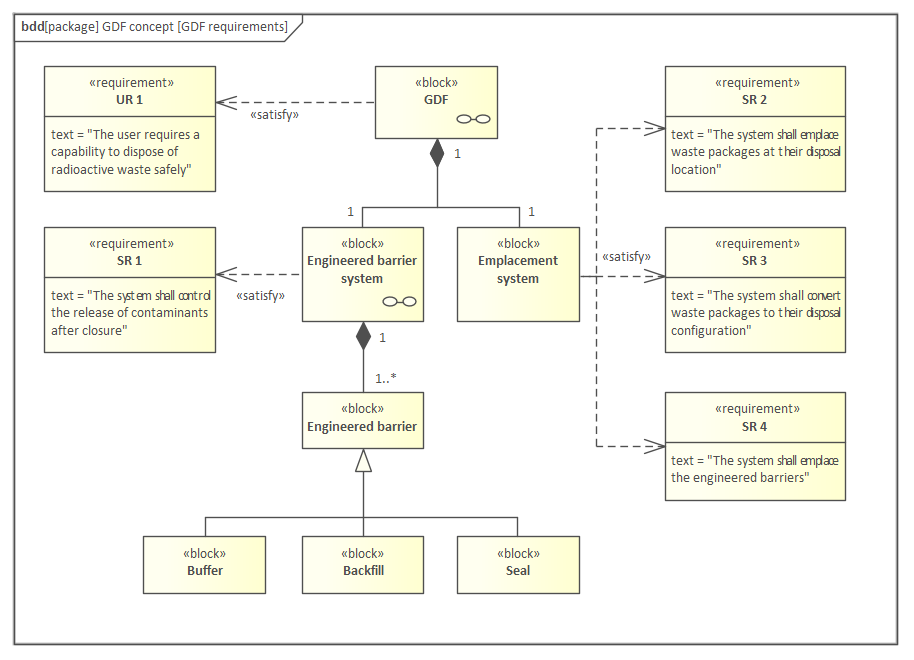
Research Data D: Stakeholder Evaluation Questionnaire

The diagram on this page is intended to show the key components and requirements of a Geological Disposal Facility (GDF) for radioactive waste, but not the designs of any particular organization or country.

**(1) This diagram clearly represents the key components and requirements.**

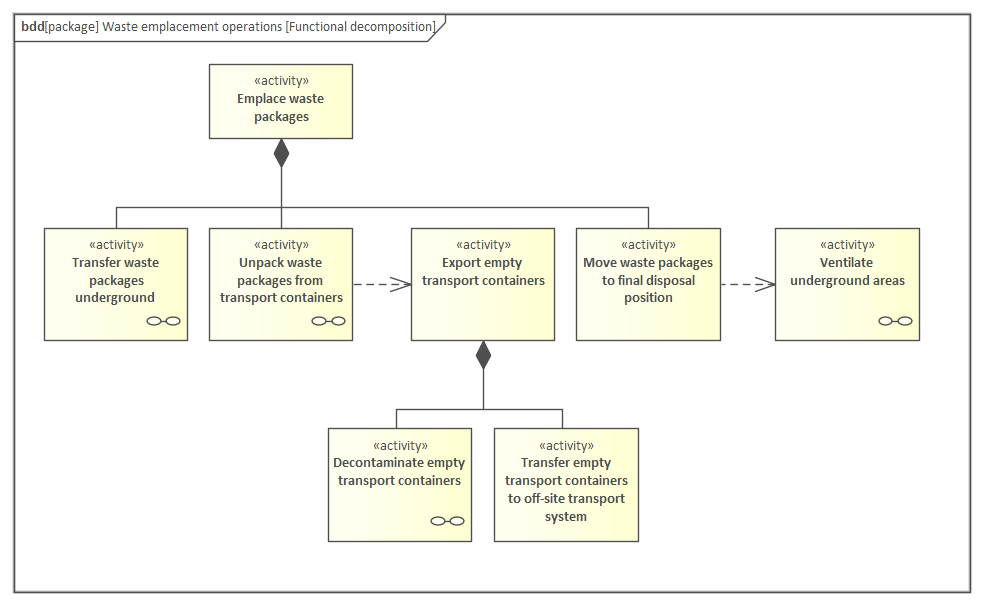
**Strongly disagree  Disagree  Agreee  Strongly agree**



The diagram on this page is intended to show the key functions involved in emplacing waste packages in a GDF.

**(2) This diagram clearly states the key functions.**

**Strongly disagree  Disagree  Agreee  Strongly agree**



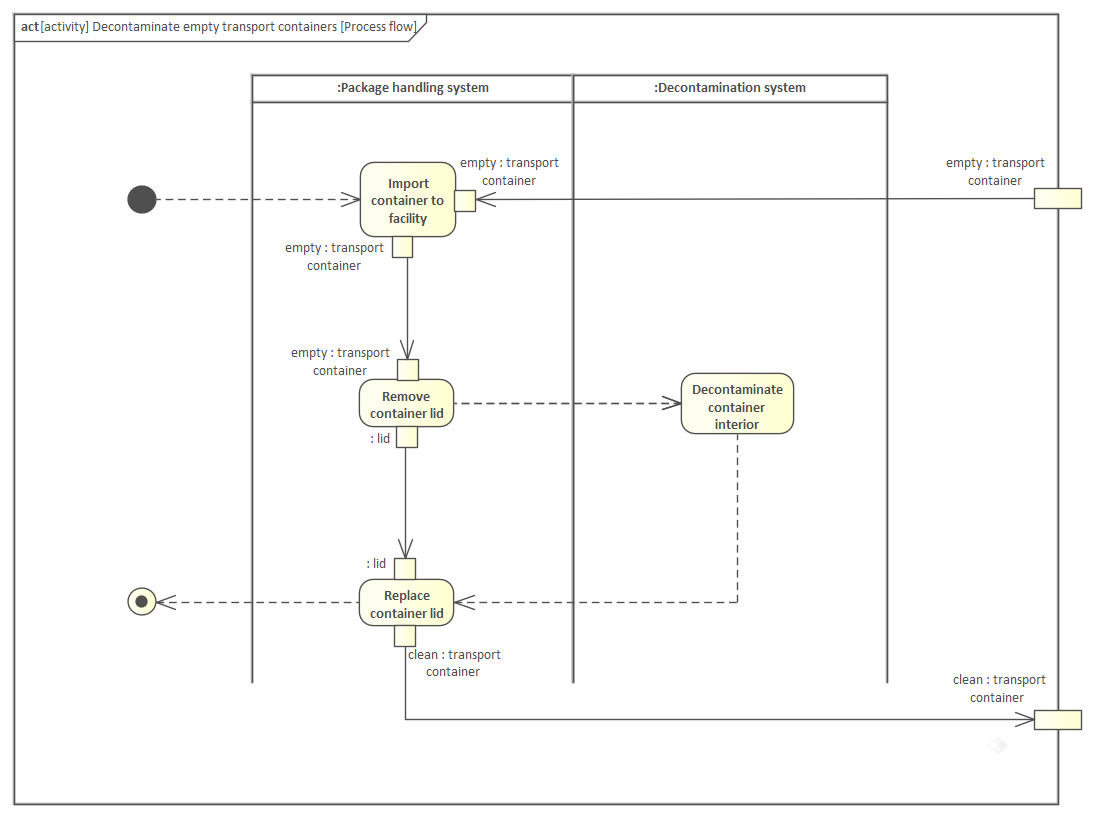
The diagram on this page is intended to describe the “decontaminate empty transport containers” function.

**(3) This diagram clearly describes the decontamination function.**

**Strongly disagree  Disagree  Agreee  Strongly agree**

**(4) This diagram clearly shows the allocation of function to systems.**

**Strongly disagree  Disagree  Agreee  Strongly agree**



The table on this page is part of a hazard log for GDF operations.

**(5) Describe your familiarity with this method of presenting hazard information.   
  
Very unfamiliar  Unfamiliar  Familiar  Very familiar**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Hazard realization | Freq. [/year] | Hazard | Harm / Consequence | Fault sequences | Safety functions (SF) / requirements | SF Cat. | Sub safety functions | Safety measures |
| Exposure to waste package during unpacking operations | 0.1 | Radiation from packages | External radiation dose / C | Worker opens facility door while unshielded package present | Prevent access to facility during unpacking operations | B | Detect package presence in facility | Package detection system |
| Lock facility door | Access control system |
| Warn workers of unpacking operations |
| Facility door fails open | Single failure criterion | - | - | Redundant shield door |
| Exposure to waste package during container maintenance | 0.01 | Radiation from packages | External radiation dose / B | Loaded waste container returned to container maintenance facility in error | Prevent exposure to waste package during container maintenance operations | A | Determine container configuration (loaded/empty) | Package detection system |
| If loaded container present, disable package handling | Package handling system |
| If worker exposed to waste package, warn worker of radiation flux | C | - | Alarm system |
| Flammable gas build-up in disposal vaults | 0.1 | Flammable gas released from packages | Injury from fire or explosion / A | Loss of off-site power; loss of power to ventilation | If loss of off-site power, maintain power supply to ventilation system | A | Provide back-up power | Power supply system |
| Maximum evacuation distance | C | - | Safe haven |
| Derailment of drift vehicle during transport | 0.0001 | Earthquake | Internal radiation dose / B | Earthquake derails drift vehicle during transport of waste | Prevent derailment of drift vehicle under seismic load | A | Detect seismic load on drift vehicle | Earthquake detection system |

The diagram on this page is a model-based representation of the drift vehicle derailment fault.

**(6) This diagram clearly presents the information about the fault.   
  
Strongly disagree  Disagree  Agreee  Strongly agree**

Diagram

Description automatically generated

Compare the diagram on the previous page to the tabular description below.

**(7) Which method is more effective at communicating the information about the fault?**

**Table, strong preference**

**Table, slight preference**

**Diagram, slight preference**

**Diagram, strong preference**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Hazard realization | Frequency | Bounding consequence | Hazard | Harm | Fault sequences | Safety functions / safety requirements | Safety function category | Sub safety functions | Safety systems |
| Derailment of drift vehicle during transport of waste package to sub-surface | 0.0001 | B | Earthquake | Internal radiation dose | Earthquake derails drift vehicle during transport of waste package to sub-surface | Prevent derailment of drift vehicle under seismic load | A | Detect seismic load on drift vehicle | Earthquake detection system |
| Radioactive material in packages | If seismic load on drift vehicle detect, decelerate drift vehicle to stop | Surface-to-subsurface conveyance system |

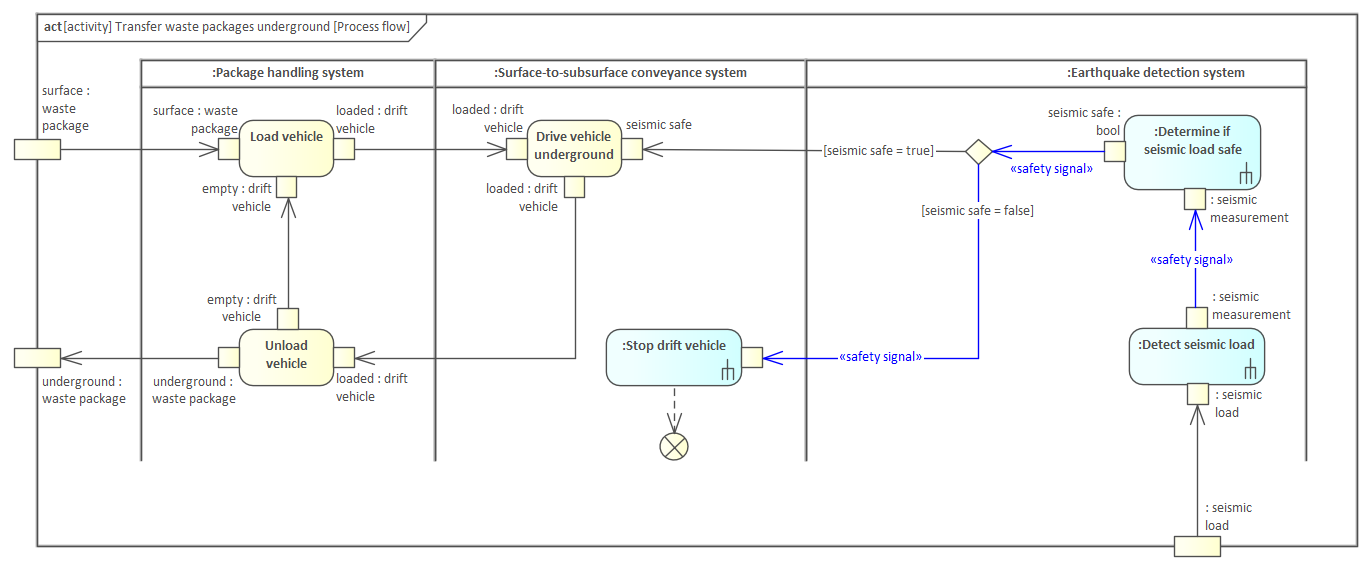
The diagram on this page is intended to describe the function “transfer waste packages underground”, including the action of the safety functions derived from the derailment fault.

**(8) This diagram clearly describes the underground transfer including action of the safety functions.   
 Strongly disagree  Disagree  Agreee  Strongly agree**

**(9) Adding this diagram improves understanding of the safety functions, compared to the hazard log alone (either tabular or diagrammatic).   
Strongly disagree  Disagree  Agreee  Strongly agree**

This diagram also represents the integration of the safety functions back into the general model of the GDF.

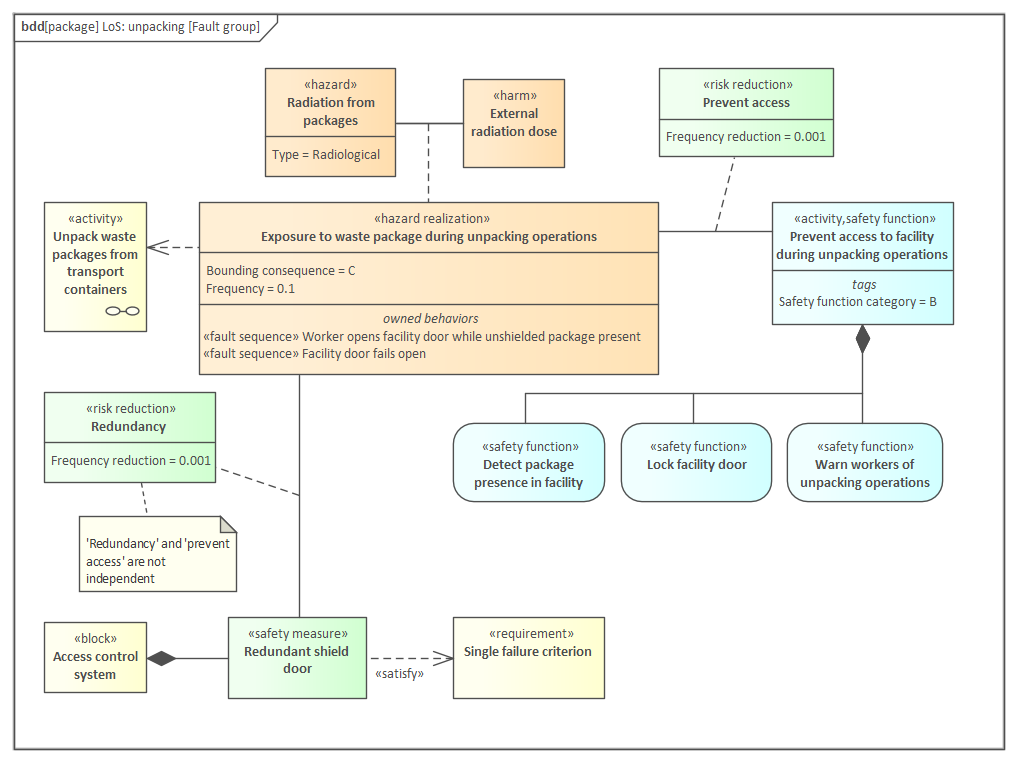
**(10) Integrating safety functions into the general model of the system, in this way, adds value to the model.   
Strongly disagree  Disagree  Agreee  Strongly agree**



The diagram on this page is a model-based representation of the exposure during container unpacking fault. It is intended to show both safety functions and non-functional safety requirements.

**(11) This diagram clearly presents the information about the fault.   
  
Strongly disagree  Disagree  Agreee  Strongly agree**

**(12) Which type of mitigation is expressed most clearly?   
  
Functional, strong preference  Functional, slight preference    
Non-functional / physical, slight preference  Non-functional / physical, strong preference**



Compare the diagram on the previous page to the tabular description below.

**(13) Which method is more effective at communicating the information about the fault?**

**Tabular, strong preference**

**Tabular, slight preference**

**Diagram, slight preference**

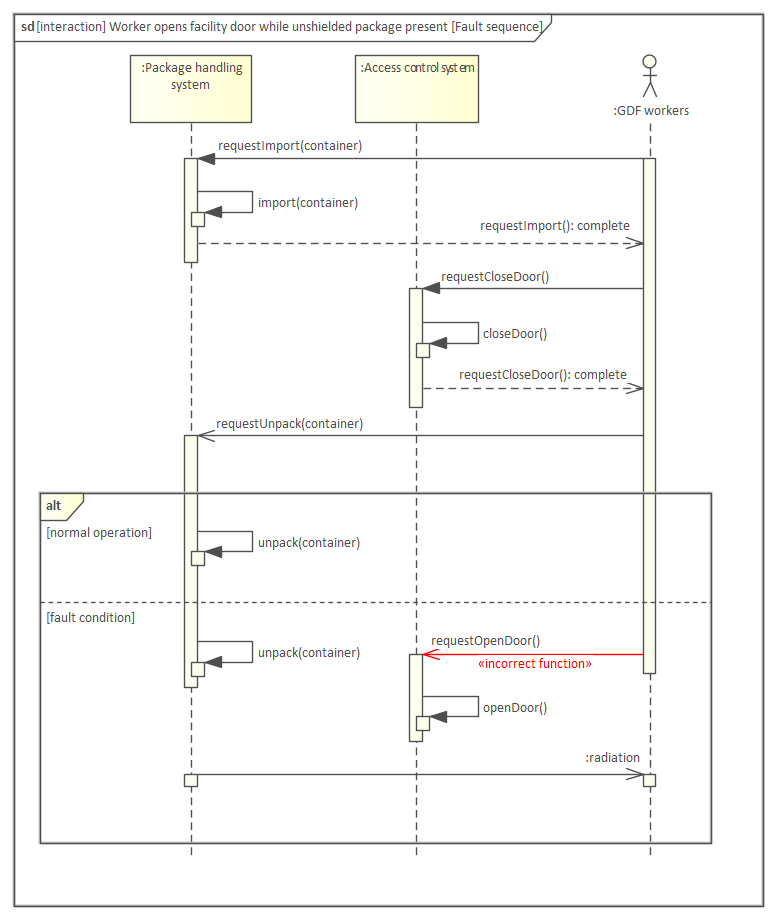
**Diagram, strong preference**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Hazard realization | Frequency | Bounding consequence | Hazard | Harm | Fault sequences | Safety functions | Safety function category | Sub safety functions | Safety systems |
| Exposure to waste package during unpacking operations | 0.1 | C | Radiation from packages | External radiation dose | Worker opens facility door while unshielded package present | Prevent access to facility during unpacking operations | B | Detect package presence in facility | Package detection system |
| Lock facility door | Access control system |
| Warn workers of unpacking operations |
| Facility door fails open | Single failure criterion | - | - | Redundant shield door (access control system |

The exposure during unpacking fault groups two fault sequences:

* Worker opens facility door while unshielded package present
* Facility door fails open

The diagram on this page is intended to describe the former of these fault sequences.



The diagram on this page is intended to describe the “facility door fails open” fault sequence.

**(14) The fault sequence diagrams clearly show what happens in the fault sequences.**

**Strongly disagree**

**Disagree**

**Agree**

**Strongly agree**

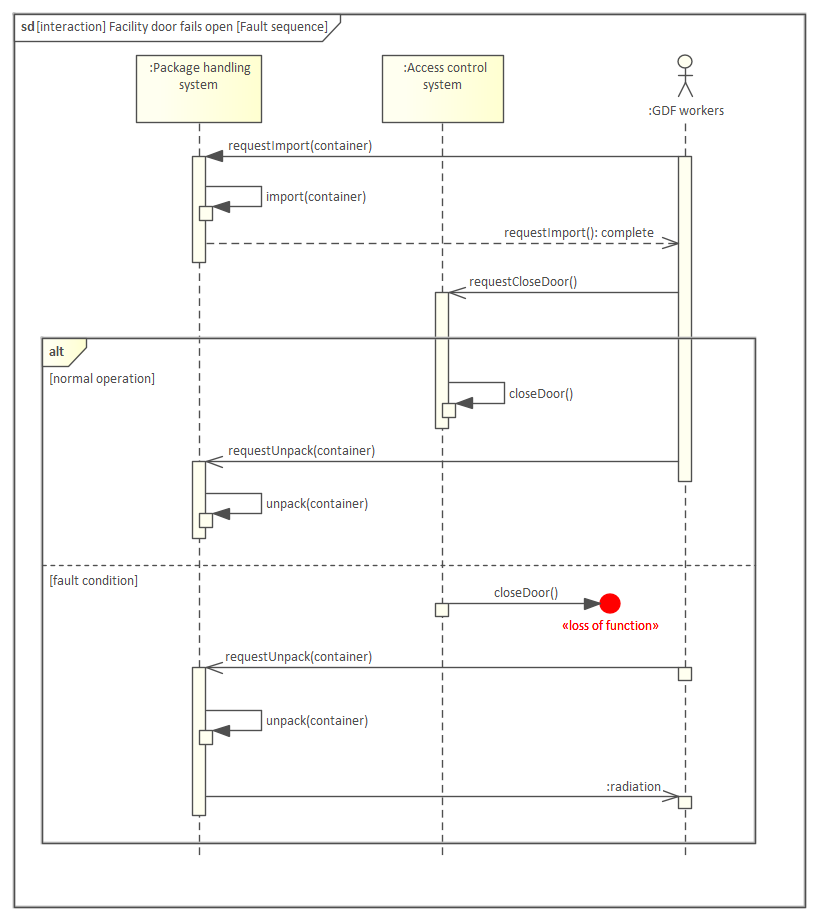
**(15) The fault sequence diagrams improve understanding compared to textual descriptions of the fault sequences.**

**Strongly disagree**

**Disagree**

**Agree**

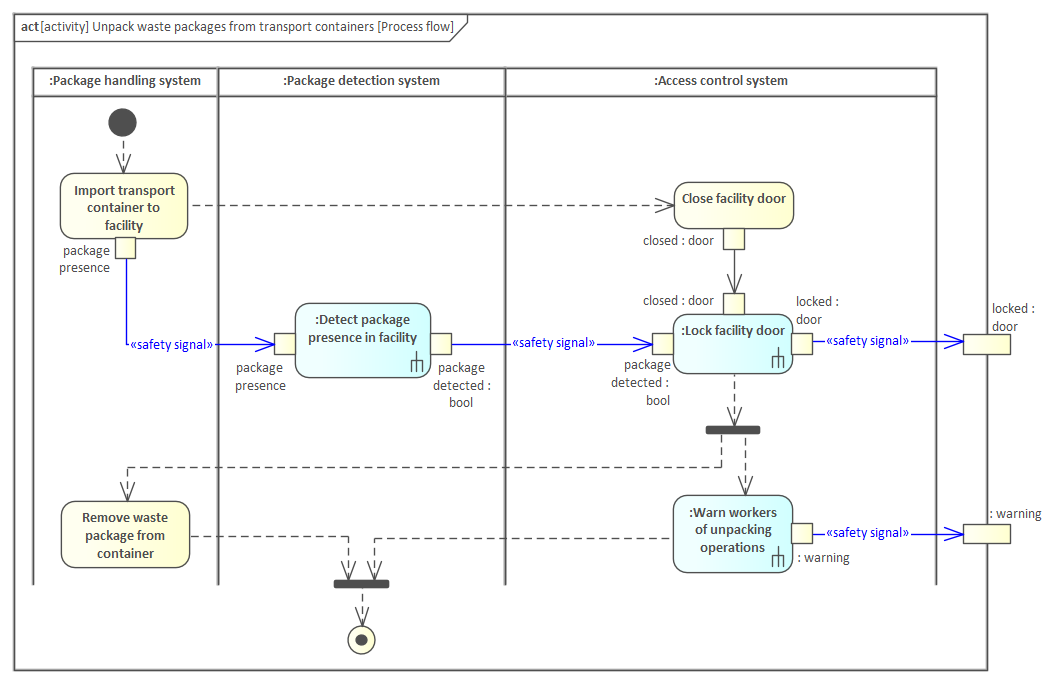
**Strongly disagree**



The diagram on this page is intended to describe the function “unpack waste packages from transport containers”, including the action of the safety functions derived from the inadvertent exposure fault.

**(16) Adding this diagram improves understanding of the safety functions, compared to the hazard log alone (either tabular or diagrammatic).**

**Strongly disagree  Disagree  Agreee  Strongly agree**



The diagram on this page shows part of a GDF system breakdown structure, updated to show safety functions derived from the safety analysis.

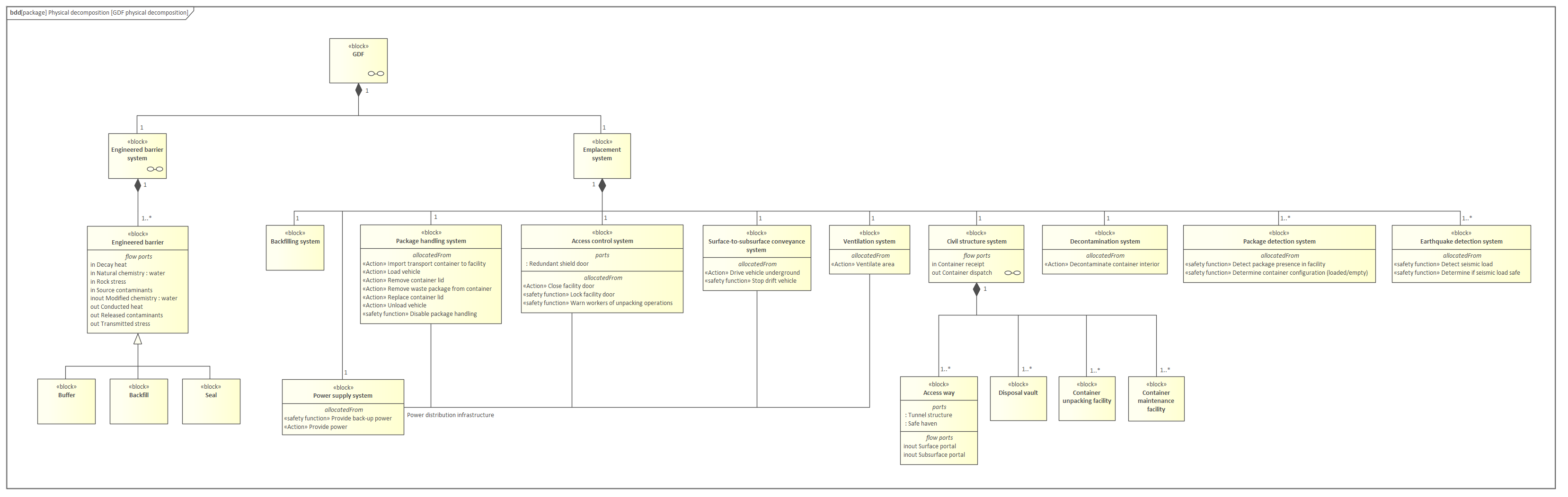
**(17) Integrating safety functions into the general model of the system, in this way, adds value to the model.**

**Strongly disagree**

**Disagree**

**Agreee**

**Strongly agree**



Compare the overall merits of the tabular and model-based representations of hazard information.

**(18) Which technique would you prefer to work with as a *consumer* of hazard information? For the purpose of this question, assume the two techniques are equal in terms of ease of construction and stakeholder acceptance.**

**Tabular**

**Model-based**

**(19) What is the main reason for your answer to question (18)?**

**Brevity**

**Clarity or intelligibility**

**Expressiveness or ability to convey varied meaning**

**Familiarity**

**Integration with the general system model**

**Other**

This research project is based on a simplified model of a GDF. Hazard management in real concept design will be more complex.

**(20) In real concept design, would you expect the use of the model-based technique to:**

**Add less value, e.g. because it’s not sophisticated enough to deal with real complexity**

**Add more value, e.g. because it can accommodate complexity more readily than  
 tabular techniques**

**Have the same value as represented in the simplified GDF model**