Agenda Item TW 2.1

Approach to Define Generic Test Conditions for Dual Purpose Casks
– For information and discussion –

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Background

The guidance document is under publishing process to be published as an IAEA technical document.

The document considers various aspects of the demonstration of safety, including acceptance criteria, consideration of the ageing of spent fuel and of materials used for the safety related cask structure, and methods for inspecting casks for transport after storage.
INTRODUCTION

PART 1: GENERAL PRINCIPLES AND TECHNICAL INFORMATION

PART 2: SPECIFIC TECHNICAL ASSESSMENT

REFERENCES

DEFINITIONS

ANNEX: EXAMPLE FOR THE HOLISTIC APPROACH OF A DPCSC FOR AN OPERATIONAL SCENARIO
PART 1: GENERAL PRINCIPLES AND TECHNICAL INFORMATION

1.1 Document control of DPCSC
1.2 Administrative information
1.3 Specification of contents
1.4 Specification of the DPC
1.5 Storage and transport conditions
1.6 General design considerations and acceptance criteria
1.7 Ageing considerations
1.8 Compliance with regulatory requirements
1.9 Operation
1.10 Emergency plan
1.11 Management systems
1.12 Decommissioning
PART 2: SPECIFIC TECHNICAL ASSESSMENT

2.1 Common provisions for all technical analyses in part 2 of the safety case
   - Bases for technical assessment
   - Description and justification of analysis methods
   - Analysis of DPC design
   - Comparison of acceptance criteria with results of analysis

2.2 Structural Analyses
2.3 Thermal analyses
2.4 Activity release analysis
2.5 External dose rates analysis
2.6 Criticality safety analysis
JWG Results

Operational steps
Proposed Structure of a DPC safety case

Dual Purpose Cask Safety Case

Part 1
- Administrative Information
- Specification of Contents
- Specification of Dual Purpose Cask
- Storage and Transport Conditions
- General Design Considerations and Acceptance Criteria
- Ageing Considerations
- Compliance with Regulatory Requirements
- Operation
- Emergency Plan
- Management Systems
- Decommissioning

Contents List

Part 2
- Structural Analysis
  - Subdocument (if necessary)
  - Subdocument (if necessary)
- Thermal Analysis
- Activity Release Analysis
- External Dose Rates Analysis
- Criticality Safety Analysis
Follow up activity

Approach to Define **Generic Test Conditions** for Dual Purpose Casks (2017-2019)
The purpose of the Project is to develop an approach for implementing safety assessment by defining generic test conditions for dry storage of spent nuclear fuel in DPCs and on-site transport of DPCs.

The scope: the project is focused on the storage, on-site transport and transportation (including transportation after storage) of DPCs for spent nuclear fuel.

This may assist Member States in establishing their national safety requirements for DPCs that are to be transported after several decades of storage.
Scope

Offsite Transport Conditions

Storage Conditions

Scope of GeTec

Handling Conditions

Onsite Transport Conditions

DPC
DPC Scope Considerations
Working Method

a. Collecting information on existing national safety requirements and licensing for storage and on-site transport of DPCs and other types of storage/transport packages with respect to accidents

b. Collecting information about incidents which could occur during the operation of DPCs

c. Developing an approach for implementing safety assessment to define generic test conditions for storage

d. Developing an approach for implementing safety assessment to define generic test conditions for on-site transport

e. Developing a joint approach for (c) and (d)
General Approach to identify Test Conditions

1. Conditions
   - Identify initiating events and subsequent events (mechanical and thermal impact)
   - Define conditions for assessment

2. Requirements
   - Define acceptance criteria
   - Site-specific → single DPC

3. GeTeC
   - Define GeTeC as an envelope of impacts and criteria for DPC

- Normal conditions
- Anticipated operational occurrences
- Accident conditions

Criteria
- Dose rate
- Activity release
- Sub-criticality
STORAGE
Scope and Configuration

Storage building or Storage area (open-air)

Transfer
Lifting

Preparation for storage
Positioning
Anchor, if needed
Monitoring connection
Install additional components, if needed

Storage
Static state

Termination of storage
Remove additional components, if needed
Disconnect monitoring
Disconnect anchor, if needed

Transfer
Lifting

- Relocation
- Maintenance
- On-site transport
- Off-site transport

Handling

Storage

Handling
Example: Storage Events and Conditions - Normal

**Ambient conditions**

- $T_u$
- $f$
- $S_{\%}, Cl_{\%}$

**Storage configuration**

**Storage Pad Configuration/Design**
Example: Storage Events and Conditions - AOO

1. Exceed ambient conditions
2. Loss of monitoring
3. DPC minor damage
4. Significant pressure change
Example: Storage Events and Conditions - Accident

- Seiche, Tsunami, Dam Failure
  - Wave speed
  - Wave dimension
  - Flood height
  - Debris size

- Tornado, Hurricane, Typhoon, Cyclone
  - Wind speed
  - Size, mass and material of the missile
  - Orientation of the impact

- Avalanche, mud slide
  - Mass and momentum
  - Mass size

- Aircraft Impact
  - Aircraft speed
  - Aircraft characteristics (masses, material, size, fuel quantity)
  - Impact orientation
Example: Storage Events and Conditions - Accident

Fire from man-made or natural event

- Combustible materials present around storage location

Earthquake

- Ground accelerations spectrum

Volcanic event

- Portion of surface covered by ashes

External event causing flooding

- Maximum flood height
Example: Storage
Events and Conditions - Accident

Building collapse

- Characteristics of the building (height, material)
- Portion of surface covered by debris

Lightning

- Voltage and current of the lightning

Explosion

- Pressure-time function of the wave
- Overall impulse
Seiche, Tsunami, Dam Failure, Tornado, Hurricane, Typhoon, Cyclone, Avalanche, mud slide, Aircraft Impact, Earthquake, Building collapse, Explosion

Building collapse, Volcanic event, Seiche, Tsunami, Dam Failure, Avalanche, mud slide, Aircraft Impact, Fire form man-made or natural event, Lightning

Seiche, Tsunami, Dam Failure, Tornado, Hurricane, Typhoon, Cyclone, external event causing flooding

Impact on Criticality
Requirements

For normal, anticipated operational occurrence and accident conditions, requirements (acceptance criteria) can be written into the same format as:

- Dose rate criteria for each DPC,
- Activity release or leak-tightness criteria for each DPC,
- Sub-critical.

For normal and anticipated operational occurrence, these criteria may be as same as the design criteria for normal storage conditions. For accidents resulting dose rate increase or activity release, criteria at the site boundary have to be translated to the criteria for each DPC.
Storage - GeTeC

Mechanical Impact
- Containment
- Confinement
- Movement

Thermal Impact
- Activity Release
- Dose Rate

Shielding Analysis
- Subcriticality Impact
- Containment Impact
- Confinement Impact

Storage Site Specific
- GeTeC
- Requirements

Subcriticality
- F-t-curve
- F_max
- A
- s
- A
- T
- t
- h
- T_max
- k_eff
ON-SITE TRANSPORT

- Scope and definition of onsite transport
  - DPC movement on the Vehicle within site boundary and out of the buildings (reactor, storage facility) or designated area (storage area).

Scope of On-site Transport
On-site Transport Events and Conditions – Accident Summary

Vehicle Impact, Transport vehicle failure, frame failure, Road collapsing, vehicle mis-maneuvering, Explosion of the vehicle

Mechanical Impact

Thermal Impact

Fire, Explosion of the vehicle
On-site Transport - GeTeC

Mechanical Impact

- Containment
- Confinement
- Movement

Thermal Impact

- Containment Impact
- Confinement Impact

Shielding Analysis

- Activity Release
- Dose Rate

Site Specific

- Requirements

Subcriticality Analysis

- Subcriticality

GeTeC

Site Specific Boundary Conditions

- $A$
- $F_{\text{max}}$
- $T_{\text{max}}$

$k_{\text{eff}}$
HANDLING

• Scope and definition of handling
  - Handling of a loaded DPC in preparation for onsite transport

  **Scope of Handling (in-reactor building)**

  - **SF loading**
    - DPC preparation
      - Lid closure
      - Decontamination
      - Draining
      - Drying
      - Gas filling
      - Inspection
    - Transfer
      - Lifting
    - Preparation for transport
      - DPC tilting
      - Loading to vehicle/transport frame
      - Transport configuration
      - Preshipment inspection

  - Reactor building
  - **Onsite transport**
  - Out of scope of this publication
  - Start movement
  - Handling
  - Onsite transport
HANDLING

• Scope and definition of handling
  - Handling of a loaded DPC to place in an onsite storage configuration

Scope of Handling (in-storage facility)
HANDLING

- Scope and definition of handling
  - Handling in preparation for offsite transport

**Scope of Handling (termination of storage)**
Handling Events and Conditions – Accident Summary

Impact, Crane Failure

Mechanical Impact

Thermal Impact

Fire
Handling - GeTeC

Mechanical Impact

Thermal Impact

Shielding Analysis

Site Specific

Requirements

Containment
Confinement
Movement

Activity Release
Dose Rate

Subcriticality Analysis

Subcriticality

GeTeC
GeTec – Summary of Impact of Handling, Storage and onsite Transport
<table>
<thead>
<tr>
<th>GeTec – Mechanical Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Offsite Transport</strong></td>
</tr>
<tr>
<td>Configuration</td>
</tr>
<tr>
<td><strong>Onsite Transport</strong></td>
</tr>
<tr>
<td>Configuration</td>
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<tr>
<td><strong>Storage</strong></td>
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<tr>
<td>Configuration</td>
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<td><strong>Vibration</strong></td>
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<td><strong>Frequenz</strong></td>
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<td><strong>Acceration</strong></td>
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<td><strong>Height</strong></td>
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<td><strong>Puncture Impact</strong></td>
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<td><strong>Force-time Area</strong></td>
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<td>------------------</td>
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<tr>
<td>Heat Impact</td>
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<tr>
<td>Adiabatic Impact</td>
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<tr>
<td>Point load</td>
</tr>
</tbody>
</table>

**Input**

- Heat Impact
- Adiabatic Impact
- Area
- Duration
- Temperature
- %-affected Surface
GeTec – Criticality Impact

Offsite Transport Configuration

Onsite Transport Configuration

Storage Configuration

Handling Configuration

Water Impact

Duration Height
GeTeC - Summary

- Different GeTeC necessary
- No overall covering GeTeC is possible
- Influence on the configuration
- Site/facility specific Input Parameter
- Site/facility specific Requirements
Next Steps

• Consultancy Meeting (20-24 April 2020)
  – To finalise draft GeTeC report and move to publication process (as a TECDOC)

• Consultancy Meeting to address editorial comments (if needed) and to prepare proposal for follow up activity
Thank you!