MELISSA

Memorandum of Understanding
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TECHNICAL NOTE : 62.7

Dependability analysis of MELISSA
Model building methodology – Physical description

Version : 1
Issue : 0

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SUMMARY

1. PRELIMINARIES

1.1 Document historical record

Date	Version	Issue	Author	Up to date object
2002/02/20	1	0	JL Testud L. Savary A. Bahet	Creation
2002/06/10	1	0	N. Braunwald	Verification

1.2 List of the modified pages

All pages from this edition are located at the last document index

Without object for this edition

2. OTHER INFORMATIONS

2.1 Adersa contacts

People in charge of:

- Functional aspects,
  - Jean-Louis TESTUD (01.60.13.53.37)
- Technical aspects concerning process
  - Jean-Joseph LECLERCQ (01.60.13.53.27)
- Technical aspects concerning industrial coding,
  - Azzedine BAHET (01.60.13.53.40)
  - Ninon BRAUNWALD (01.60.13.53.52)

2.2 Data source

TN 62-7_0 VA.doc

2.3 Reference documents

- ESA Documents:
  - TN 18-1
  - TN 37-6
  - TN 47-5
  - …
- UAB Documents
  - Anne VERNEREY's thesis
  - Julio PEREZ's thesis
  - …

3. REQUIREMENTS

3.1 Requirements definition

The aim of this memo is to provide the relevant information in order to offer technical solutions for the Melissa driving system described herewith.

3.2 Description reminders of the MELISSA loop

3.2.1 Principle

Melissa project (Micro Ecological Life Support System Alternative) is developed by the European Space Agency (ESA) for an ecosystem mainly based on the microorganisms. It claims to be a tool for artificial ecosystem understanding and for a next LIFE SUPPORT SYSTEM for long spatial flights (Mergeay and al, 1988).

The Melissa project is based on the eatable biomass recovery from wastage, CO2 and minerals and using the light as energy source for photosynthesis.

The process is composed of 5 sub-systems (called compartments) strongly interconnected through liquid, solid or gas exchanges. These material exchanges are shown on graphic representation in order to materialise existing links between sub-systems. The crew compartment (COMP 5) mainly consists of human staff that consumes oxygen and biomass and produces waste and CO2. Other compartments are made with the necessary elements for the waste reprocessing and the production of nutritive elements and oxygen (bioreactors, separators …)

The diagrams below describe the main loop and links organization.

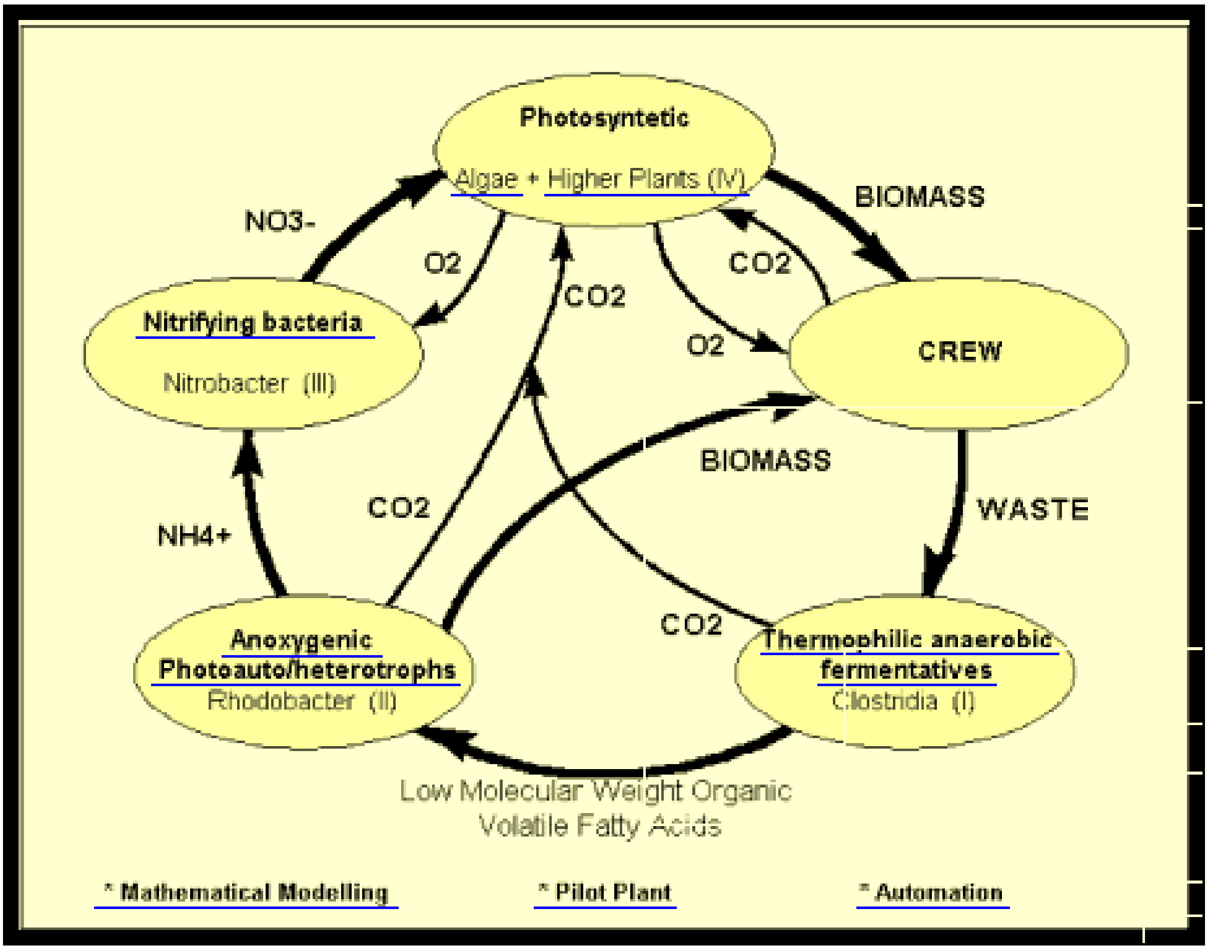

Diagram N ° 1 : Principle schema of the Melissa loop (from ESA)

4. INTRODUCTION:

Safety analysis is a large and crucial problem for MELISSA

- specially for a mission which is long duration (> 30 months), long distance (ISS, Mars, …), under hard constraints (weight, spare part limited)
- specially for a process which is the result of a multi partner work (more than 7 teams), and is composed of several interconnected processes designed by different teams.

It is important to act as soon as possible and with the efficient tools and partners to solve correctly these problems.

Safety analysis

Main concepts
Vocabulary recalls
Process

- Safety Analysis (SDF) encloses:
  - Reliability
  - Maintainability
  - Availability
  - Safety
- Objectives of a safety analysis:
  - Identification of the failures
  - Evaluation of their importance
  - Detection (choice of sensors)
  - Prevision
  - Control (procedures)
  - Design of a fault tolerant system

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We have used an analytical method for complex system to model MELISSA process and to prepare a dependability analysis.

This approach is based on M3C concept for modelling according three distinct viewpoints called layers (physical plane, functional plane and control plane). This method helps to verify safety requirements at complex system designing time.

This model building is expressed by a construction methodology of models, supported by computer aids for checking and validation of generated models. It is based on the description of the model in text file forms, which makes possible a certain rigour for the model description, and easier output process and will apply on MELISSA loop definition.

4.1 Typical timing of a safety analysis

If we describe an ideal situation, safety analysis comprises four main steps:

- Step I – Technical and functional analysis
- Step II – Qualitative analysis
- Step III – Quantitative analysis
- Step IV – Conclusions and synthesis

If verification of objectives cannot be proved, then design must be altered in order to satisfy these objectives along these four steps, we adapt the project and we act the four steps one more time until objectives are reached.
Interaction allows to modify system modelling and iterating objectives check ands system modification must lead to a safety-proven system design.

4.2 Presentation of work

Main objective - Propose a first global model of MELISSA loop useful for safety analysis.
The model is static and it represents the loop under three points of view (physical, functional and control)

4.3 Principe of modelling

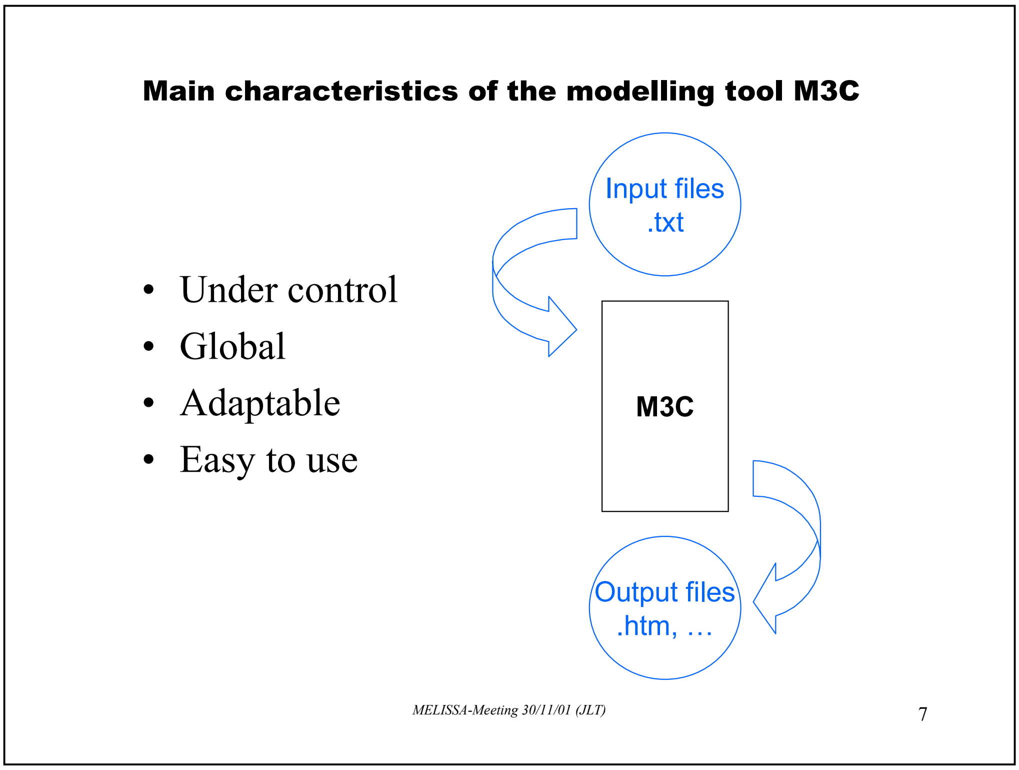
To represent a complex model, it seems easier to consider several complementary layers:

- Physical layer – description of components of the system without consideration with functions they have to ensure
- Functional layer – description of system functionalities
- Control layer – description of system operating modes

We will then obtain three linked models which hold the different properties of the system.

All the models are built with the help of a software called M3C ("Modelling according to 3 layers").

4.4 Main characteristics of the M3C modelling tool



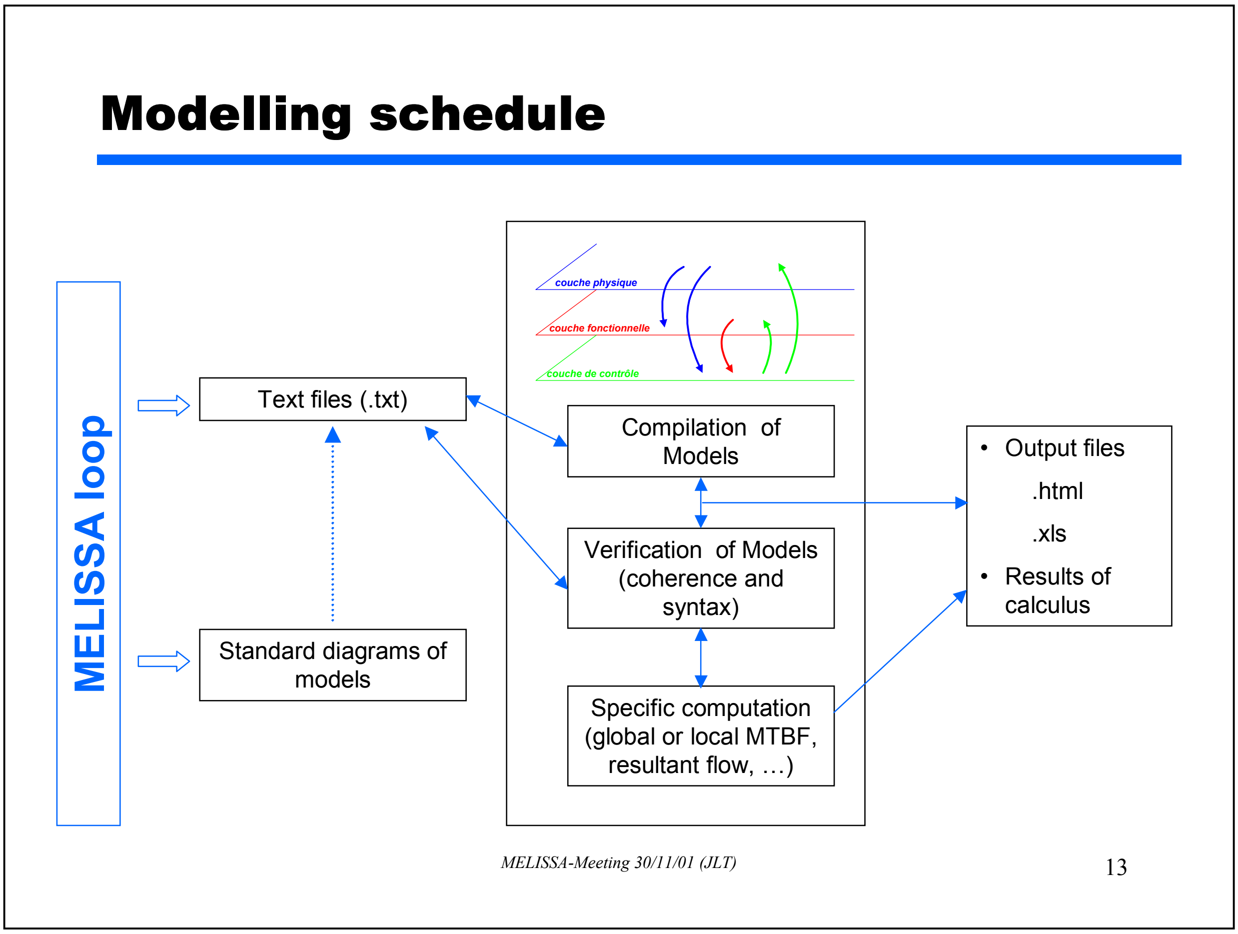
Under control – M3C software was developed by ADERSA and fit needs of MELISSA problem at this step of the study. ADERSA owns all the rights on this software.

Global – Several linked points of view

Adaptable – Open software M3C can follow system evolutions (methodology and/or technology) and accept extension of functionalities.

Easy to use – Useful to support exchange between partners, to communicate models, to define standards, …

4.5 Modelling schedule



5. MELISSA LOOP AND COMPARTMENTS DIAGRAM :

5.1 MELISSA Loop :

5.1.1 Diagram of the loop :

In the figure 1, MELISSA loop is shown as a set of interconnected compartments with the use of links that describe flows of material exchanges.

Exchanged materials are described in the following table.

5.1.2 Description of links between compartments of MELISSA Loop:

links between compartments of MELISSA loop		**Comp. I**	**Comp. II**	**Comp. III**	**Comp. IV**	**Comp. IV HP**	**Comp. 0**	**EXT**
Comp. I	One input from		**BN**		**BS**	**BN**	**U + F**	
5x5	One output to		**C + V**		**C**	**C**		**D**
Comp. II	One input from	**C + V**						
2x4	One output to	**BN**		**Nh**		**C**	**B**	
Comp. III	One input from		**Nh**			**O**		
2x3	One output to				**No + C**			**D**
Comp. IV	One input from	**C**		**No + C**				
3x5	One output to	**BS**				**No + O**	**B + O**	
Comp. IV HP	One input from	**C**	**C**		**No + O**		**C**	**C**
6x7	One output to	**BN**		**O**			**B + O + H**	**O+D**
Comp 0	One input from		**B**		**B + O**	**B + O + H**		**B**
7x3	One output to	**U + F**				**C**		
EXT	One input from	**D**		**D**		**O+D**		
4x2	One output to					**C**	**B**	

Table A. Description of links between compartments of the MELISSA Loop

5.1.3 Descriptions of the flows between MELISSA Loop compartments :

Type of link				
	From	**To**		**Term used in M3C**
C	I	II	Gas - CO2	CI_CII_CO2
C	I	IV	Gas - CO2	CI_CIV_CO2
C	I	IV HP	Gas - CO2	CI_CIVHP_CO2
C	0	IV HP	Gas - CO2	C0_CIVHP_CO2
C	II	IV HP	Gas - CO2	CII_CIVHP_CO2
C	III	IV	Gas - CO2	CIII_CIV_CO2
O	IV	IV HP	Gas - O2	CIV_CIVHP_O2
O	IV	0	Gas - O2	CIV_C0_O2
O	IV HP	0	Gas - O2	CIVHP_C0_O2
O	IV HP	III	Gas - O2	CIVHP_CIII_O2
C	EXT	IVHP	Gas - CO2	EXT_CIVHP_CO2
O	IVHP	EXT	Gas - O2	CIVHP_EXT_O2
U	0	I	Liquid - URINE	C0_CI_URINE
V	I	II	Liquid - Volatil Fatty Acids (VFA) diluted	CI_CII_VFA
H	IV HP	0	Liquid - H2O	CIVHP_C0_H20
Nh	II	III	Liquid - NH3 Ammoniaque	CII_CIII_NH3
No	III	IV	Liquid - NO3 Nitrates	CIII_CIV_NO3
No	IV	IV HP	Liquid - NO3 Nitrates	CIV_CIVHP_NO3
B	EXT	0	Solid - Edible BIOMASS (External Food)	EXT_C0_BIOMASSE_CONS
B	IV	0	Solid - Edible BIOMASS	CIV_C0_Biomasse_CONS
B	IV HP	0	Solid - Edible BIOMASSE	CIVHP_C0_Biomasse_CONS
BN	II	I	Solid - Non edible BIOMASSE	CII_CI_Biomasse_NCONS
BN	IV HP	I	Solid - Non edible BIOMASSE	CIVHP_CI_Biomasse_NCONS
BS	IV	I	Solid - BIOMASS (Spirulina excess)	CIV_CI_Biomasse_SPIRU
D	IVHP	EXT	Solid - Wastes	CIVHP_EXT_BIOMASSE_NCON
D	III	EXT	Solid - Wastes	CIII_EXT_BIOMASSE_NCONS

D	I	EXT	Solid - Wastes	CI_EXT_BIOMASSE_NCONS
F	0	I	Solid FAECES + liquid	C0_CI_Faeces

Table B. Description of the flows between MELISSA Loop compartments

Remark: All information in this document (particularly the precedent tables A and B, and the next diagrams have to be validated by all concerned partner of the project.

5.2 DIAGRAMS OF COMPARTMENTS :

We represent, in the figures 2 to 7, all diagrams of MELISSA loop compartments.

5.2.1 COMPARTMENT 0 :

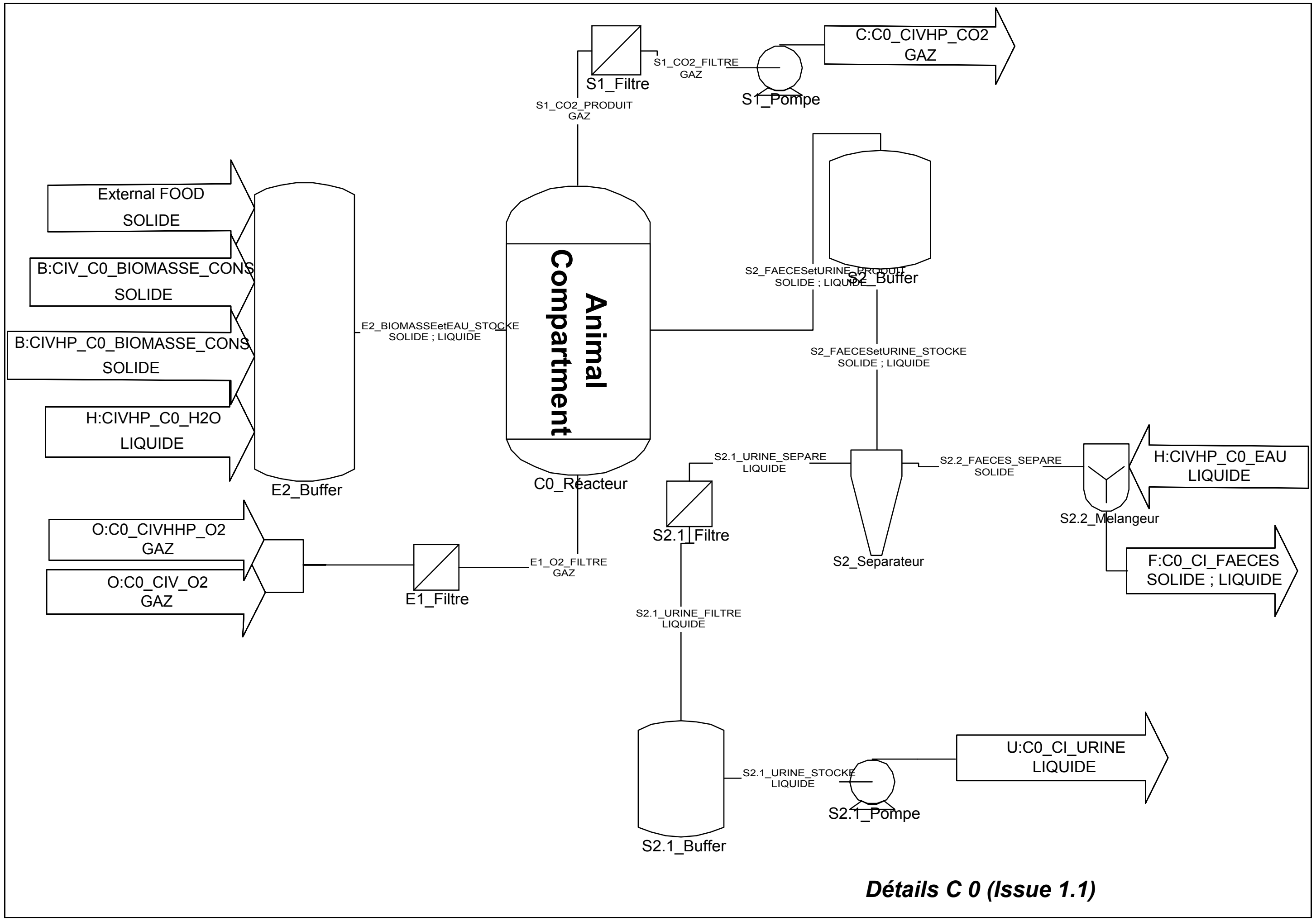


Figure 1 - General overview of Animal compartment configuration

5.2.2 COMPARTMENT I :

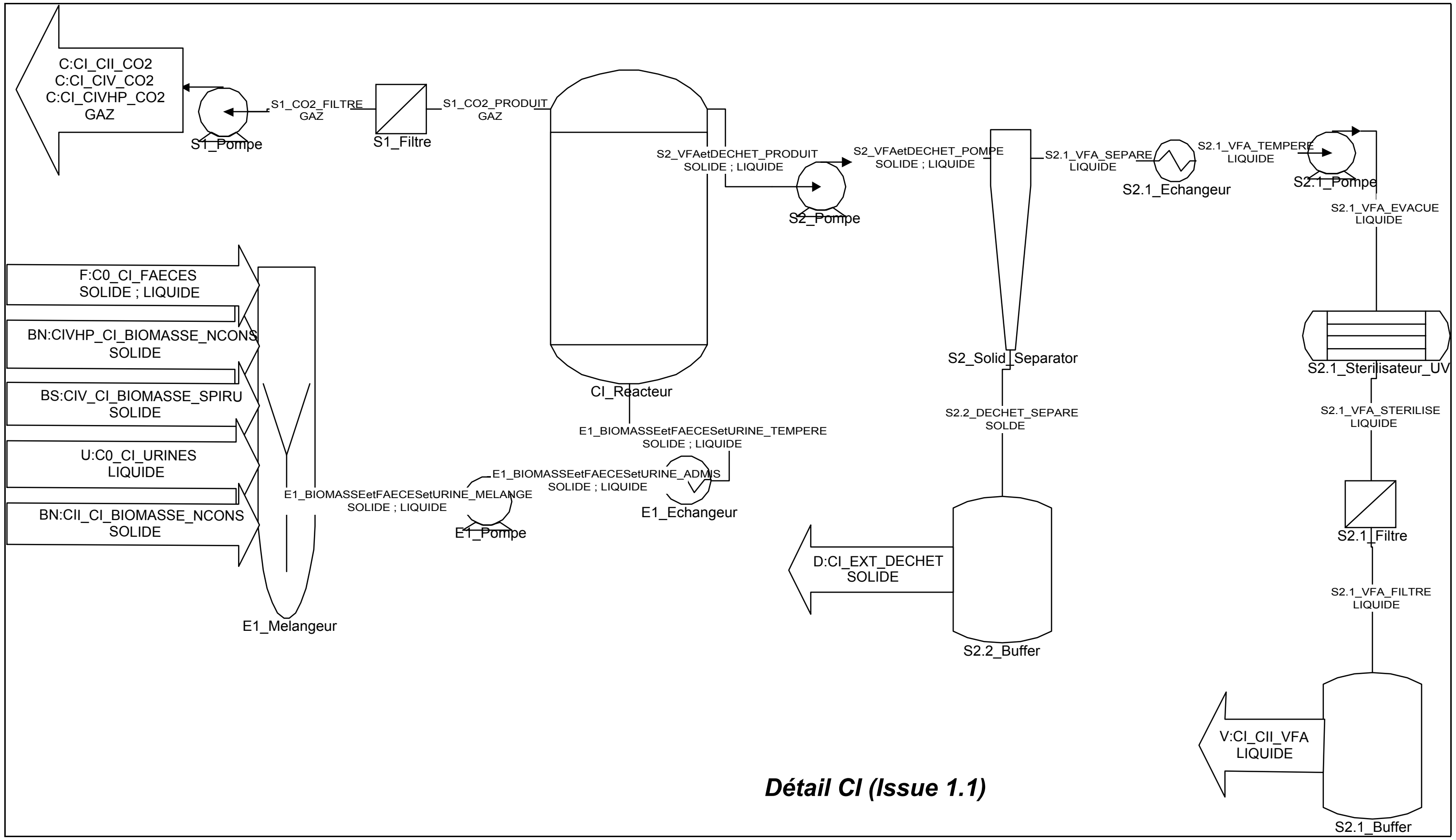


Figure 2 - General overview of compartment I interconnections

5.2.3 COMPARTMENT II :

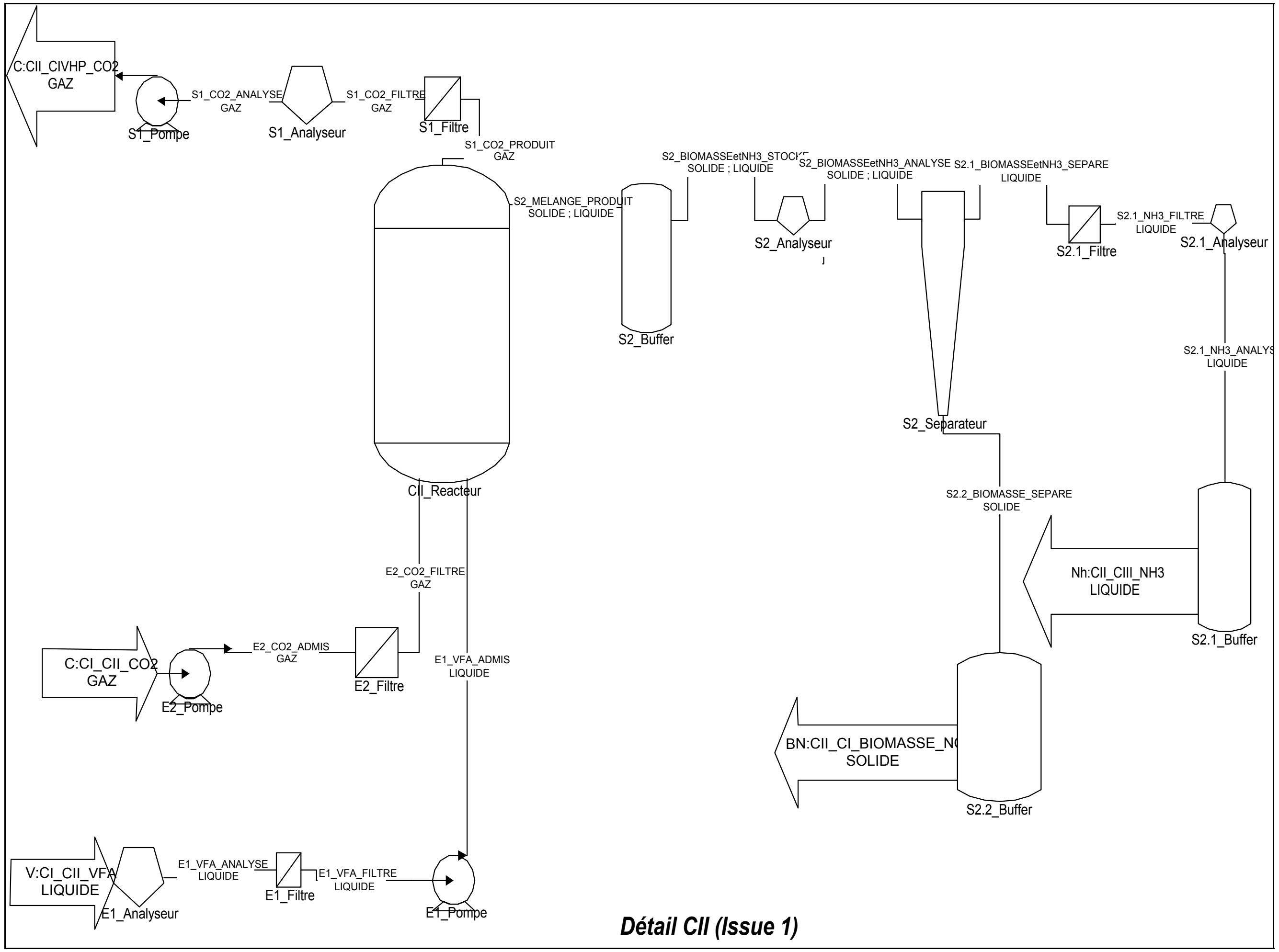


Figure 3 - General overview of Compartment II interconnections

5.2.4 COMPARTMENT III :

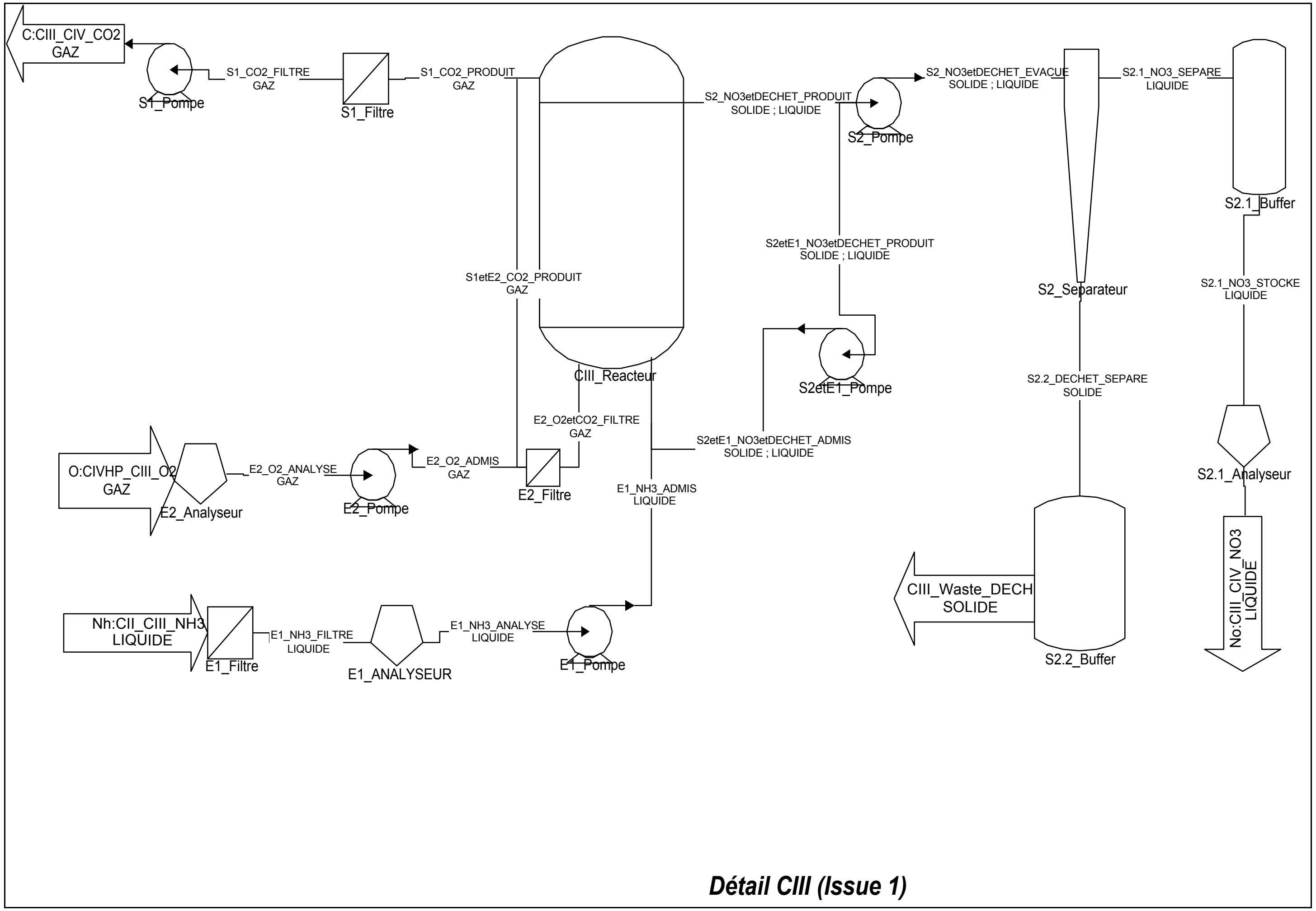


Figure 4 - General overview of Compartment III interconnections

5.2.5 COMPARTMENT IV :

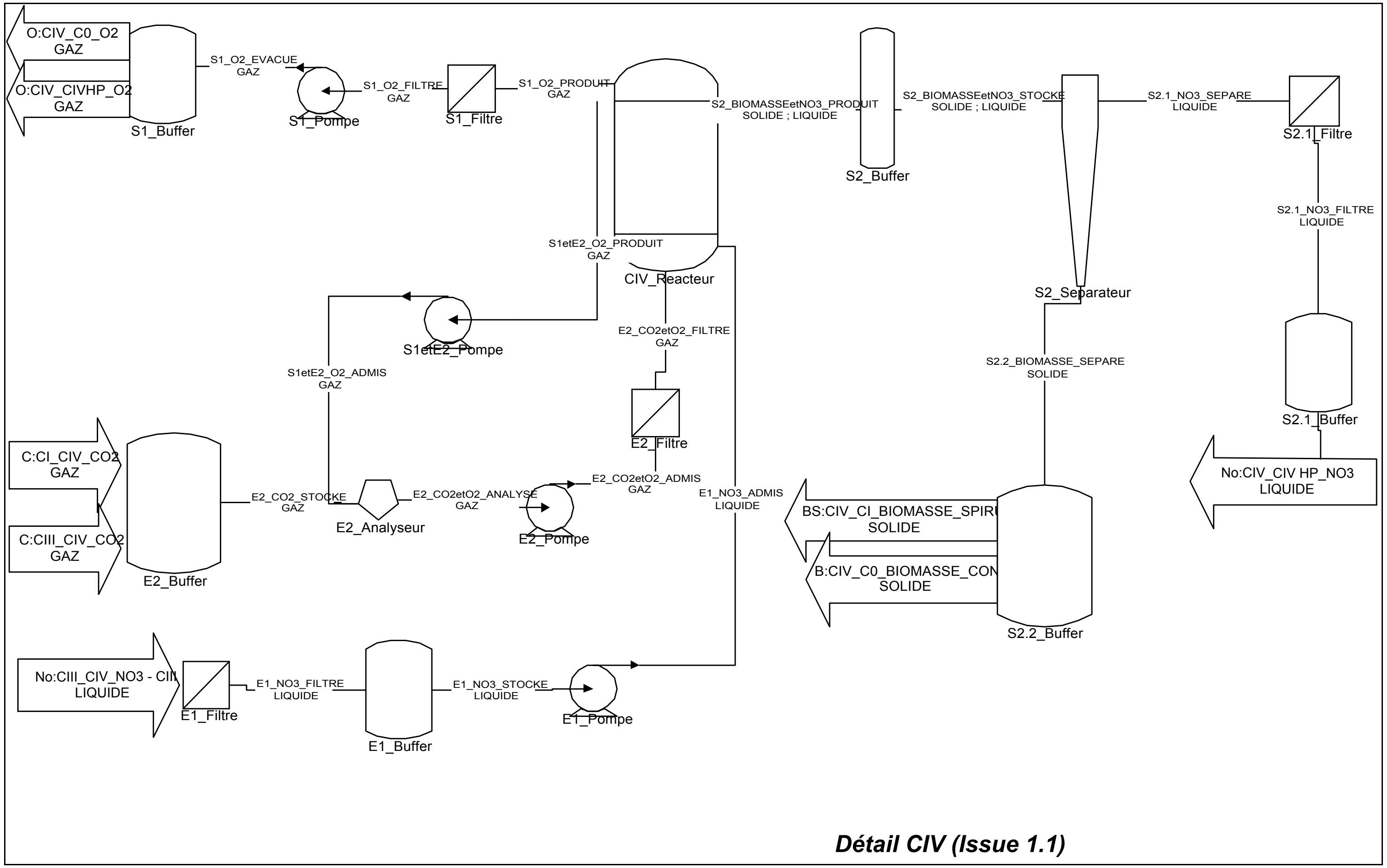


Figure 5 - General overview of Compartment IV interconnections

5.2.6 COMPARTMENT IVHP :

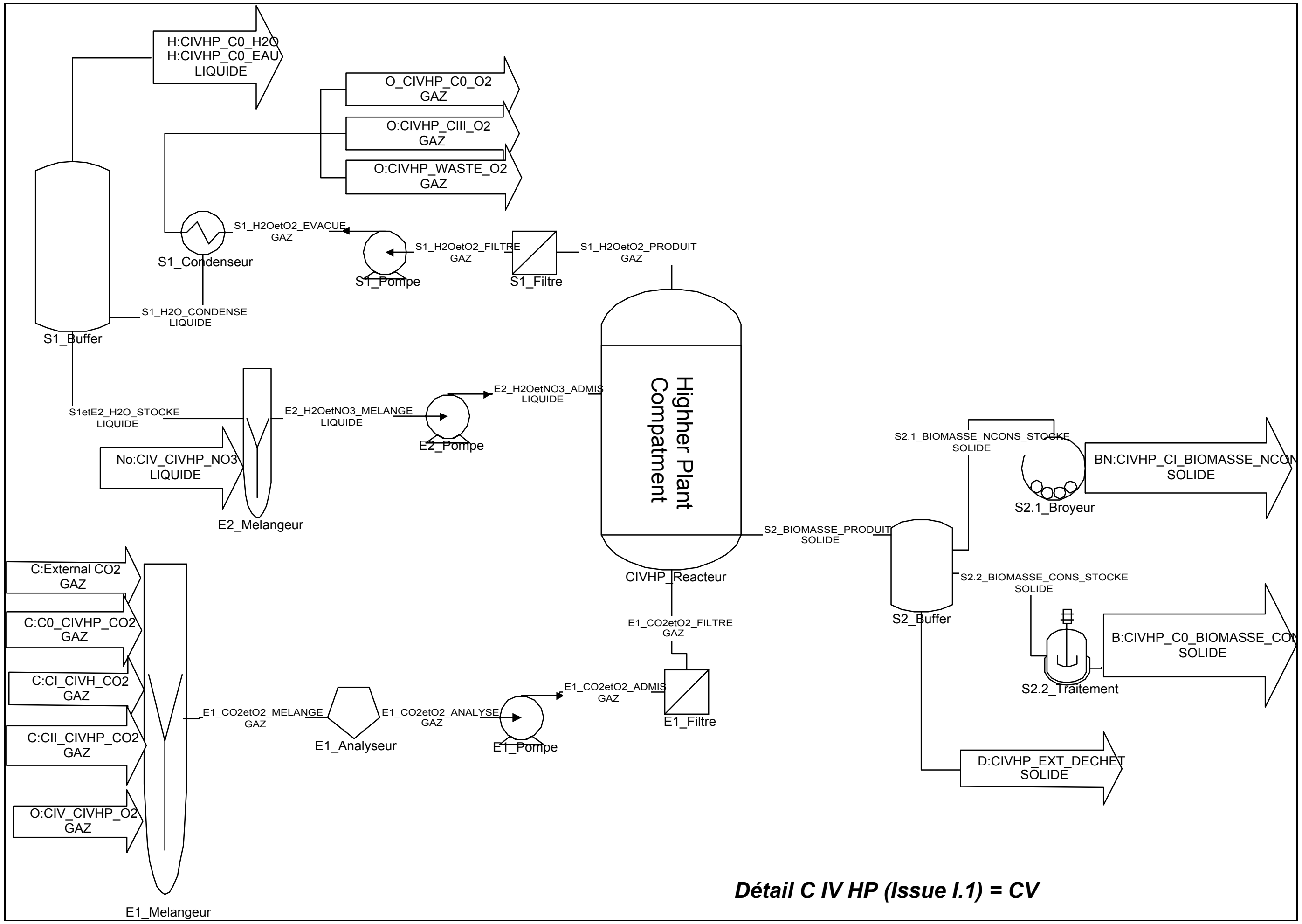


Figure 6 - General overview of higher plant compartment interconnections

6. MODELLING:

6.1 Hypothesis on the MELISSA loop :

⇒ For simplification, exchange flows between compartments will be assumed as perfect ones hence the non-necessity to represent them in the model.

⇒ MELISSA is modelled at its nearly highest complexity level. So, the reactor of each compartment is supposed to be one equipment fulfilling one function.

6.2 Elements of model :

6.2.1 General elements:

Equipment :

MELISSA general way of naming has been kept for describing entities in M3C description text files. Each equipment displays their text field created for this need: the different links that are tied between them and through which the flows being propagated are as the same nature as their specified links.
Equipments are described in an equipment description file. Their functions are specified and all links for other ones are listed.

Links :

In M3C models, flows are specified according to their physical state that can be one or either of the three different kinds: solid, liquid and gas.
The given kind of a flow must be specified.
If real nature of a flow is a mixing of two or three different kinds, a particular flow must be created in the model for each.

⇒ Solid link: medium propagation of the solid flows
⇒ Liquid link: medium propagation of the liquid flows
⇒ Gas link: medium propagation of the gas flows

Generally speaking, theses links will be seen on one hand, as a way to connect the different equipment which are the compartments, and on the other hand, as a support through which the different flows of the same nature as the links will propagate.

Functions :

A name has been given to the functions, which show the functionality equipment, and specify in the description assigned to this entity, the right role to play. So functions work as black boxes transforming input flows into output ones.

Flows :

For the flows, we have kept MELISSA project names The precise name and nature of this entity is stated in the description. Each flow shows in the field that is combined the link through which it is lead.

The MELISSA loop has been designed for the treatment of human and vegetal wastes and then to enable life on board a space shuttle. This one is made of all the flows moving across all equipments, to come back sometimes to their original equipment and be chemically transformed. To avoid theses problems that we can encounter with M3C, we suggest an appropriate coding as shown in the §4.

6.2.2 Others elements regarding the safety analysis:

The MELISSA loop is a recurrent process and intend a crew to live aboard a space shuttle. This one contains the compartments which are composed of machines dedicated to the treatment and to recycle the flows of any nature. For safety analysis application, we use the following functions in the MELISSA model:

MTTF calculus :

The MTTF (Mean Time To Failure) indicates the working time of an equipment before a first failure. This value must be calculated for each equipment, using a parameter formula.

<u>Syntax:</u>

Mttf Value ;

⇒ Mttf, is an indication for the program that a MTTF type value is required for an Equipment
⇒ Value, is the value given to MTTF

Others functions are used for time calculus in MELISSA model:

MTBF: Mean Time Between Failure
MTTR: Mean Time to Repair
MUT: Mean Up Time
MDT: Mean Down Time

Global MTTF calculus :

Global MTTF allows to handle a lot of equipment like those with MTTF that are equivalent to all required equipment.

<u>Syntax:</u>

Glob_Mttf Name { Equipment_start ; Equipment_end ; }

⇒ Glob_Mttf indicates for the program that we want to do a global MTTF calculus
⇒ Name is the name given to global MTTF that we want to calculate
⇒ Equipment_start and Equipment_end flank the Equipment that will use for the MTTF calculus

Calculus of flows:

The calculus of a flow which goes from an equipment 1 to an equipment 2, is carried out by the following syntax:

"Calculus_Flow PF1 {
Flow ;
Equipment1 ;
Equipment2 ;
}"

⇒ Calculus_Flow: Shows that we want to calculate the flow between two equipments
⇒ PF1: Name of this calculus
⇒ Flow: The flow to calculate
⇒ Equipment1: Start equipment
⇒ Equipment2: End equipment

We have two states of working for different entities (flows and equipment): Normal or HS (out of order). The user must specify for each of these entities:

En_Etat State ;

- ⇒ En_Etat: Shows that we want to define the working state of an entity
- ⇒ State: Normal or HS (out of order)
- ⇒ If equipment is in the HS State, then all the flows from this equipment will have zero value
- ⇒ If flow of an exit flows composition flows is in HS State, the resulting flow will have the zero value

Valeur V ;

- ⇒ Valeur: Shows that we want to give a value to a flow
- ⇒ V: Flow value

Output flows are computed using input flows by applying the following formula:

Flow leaving = Flow1*c1 + Flow2*c2 + Flow3*c3

Where Flow1, Flow2, Flow3, are the input flows, and c1, c2, c3, their related coefficients:

Coef {
c1 ;
c2 ;
c3 ;
}, In the output flow.

Input flows are defined according to the following syntax:

Dependences {
Flow1 ;
Flow2 ;
Flow3 ;
…
}

- ⇒ Dependences: Shows what are the input flows of an input one

We must have as many coefficients as dependences Flows. The program is designed like this:

- ⇒ If a F1 flow as depend the F flow is placed in HS state that its value is to « 0 », then the Flow F will be place to « 0 » value, and in HS State.
- ⇒ If Equipment is placed in HS State, then all the exit flows of this Equipment will be set in HS State, with a zero value.

In accordance with the coefficients and the value calculated for the exit flow, it is possible that the exit flow oscillates between certain values, which are considered like normal, out of order, or as an intermediate state. A threshold can be specified in order to take in consideration the alternation of flows values. If the flow is superior to this value, it is considered in a Normal state, otherwise it is in an HS state. Threshold syntax is:

Threshold Value ;

- ⇒ Threshold: Shows that the flow admit a limit value
- ⇒ Value: value of this limit

Calculus of the costs:

A cost parameter can be specified for each equipment. It can be defined using the following syntax:

Eq_cost Value ;

- ⇒ Eq_cost: shows to the program that we want to give a cost to Equipment
- ⇒ Value: shows the cost of this Equipment

7. CODING IN M3C :

7.1 Directory :

To describe a model, we must be placed in the models directory, and create a working directory. In this directory, we can open a file which has a « m3c » extent (example: MELISSA.m3c), and describe our model.

7.2 General elements of a model :

7.2.1 Equipment :

In the description file, equipments are written in accordance with the following coding:

"Compartment_Link _ Equipment_ N° of Equipment"

Example of coding :

⇒ C0_E2_Buffer: Compartment : C0
Link: E2 like entrance 2
Equipment: Buffer

⇒ CII_S2.1_Filter: Compartment : CII
Link: S2.1 like exit 2.1 (in this case, the S2 link is separate in lots of sub links)
Equipment: Filter

⇒ CIII_S2etE1_Pompe: Compartment : CIII
Common link between: S2 and E1
Equipment: Buffer

The equipment number is optional. However, It is getting necessary to show it when the same equipment is present once again on the same link.

The letters E and S indicates respectively the entrance and the exit of the Reactor. This one is written like this:

"Compartment_ Reactor" (example: CI_ Reactor, CII_ Reactor…)

Syntax example :

This is a syntax example regarding the filter at the entrance 1 of Reactor in the compartment C0:

```
// Bronche_E1

Equipment C0_E1_Filter{
Ent_Etat Normal ;
Description "O2 filtering" ;
Contact{ Gas ; }
}
```

7.2.2 Links :

In the MELISSA model, three Links are defined:

⇒ The Gas Link
⇒ The Liquid Link
⇒ The Solid Link

Example of syntax :

Here is the syntax of these three links:

```
/***********************
 *  COMMON LINKS  *
 ***********************/

Gas Link {
Description "Gas" ;
}

Liquid Link {
Description "Liquid" ;
}

Solid Link {
```

```
Description "Solid" ;
}
```

7.2.3 Functions :

The functions are written in accordance with the following coding:

"Compartment_Link_ Function"

Example of coding :

⇒ C0_E1_Filter : Compartment : C0
Link: E1 like entrance 1
Function: "Filter"

⇒ CII_S2.1_Analyze: Compartment : CII
Link: S2.1 like exit 2.1 (in this case, the link S2 is separated in lot of sub links)
Function: "Analyze"

⇒ CIII_S2etE1_Pump: Compartment : CIII
Link between the exit 2 and the input 1
Function: "Pump"

The Equipment Reactor function is described like this:

"Compartment _Reactor Function" (example: CIV_ Product_ Biomass)

Example of syntax :

This example regards the function "Filter" at the entrance1 of Reactor in the compartment C0.

```
// Link_E1

Function C0_E1_Filter {
Description "O2 Filtering" ;
Use_Equipment { C0_E1_Filter ; }
Inputs { CIV_C0_O2; CIVHP_C0_O2; }
Outputs { C0_E1_O2_FILTER ; } }
```

7.2.4 Flow :

Example of coding of the inter-compartment flows:

The inter-compartment flows are written in accordance with the following coding:

“Compartment _Link_ Flow_ Action suffered

⇒ C0_S1_CO2_FILTER : Compartment : C0
Link: S1 like exit 1
Flow: CO2 “filtered”

⇒ CIII_S2.1_NO3_SEPARATE: Compartment : CIII
Link: S2.1 like exit 2.1 (in this situation, the link S2 is separated in lot of sub links)
Flow : NO3 “separated”

⇒ CIII_S2andE1_NO3andWASTE_PRODUCT: Compartment CIII
Link between: S2 and E1
Flow : NO3 and WASTE product

Example of coding of the commons Flows :

That has the common flows between the compartments. They are described as follow:

“Original Compartment _destination Compartment _Flow”

We quote like example the following flows:

C0_CI_URINE: Urine Flow in moving from C0 compartment to the CI compartment

CIII_CIV_CO2: CO2 Flow in moving from CIII compartment to the CIV compartment

Example of syntax for commons Flows :

```
// FLOW Link_E1
Flow C0_E1_O2_FILTER {
Description "Input flow O2 Filtration" ;
```

```
Use_Link { Gas ; }
}
```

Example of syntax of commons Flows:

```
/*********************
 *  COMMON FLOWS *
 *********************/

Flow CIVHP_EXT_WASTE {
Description "Non edible Biomass non WASTE threw outside" ;
Use_Link { Solid ; }
}

Flow  CIVHP_EXT_O2 {
Description "Outside lack of oxygen" ;
Use_Link { Gas ; }
}
```

8. RESULTS :

8.1 Compilation of model :

For the model compilation, we use the Makefile given with the M3C code. So, that is advisable to enter in CYGWIN window the "make" command.

8.2 Directories of results files :

The files which result from the description file compilation will be created in the Bd and Htm directories.

8.3 Visualization of results

Once, the file is compiled without errors, we can visualize the obtained results:

8.3.1 Textual Visualization:

Text files:

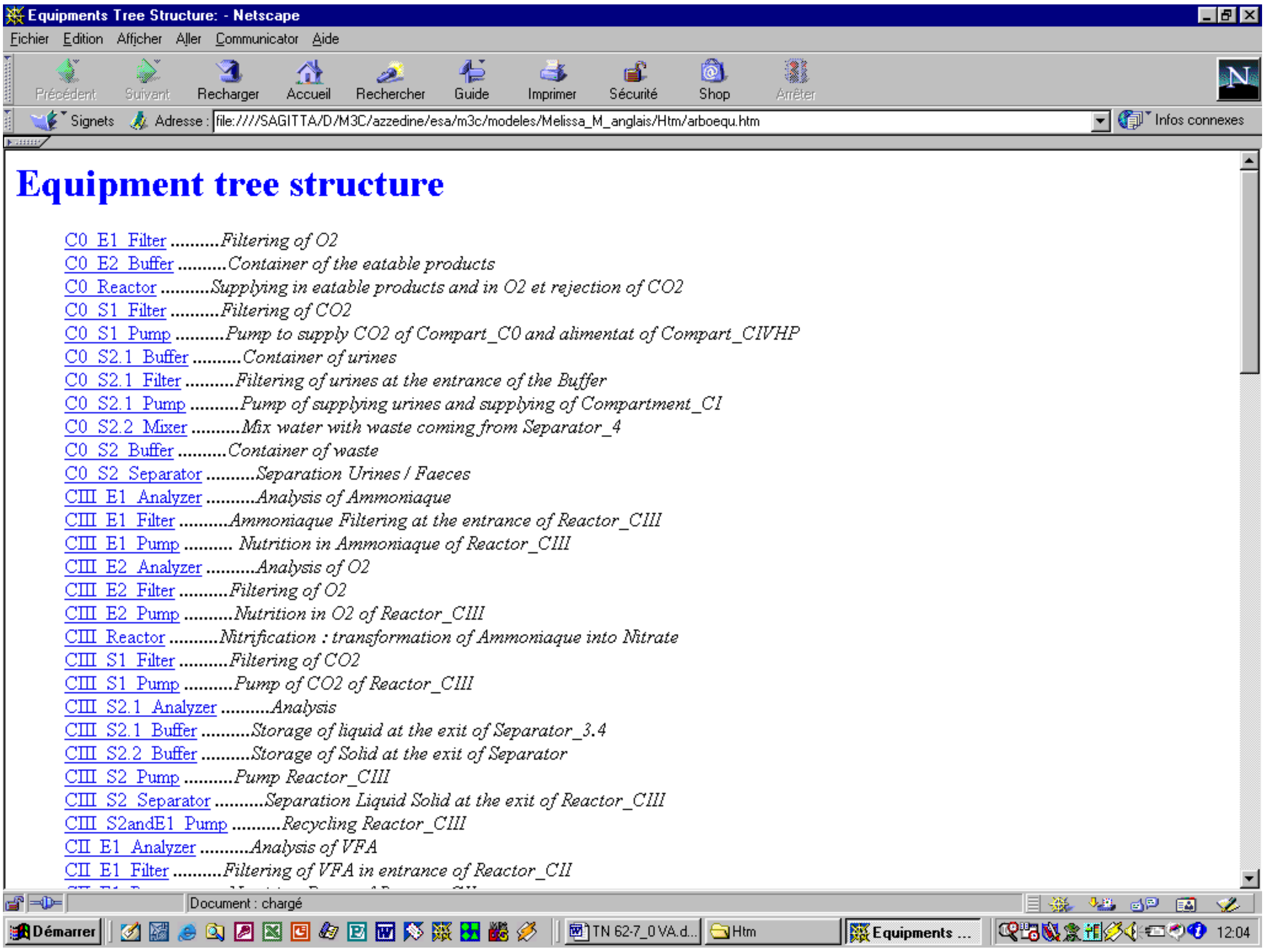
The “output.txt” files allows the visualization of result in textual shape.

HTML files:

The visualization of the “htm file” is carried out in the Htm directory. So, that is advisable to click on one of htm files or, to start Netscape Navigator and to open the required file.
The htm files possess the particularity to have at one's disposal reference links between the different htm files. That implicates the possibility to surf from one file to another by clicking on the elements of the opened file.

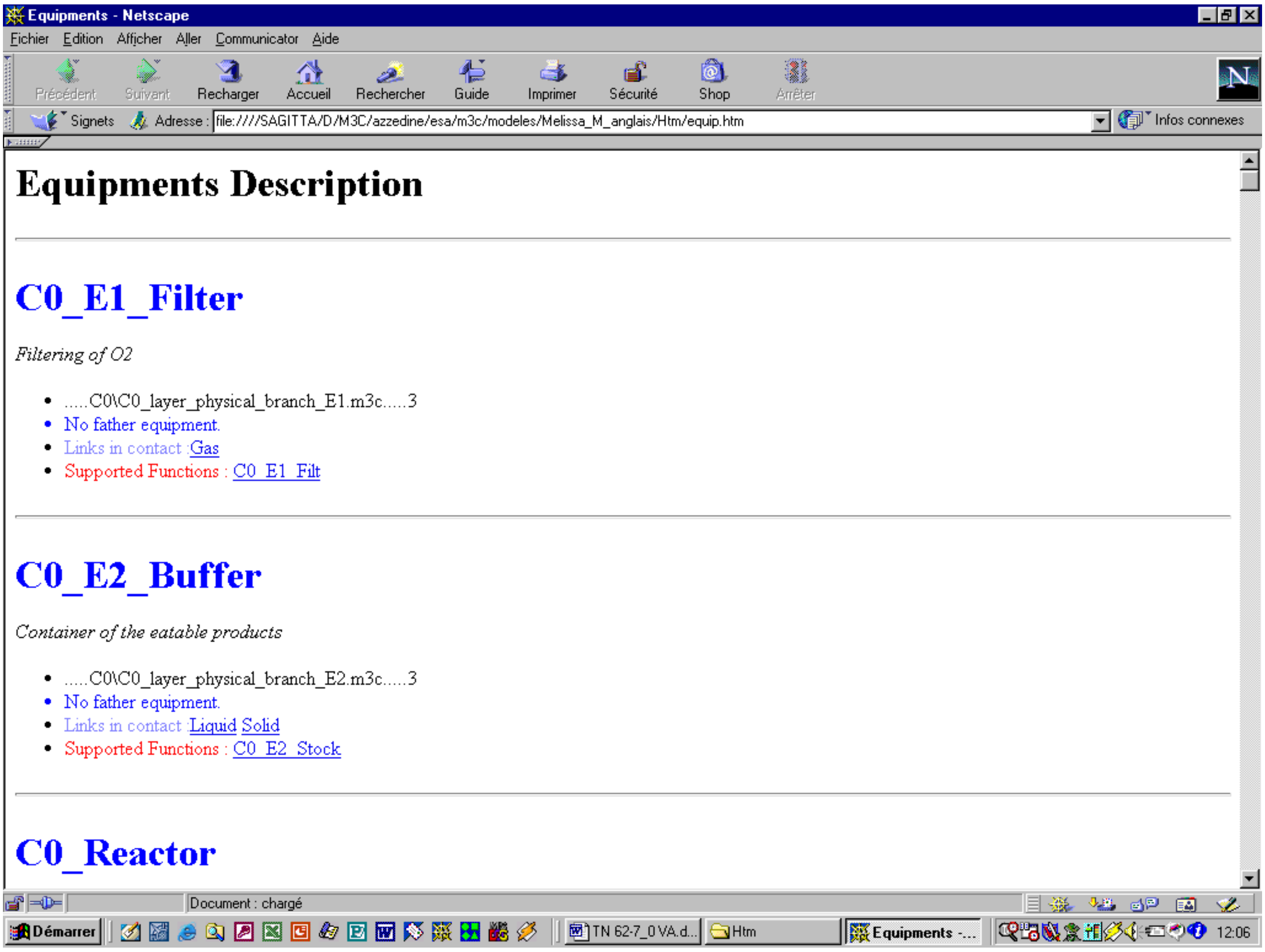
⇒ The arboequ.htm, arbofct.htm, arboflx.htm, arbolie.htm files, display the list of the respective tree diagrams of equipment, functions, flows, links.

⇒ The equip.htm, etat.htm, flux.htm, fonction.htm, lien.htm files, represent textually the respective entities: equipment, state, flow, function, link, and the entities, which they directly depend.



Window 2. arboequ.htm

Clicking on one of the Equipment of arboequ.htm file, opens the equip.htm file which contains all the Equipment and the entities that are directly linked (see window 3).



Window 3. equip.htm

⇒ The arbre.htm file, displays causality tree of physical and functional plans
⇒ The arbref.htm file, displays causality tree of functional plan
⇒ The doc.htm, displays causality tree of physical and functional plans without details
⇒ The ectrl.htm file, displays the entities list in shape of hierarchic trees, lists of the objects and causal trees.

8.3.2 **Graphical visualization :**

TCL/TK files:

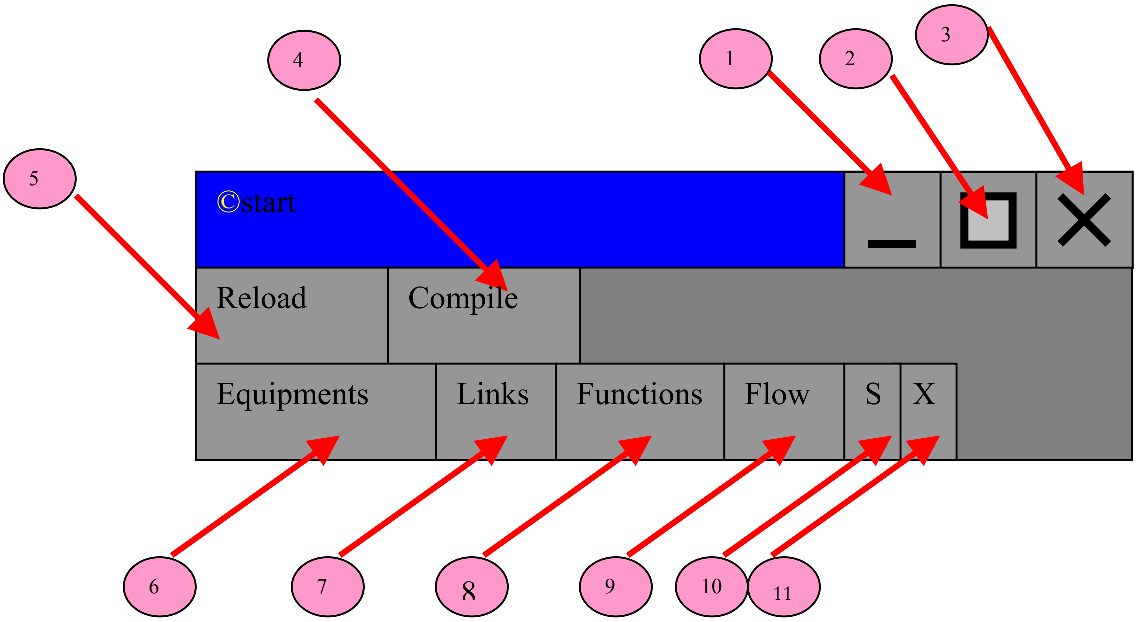
To visualize the TCL/TK graphical files in CYGWIN or in UNIX, it is essential to change the path in the "start.tcl" file, which is responsible for running of graphical application.

In this file, we must change the following parameters:

⇒ set common_m3c "c:\\Directory1\\Directory2\\common_m3c", showing the right path of common_m3c directory.

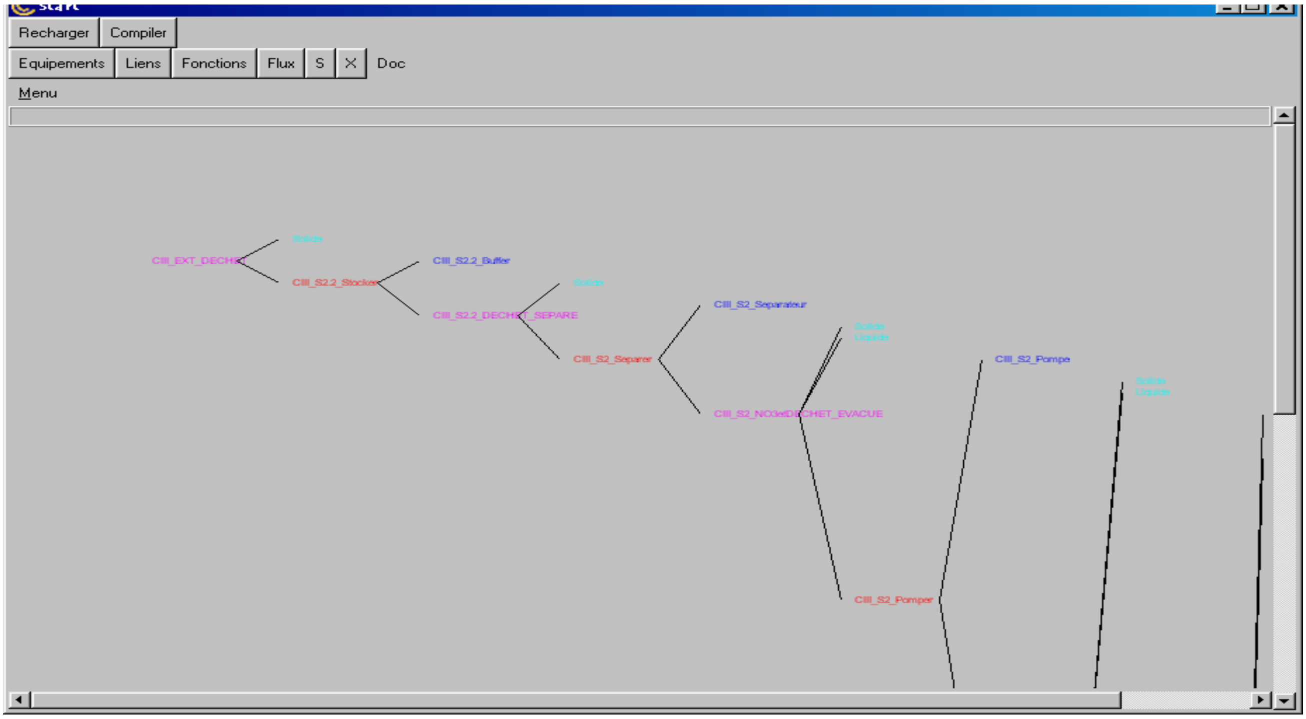
⇒ set directory "c:\\Directory1\\Directory2\\modeles\\Rep", showing the right path of work directory container the file of description.

Then, we can start the graphical application with the "./start.tcl" command.



The buttons numbers correspond to:
1. Minimal reduction of operating environment
2. Zoom total screen of operating environment
3. Close operating environment
4. When we change the description file, we must compile then load again to allow the new graphical version of the application.
5. When we change the file of description, we must compile then recharge to allow the new graphical version of the application.
6. Display the Equipment list
7. Display the Links list
8. Display the Functions list
9. Display the Flows list
10. Display the tree, which is composed of functional and physical plans
11. Display the tree compound of functional, physical and control plans.

Clicking on the S button, we will have the following result in the window 3:

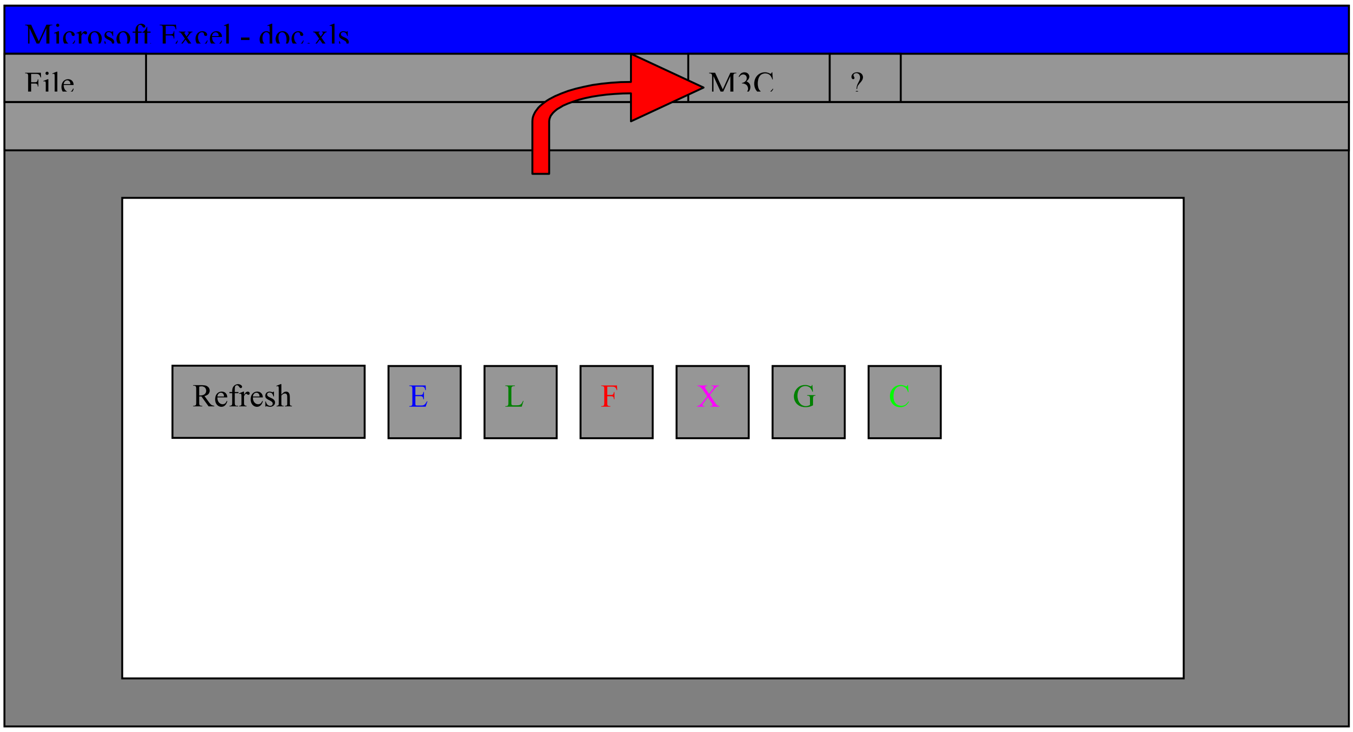


Window 4. TCL-TK screen

EXCEL files:

To visualize the graphical application in EXCEL, we must open the two files: doc.xls and m3c.xls, and activate the commands in EXCEL.

The visualization of doc.xls file allows to obtain this operating environment type:



Clicking on M3C icon, we must click on “reload file” to load again the description file. (See below diagram)

The different texts that appear when clicking on the M3C icon mean:

"Close file", close the description file
" Reload file", reload the description file
" Button => place button", place the buttons "drawing button" (see below figure)
" Button => suppress all buttons", remove the buttons "drawing buttons" (see below figure)
"Redraw links", draw the links which tie the Equipment
"Redraw links all figures", draw the Links which tie all the Equipment from all the figures
" Update texts and links", to update texts and links
" Colour texts", colour the texts

" Insert=> Equipment", to insert an Equipment
" Insert => Lien", to insert a Link
" Insert => Function", to insert a Function
" Insert => Flux", to insert a Flow
" Insert => Graph", to insert a Graph
" Insert => Control flow", to insert a control Flow

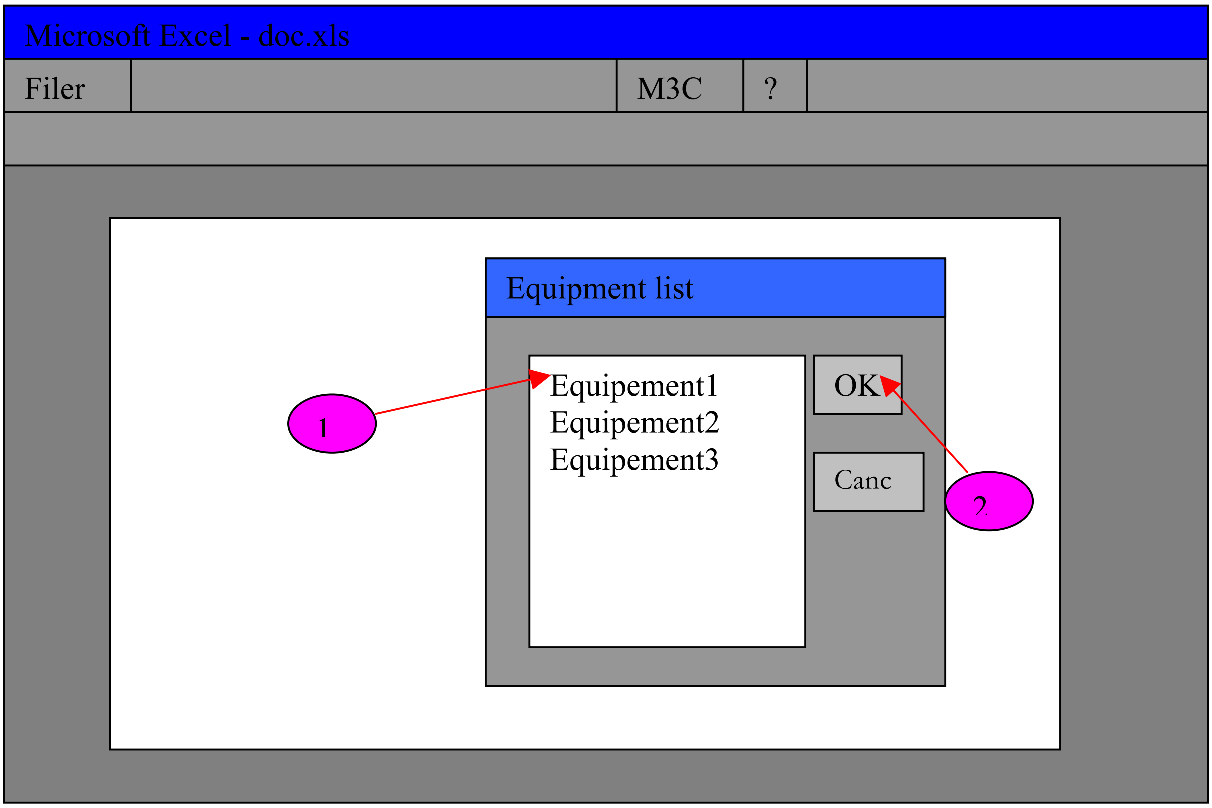
The draw buttons:

" Redraw", allows to draw the links
" E", allows to insert an Equipment
" L", allows to insert a link
" F", allows to insert a function
" X", allows to insert a flow
" G", allows to insert a control graphic
" C", allows to insert a control flow

To insert any entity, we must:

Click on "M3C", then "Insert", then "Equipment"
Or click on the “E” draw button.

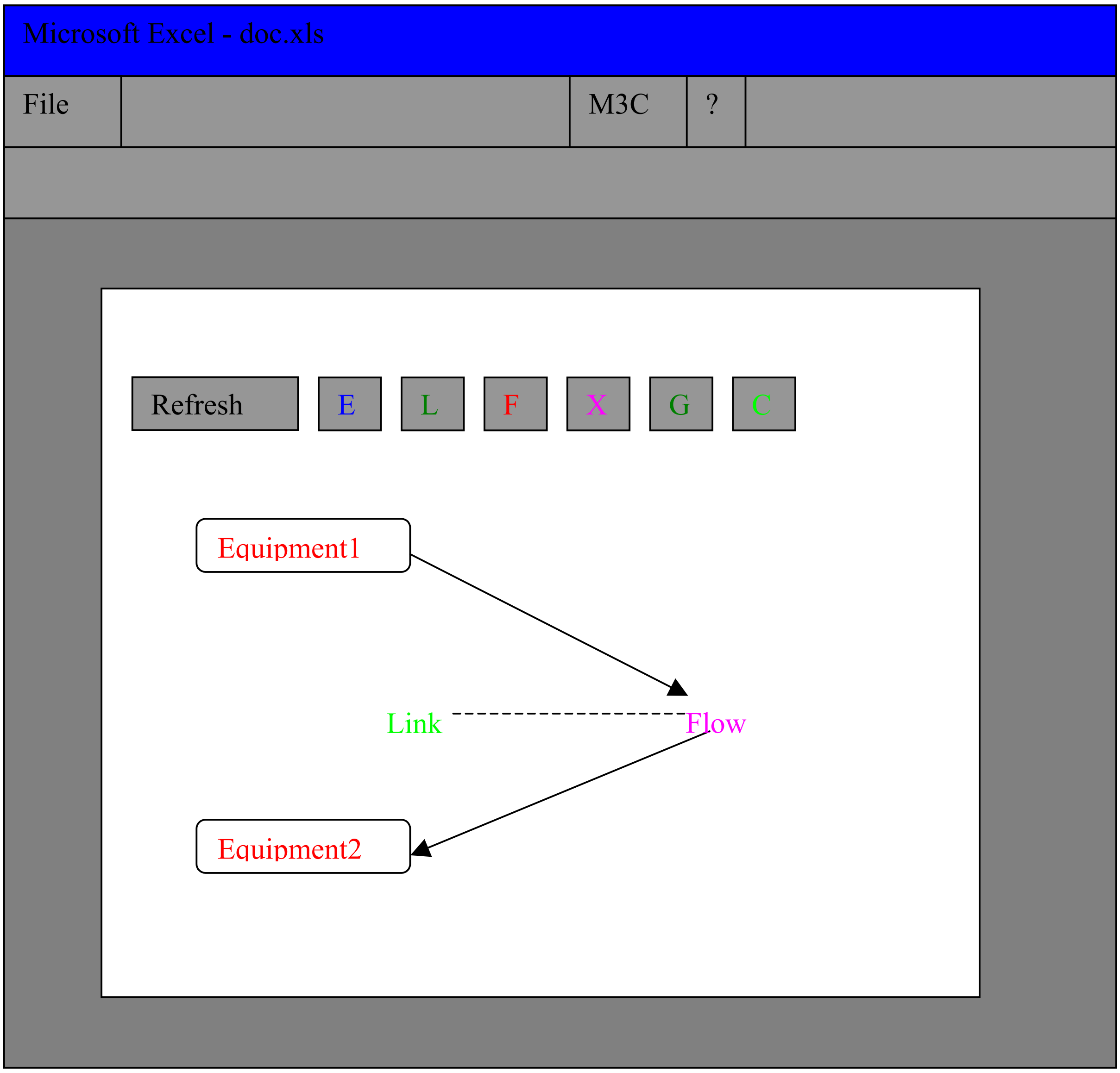
In that way, We obtain the following figure:



We have only to click on the required Equipment as shown on the figure (steps 1 and 2).

Then the required Equipment appears on the left superior corner of operating environment. We can click on this icon and translate it where we want.

Once the Equipment, Flows, Links and others entities are placed, we just have to click on the button "refresh", and the program draws the lines between the different entities with arrows:



In the above figure, we realize that the Equipment1 is linked to the Equipment2 by the Link1, which supports the Flow1 from the Equipment1 to the Equipment2.

9. CONCLUSIONS :

We have adapted a methodical analysis thought process for the modelling of a complex system like MELISSA process to study its safety working.

This method is presented in upstream from the design system. MELISSA loop modelling with M3C method is realized in order to study the assistance requirements, at the time of the MELISSA loop model definition and construction.

This model building is expressed by a construction methodology of models, supported by computer aids to check and validate the generated models. It is based on the description of the model in text file forms, which make possible a certain rigour for the model description, and an easier output process in a large editor range. It allows to obtain the following results:

- ⇒ model approach in three levels
- ⇒ simple visualization of model
- ⇒ rigour description of model
- ⇒ HTML model textual visualization, which allows to surf easier in the different levels of this one (this function does not request any additional installation, it is assured by Internet)
- ⇒ A graphical visualization in TCL/TK and EXCEL, which set a discussion base of the model and a graphical sight. This part will be improved in a following version of code (Cf. WP 66.5)

This model allows to calculate the following parameters:

- ⇒ Introduction of cost values and MTTF (Main Time To Failure) for each Equipment, which helps to decide and to select components to be introduced in a physical model
- ⇒ Calculus of Flow and introduction of Flows dependencies

10. DEVELOPMENT PROSPECTS

10.1 Standardisation and consolidation of MELISSA loop SDF models:

- Validation by partners
- Structure proposition for technical equipment data base
- Coupling of the technical data base with the models defined previously with M3C
- Upgrading of the models
- Data collection parameters of each equipment

10.2 Select a strategy and a process for safety analysis

- Analyse and discuss propositions of the TN 62.9
- Preliminary Risks Analysis
- Valuation (benchmark) and choice about software tools (go on with M3C and develop new functionalities, choice another software, …)