The Use of the IAEA Safety Case Concept in Management of Near-Surface Disposal

PRISM components and Approaches

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Overview

• The concept of Safety Case in the IAEA

• The concept of Safety Case for Near Surface disposal: PRISM components and Approaches

• Focus on Task 1: Understanding the Safety Case

• Link with other tasks
The concept of Safety Case in the IAEA

- The concept of Safety Case has been circulated for many years now.

- The NEA defines the Safety Case as: “The synthesis of evidence, analyses and arguments that quantify and substantiate a claim that the repository will be safe after closure and beyond the time when active control of the facility can be relied on”.

- IAEA defines it as the collection of arguments and evidence to demonstrate the safety of a facility.

- The SC has to be developed in the early phases of the development of a project. For the operator as a basis for internal decisions (R&D, site selection and evaluation, design conceptualization...) as well as for dialogue with the regulator.
The concept of Safety Case in the IAEA

• IAEA approach of the SC for disposal is mainly given in:
  • Safety requirements (SSR -5) on Disposal of Radioactive Waste addressing SC
  • Specific Safety Guide on SC and SA (DS355) in final process of development
  • These documents cover all types of radioactive waste that require specialized disposal facilities
  • In addition, one safety guide on near surface disposal facilities in development
The concept of Safety Case in the IAEA

- **Requirement 12: Preparation, Approval and use of the safety case and safety assessment for a disposal facility**

“A safety case and supporting safety assessment shall be prepared and updated by the operator, as necessary, at each step in the development of a disposal facility, in operation and after closure. The safety case and supporting safety assessment shall be submitted to the regulatory body for approval. The safety case and supporting safety assessment shall be sufficiently detailed and comprehensive to provide the necessary technical input for informing the regulatory body and for informing the decisions necessary at each step”

- **Requirement 13: scope of the Safety Case and safety assessment**

The safety case for a disposal facility shall describe all safety relevant aspects of the site, the design of the facility, and the managerial control measures and regulatory controls. The safety case and supporting safety assessment shall demonstrate the level of protection of people and the environment provided and shall provide assurance to the regulatory body and other interested parties that safety requirements will be met”

- **Requirement 14: Scope of the Safety Case and Safety Assessment**

The safety case and supporting safety assessment for a disposal facility shall be documented to a level of detail and quality sufficient to inform and support the decision to be made at each step and to allow for independent review of the safety case and supporting safety assessment”
The concept of Safety Case in the IAEA

- Number of member states questioned themselves on the real significance of safety case as well as safety assessment, the linkage and differences between both concepts.

- Terminology used for Safety Case can differ from country to country ("Dossier de Sûreté" i.e. "Safety File", Safety Report, Performance assessment report…)

- This can create confusion

- In practice, the SC is a collection of different reports related to the disposal project (including the documentation related to the basic data (geology, hydrogeology, chemistry, waste inventory…), the design, the safety approach, the evolution scenarios…) that substantiate the demonstration of safety of the disposal.
Components of the safety case

- Safety case Context:
  - Purpose of the safety case
  - Demonstration of safety
    - Safety objectives
    - Safety principles
  - Graded approach
- Safety Strategy
- Description of the disposal system
Components of the safety case

- Safety Assessment
  - Radiological impact assessment
  - Site and engineering aspects
    - Passive safety
    - Robustness
    - Scientific and engineering principles
    - Quality of the site characterization
  - Operational Safety Aspects
    - Non-radiological environmental aspects
    - Management system
- Management of uncertainties
- Iteration and design optimization
- Limits, controls and conditions

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Components of the safety case

- Integration of safety arguments
  - Comparison with safety criteria
  - Complementary safety indicators and performance indicators
  - Multiple lines of reasoning
  - Plans for addressing unresolved issues
- Interacting processes
  - Involvement of interested parties
  - Independent review
  - Management system
Components of the safety case

- Safety Case Context
- Safety Strategy
- System Description
- Safety Assessment
- Limits, Controls and Conditions
- Integration of Safety Arguments
- Management of Uncertainty

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Management system - Regulatory and Stakeholder involvement processes

- Safety Case Context
- Safety Strategy
- System Description
- Safety Assessment
- Limits, Controls and Conditions
- Integration of Safety Arguments
- Management of Uncertainty

Stakeholder and Regulatory Involvement

Iteration and Design Optimization

Application of Management System
Safety Assessment

Aims at:

• evaluating the soundness of the safety strategy

• verifying that the disposal performs such as adequate levels of protection of man and environment are reached

• During this step the « global » performance of the disposal project is evaluated against plausible situations (scenarios).

• Provide an input for the treatment of uncertainties

• Contribute to provide a hierarchy of the studies deserving particular attention and that should be implemented in the next stage of project development.
SA: component of the SC

- Safety assessment relies on qualitative and quantitative assessment of elements relevant for the safety of the development, operation, and closure of the disposal facility.

- Safety assessment is part of the safety case.

- Radiological impact calculation is an important component of the safety assessment.

- Safety assessment also covers the evaluation of the qualitative and quantitative performances of the disposal project.
SA: component of the SC

For example, calculations should address:

- the verification of the favourable behaviour of the disposal components when no interactions are expected, individually and globally

- the evaluation of the disturbances caused by the interactions between the different disposal components and the assessment of the consequences of those disturbances on safety functions

- the modelling of the future behaviour of the repository for specific scenarios

- checking that individual exposure is acceptable.

- The results can be presented in terms of various indicators of the performances of the disposal as activity fluxes, concentrations, ratios, or doses if needed.
The IAEA concept of SC

- Not specific to Near Surface disposal
- Valid for all types radioactive waste that requires specialized disposal facilities
- However there are specificities for near surface disposal facilities
- PRISM specifically addresses the concept of SC for Near Surface disposal facilities
Requirement 14: Scope of the Safety Case and Safety Assessment

The safety case and supporting safety assessment for a disposal facility shall be documented to a level of detail and quality sufficient to inform and support the decision to be made at each step and to allow for independent review of the safety case and supporting safety assessment.”

Questions

1. Which “decision step” are concerns by the requirement 14?

2. Who are the decision-makers?

3. What are the relevant safety case argument in relation with the decision step?
Decisions are taken by government or by regulator based on operator proposal.

Public is involved through the legal process in force in the country.
NEED FOR ACTION:  
Decision:  
- Go for disposal or/and
DISPOSAL CONCEPT

Decide on the site disposal concept and on safety strategy in a given environment.

Decisions are taken by government or by regulator based on operator proposal. Public is involved through the legal process in force in the country.
SITE SELECTION AND ENGINEERING DESIGN
choose the site and its associated design

Decisions are taken by government or by regulator based on operator proposal. Public is involved through the legal process in force in the country.
Decisions are taken by government or by regulator based on operator proposal. Public is involved through the legal process in force in the country.
OPERATION

Decision
- For operate
- Authorization and license for operation

Decisions are taken by government or by regulator based on operator proposal. Public is involved through the legal process in force in the country.
Decisions are taken by government or by regulator based on operator proposal. Public is involved through the legal process in force in the country.
Decide to initiate the passive institutional control period.
POST-LICENSING

Decide or not to release the regulatory control

Decisions are taken by government or by regulator based on operator proposal. Public is involved through the legal process in force in the country.
Safety Case Arguments could be gathered in the following themes:

- Safety Case Context
- Management and Stakeholders
- Safety Strategy
- System Description
- Safety Assessment
- Surveillance
- Integration of safety arguments
- Limits, Control & Conditions
Safety Arguments

Safety Case Context includes amongst other:

- NATIONAL STRATEGY
- REGULATIONS
- INTERNATIONAL GUIDANCE AND DUTIES/COMMITMENTS
- FINANCIAL CONSIDERATIONS
- ...

Includes:
- the description of the responsibilities at the national level;
- the national waste management plan;
- ...

Financial considerations over the guaranties that the financial resources for conceive, construct, operate, close and monitor the facility, will be available when needed. Finance for R&D activities are included.
Management and Stakeholders involvement

✓ INVOLVMENT OF STAKEHOLDERS

✓ MANAGEMENT SYSTEM
  • Organization
  • Staff competence
  • Q/A
  • record keeping / traceability

✓ REGULATORY PROCESS
  • Management system
  • Licensing process
  • Early and continuous involvement

✓ ...

Management systems have to provide for assurance of the quality of all safety related activities, systems and components throughout all steps of the development, operation and closure of a disposal facility.
Safety Strategy includes amongst others, considerations on how the following topics will be taken into account:

- Graded approach
- Optimization
- Robustness
- Demonstrability
- Multiple Safety Functions
- Passive Safety
- Good engineering/scientific practices
- Management of uncertainties
- ...

The safety strategy is defined as the high-level integrated approach adopted for achieving safe disposal.
System Description includes amongst others, considerations on how the following topics will be taken into account:

- WASTE CHARACTERISTICS
- SITE CHARACTERISTICS
- DESIGN
- Identification of the safety functions, their allocation to the system components and their evolution
- ...

System description is based on the level of knowledge available at the considered stage.

System description should be considered as an internal process (internal iterative loop) of the safety case. Its outcomes is the safety concept.

The safety concept should provide the need information arguing why the disposal system could be considered as safe. It’s included the description of the waste to be disposed of, the engineered and natural components, their respective role in the safety and their evolution. Argumentation of the robustness of the disposal system could also be presented at this stage.
Safety Assessments includes amongst others:

- ENVIRONMENTAL IMPACTS ASSESSMENT
- RADIOLOGICAL IMPACT AND PERFORMANCE ASSESSMENT
- OPERATIONAL SAFETY
- ...

**Safety Assessment (DS355):** The safety assessment, a systematic assessment of radiation hazards, is an important component of the safety case. It involves the quantification of radiation dose and risk that may arise from the disposal facility for comparison with dose and risk criteria, and provides an understanding of the behaviour of the disposal facility under normal and disruptive conditions, considering the timeframes over which the radioactive waste remains hazardous.

It addresses the non-radiological hazards generated by the facility through its different lifecycle.
Safety Arguments

Surveillance includes amongst others:

✓ MONITORING
✓ SECURITY
✓ ...

Surveillance and monitoring programmes should be developed and implemented to provide evidence for a certain period of time that the disposal facility will be performing as predicted and that components have the required level of performance (safety function).
Integration of safety arguments includes amongst others:

- ARGUE (Multiple lines of reasoning)
  - the robustness
  - the defense in depth,
  - the system understanding,
  - the monitoring, etc

- COMPARISON OF OPTIONS
  - Comparison between different sites for new disposal facilities;
  - Comparison of different disposal facility types, design, ...;
  - Comparison of different risk management and remediation options for existing facilities

- ADDITIONAL MEASURES TO INCREASE CONFIDENCE
  - Independent review;
  - Complementary Safety indicators;
  - Multiples lines of reasoning

- R&D
  Any R&D activities that are needed in order to support the knowledge and the understanding of the phenomenology and also plans for addressing unresolved issues
Safety Arguments

Limits, Controls & Conditions includes amongst others:

- Limits: dose/risk limits; activity limits per waste package; per disposal unit and for the site
- Controls: active and passive institutional controls; control for waste acceptance; conformity control; compliance with design criteria and with operational procedures, etc.
- Conditions: quality management, format and nature of facility description, licensing conditions for operation, closure, etc.
- ...

The fundamental bases for such limits, controls and conditions are the safety requirements and on the licensed conditions. They generally are derived from formalized safety assessment, both operational and post-closure. Limits, Controls and Conditions contribute to the demonstration of the overall safety.
## Link between the Safety Case argument and the Decision Steps

### Main decision-making steps:

<table>
<thead>
<tr>
<th>Safety Case Context</th>
<th>Need for Action</th>
<th>Disposal Concept</th>
<th>Site Selection and Engineering</th>
<th>Construction</th>
<th>Operation</th>
<th>Closure</th>
<th>Passive Institutional Control Period</th>
<th>Post-Licensing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decision: Go for disposal or Decision for reassessment of an existing facility</td>
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<td></td>
<td>Decision: Choose the site and associated design</td>
<td>Decision: For construction (operation)</td>
<td>Decision: Authentication and/or license for construction (authorities)</td>
<td>Decision to operate (operation)</td>
<td>Decision: Authorization and license for operation (authorities)</td>
<td>Decision to close</td>
<td>Decision to initiate the passive institutional control period</td>
<td>Result: Decide or not to release the regulatory control</td>
</tr>
</tbody>
</table>

- **Management**
  - 1: Not relevant to the decision at hand
  - 2: Of value but is not significant
  - 3: Significant
  - 4: Mandatory

**For each safety case argument, a prioritisation has been performed taking into account the decision step**

These estimation have been summarized for each main topic and are illustrated in the above table—**Full MASC results**
Time dependence of the Safety Case Argument
Safety Case Arguments

How Safety Case Arguments interact together?

System Description

Management System

Limits, controls and conditions

Integration of Safety Arguments
These two sets of arguments should be applied whatever the safety case argument considered or under development.
Safety Case Arguments

- System Description
- Safety Case Context
- Safety Assessment
- Stakeholder & Regulatory Involvement
- Safety Strategy
- Limits, controls and conditions
- Management System
- Integration of Safety Arguments

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Safety Case Arguments

- System Description
- Safety Case Context
- Safety Assessment
- Limits, controls and conditions
- Integration of Safety Arguments
- Stakeholder & Regulatory Involvement
- Safety Strategy
- Management System
Safety Case Arguments

Before any development, the safety case context has to be set and the safety strategy has to be known.
Safety Case Arguments

- Safety Case Context
- Safety Strategy
- Stakeholder & Regulatory Involvement
- Management System
Having the context and the strategy, the next one should be the “System description”.
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Based on the safety Assessment, Limits, Controls and Conditions could be established

Safety Case Context

Safety Strategy

Management System

Stakeholder & Regulatory Involvement

From the safety assessment and from the limits, controls and conditions, a proposal of integration of the safety arguments could be performed established

System Description

Safety Assessment

Limits, controls and conditions

Integration of Safety Arguments

Having the safety concept, deriving from the site, the waste characteristics and from the strategy safety assessment could be performed
This way of structuring the relationship between the safety case components we call it “safety approach”

This safety approach could be organized as followed:
Link with other PRISM Tasks

Safety Case Context → Safety Strategy

System Description

Safety Assessment

Limits, controls and conditions

Integration of Safety Arguments

Management of Uncertainties

Stakeholder & Regulatory Involvement

Iteration & Design Optimisation

Management System
IAEA Safety Case and Safety Assessment: main figure

- Safety Case Context
- Safety Strategy
- System Description
- Safety Assessment
- Limits, Controls and Conditions
- Integration of Safety Arguments
- Management of Uncertainty
- Application of Management System
- Iteration and Design Optimization
- Stakeholder and Regulatory Involvement
Conclusions

- PRISM has been elaborated to put safety assessment in the perspective of the safety case
- Specific to Near Surface Disposal
- In parallel GEOSAF exists for geological disposal
- All elements to the concept of the safety case are valid for both types of facilities
- PRISM was a strong input for DS355 in its final step of development
- Contributes to the understanding of the safety case concept