auxiliary equipments.

2.2. MELiSSA Pilot Plant: integration strategy

The main goal of the MELiSSA Pilot Plant described in the previous section will be achieved once all the different compartments will be operated at is final scale, in continuous mode, fully connected, under the control system, for a long operation mode. To achieve it, an step-wise integration strategy will be defined.

The closure of the MELiSSA loop is envisaged using animals as a mock-up of the crew compartment. Indeed, this is a more realistic scenario to demonstrate and study the first closure of the loop, including the effect of perturbations. The number and type of animals to use will be defined in the corresponding study. Using animals instead of humans for this demonstration step also reduces in a great extent the feasibility of the experiments in terms of economical cost and associated safety measures.

In such scenario, the closure will be completed mainly at the level of the gas phase and water. The animal faeces and urine will not be used, that is, they will not be introduced as feed in any of the Compartments of the loop. In turn, and in order to obtain more realistic data for the MELiSSA loop operation, human faeces and urine will be collected from a group of donors, and will be used as part of the feed material to the MELiSSA loop. In this way, the closure scenario proposed will be highly realistic, and the data obtained will enable to design future closure scenarios with humans.

The integration strategy within the MELiSSA Pilot Plant will follow a **step-wise approach**:

- The first steps will focus on the continuous operation of the pilot scale compartments individually. These steps will be the opportunity of additional characterization and validation activities that cannot be performed at laboratory scale, due to the level of instrumentation or the size of the hardware. The knowledge gained will potentially engender future optimization both in terms of hardware, of mathematical models and of control.
- In parallel, studies will be performed to develop the interfaces that will be necessary between the compartments. (e.g. a waste collector to collect urine and faeces, a waste preparation unit, biomass harvesting systems…)
- Then, a progressive connection of the compartments will be performed up to the ultimate closure. This progressive connection concerns all three, i.e. solid, liquid, and gas phases. Delicate issues will have to be addressed, such as, among others:
    - Prevention of any contamination of the compartments working under axenic conditions (i.e. pure mono- or multi- bacterial culture),
    - Low range of flows to be carried from one compartment to another,
    - flexibility of the design, to follow the evolution of the integration requirements and specifications
    - operator safety and high quality control.

2.3. Detailed description

The MELiSSA Pilot Plant is divided into different rooms, as described hereafter on Figure 2 and Table 1. Basically, it consists of one area (9A, 9B, 9C and 9E) devoted to the bioreactors (i.e. compartments I, II, III and IVa), the waste collection unit and the animal compartment, one area (9 D) for the Higher Plants Chambers, and a central area for offices/meeting room and the control room.

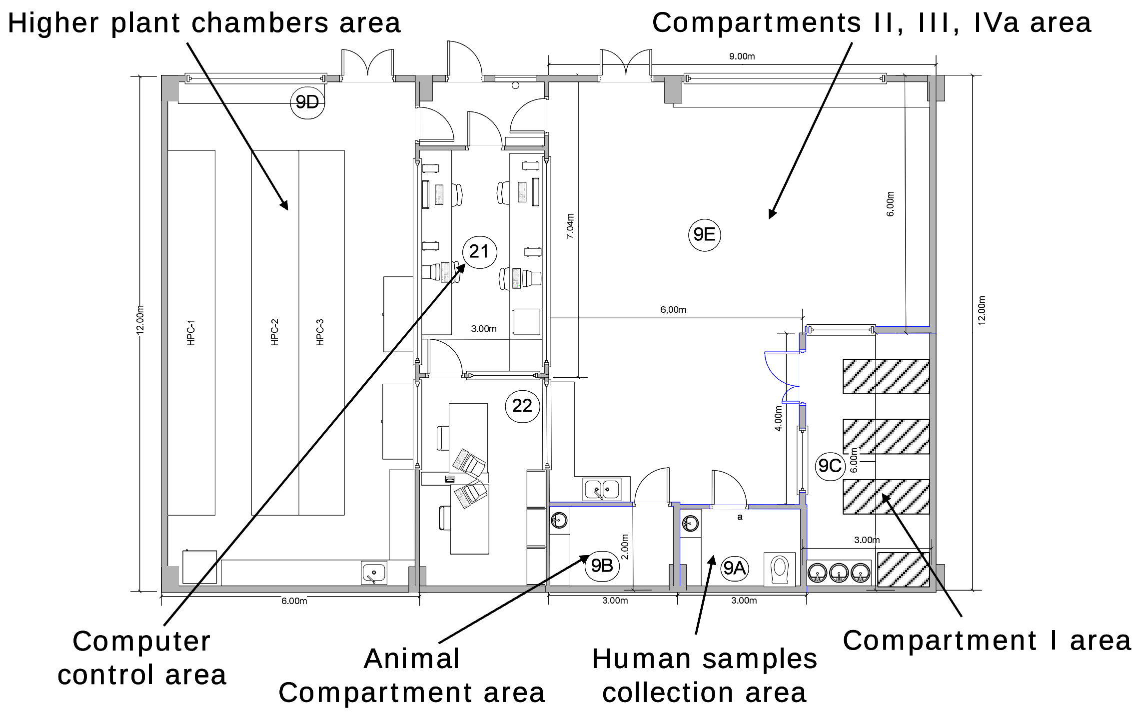


Figure 2. Basic layout of the MELiSSA Pilot Plant laboratory.

Room	Description
9E	Bioreactors area (includes compartments II, III and IVa)
9A	Human waste collection room
9B	Animal Compartment
9C	Compartment I area
9D	Higher Plant Chambers (Compartment IVb)
21	Control Room
22	Office

Table 1. Basic description regarding the distribution of the MELiSSA Pilot Plant

The document *MELiSSA Pilot Plant General Resources, Interfaces and Environment* (TEC-MCT/2006/3493/lnBLA), describes in detail all aspects of the MELiSSA Pilot Plant :

- access and design: covering sizes, maximum loads, surfaces characteristics…
- general utilities and facilities such as air filtration and ventilation, storage capacities, freezers…
- services provided by central systems, distributed over the MELiSSA Pilot Plant: steam, gas, power, cooling water..
- interfaces: with these provided services (connection types and their exact location), with additional networks (drains, gas exhausts..)..
- monitoring, alarms and safety issues.

As examples, Figure 3 provides the specific sizes of the MELiSSA Pilot Plant, and Figure 4 indicates the distribution of the different lines for power supply.

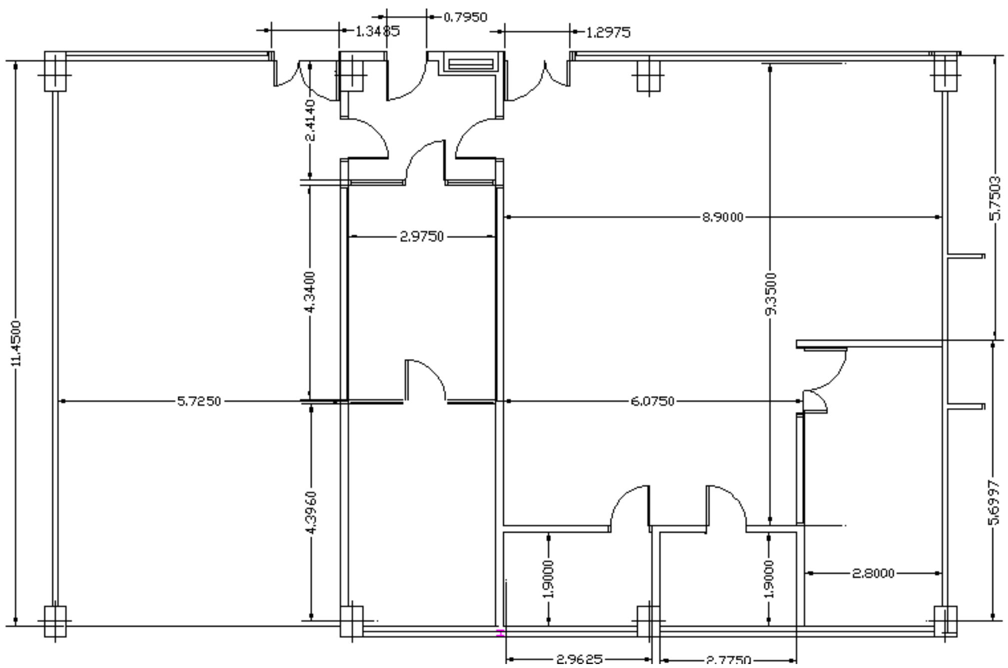


Figure 3: Sizes of the different areas in the MELiSSA Pilot Plant

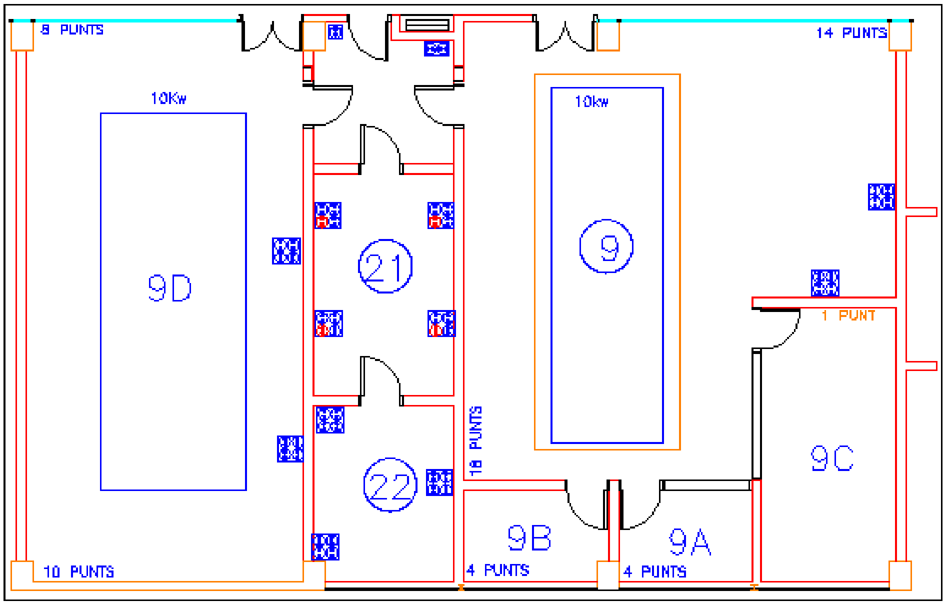


Figure 4: Distribution of the power lines in the MELiSSA Pilot Plant.

2.4. Additional technical information over the MELiSSA compartments

A brief description of each compartment in the MELiSSA loop is presented in the next paragraphs.

2.4.1. Compartment I

Compartment I, as illustrated on Figure 5, is composed of a membrane bioreactor connected to an influent feed tank and an effluent (i.e.filtrate) collection tank. The bioreactor has an approximate volume of 100 L

For the preparation of the influent, a waste preparation unit will be installed. During the integration phase, the waste preparation unit will probably be connected to the liquid phase of CIVb

Besides C-I equipment, room 9C is equipped with:

- Inert gas line to establish anaerobiosis (Helium).
- Air cooling/venting system.

- Steam line.
- Cool liquid line for temperature control and gas condensation system.
- Demineralized water.
- Tap water
- Compressed air (use of pneumatic devices).

2.4.2.Compartment II

Compartment II bioreactor will be located in room 9E. Bioreactor volume is about 50 L. A description of the reactor is given on Figure 6.

The output of C-II bioreactor, collected in an effluent collection tank, contains biomass to be further separated from the liquid output by a biomass harvesting system (today under study). The connection from the influent tank to the biomass harvesting system shall be foreseen.

Compartment C-II in room 9 will require the following services:

- Demineralized water,
- Tap water,
- Inert gas line to establish anaerobiosis (Helium),
- He and H_2 lines for gas chromatography,
- Air cooling/venting system,
- Liquid cooling supply system,
- Steam line,
- Compressed air (use of pneumatic devices).

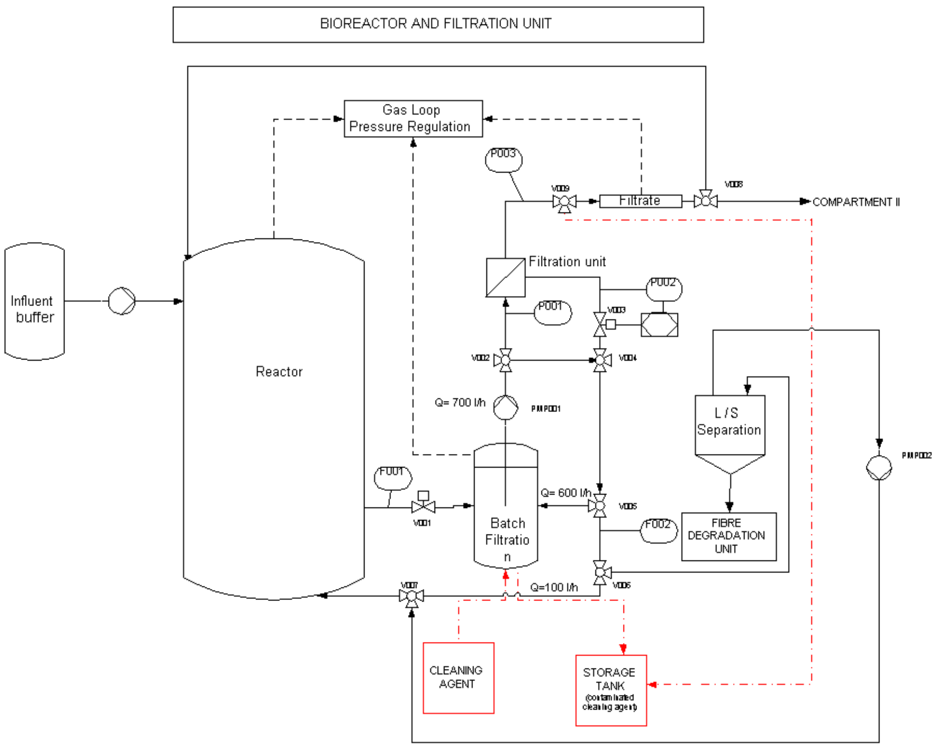


Figure 5: Schematic design of compartment I and its filtration unit.

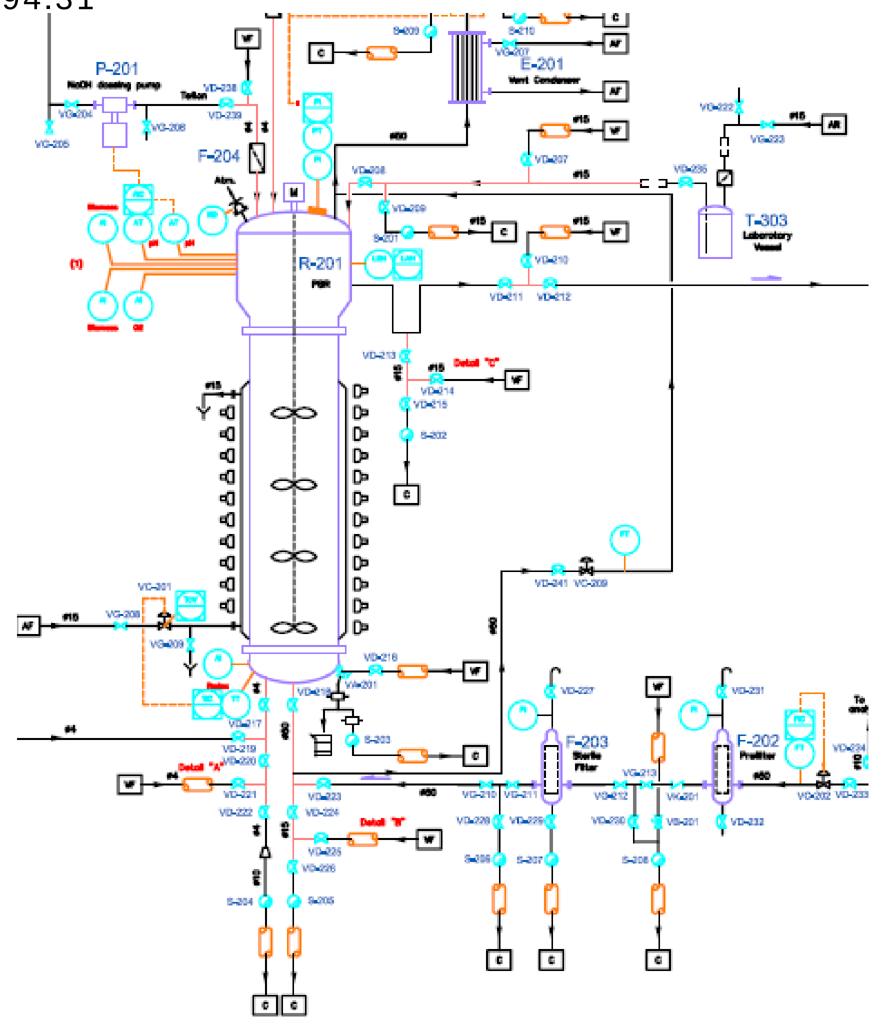


Figure 6: Configuration scheme of compartment C-II.

2.4.3.Compartment III

Compartment III bioreactor will be located in room 9E. The volume of the bioreactor is 8 L.

The present bioreactor (see Figure 7 for a schematic overview and associated picture), will be now up-graded, and the work presented here is indeed related to this up-grade.

Compartment III will require the following services:

- Demineralized water.
- Tap water
- Gas lines for independent operation O_2, CO_2, N_2.
- Compressed air as base for mixing with other gasses for independent operation and also in case of using pneumatic devices
- Liquid cooling line for output gas lines condensation.
- Steam line

2.4.4.Compartment IVa

Compartment IVa bioreactor will be located in room 9E. The volume of the bioreactor is 77 L. A schematic overview of this compartment and the equipment involved is provided on Figure 8 and associated picture.

Compartment IVa will require the following services:

- Demineralized water.
- Tap water
- Gas lines for independent operation O_2, CO_2, N_2.
- Compressed air as base for mixing with other gasses for independent operation and also in case of using pneumatic devices
- Liquid cooling line for temperature control and output gas lines condensation.
- Air cooling for lamp heat elimination.
- Steam line

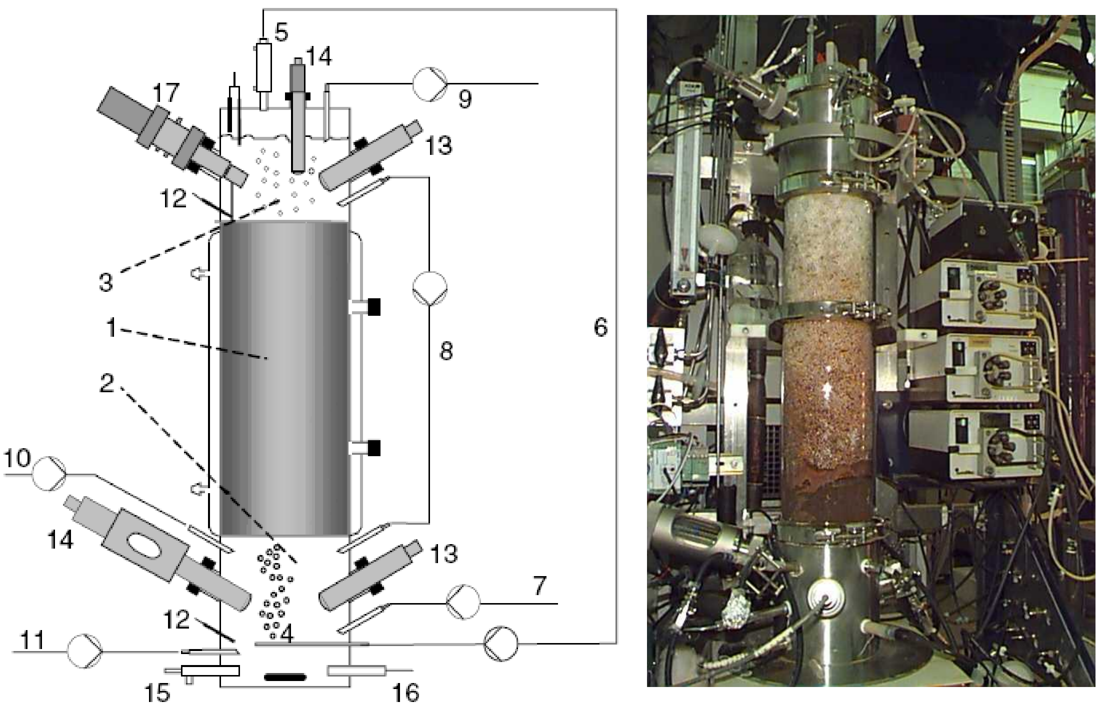
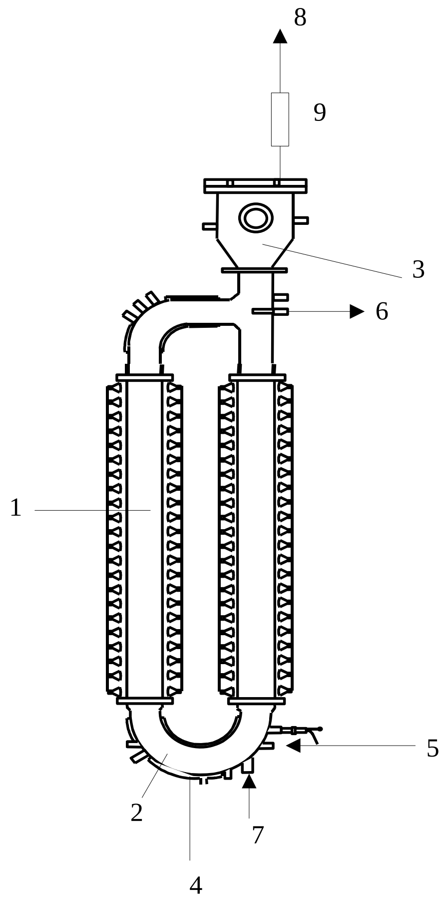


Figure 7: : Schematic overview of compartment III.

General schematic (left) and picture (right) of the nitrifying pilot bioreactor. (1) Packed-bed section with immobilized culture, (2) bottom section for aeration, liquid distribution and instrumentation, (3) top section for gas disengagement, (4) gas sparger, (5) gas exit condenser, (6) gas loop, connected to oxygen/nitrogen regulated supply to control dissolved oxygen, (7) liquid feed, (8) liquid recirculation, (9) liquid outlet, (10) acid addition, (11) base addition, (12) temperature probes, (13) dissolved oxygen probes, (14) pH probes, (15) cooling system, (16) heating system, (17) sampling device.



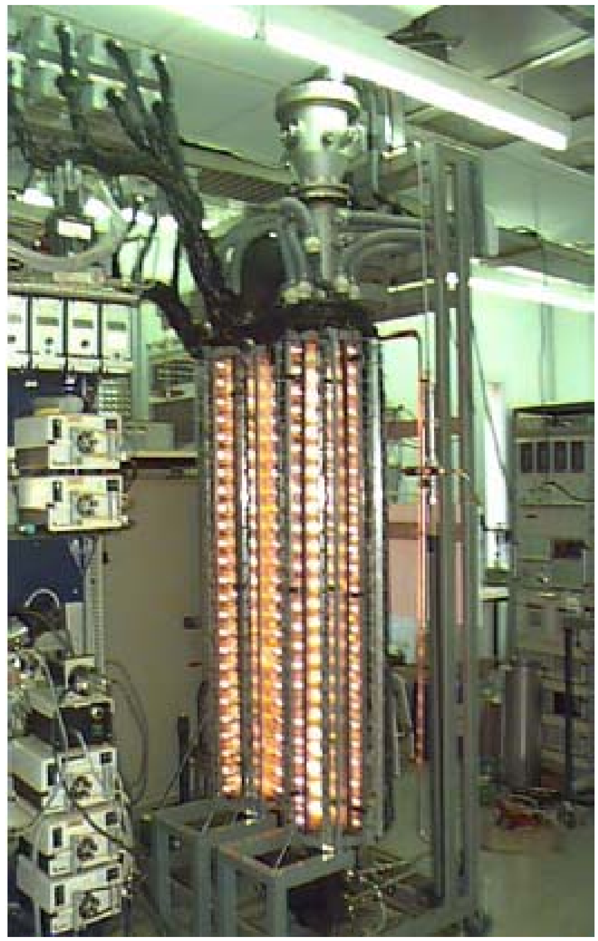


Figure 8: Schematic view of compartment IVa.

General scheme of the 77 litres photobioreactor designed for the culture of Spirulina cells. 1, transparent cylindrical parts (illuminated section) : riser (right column and downcomer (left column), 2, stainless steel connection parts , 3, gas-liquid separator, 4, external cooling jackets, 5, liquid medium inlet, 6, liquid outlet, 7, gas inlet through sparger, 8, gas outlet, 9, condenser, 10, halogen lamps.

2.4.5.Compartment IVb

The higher plant compartment C-IVb will be installed in room 9D. It will be composed of 3 Higher Plants Chambers. A schematic overview of the compartment is shown in Figure 9.

CIVb will require the following services:

- Demineralized water.
- Tap water
- Gas lines for independent operation O_2, CO_2, N_2.
- Compressed air as base for mixing with other gasses for independent operation and also in case of using pneumatic devices.
- Air cooling for lamps heat elimination and temperature control.
- Liquid cooling line for temperature control and maybe for evapo-transpiration condensation depending on chamber design (green solid line in figure 15).

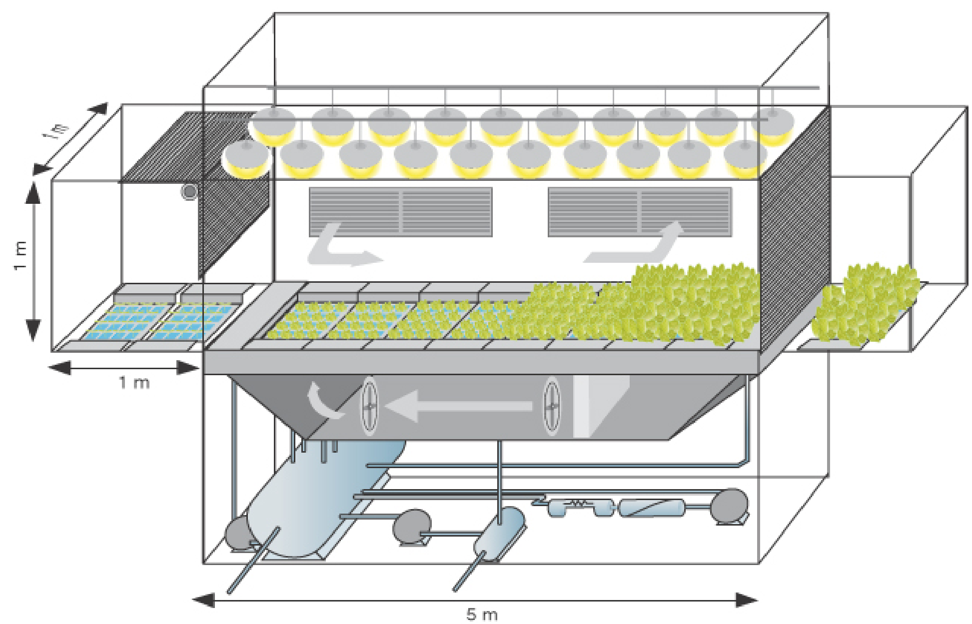


Figure 9: schematic view of the design concept for the Higher Plant chamber.

2.4.6. Compartment V

The animal compartment will be installed in room 9B. This compartment is currently under design. In principle, it will consist in an air tight cage where animals are going to live.

The animal compartment (CV) will require the following services:

- Demineralized water.
- Tap water
- Gas lines for independent operation O_2, CO_2, N_2.
- Compressed air as base for mixing with other gasses for independent operation and also in case of using pneumatic devices.
- Liquid cooling for humidity of breath air condensation.

3. Frame of the work: Compartment I additional characterisation phase

Compartment I was developed during many years by the MELiSSA partner EPAS (Eco Process Assistance), a company located in Ghent (Belgium). EPAS constructed the hardware corresponding to Compartment I of the MPP, and completed the final delivery to the MPP of C-I compartment hardware, on September 2007. The proposed study on this Compartment will allow the further characterisation of the Pilot Compartment I at the MPP site in UAB. The pilot reactor was installed in the MPP and connected to all utilities, and will be completed in terms of hardware/software for its monitoring and control, and tested for approximately eighteen months. During this period, it will be operated in order to collect data for process, model and control development. The Filtration Unit will be optimised and an up-scaling of the waste preparation system will be performed.

The objectives of this additional characterization work (included in the COO WO_CI_OFR_ESA_0307_UAB) are the installation and integration of Compartment I in the MELiSSA Pilot Plant, the performance of a long series of experiments with the proper analyses to fully characterize its operation and to provide data for mathematical model and control algorithms development, the improvement and optimization of the unit to prepare the feed to the reactor, and the optimization of the membrane unit of Compartment I. At the finalisation of the work, Compartment I should be completely operational in the MPP at the corresponding quality standards and ready to be connected to other MPP compartments.

In order to perform this work, one of the components to be developed is the scale-up of the Waste Preparation Unit of Compartment I in the MELiSSA Pilot Plant. It involves a number of steps:

The tasks to be done consists in the following blocks:

1. Detailed analysis of the characteristics and operation of the WPU used previously
2. Definition of the user requirements of the new unit
3. Definition of supply and storage procedures at the MPP
4. Definition of new hardware and its procurement
5. Definition of the waste preparation procedure and validation test of the scaled-up unit in the MELiSSA Pilot Plant.

The present document defines the User's Requirements and Technical specifications for the scale-up of the Waste Preparation Unit of Compartment I.

4. Scope of the study: User's Requirements and Technical specifications of the Waste Preparation Unit

The aim of the present document is to define the User´s Requirements and Technical Specifications of the Waste Preparation Unit. The main conditions considered to be critical for the design of the unit are the following:

- substrate composition
- feed preparation
- particle size ,
- ease of preparation,
- safety and biosafety,
- ergonomics,
- cleanliness,
- influent quality requirements
- foam detection and prevention
- improvement of influent homogeneity

<u>Substrate composition:</u>

In TN 71.1 "Requirements, Performances and Sizing of the MELiSSA Waste Compartment", section 3, the substrate composition and substrate preparation requirements for the WPU are described. Regarding the substrate composition, the following one is defined:

Material	Amount DW (g/d)	Percentage (%)
Lettuce	54	30
Beet	54	30
Wheat Straw	54	30
Toilet paper	18	10
Total plants and paper	***180***	***86%***
Faecal material	***30***	***14%***
Total amount of material	**210 DW g/d**	**100%**

<u>Table 2</u>. Feed composition of Compartment I (from TN 71.1 and Engineering of the Waste Compartment. Design Report (EPAS))

This composition leads to the following one, in terms of fresh weight composition:

	1 day		**1 week**		**Expected Dry Matter concentration (g/L)**
	Fresh	Dry	Fresh	Dry	
Mass Faecal Material (g)	100 g nominal (80-120 g)	30 g	700 g nominal (560-840 g)	210 g	21 g/L nominal
Mass Toilet paper (g)	-	18 g	-	126 g	
Mass Wheat (g)	-	54 g	-	380 g	
Mass Lettuce (g)	1080 g nominal (1050-1100 g)	54 g	7560 g nominal (7350-7700 g)	380 g	
Mass Beet (g)	680 g nominal (650-700 g)	54 g	4760 g nominal (4550-4900 g)	380 g	
Total Volume after dilution with deionised water (L)	10		70		

<u>Table 3</u>. Feed preparation for Compartment I (adapted from TN 71.3)

Feed preparation

Regarding the feed preparation, the selected parts of the higher plants need to be pre-treated, before introducing the material into the first compartment. TN 71.1 requests to provide a material with a diameter of around 0.5 mm to avoid clogging of the filtration unit and to facilitate the biodegradation of the material by the anaerobic bacteria. TN 71.2 on Bioreactor Design establishes as well a limit for the particle size of máx. 1 mm to avoid clogging of the membrane modules. However, new inputs taking into account as well the constraints of the future Fiber Degradation Unit under development have modified these conditions as will be shown later on in the present document.

Respect to the conditions for the materials to be treated, it was decided to pre-treat the plant material in its natural state: this means wet for beet and lettuce, and dry for wheat straw, and the plant waste to be grounded first and then frozen to preserve the material. However, taking into account the logistic constraints for the MPP and in order to to maintain as much as possible the homogeneicity of the raw materials used for CI along the extension of the tests, a complete batch of lettuce and beet for approx. one year of use is being frozen and stored before being treated.

Taking into account the safety concern regarding the manipulation of faeces, the faeces doses will be weighed first and then the required plant amounts will be prepared accordingly, in agreement with the recipe composition.

Taking into account those aspects, the User's Requirements for the WPU scale-up have been splitted accordingly in the following main categories:

4.1 Process requirements
4.2 Design specifications
4.3 Requirements regarding biosafety and long-term operation

4.1. Process requirements

1. The WPU shall receive, cut and mix frozen lettuce crops.

a) Precuttting phase: frozen lettuce crops should be precutted to aprox. 1 cm particle size particles by means of an industrial food cutter.

b) Final cutting phase: precutted lettuce already diluted should be cutted by means of a shear pump to a size of 2 mm.

2. The WPU shall receive, cut and mix frozen beet crops, without leaves.

a) Precuttting phase: frozen beet crops should be precutted to aprox. 1 cm particle size particles by means of an industrial food cutter.

b) Final cutting phase: precutted beet already diluted should be cutted by means of a rotor shear pump up to a size of 2 mm.

3. The WPU shall receive, cut and mix dry wheat straw

a) Precuttting phase: wheat straw should be precutted in dry to aprox. 1 cm particle size particles by means of a cutting mill.

b) Final cutting phase: precutted wheat straw should be cutted in dry by means of a centrifugal rotor mill up to a size of 0,2 mm.

c) Mixing phase: cutted wheat straw shall be added to the diluted mixture of vegetables (lettuce and beet) in order to be mixed by means of a rotor shear pump.

4. The WPU shall receive, cut and mix frozen faeces

Frozen faces doses (preweighed) should be thawed by submerging it in the diluted mixture of vegetables in order to be mixed and grinded by means of a rotor shear pump up to a size of 2 mm..

5. The WPU shall receive, cut and mix toilet paper

Toilet paper shall be added to the diluted mixture of vegetables (lettuce and beet) in order to be mixed and grinded by means of a rotor shear pump up to a size of 2 mm.

4.2. Design specifications

6. The WPU will consist of the following elements:

- Mixing tank, made in stainless steel AISI-316L internally polished, 100 liters working volume, in order to allow the preparation of the required quantity of inlet feed for one week of process in Compartment I.
- Hopper connected to the mixing tank, to add the raw materials previously described.
- Rotor shear pump, adequate to grind the mixture of pregrinded vegetables, faeces and paper and mix them with the pregrinded wheat straw.
- Recirculation pipe, in order to recirculate the mixture of raw materials to be grinded from the mixing tank to the pump and again to the tank.

7. The mixing tank will show a hatch in order to download the raw materials directly if needed. It will have a double jacket in order to be cooled down by the available cooling water in the MPP during the grinding process, according to a temperature sensor . It will have an inlet of deionised water in order to dilute the mixture, and a volume or level measurement device in order to calculate the total amount of mixture. It will have both high and low level switches in order to stop the water feeding and avoid the pump run in dry, respectively. It will as well incorporate a CIP inlet and the appropriate spray ball, to be connected to an external CIP system if desired (cleaning solution or decalcified water for rinsing).

Mixing tank features:

- Hatch
- Double jacket, cooling water inlet
- Temperature sensor and temperature control
- Inlet of deionised water
- CIP inlet (including decalcified water for rinsing)
- Level sensor, volume measurement or weighing platform
- High and low level switches
- Spy-hole and light

8. The rotor shear pump will be adequate to grind the mixture of pregrinded vegetables, faeces and paper and mix them with the pregrinded wheat straw for a one-week feed preparation, in a reasonable time (some minutes). The motor will be powerful enough to achieve at least to 5000 rpm, and will be managed by a frequency variator.

Pump features:

- Rotor to provide reduction in size up to 2 mm
- Motor providing 5000 rpm
- Frequency variator

9. The recirculation pipe will include a regulating valve with micrometric adjustment adequate to regulate the flow downstream the pump to the mixing tank. It will as well incorporate the adequate valves and a derived flexible pipe to allow the transfer to the CI Feeding tank. The entrance of the recirculation pipe in the mixing tank will be done by means of a dip tube in order to reduce as much as possible the formation of foam when the inlet liquid flow is mixed with the medium in the tank.

4.3. Requirements regarding biosafety and long-term operation

10. The materials used in pump, mixing tank, hopper, sensors, valves and pipelines will be sanitary design when feasible.

11. The system will be compatible with steam sterilisation if required, according to the SOP to be stablished, taking into account the microbial composition of the raw materials used, especially the faecal material. For that purpose, the appropriate drains will be provided and the pipelines will be isolated when necessary.

12. The system (hopper, mixing tank, pump and recirculation pipeline) will allow to be cleaned internally diluting the cleaning agent in the mixing tank and mixing it by means of the pump, or by means of CIP connection, and allowing to be rinsed by means of decalcified water.

13. Safety of the operators shall be guaranteed.

5. References

TN 71.1 "Requirements, Performances and Sizing of the MELiSSA Waste Compartment". EPAS. 18.07.03

TN 71.2 "Bioreactor Design". EPAS. 18.07.03

TN 71.3 "Solid loop design". EPAS. 25.02.04

REFERENCE DOCUMENT TEC-MCT/2007/3602/ln/BLA "Reference values for MELiSSA Compartment I"

6. Comments

Waste preparation unit, User requirements and Technical specifications

Comments

General comments

Reference document: to be updated
Updated MELiSSA Pilot Plant Frame Contract 19445/05/NL/CP

Detailed comments

Page/paragraph	Comment
21/Table 2	Contradictory with Reference document?: 30g DW faeces correspond to 90g fresh (300g in Ref. doc. Faeces samples are weighed (1box=1day in Ref. doc.) Lettuce and beet are weighed (estimated by the number of plants in Ref. doc.) With regards to the issue of wet weight/dry weight of faecal material, ESA will update the C1 reference documents, as 300/30 ratio is clearly not appropriate. The proposed value of 80-100/30 should maybe be extended to 80-120/30 with an average of 100/30 to be used in the MPP? If this is OK for MPP then please update the TN draft accordingly. According to our previous discussion, Mass Fresh FM has been changed to 100 g nominal (80-120g)
24/bullet nº8	In the first design of the WPU, we agreed withy CIFA not to implement the hopper, considering thet there is not a required isolation of the pre-mix because the faeces will be anyway loaded directly in the tank after all the other materials have been added. The id is to test this simpler design and then take decisions for the hopper if needed.

	If approved, this requirement would be eventually removed or modified. Approved in Progress meeting on 04.02.10 (MOM-10-0001-EP-20100204)