

ProtecSys System

Stakeholder needs

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1. INTRODUCTION

1.1. Subject

The subject of this document is to analyze, appropriate and formalize the needs of the stakeholders of the ProtecSys system.

1.2. Reference documents

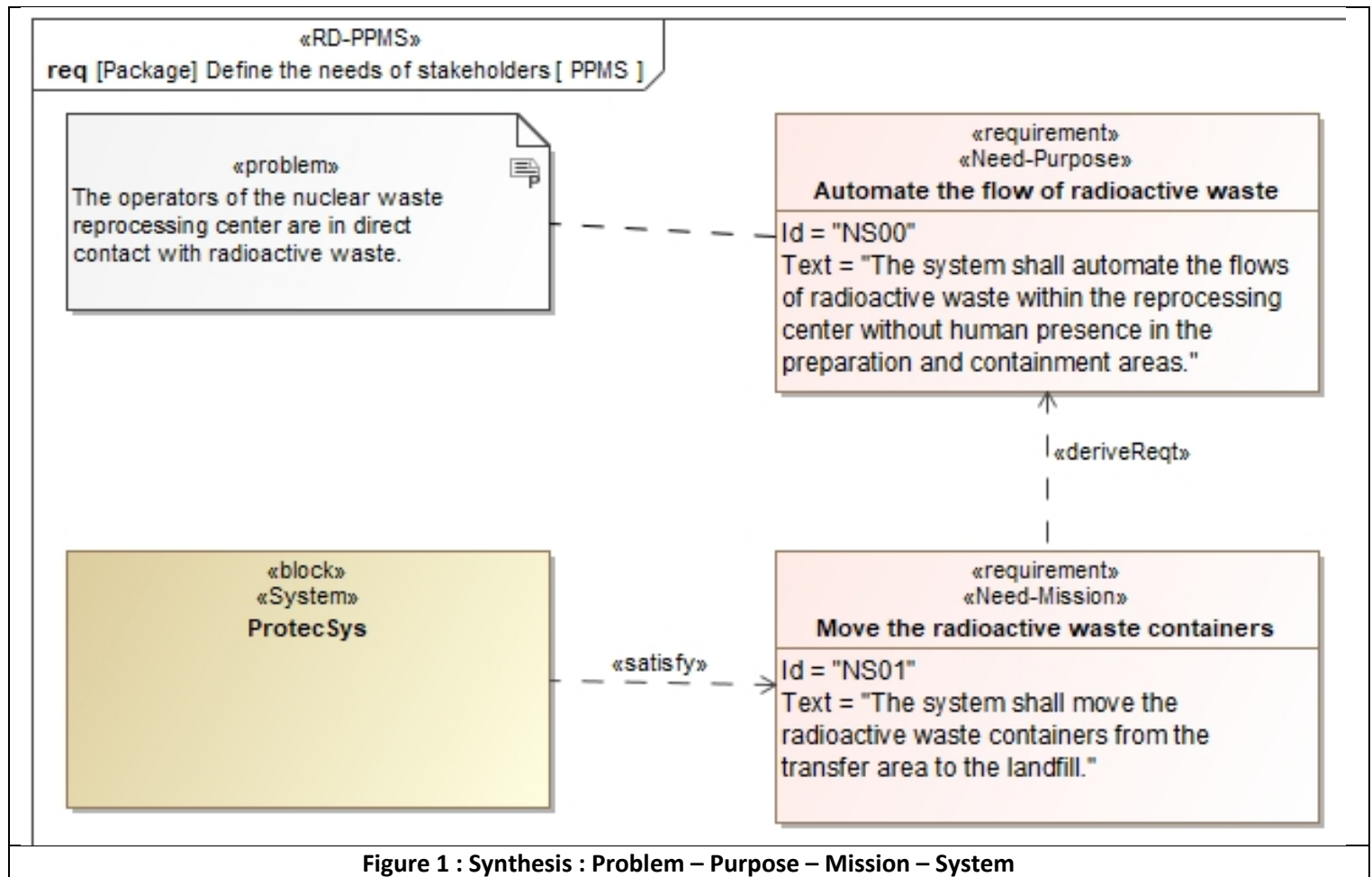
- Initial need : ProtecSys - ProtecSys_Initial need V1-0.pdf.

1.3. Terminology

In this document, the system studied is referred to as either the "ProtecSys System" or "ProtecSys".

In the same way, the robotic sub-system is indifferently named "Robot" or "Mobile Robot". The personnel integrated into the system are identified as part of the ProtecSys team of students participating in the contest.

2. DEFINITION OF THE SYSTEM MAIN MISSION



3. SYSTEM CONTEXT DEFINITION

This section identifies the stakeholders of the system to be done and the contextual elements in relation to the different phases of the system's life cycle.

3.1. Life cycle

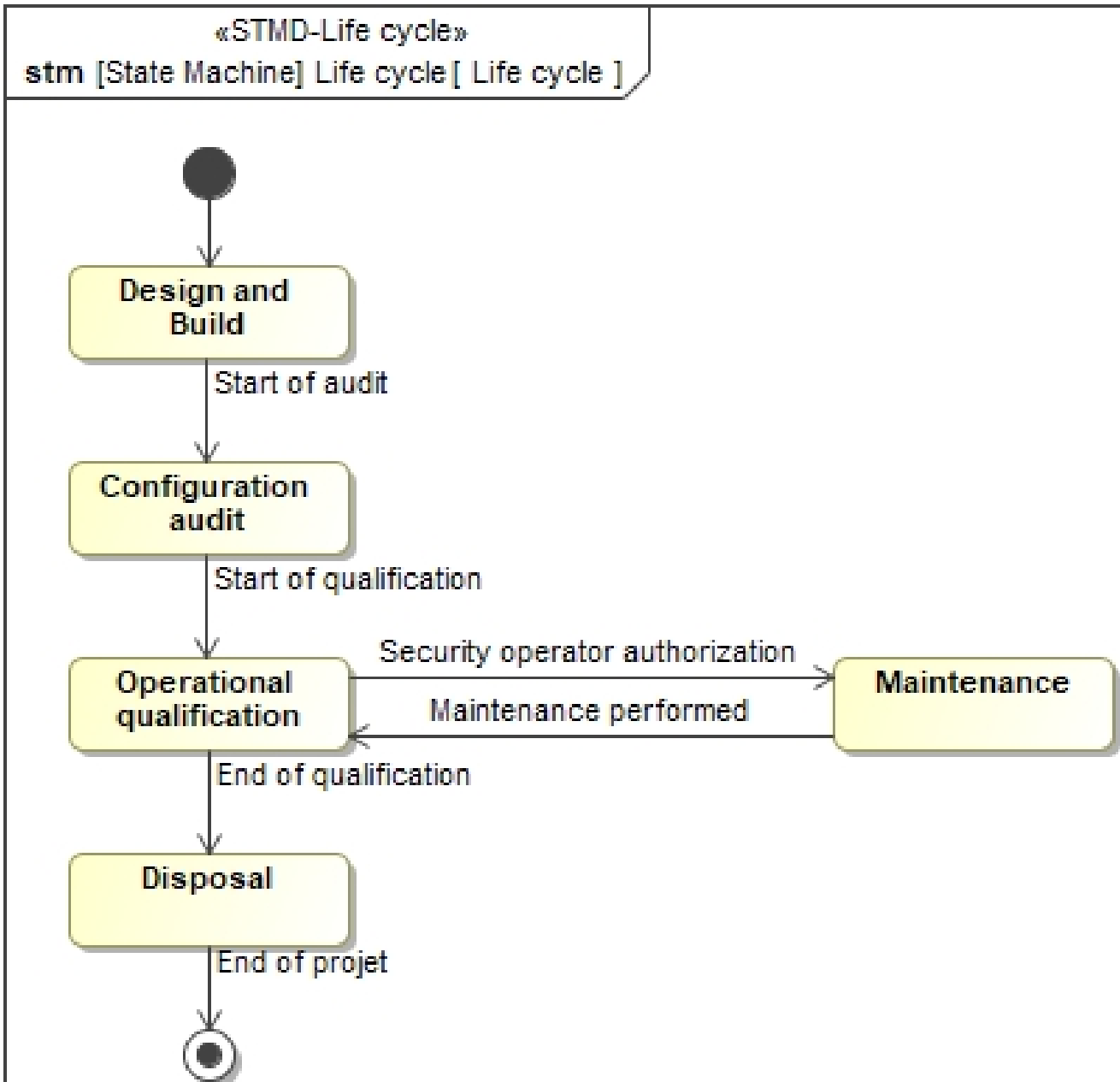


Figure 2 : Life cycle

3.2. Life cycle stage context

3.2.1. Design and Build stage

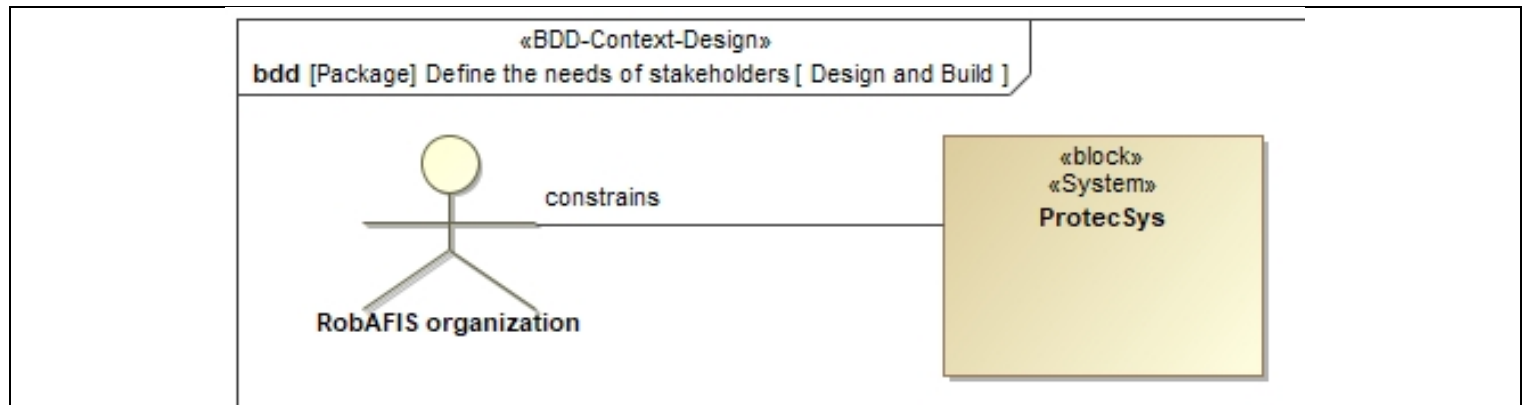


Figure 3 : Design and Build stage context

3.2.2. Configuration audit stage

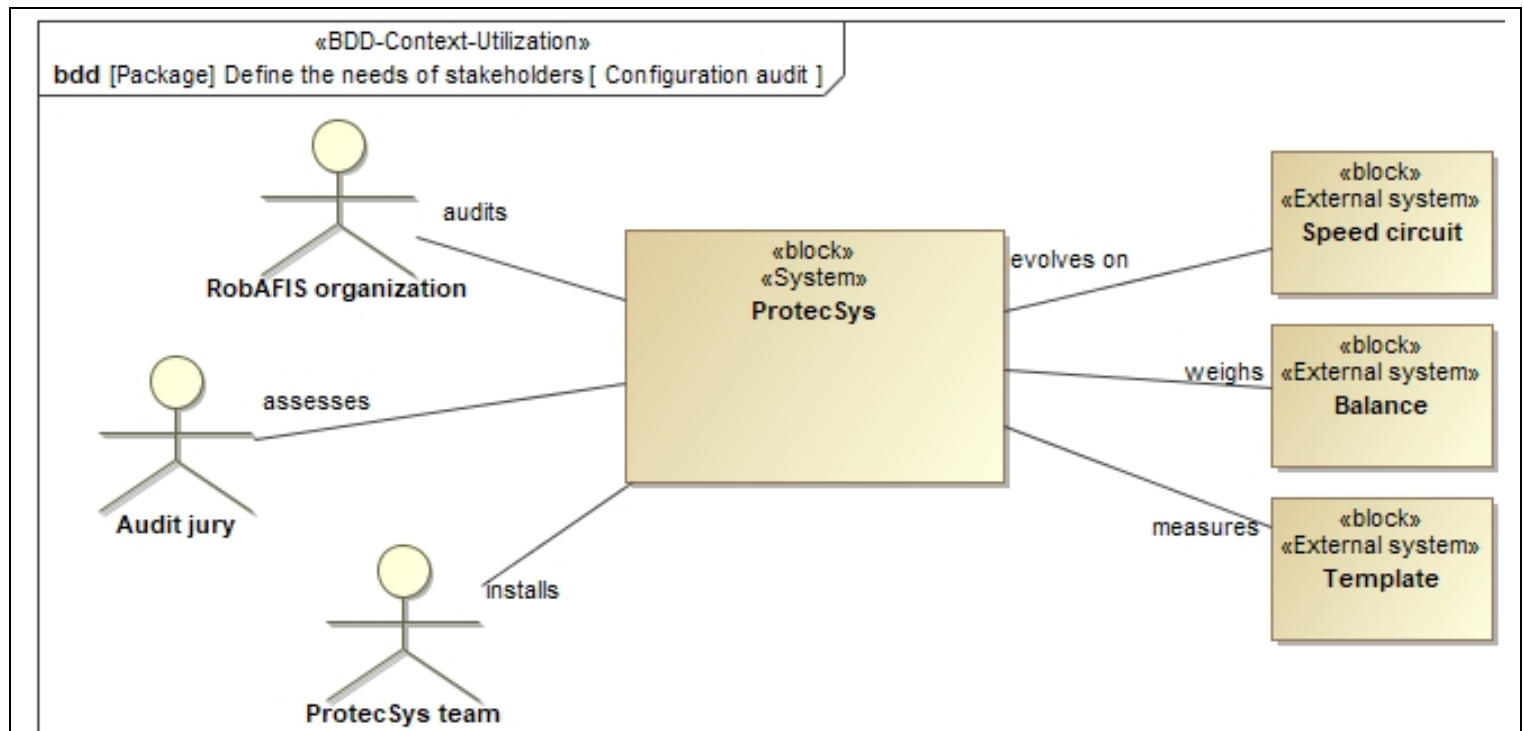
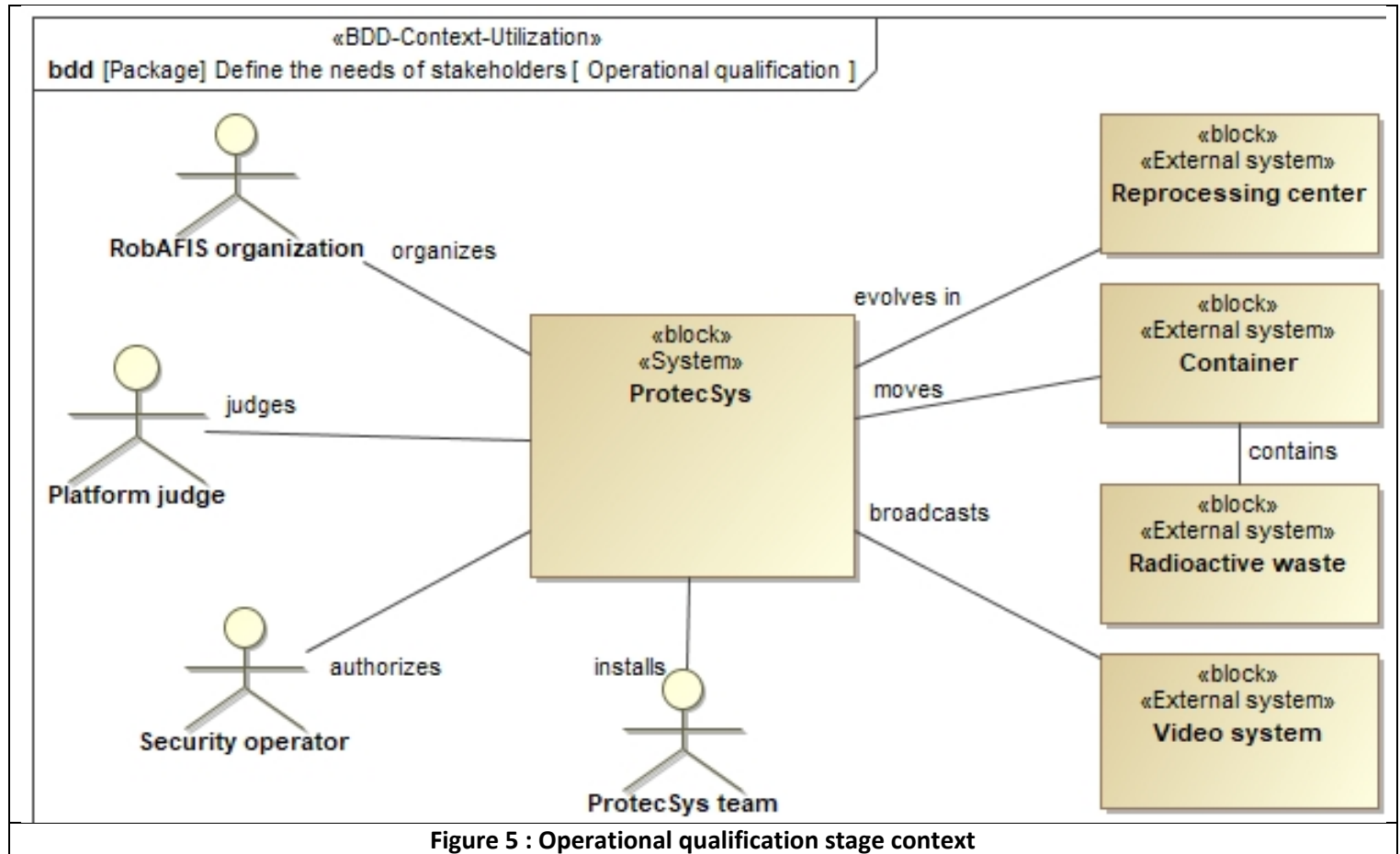
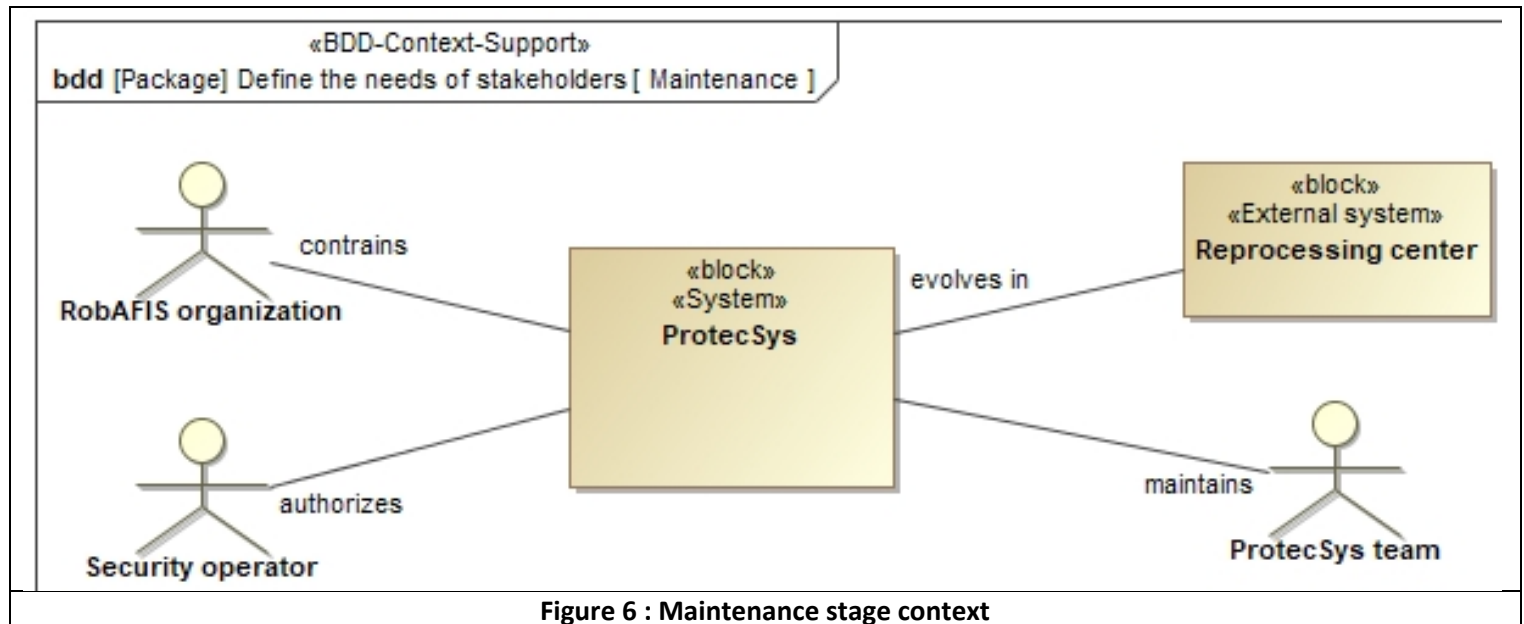


Figure 4 : Configuration audit stage context

3.2.3. Operational qualification stage



3.2.4. Maintenance stage



3.2.5. Disposal stage

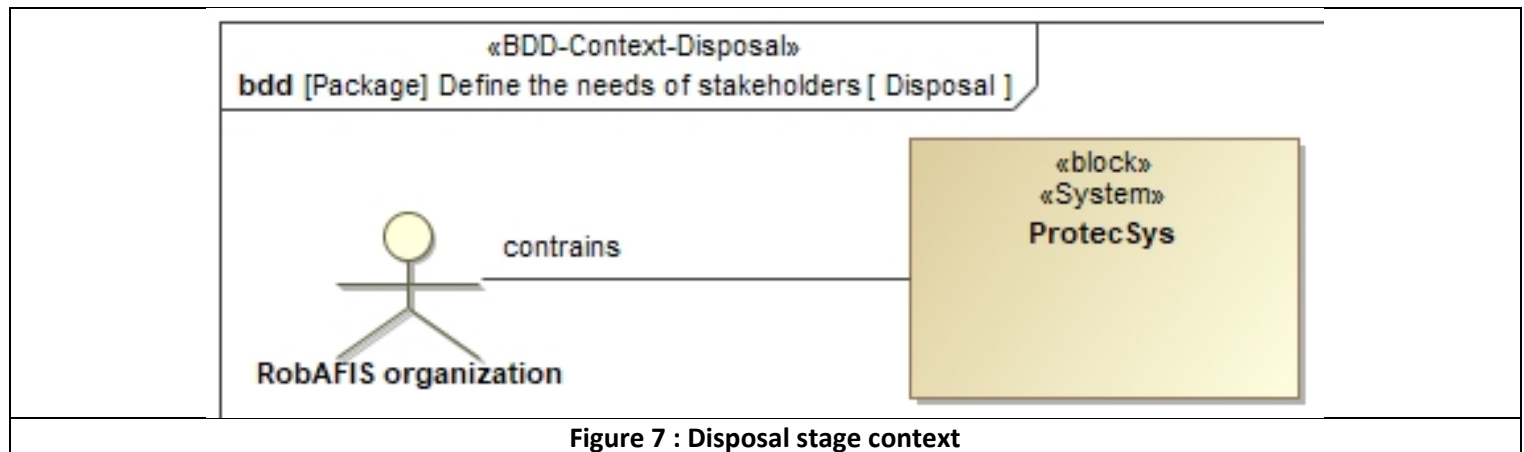


Figure 7 : Disposal stage context

4. DEFINITION OF THE SYSTEM'S USE

4.1. System concepts

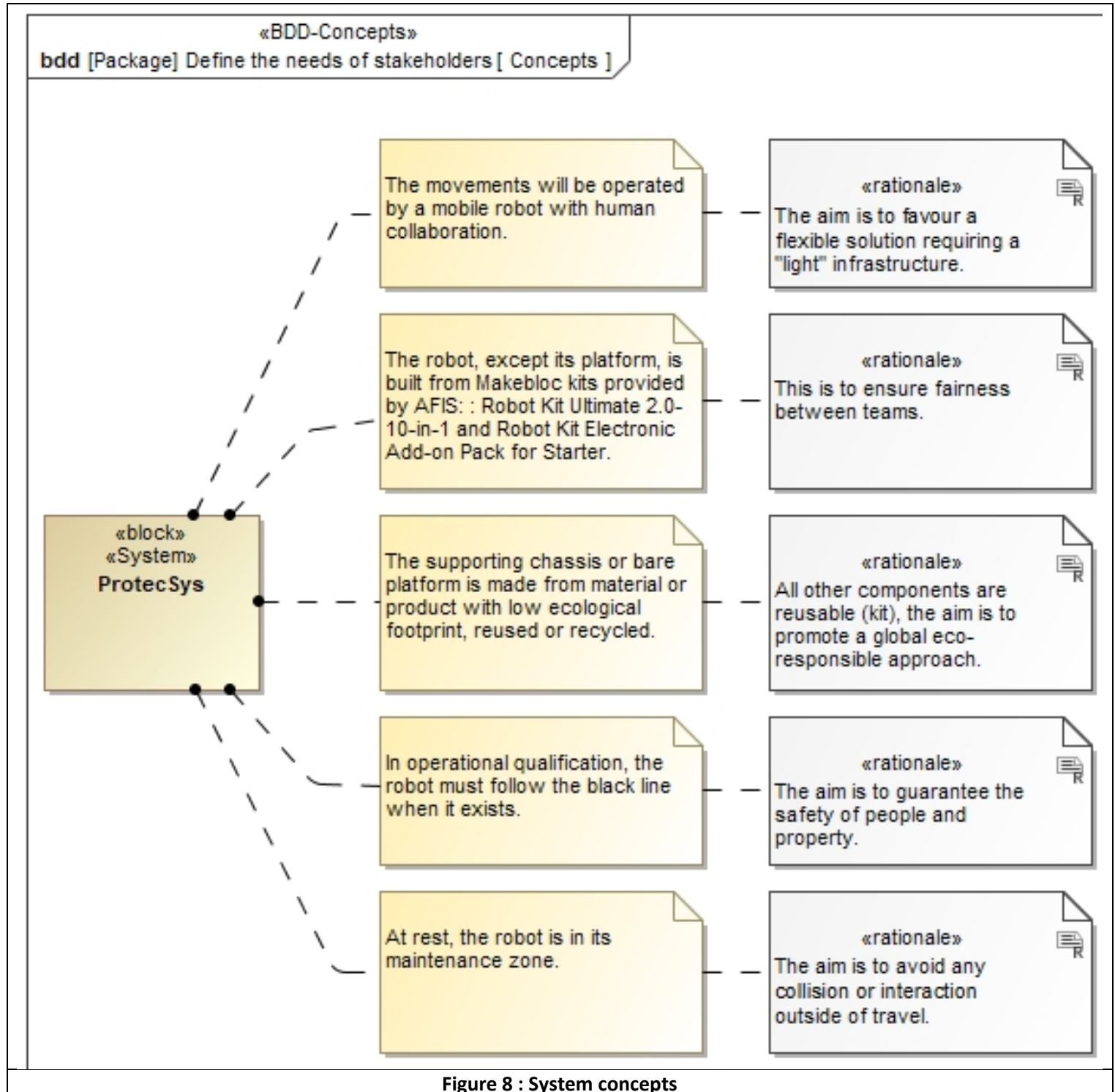
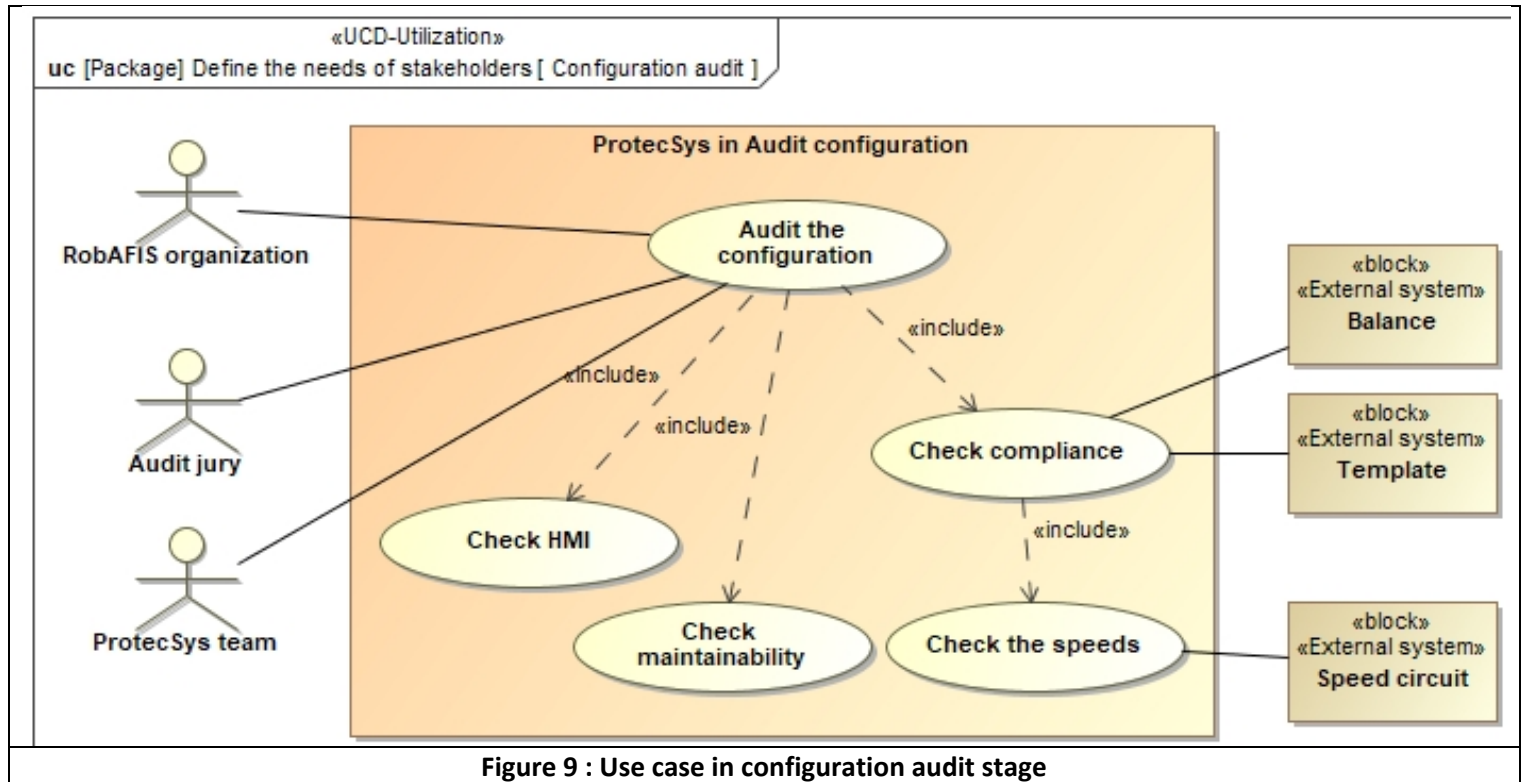


Figure 8 : System concepts

Here, the design and disposal phases do not give rise to use of the system. While the operational qualification and maintenance phases have been grouped together because of their common temporality.

4.2. Configuration audit stage



«UCD-Utilization»

uc [Package] Define the needs of stakeholders [Configuration audit - Scenarios]

Audit the configuration

- The RobAFIS organization calls the ProtecSys team to:
 - + Check compliance;
 - + Check maintainability;
 - + Check the HMI.

Check compliance

- A ProtecSys operator installs the robot on the scale;
- The audit jury takes note of the weight;
- A ProtecSys operator installs the robot in the dimensional template;
- The audit jury takes note of whether or not the authorized dimensions are respected;
- A ProtecSys operator positions the robot on the speed circuit in the start area;
- The audit jury gives the "top" start of the speed check.

Check the speeds

- The robot moves at a speed of 80 mm / s up to the red line;
- The audit jury notes the corresponding time and the speed displayed on the HMI;
- The robot moves at a speed of 15 mm / s to the arrival area;
- The audit jury notes the corresponding time and the speed displayed on the HMI.

Check maintainability

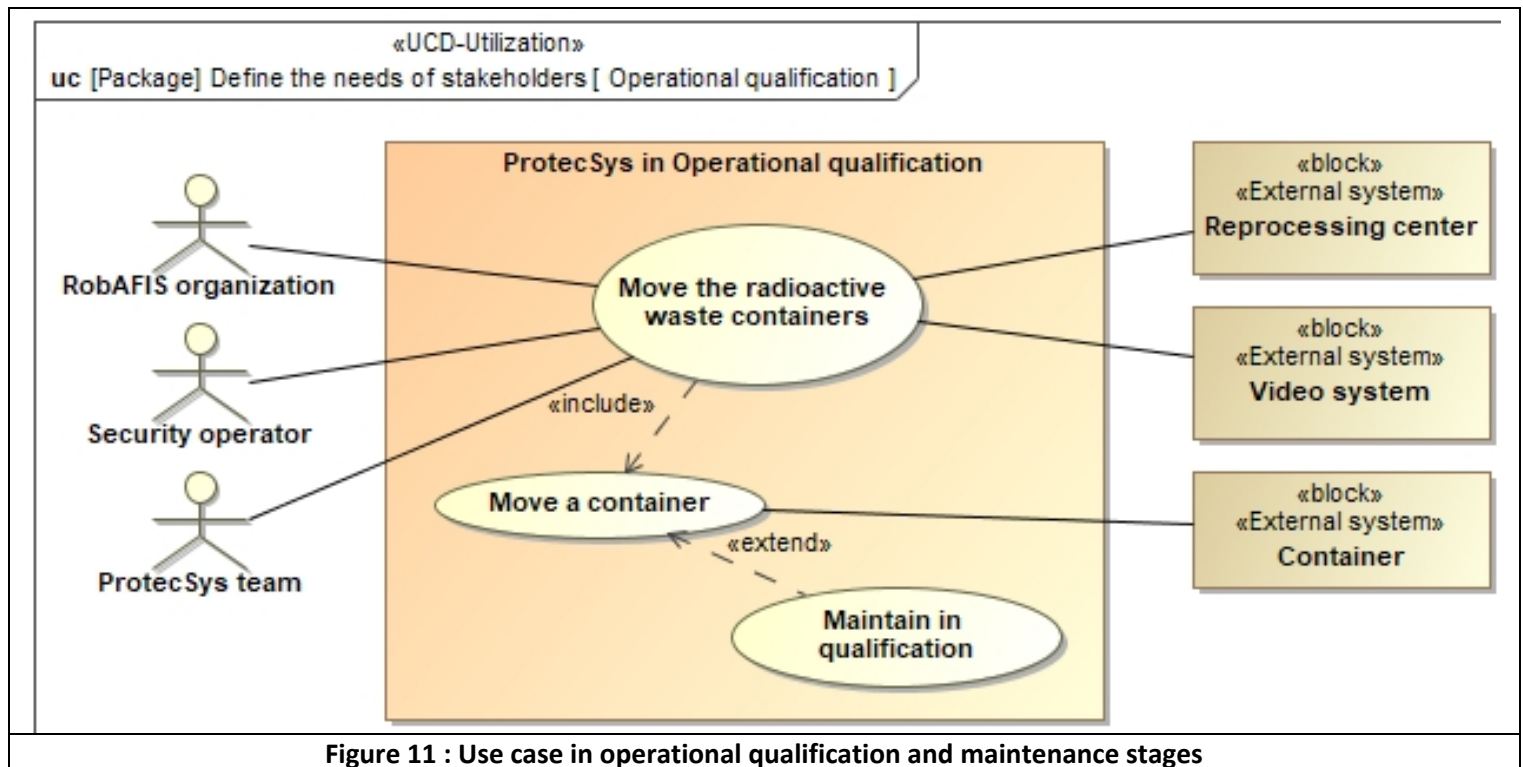
- The audit jury indicates one of the 3 maintenance procedures (change of the on-board energy reserve, change of an actuator, change of a sensor):
- The maintenance operator explains the documented procedure;
- The maintenance operator performs the maintenance procedure;
- The audit jury assesses compliance with its execution.

Check HMI

- The HMI is presented by the ProtecSys operators concerned;
- The audit jury assesses its characteristics;
- The audit jury takes note of the use to be made of it for an in situ evaluation during the operational qualification phase.

Figure 10 : Scenarios in configuration audit stage

4.3. Operational qualification and maintenance stages



«UCD-Utilization»

uc [Package] Define the needs of stakeholders [Operational qualification - Scenarios]

Move the radioactive waste containers

For each of the three qualifying rounds:

- The RobAFIS organization calls on the ProtecSys team to set up;
- The ProtecSys team installs ProtecSys:
 - + Position the robot in the maintenance area;
 - + Connects the video system for the public;
 - + Operators take their positions;
- The security operator gives the "top" start for moving a container.

Move a container

- The start of the robot is remotely operated by a ProtecSys operator;
- The robot moves to the loading area following the black line;
- The robot picks up the container;
- The robot moves to the entrance door of the containment area following the black line;
- The robot moves to the landfill area;
- The robot deposits the container;
- The robot moves to the exit door of the containment area by crossing the pre-filtration and filtration tanks;
- The robot moves to the maintenance area following the black line;
- The robot goes into standby mode.

In case of failure during the mission, a request can be made by a ProtecSys operator to the security operator, who authorizes or not a curative maintenance.

If the authorized time is exceeded or if a negative number of points is reached which does not allow the total number of points to remain positive, the security operator can stop the mission (total of 0 points in qualification). The robot is then remotely operated by a ProtecSys operator to be put in standby mode.

On return to the maintenance area, a request can be made by a ProtecSys operator to the security operator who authorizes or not a preventive maintenance.

Maintain in qualification

- In case of curative maintenance:
 - + Following a loss of the black line, the robot is remotely controlled by a ProtecSys operator to be repositioned before resuming the movement;
 - + In other cases of failure, only the case where the container is not yet taken care of allows the robot to be remotely controlled by a ProtecSys operator for a return to the maintenance area by following the black line. After maintenance by a ProtecSys operator, the route is resumed at the start.

- In the event of preventive maintenance, only the replacement, by a ProtecSys operator, of the on-board energy reserve is authorized.

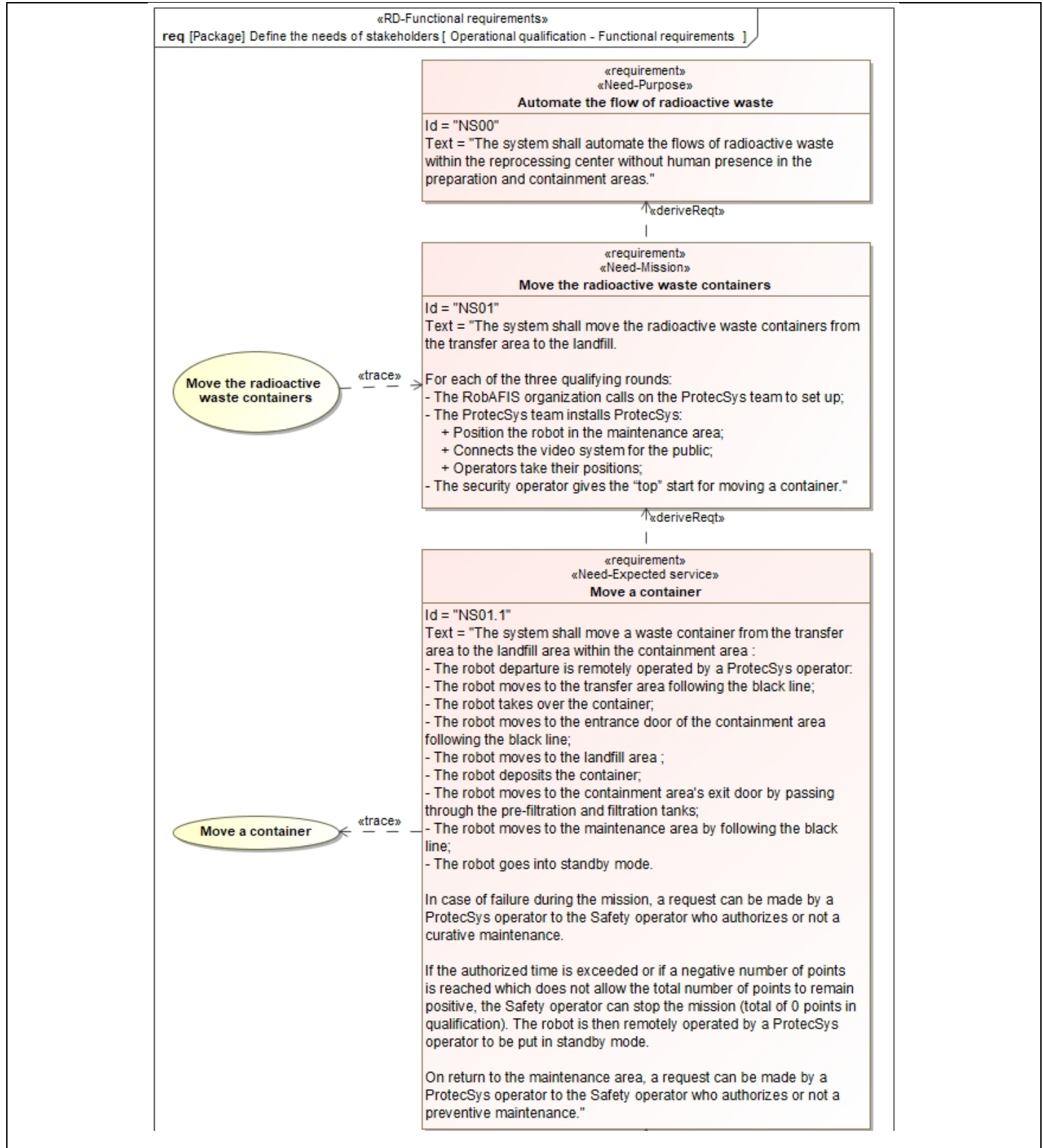
NB: In all other cases, there is a failure to move the container!

Figure 12 : Scenarios in operational qualification and maintenance stages

5. STAKEHOLDER NEEDS

5.1. Expected service needs

5.1.1. Operational qualification and maintenance stages



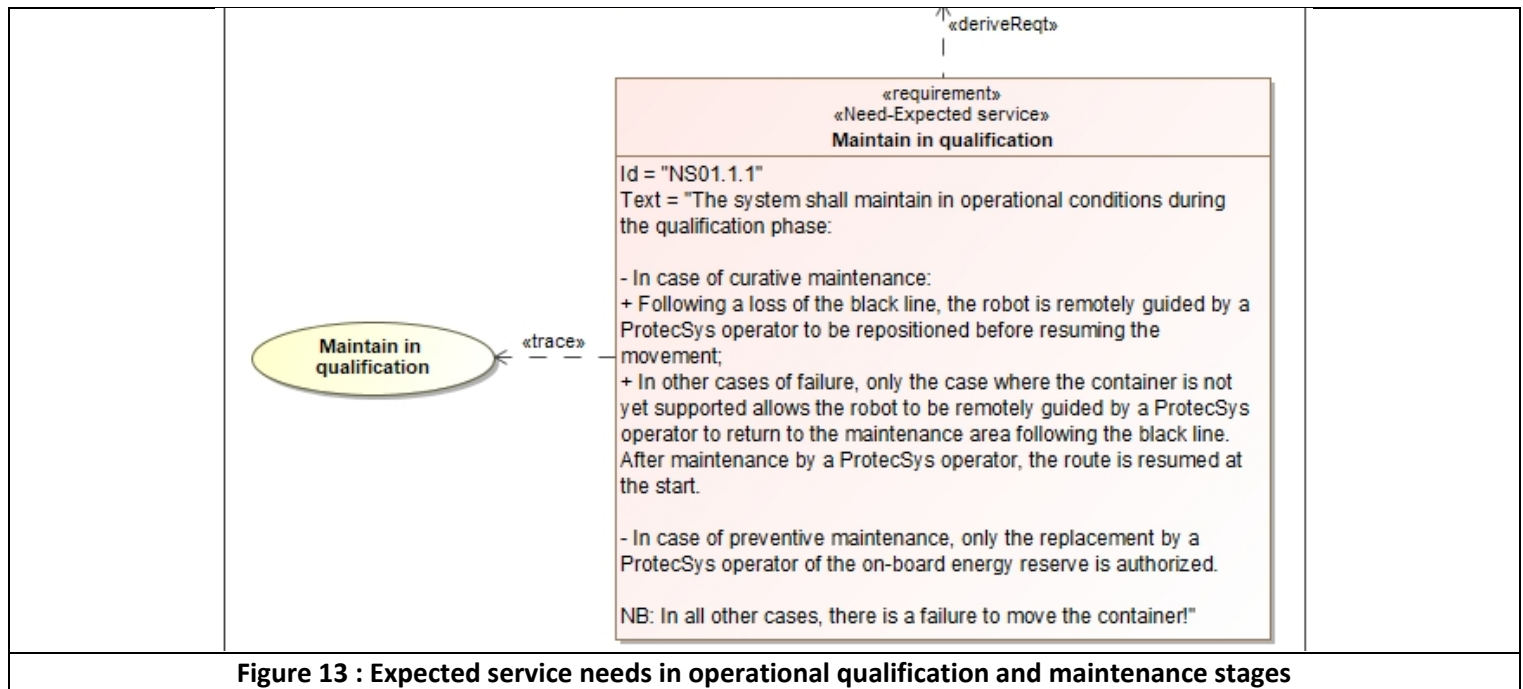
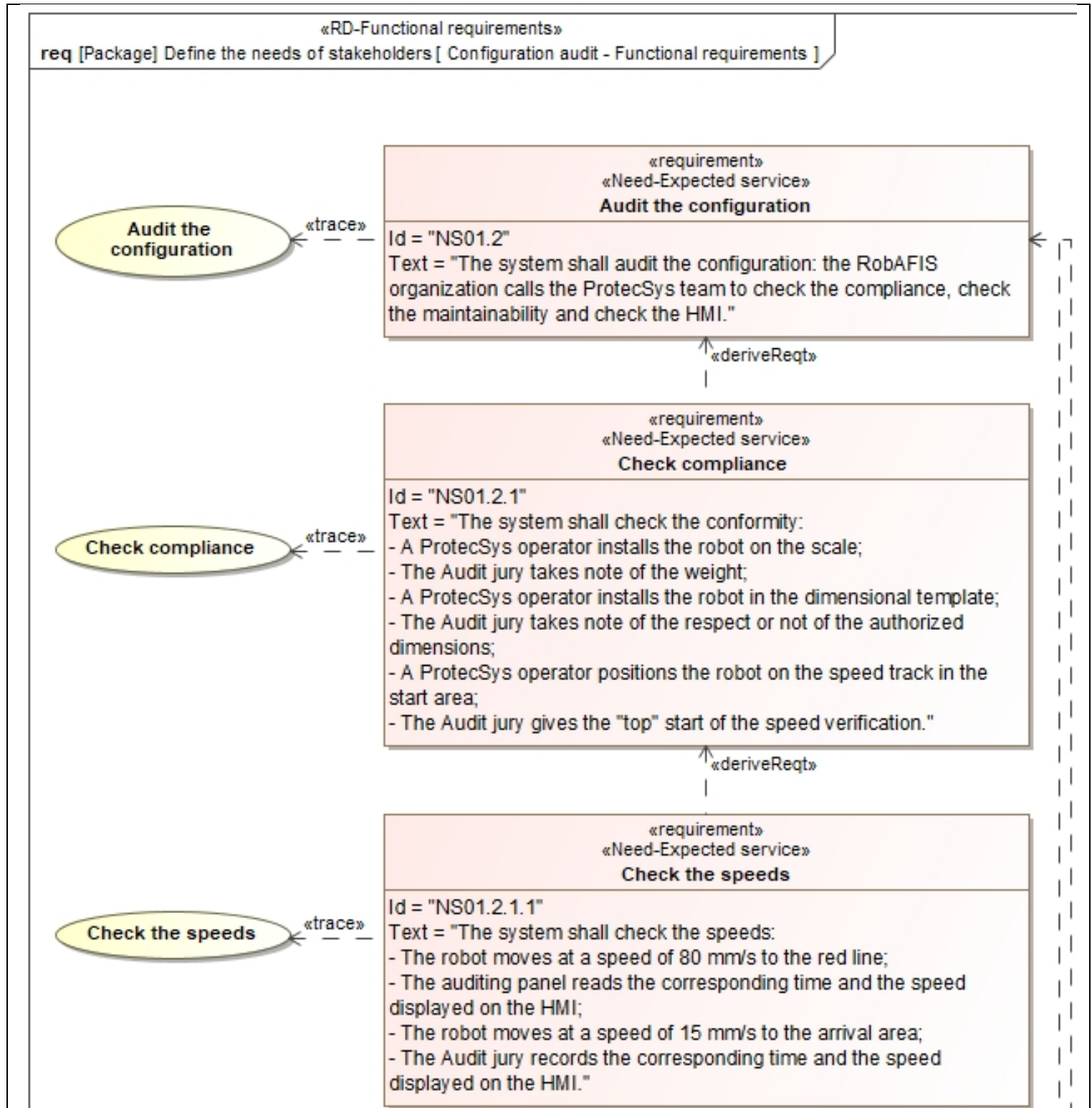


Figure 13 : Expected service needs in operational qualification and maintenance stages

Identifier	Need name	Description
NS00	Automate the flow of radioactive waste	The system shall automate the flows of radioactive waste within the reprocessing center without human presence in the preparation and containment areas.
NS01	Move the radioactive waste containers	The system shall move the radioactive waste containers from the transfer area to the landfill. For each of the three qualifying rounds: - The RobAFIS organization calls on the ProtecSys team to set up; - The ProtecSys team installs ProtecSys: + Position the robot in the maintenance area; + Connects the video system for the public; + Operators take their positions; - The security operator gives the "top" start for moving a container.

NS01.1	Move a container	The system shall move a waste container from the transfer area to the landfill area within the containment area : - The robot departure is remotely operated by a ProtecSys operator; - The robot moves to the transfer area following the black line; - The robot takes over the container; - The robot moves to the entrance door of the containment area following the black line; - The robot moves to the landfill area ; - The robot deposits the container; - The robot moves to the containment area's exit door by passing through the pre-filtration and filtration tanks; - The robot moves to the maintenance area by following the black line; - The robot goes into standby mode. In case of failure during the mission, a request can be made by a ProtecSys operator to the Safety operator who authorizes or not a curative maintenance. If the authorized time is exceeded or if a negative number of points is reached which does not allow the total number of points to remain positive, the Safety operator can stop the mission (total of 0 points in qualification). The robot is then remotely operated by a ProtecSys operator to be put in standby mode. On return to the maintenance area, a request can be made by a ProtecSys operator to the Safety operator who authorizes or not a preventive maintenance.
NS01.1.1	Maintain in qualification	The system shall maintain in operational conditions during the qualification phase: - In case of curative maintenance: + Following a loss of the black line, the robot is remotely guided by a ProtecSys operator to be repositioned before resuming the movement; + In other cases of failure, only the case where the container is not yet supported allows the robot to be remotely guided by a ProtecSys operator to return to the maintenance area following the black line. After maintenance by a ProtecSys operator, the route is resumed at the start. - In case of preventive maintenance, only the replacement by a ProtecSys operator of the on-board energy reserve is authorized. NB: In all other cases, there is a failure to move the container!

5.1.2. Configuration audit stage



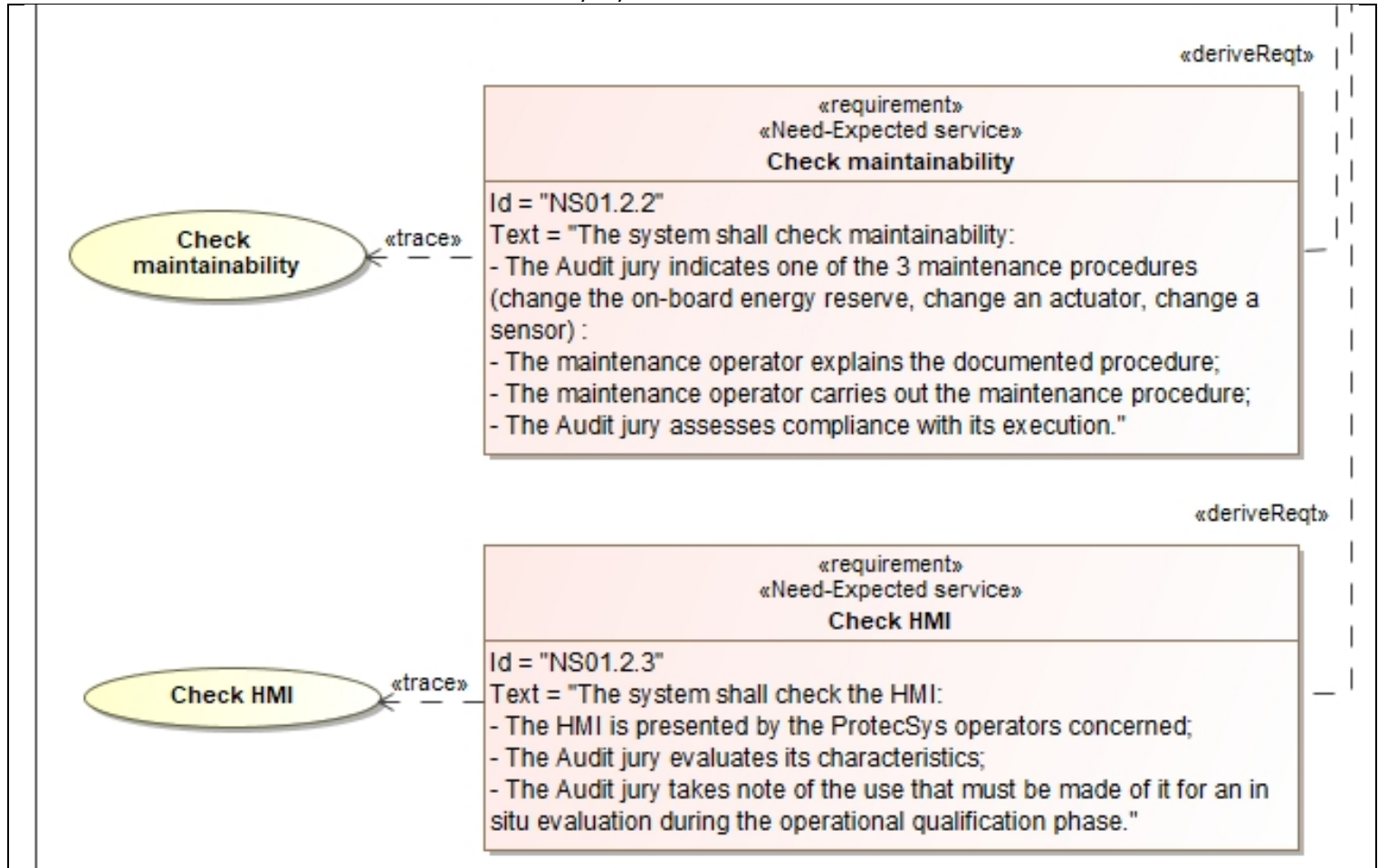


Figure 14 : Expected service needs in configuration audit stage

Identifier	Need name	Description
NS01.2	Audit the configuration	The system shall audit the configuration: the RobAFIS organization calls the ProtecSys team to check the compliance, check the maintainability and check the HMI.
NS01.2.1	Check compliance	The system shall check the conformity: - A ProtecSys operator installs the robot on the scale; - The Audit jury takes note of the weight; - A ProtecSys operator installs the robot in the dimensional template; - The Audit jury takes note of the respect or not of the authorized dimensions; - A ProtecSys operator positions the robot on the speed track in the start area; - The Audit jury gives the "top" start of the speed verification.
NS01.2.1.1	Check the speeds	The system shall check the speeds: - The robot moves at a speed of 80 mm/s to the red line; - The auditing panel reads the corresponding time and the speed displayed on the HMI; - The robot moves at a speed of 15 mm/s to the arrival area; - The Audit jury records the corresponding time and the speed displayed on the HMI.
NS01.2.2	Check maintainability	The system shall check maintainability: - The Audit jury indicates one of the 3 maintenance procedures (change the on-board energy reserve, change an actuator, change a sensor) : - The maintenance operator explains the documented procedure; - The maintenance operator carries out the maintenance procedure; - The Audit jury assesses compliance with its execution.

NS01.2.3	Check HMI	The system shall check the HMI: - The HMI is presented by the ProtecSys operators concerned; - The Audit jury evaluates its characteristics; - The Audit jury takes note of the use that must be made of it for an in situ evaluation during the operational qualification phase.
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5.2. Performance needs

Identifier	Need name	Description
NP01	Do not exceed 480 s	The system shall not exceed 480s for move the container (+16 points in qualification).
NP01.1	Do not exceed 420s for bonus	The system shall not exceed 420s to move the container with bonus (+4 points in qualification).

5.3. Interface needs

Identifier	Need name	Description
NI01	Have a video output	The system shall have a video output in VGA or DVI or HDMI format that allows for the projection of HMIs to the audience in the control room.
NI02	Use the lifting handle of the container	The system shall use the lifting handle of the container.
NI03	Communicate with the RobAFIS organization via the ProtecSys team	The system shall communicate with the RobAFIS organization and its representatives (Security operator, Audit jury, etc.) via ProtecSys team.

5.4. Operational needs

Identifier	Need name	Description
NO01	Move a container 3 times in 4 hours	The system shall move a container 3 times over a period of 4 hours without any maintenance other than that allowed in qualification.
NO02	Perform remote operations from the control room	The system shall perform remote operations/remote guidance from the control room.
NO03	Perform remote control in risky situations	The system shall perform remote control of the mobile robot in high-risk situations: taking / depositing the container, moving in the containment area.
NO04	Carry the container vertically	The system shall carry the container vertically and without contact with the ground (-1 point in qualification).

5.5. Constraint needs

Identifier	Need name	Description
NC01	Operate within the reprocessing center	The system shall operate within the reprocessing center as defined in appendix 1.
NC01.1	Avoid entering the Prohibited Areas to the Robot	The system shall avoid entering the Prohibited Areas to the Robot in the preparation area (-4 points in qualification).
NC01.2	Avoid any contact with vertical walls	The system shall avoid any contact with vertical walls: outer edge, separation of preparation and containment areas (-1 point in qualification).
NC01.3	Operate under normal climatic conditions	The system shall operate under normal climatic conditions in the reprocessing center: ambient temperature between 10 °C and 32 °C, atmospheric pressure between 1000 and 1030 mb and humidity between 40 and 75 %.

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NC01.4	Operate under normal lighting conditions	The system shall operate under normal lighting conditions: homogeneous lighting, except for shadows produced by objects present in the preparation and containment areas, and light intensity in these areas between 100 and 300 Lumen/m2.
NC02	Use the specific container	The system shall use the specific container as defined in Appendice 2.
NC02.1	Avoid any shock of the container	The system shall avoid any shock of the container (-2 points in qualification).
NC03	Use a mobile robot	The system shall use a mobile robot.
NC04	Comply with the speed limits for the mobile robot movements	The system shall comply with the speed limits for the mobile robot movements allowed in risk areas.
NC04.1	Do not exceed the speed of 80	The system shall not exceed the speed of 80mm/s in the preparation area (-2 points in qualification).
NC04.2	Do not exceed the speed of 15	The system shall not exceed the speed of 15mm/s in the containment area (-4 points in qualification).
NC05	Retransmit the HMIs	The system shall retransmit the HMIs on the video output for the audience.
NC05.1	Display the actual robot speed	For qualification and auditing purposes, the system shall permanently display the actual robot speed on the active HMI in green if the limitation is met and in red if not.
NC06	Do not exceed 1200 g	The system shall use a mobile robot, in working order, of a mass not exceeding 1200 g.
NC07	Do not exceed 300 mm	The system shall use a mobile robot, in working order, of a length not exceeding 300 mm.
NC08	Operate on the speed circuit	During the speed verification audit, the system shall operate on the speed circuit as defined in Appendice 3.
NC09	Be testable and maintainable	The system shall be testable and maintainable.
NC09.1	Have three maintenance procedures	The system shall have three maintenance procedures concerning the following points: change of the on-board energy reserve, change of an actuator, change of a sensor.
NC10	Include a development file	The system shall include a development file as defined in the standard document available at www.robafis.fr .
NC11	Take into consideration the contest rules	The system shall take into consideration the RobAFIS contest rules available at www.robafis.fr .
NC12	Integrate a maximum of 3 operators	The system shall integrate a maximum of 3 operators from the ProtecSys team: 1 maintenance operator residing in the clean room to intervene in the maintenance area and 1 to 2 remote operation operators in the control room.
NC12.1	Involve only authorized personnel	The system shall involve only authorized personnel such as CASES forklift operators, Nuclear Authorization "Savoir Commun du Nucléaire », etc.
NC13	Consist of a support frame and components	For the robot, the system shall consist of a support frame and components mounted on/in this frame.
NC13.1	Use a support frame with a low ecological footprint	For the robot, the system shall use a support frame made of a material with a low ecological footprint, reused or recycled.
NC13.2	Use the Makeblock kits components	The system shall, for the robot, use the Makeblock kits components provided by the RobAFIS organization without any addition or modification: Robot Kit Ultimate 2.0-10-in-1 (https://store.makeblock.com/buy/ultimate-2-0-10-in-1-robot-kit) and Robot Kit Electronic Add-on Pack for Starter (https://store.makeblock.com/electronic-add-on-pack-for-starter-robot-kit).
NC14	Use Bluetooth communications	The system shall use for its internal communication only password-protected Bluetooth type communications (to limit access distance and intrusion).

6 STAKEHOLDER NEED VALIDATION

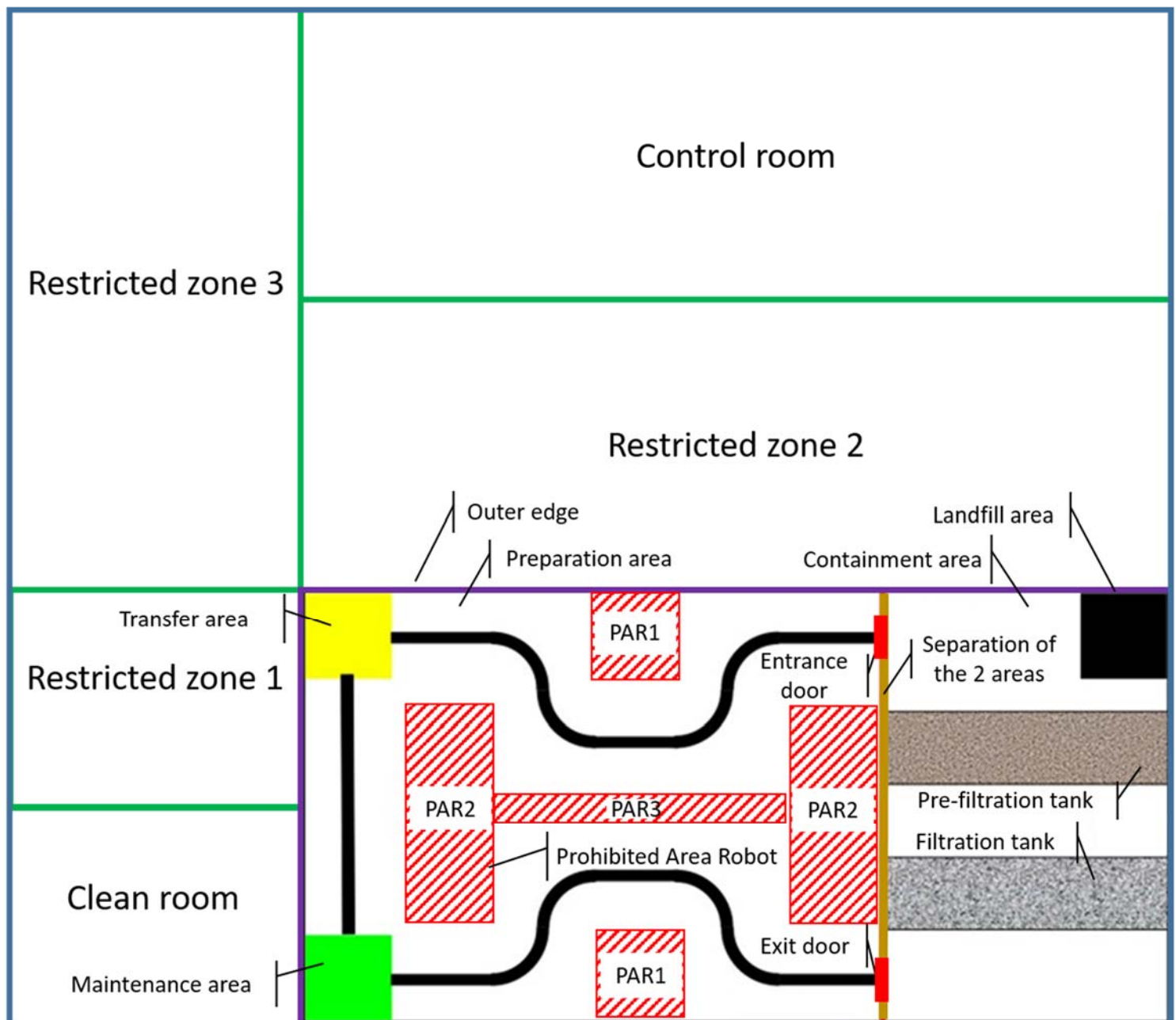
Updated by JYB on 10/01/2020	Verified by XY on 11/01/2020	Validated by JC on 14/01/2020
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ProtecSys System

Appendices

APPENDICES 1 –SPECIFICATIONS OF THE PROCESSING CENTER

A1.1 Ground plan



A1.2 Dimensions, materials and colors

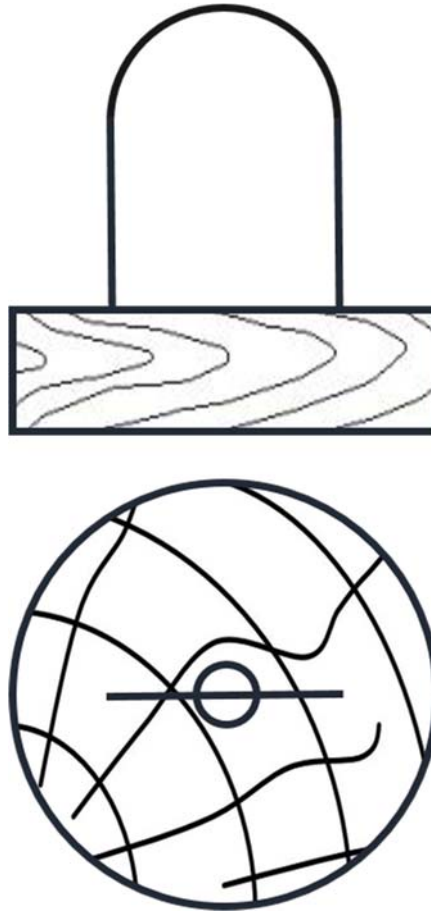
Area	Dimensions (mm)	Material / Color
Clean room	1000x750 (+/- 100)	Not applicable
Restricted zone 1	1000x750 (+/- 100)	Not applicable
Restricted zone 2	3000x1000 (+/- 100)	Not applicable
Restricted zone 3	1000x2000 (+/- 100)	Not applicable
Control room	3000x1000 (+/- 100)	Not applicable
Preparation area	2200x1500 (+/- 20)	White floor
Containment area	800x1500 (+/- 20)	White floor
Maintenance area	300x300 (+/- 10)	Green
Transfer area	300x300 (+/- 10)	Yellow
Landfill area	300x300 (+/- 10)	Black
Prohibited Area Robot 1	300x300 (+/- 10)	Hatched red
Prohibited Area Robot 2	300x750 (+/- 10)	Hatched red
Prohibited Area Robot 3	1000x100 (+/- 10)	Hatched red
Black line	Width 40 (+/- 2)	Black
Pre-filtration tank	800x250 (+/- 10) – depth 10	10 mm of gravel gauge 6-16mm
Filtration tank	800x250 (+/- 10) – depth 10	10 mm of gravel gauge 2-6mm
Outer edge of preparation and containment areas	Width 5 (+/- 1)	Rigid (wood or similar)
Separation of preparation and containment areas	Thickness 10 (+/- 1) Height 500 (+/- 10)	Rigid (wood or similar)
Door openings	Width 180 (+1/-0) Height 300 (+2/-0) Center spacing 1200 (+/- 10)	Empty and centered on the black line
Red line of the doors	Width 40 (+/- 2)	Red

Preparation and containment area floors at the same level, pre-filtration and filtration tank bottoms at -10mm.

Floor of the areas: paper 150g

APPENDICE 2 –SPECIFICATIONS OF THE CONTAINER

A2.1 Plan of the container



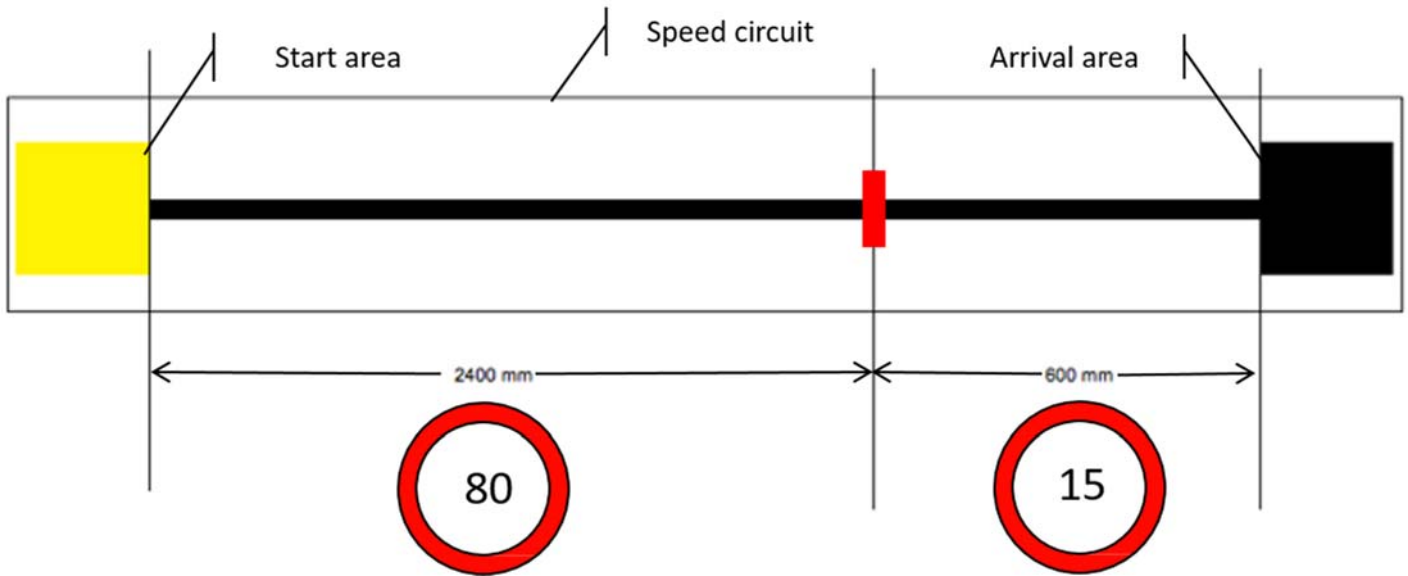
A2.2 Dimensions, materials and masse

Component	Dimensions (mm)	Material
Base	Diameter 56 (+/- 1) Height 16 (+/- 1)	Plywood or the like
Lifting handle	Diameter 30 (+/- 2) Height 40 (+/- 2) Wire diameter 1 (+/- 0,2)	Steel like piano wire

Mass between 25g to 30g.

APPENDICE 3 – SPECIFICATIONS OF THE SPEED CIRCUIT

A2.1 Plan of the speed circuit



A2.2 Dimensions, materials and colors

Area	Dimensions (mm)	Color
Speed circuit	3800x500 (+/- 50)	White floor
Start area	300x300 (+/- 10)	Yellow
Arrival area	300x300 (+/- 10)	Black
Black line	Width 40 (+/- 2)	Black
Red line	120x40 (+/- 2)	Red

Material: paper 150g

ProtecSys System

Initial need

An industrial company specializing in the reprocessing of nuclear waste, we want to upgrade one of our French sites in order to limit the risk of contamination of our staff.

In a first step, we want to focus on the internal flows, which are carried out by qualified handlers (*CACES Cariste*, nuclear accreditation *Savoir Commun du Nucléaire niveau 1*). Their job is to pick up with their forklift radioactive waste containers available in a transfer area, to transport and deposit them in a landfill area. These manoeuvres require suitable protective equipment (suits, gloves, masks, etc.) and systematic decontamination of people and equipment. Despite all the precautions taken, there is no such thing as zero risk. Furthermore, moving waste under these conditions is also a risky activity (falls, shocks, damage to sealed packaging, etc.).

Our strategy is to develop a system that would allow these operations to be carried out by remote control from the site control room. The use of mobile robotics is envisaged for its flexibility and the limited infrastructure necessary for its implementation under controlled conditions.

This system will be called ProtecSys.

Done at the head office in Morez on May 3, 2019,

A handwritten signature in black ink, appearing to read 'Just'.

PGM