Agenda Item W 5.1

Overview on the IAEA Activities related to the Development of Waste Acceptance Criteria for Disposal
– For information and discussion –

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Waste acceptance requirements - Quantitative or qualitative criteria specified by the regulatory body, or (more usually) specified by an operator and approved by the regulatory body, for radioactive waste to be accepted by the operator of a repository for disposal, or by the operator of a storage facility for storage.

Waste acceptance requirements might include, for example, restrictions on the activity concentration or total activity of particular radionuclides (or types of radionuclide) in the waste, or requirements concerning the waste form or packaging of the waste.

(IAEA Safety Glossary, 2007)
Waste Acceptance Criteria

Acceptance criteria - Specified bounds on the value of a functional indicator or condition indicator used to assess the ability of a structure, system or component to perform its design function.

Waste acceptance criteria - Quantitative or qualitative criteria specified by the regulatory body, or specified by an operator and approved by the regulatory body, for the waste form and waste package to be accepted by the operator of a waste management facility.

(IAEA Safety Glossary, Draft 2016)
Waste Acceptance Criteria

• *Waste acceptance criteria* specify the radiological, mechanical, physical, chemical and biological characteristics of *waste packages* and unpackaged *waste*

• *Waste acceptance criteria* might include, for example, restrictions on the *activity concentration* or total *activity* of particular radionuclides (or types of radionuclide) in the *waste*, on their heat output or on the properties of the *waste form* or of the *waste package*

• *Waste acceptance criteria* are based on the *safety case* for the *facility* or are included in the *safety case* as part of the *operational limits and conditions* and controls

• *Waste acceptance criteria* are sometimes referred to as ‘waste acceptance requirements’

(IAEA Safety Glossary, 2016)
Long-term Safety Assessment Methodology

Safety assessment context

Detailed description of disposal system

Scenario generation and justification

Development and implementation of models

Calculation and analysis of endpoints

Changing of safety assessment components

Comparison with regulatory criteria of safety

Assessment results

Is this model behavior adequate or not?

Is correction possible?

YES

NO

YES

NO
Illustrative EXAMPLE

- Considers the use of safety assessment to derive activity limits using an example based on taken from an IAEA study
- In particular:
  - describes the approach used
  - discusses the results obtained
  - discusses their application
ASSESSMENT CONTEXT

• Purpose
  – derive illustrative operational and post-closure activity limits for the disposal of radioactive waste to two example near-surface disposal facilities
  – resulting illustrative limits can be used as a benchmark against which to compare limits for specific disposal systems
### SYSTEM DESCRIPTION

- Radionuclides considered for Operational Safety Assessment

<table>
<thead>
<tr>
<th>3H</th>
<th>10Be</th>
<th>14C</th>
<th>22Na</th>
<th>41Ca</th>
<th>54Mn</th>
<th>55Fe</th>
<th>59Ni</th>
<th>63Ni</th>
<th>60Co</th>
<th>65Zn</th>
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</thead>
<tbody>
<tr>
<td>90Sr</td>
<td>93Zr</td>
<td>94Nb</td>
<td>99Tc</td>
<td>106Ru</td>
<td>110mAg</td>
<td>121mSn</td>
<td>125Sb</td>
<td>126Sn</td>
<td>129I</td>
<td>134Cs</td>
</tr>
<tr>
<td>137Cs</td>
<td>144Ce</td>
<td>147Pm</td>
<td>151Sm</td>
<td>152Eu</td>
<td>154Eu</td>
<td>204Tl</td>
<td>210Pb</td>
<td>226Ra</td>
<td>228Ra</td>
<td>227Ac</td>
</tr>
<tr>
<td>232Th</td>
<td>234U</td>
<td>235U</td>
<td>238U</td>
<td>237Np</td>
<td>238Pu</td>
<td>239Pu</td>
<td>240Pu</td>
<td>241Pu</td>
<td>241Am</td>
<td></td>
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</tbody>
</table>
### Radionuclides considered for Post-closure Safety Assessment

<p>| | | | | |</p>
<table>
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<tr>
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</thead>
<tbody>
<tr>
<td>$^3$H</td>
<td>$^{90}$Sr</td>
<td>$^{151}$Sm</td>
<td>$^{237}$Np</td>
<td></td>
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<td>$^{226}$Ra</td>
<td>$^{238}$Pu</td>
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<td>$^{238}$U</td>
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</table>
• Disposal Facility Layout
SYSTEM DESCRIPTION

• Disposal facilities:
  – trench adapted from NSARS Test Case 2C
  – vault adapted from NSARS Test Case 1
SYSTEM DESCRIPTION

• Length-wise cross-section of operational trench
DESCRIPTION OF DISPOSAL SYSTEM

• Width-wise cross-section of closed trench
## Total activities and post-closure safety (off site scenario, vault)

<table>
<thead>
<tr>
<th></th>
<th>Sand temperate</th>
<th>Sand arid</th>
<th>Clay temperate</th>
<th>Clay arid</th>
</tr>
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</table>
## Total activities and post-closure safety
*(off site scenario, trench)*

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</tr>
</thead>
<tbody>
<tr>
<td><strong>Cs-137</strong></td>
<td>&gt;1.E+20</td>
<td>&gt;1.E+20</td>
<td>&gt;1.E+20</td>
<td>&gt;1.E+20</td>
</tr>
</tbody>
</table>
The limiting total activity depends on

- How the disposal facility is engineered (trench or vault)
- Amount of rainwater infiltration
- Groundwater movement through the geosphere
- Institutional control duration
Specific activity limited by

- Operational safety (worker doses, esp. for vaults)
- Operational safety (off site releases for trenches)
- Post-closure safety e.g. on site residence scenario (may or may not be classed as human intrusion)

Total activity limited by

- Off site groundwater releases
- Duration of institutional control period
Permissible specific activity limits broadly correspond to widely accepted definitions of LLW

\[
\begin{align*}
\text{LLW} & \quad \beta\gamma \ <12 \text{ MBq/kg} \\
& \quad \alpha \quad <0.4 \text{ MBq/kg average}
\end{align*}
\]

But not for short-lived ILW, which could be very active if the institutional control period is 300 years

\[
\begin{align*}
\text{ILW-SL} & \quad \beta\gamma \ <60 \text{ TBq/kg}
\end{align*}
\]
APPLICATION OF RESULTS

• The derived illustrative activity limits can be used:
  – as a starting point for countries that do not yet have disposal system specific data and are at an early stage in a near surface disposal programme
  – as a benchmark against which to compare disposal system specific limits
APPLICATION OF RESULTS

• Caveats (1 of 2):
  – application of the illustrative activity limits should be restricted to assessment contexts and disposal systems similar to those in the IAEA study
  – compliance with activity limits derived using the approach does not, on its own, ensure the overall safety of disposals, since such safety also relies upon other elements
  – be aware of various sources of uncertainty
APPLICATION OF RESULTS

• Caveats (2 of 2):
  – derivation of the limits assumes a linear relationship between dose and radionuclide inventory and a uniform distribution of activity in the facility
  – when disposing a spectrum of several radionuclides, it is necessary to combine their impacts in order to ensure that the dose limit is not exceeded for any given scenario
IAEA Activities
Current IAEA activities on RWM

Classification of radioactive Waste

Activity content

PREDISPOSAL

SFM

GeTeC

WM

ECLiPSE

DISPOSAL

HLW
high level waste
(deep geologic disposal)

GEOSAF-III

ILW
intermediate level waste
(intermediate depth disposal)

PRISMA

LLW
low level waste
(near surface disposal)

VSLW
very short lived waste
(decay storage)

VLLW
very low level waste
(landfill disposal)

EW
exempt waste
(exemption / clearance)

half-life
Human Intrusion in the Context of Disposal of Radioactive Waste (HIDRA)

- **2013-2014 - Phase I**
  - to provide insights regarding the role of IHI for these decisions and to provide a common framework for consideration of IHI as part of development of a safety case for a disposal facility

- **2016-2018 - Phase II**
  - to test and refine the general approaches and concepts described in the first phase of the HIDRA project by applying those approaches to generic near-surface and geologic disposal facilities
General HIDRA Approach

Safety Framework
- Safety Case Context
- Safety Strategy
- Disposal System Description

Inadvertent Human Intrusion Considerations
- Stylised Scenarios
- Protective Measures

Facility-Specific Scenarios and Measures

Assessment/Analysis and Additional Considerations

Implement Measure(s)?
- Yes
  - Modify Safety Framework
- No
  - Unchanged Framework

Proceed to next step in lifecycle

Societal Factors
Iterative approach for scenario development
HIDRA way forward

broader “future human actions”;

development of practical guiding document on using developed approach for assessing, demonstrating safety and for decision making;

use IHI for derivation of waste acceptance criteria.
Summary and Conclusions

- Waste Acceptance Criteria are part of the formal program used to ensure that waste is treated as assumed in the safety case

- WAC are generally proposed by the site operator and reviewed and approved by the regulator

- Common WAC are related to the physical, chemical and radiological characteristics of the wastes
Summary and Conclusions

- National Regulation
- Safety assessment
- Requirements of the Authorities
- International standards, recommendations

Waste Acceptance Criteria (WAC)
Single international WAC not possible: different processing results in different WAC

Waste acceptance not only serves to provide the information necessary to initially design the waste treatment process and waste form, but also provides the information necessary to validate the actual treatment process and hence meet quality assurance standards.
Raw Waste

Treatment and Conditioning

Requires further conditioning

Strg Waste Pkg Review

Storage

Requires further conditioning

Repository

New Waste Type Review

Transfer to repository

Not Acceptable

Repository

Rep Waste Pkg Review
Thank you!