Japanese Regulations for Waste Management

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Category of radioactive waste disposal

- Generic maximum concentrations for each waste package
  - Co-60: 10 GBq/t
  - Sr-90: 10 MBq/t
  - Cs-137: 100 MBq/t
  - C-14: 100 GBq/t
  - Co-60: 1 PBq/t
  - Ni-63: 10 TBq/t
  - Sr-90: 10 GBq/t
  - Cs-137: 100 TBq/t
  - α emitters: 100 GBq/t

- Specific radioactive concentrations should be decided so as to comply with the dose criteria, considering the site characteristics and the repository design.

- Average concentrations of wastes are well below the generic maximum concentrations.

- The burial of category 1 waste
  - TRU waste
  - HLW
  - Geothermal disposal
  - Intermediate Depth Disposal
  - Concrete vault disposal
  - Trench disposal

- The burial of category 2 waste

- 100m
- 300m

- ✔ Generic maximum radioactive concentrations are listed above for each type of repositories.
- ✔ Specific radioactive concentrations should be decided so as to comply with the dose criteria, considering the site characteristics and the repository design.
- ✔ Average concentrations of wastes are well below the generic maximum concentrations.
Concept of Intermediate Depth Disposal

Cross section
Longitudinal section

Support

Approx. 13m
Approx. 18m
Approx. 18m
Approx. 18m
Approx. 18m
Approx. 12m
Approx. 12m
Approx. 14m

Backfill (soil, concrete)
Bentonite
Mortar
Reinforced concrete pit
Mortar fill
Waste packages

Lid (welded)
Main body of waste package
Additional shield

Waste package

*1: Figures are cited from the Federation of Electric Power Companies of Japan
Regulatory procedures on LLW disposal

Pre-construction activities

- Application of License

Construction activities

- Start of Operation
- Safety Inspection (monitoring, PSR)
- Safety Confirmation of Radioactive Waste Package
- Safety Confirmation of Disposal Facility

Operational activities

- Stepwise control (about 300 ~ 400 y)
- Post closure activities (Institutional control)

Closure

- Safety Confirmation of Disposal Facility

After termination of license

- Termination of license
- Application of Decommissioning plan

Restriction of Land use (for Intermediate Depth Disposal)

Construction and operation → Post closure → Passive safety

NRA, Japan
Characteristics of Radioactive Waste of Intermediate Level Disposal

Relative effects of wastes vs. time

*1) Average values for radioactive waste from operation and decommissioning of BWR, PWR, and GCR
*2) 1 mSv/y when sum of nuclide concentration divided by clearance level equals to 100

- Requirements for design and controls are related to the characteristics of wastes.
- Wastes containing longer half lives of radionuclides require longer time of control or isolation.
Radio Nuclides Pathway of Intermediate Depth Disposal

Drinking river water, ingestion of agricultural products, ingestion of fish

Drinking well water

Agricultural work

Engineering barrier

Natural barrier

Waste
## Requirements for radioactive waste disposal

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<tr>
<th>Category</th>
<th>ID</th>
<th>Requirements</th>
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<td>Radiation protection</td>
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</tr>
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<td>R1</td>
<td>During License</td>
</tr>
<tr>
<td></td>
<td>R2</td>
<td>After license termination</td>
</tr>
<tr>
<td>Design</td>
<td>A</td>
<td>Location of repository</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>Limitation on concentrations of long-lived nuclides</td>
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<td></td>
<td>C</td>
<td>Confinement of nuclides until the termination of license</td>
</tr>
<tr>
<td></td>
<td>D1</td>
<td>Containment of nuclides</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Engineered barriers</td>
</tr>
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<td>• Natural barrier</td>
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<tr>
<td>Human intrusion</td>
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<td>Monitoring</td>
</tr>
<tr>
<td></td>
<td>K</td>
<td>Confirmation of decommissioning</td>
</tr>
</tbody>
</table>
Requirements on Location of Repository (Exclusion Criteria)

- Avoid direct hit by volcanic eruption during at least 100ka
- Avoid direct hit by faulting during at least 100ka
- Maintain minimum depth of 70m taking into account of uplift and erosion at least 100ka
- Away from significant known mineral resources

Consider uplift and erosion in 100ka
ALARA (Optimization of radiation protection)

The principle of Optimization is defined as the source related process to keep likelihood of incurring exposures (where these are not certain to be received), the number of people exposed, and the magnitude of individual doses as low as reasonably achievable, taking economic and societal factors into account. (ICRP Publ.103)

- Optimization is a frame of mind, always questioning whether best has been done in the prevailing circumstances.
- Compare and select preferable measure from available options.
- Optimization is an iterative process taking into account both technical and socio-economic development.
- Requirement not for the solution but for the process.
- The goal of an optimization of protection is not a mathematically optimized solution.
Background and specific feature of ALARA for radioactive waste disposal

- Protection after the termination of license relies on the characteristics of the selected site and the design of the disposal facility.
- Estimated dose and risk in the far future are not the absolute measure to ensure safety.
- Site characteristics, element of Best Available Technique (BAT), concept of good practice, reliable engineering, etc. are important.
Requirements on Disposal Design

Design Process

① Design concept
② Engineering barrier design
③ Selection of location of disposal
④ Selection of disposal system
⑤ Dose assessment of public
## Example of engineered barrier function

<table>
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<tr>
<th>Barrier function</th>
<th>Barrier Performance</th>
<th>Related Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Confinement and Containment of Nuclide</strong></td>
<td>Confinement</td>
<td>Duration of opening holes on waste package</td>
</tr>
<tr>
<td></td>
<td>Retardation</td>
<td>Long travel time of nuclide in barriers</td>
</tr>
<tr>
<td></td>
<td>Low Release Rate</td>
<td>Low release rate from engineered barrier</td>
</tr>
<tr>
<td><strong>Stable Condition</strong></td>
<td>Restrict ground water inflow</td>
<td>Low ground water inflow to engineered barrier</td>
</tr>
<tr>
<td></td>
<td>Stabilize Mechanical Condition</td>
<td>Small deformation</td>
</tr>
<tr>
<td></td>
<td>Stabilize Geochemical Condition</td>
<td>Buffer of red-ox and chemical condition</td>
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</tbody>
</table>
# Example of Natural Barrier Function

<table>
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<tr>
<th>Barrier Function</th>
<th>Barrier Performance</th>
<th>Related Feature</th>
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<tbody>
<tr>
<td><strong>Containment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retardation</td>
<td>Long travel time of ground water. Long travel time of nuclide.</td>
<td>Kd value, ground water velocity, distance from highly conductive geological feature.</td>
</tr>
<tr>
<td><strong>Stable Condition</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condition</td>
<td></td>
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</tbody>
</table>
Conclusion

• NRA is preparing new regulatory framework for the Intermediate Depth Disposal.
  - Disposal should be designed so as to confine nuclides within the engineered barrier, until the termination of the license.
  - Disposal should be isolated from natural disruptive events and human activities for a period of at least 100 K years.
  - Disposal should be designed and natural barrier should be selected so that the release of nuclides from the disposal would be As Low As Reasonably Achievable. The dose for the representative person shouldn’t exceed dose constrain.
  - Inventory of long-lived nuclides should be limited below the level considering the dose of person hypothetically contacting with wastes at 100 K years after closure should not exceed 20 mSv/y.

• NRA is considering the way to take these regulation framework to that of shallow land disposal, even though they wouldn’t have much design options and most of radio activities will decay by the time of termination of licence.
Thank you for your attention.