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Japanese Regulations for Waste Management

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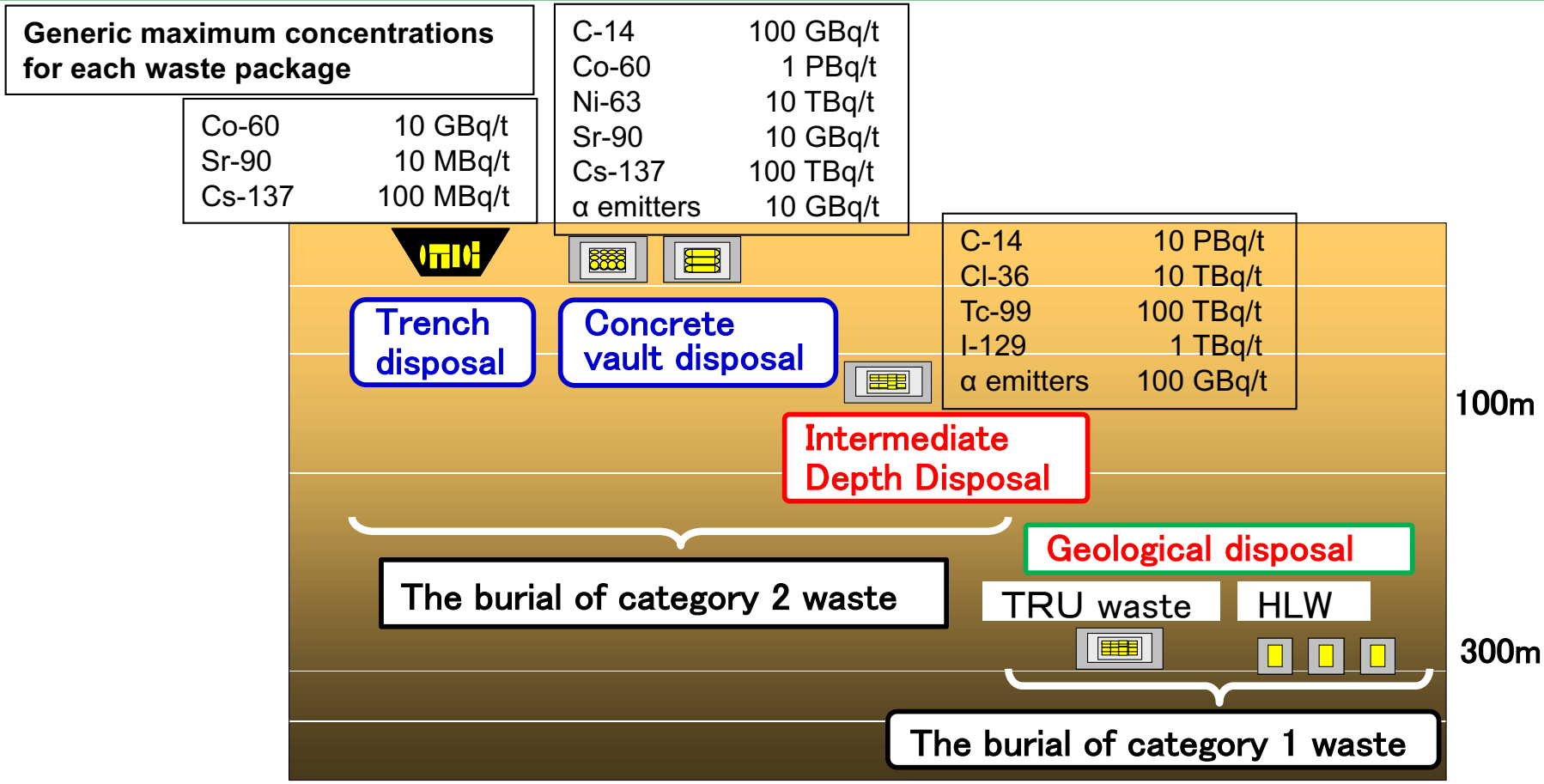
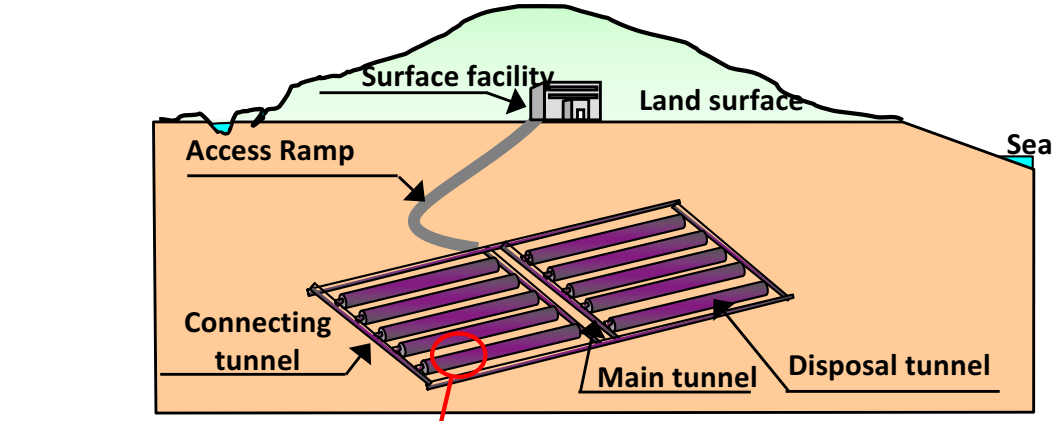
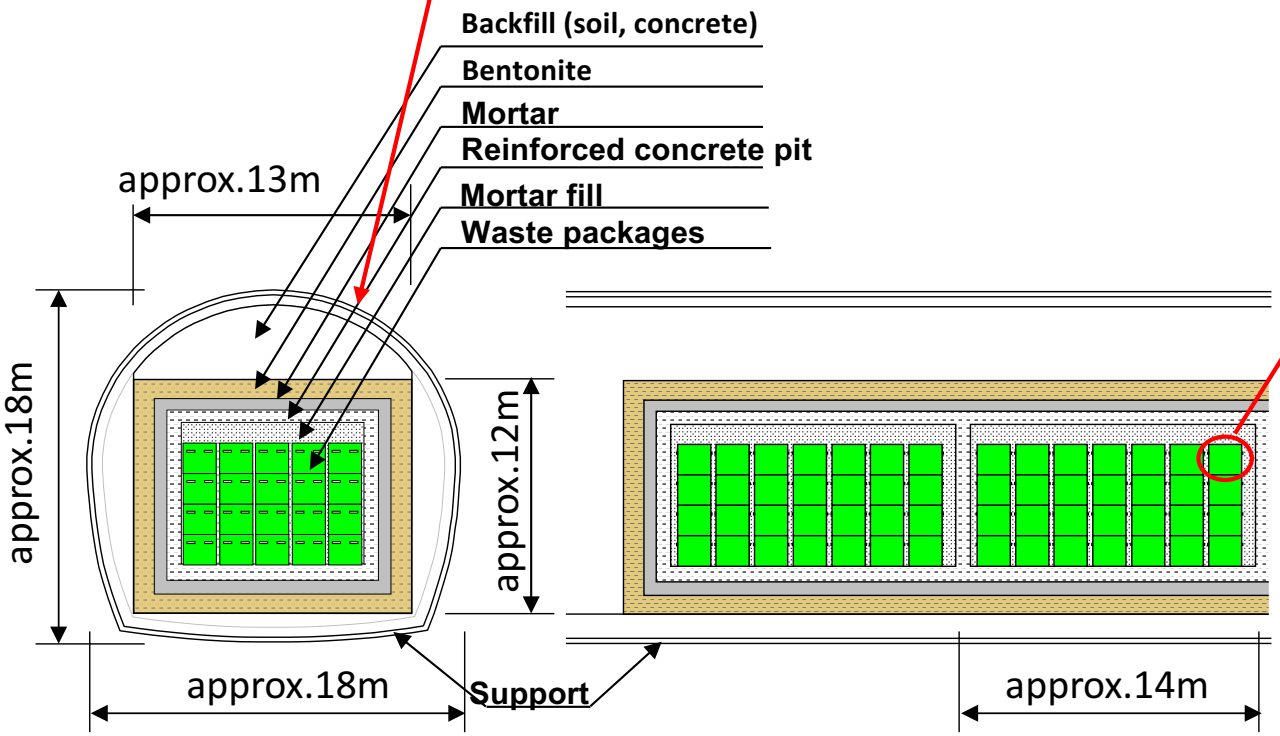
Category of radioactive waste disposal

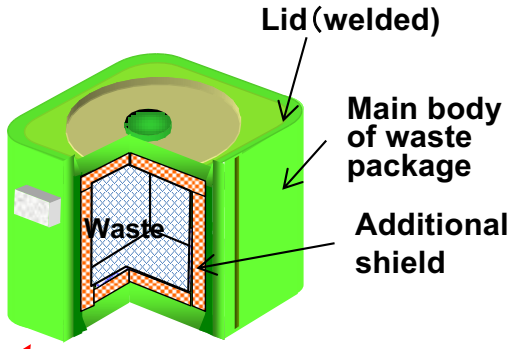


- ✓ Generic maximum radioactive concentrations are listed above for each type of repositories.
- ✓ Specific radioactive concentrations should be decided so as to comply with the dose criteria, considering the site characteristics and the repository design.
- ✓ Average concentrations of wastes are well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

Concept of Intermediate Depth Disposal



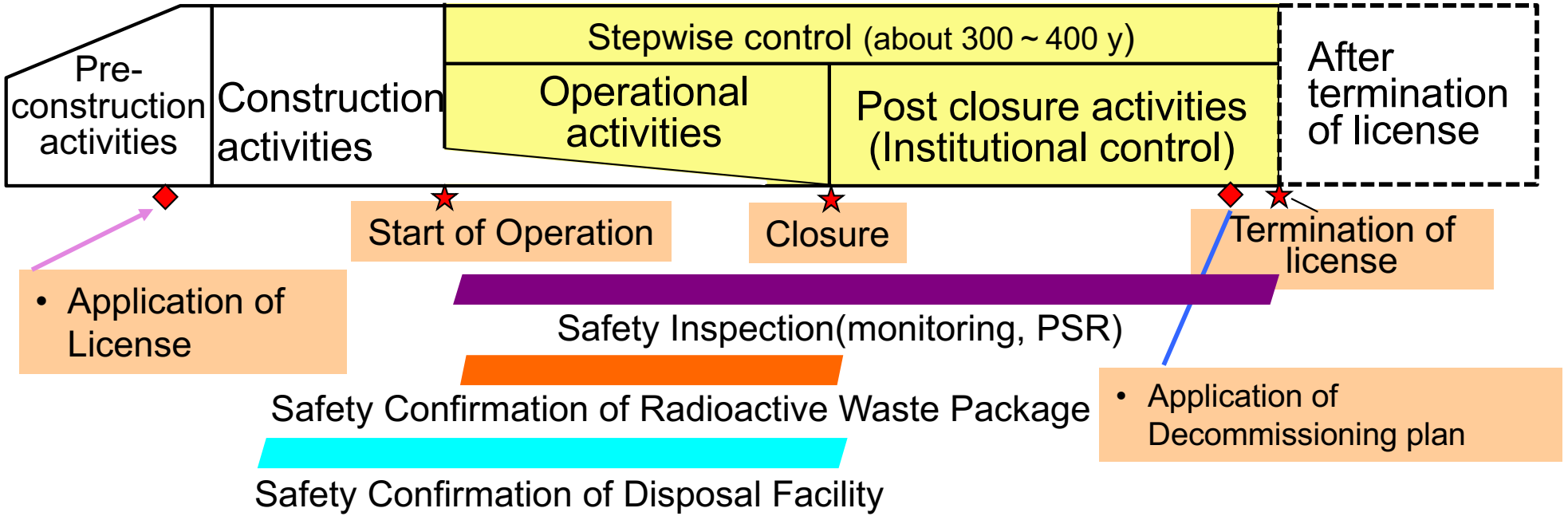


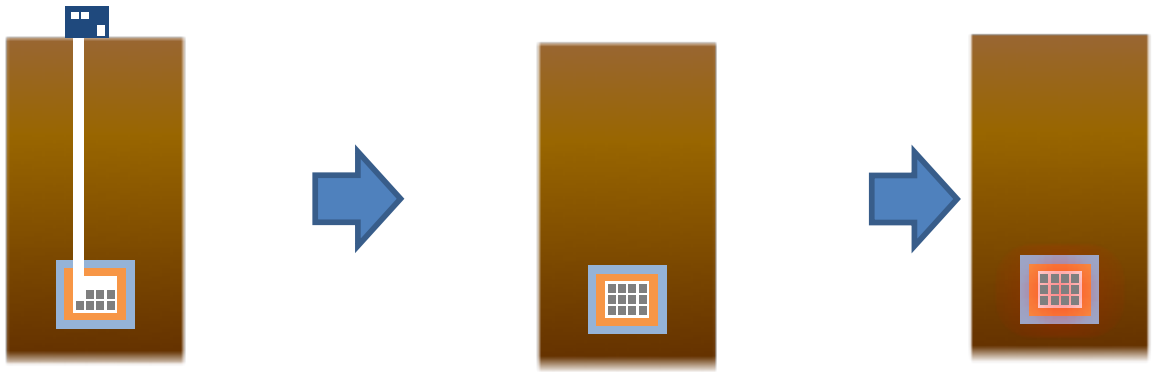


Waste package

*1: Figures are cited from the Federation of Electric Power Companies of Japan

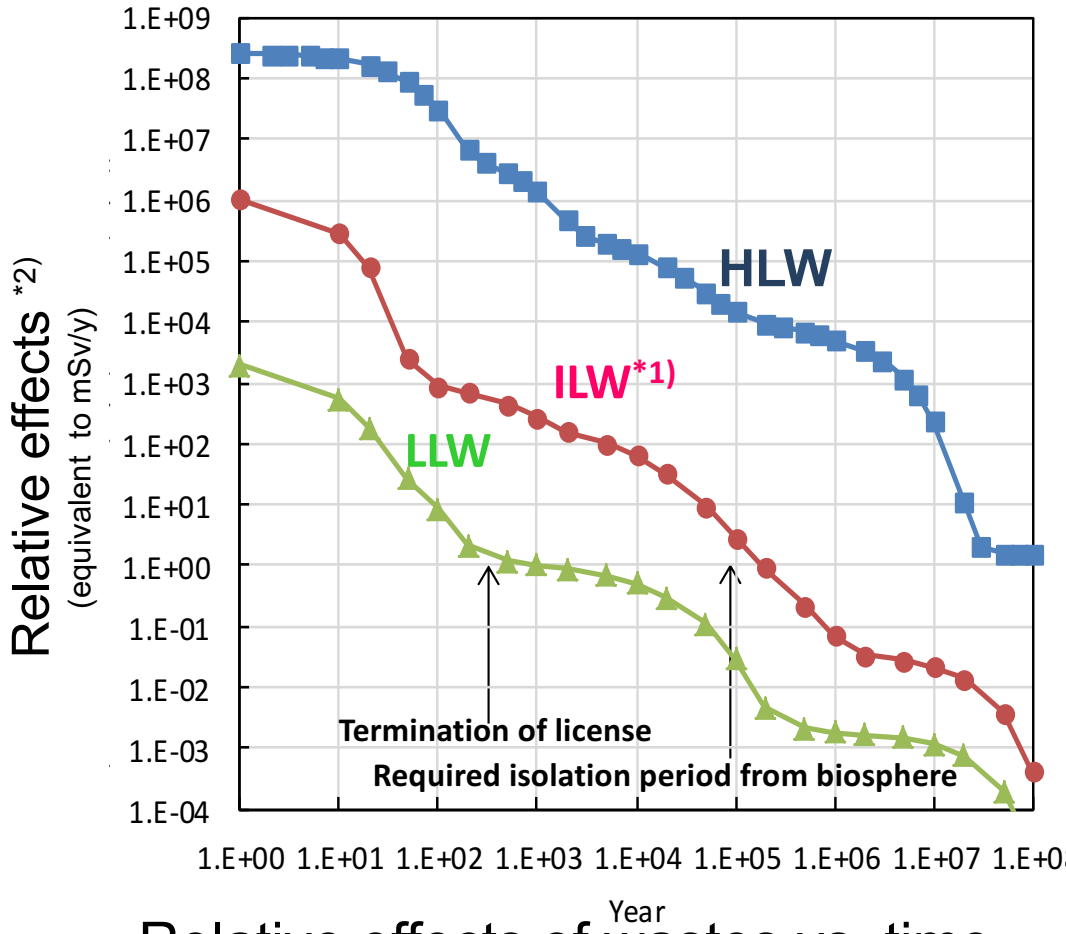
Regulatory procedures on LLW disposal





Construction and operation | Post closure | Passive safety

Characteristics of Radioactive Waste of Intermediate Level Disposal



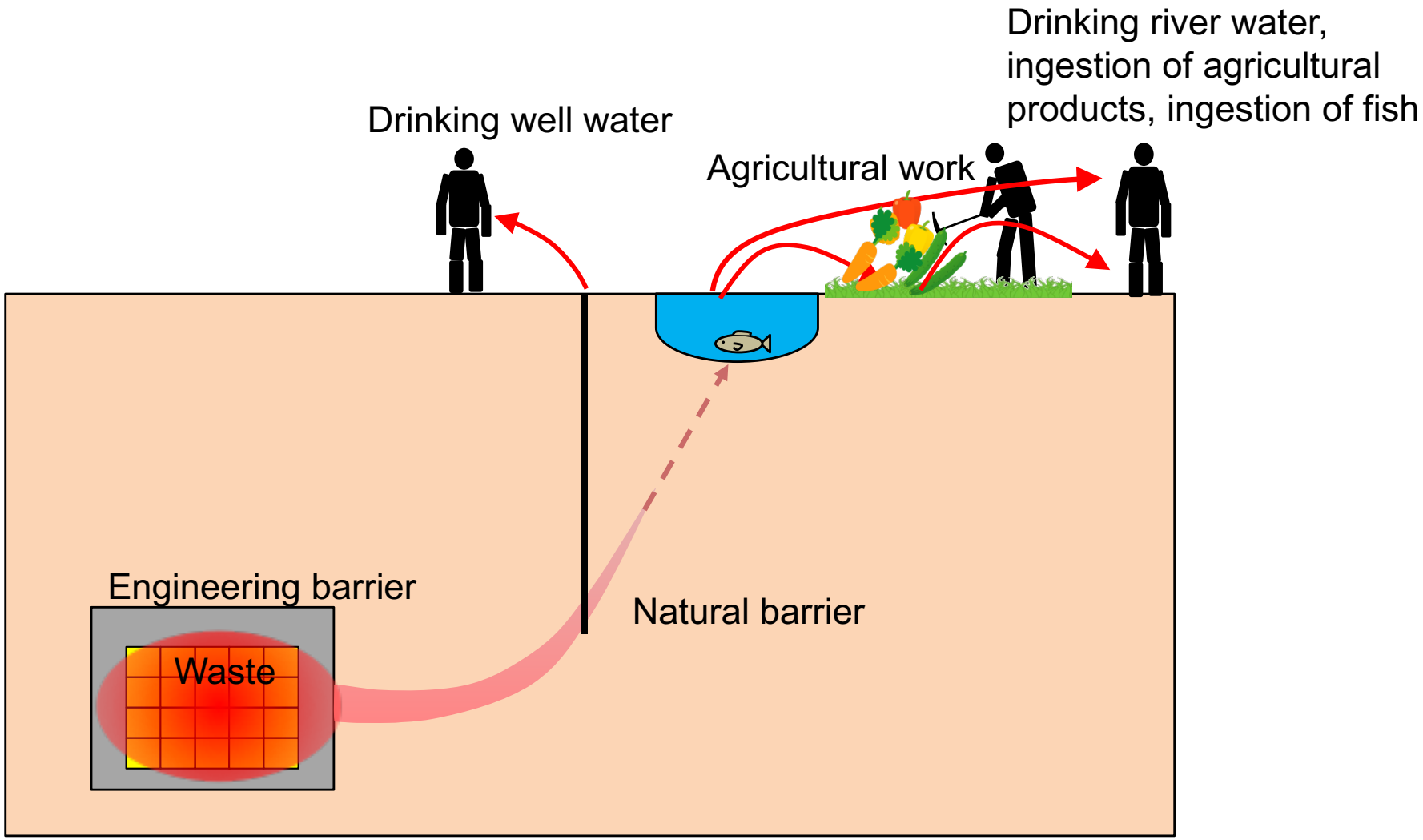
Relative effects of wastes vs. time

*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.

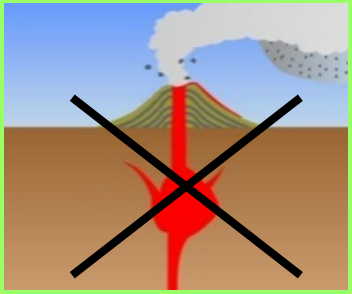
Radio Nuclides Pathway of Intermediate Depth Disposal

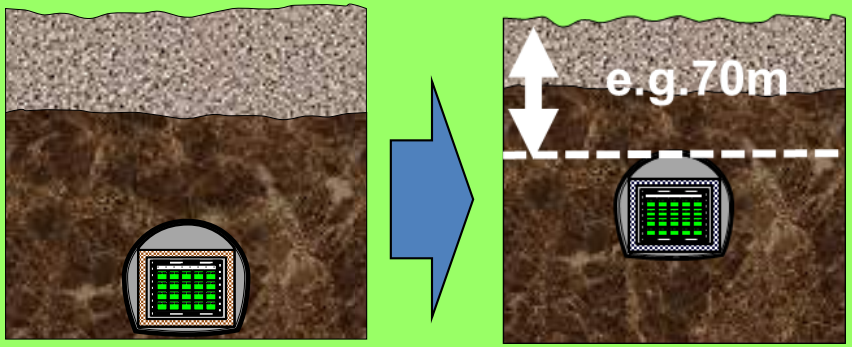


Requirements for radioactive waste disposal

Category		ID	Requirements
Radiation protection		R1 R2	During License After license termination
Design	Natural process	A	Location of repository
		B	Limitation on concentrations of long-lived nuclides
		C	Confinement of nuclides until the termination of license
		D1 D2	Containment of nuclides • Engineered barriers • Natural barrier
	Human intrusion	E	Prevention of human intrusion
		F	Mitigation of consequence of human intrusion
Control		G	Confirmation of barrier function
		H	Periodic safety review
		I	Closure of tunnel
		J	Monitoring
		K	Confirmation of decommissioning

Requirements on Location of Repository (Exclusion Criteria)





Consider uplift and erosion in 100ka

- 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

Radiation Protection Criteria for Waste Disposal (1/2)

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)

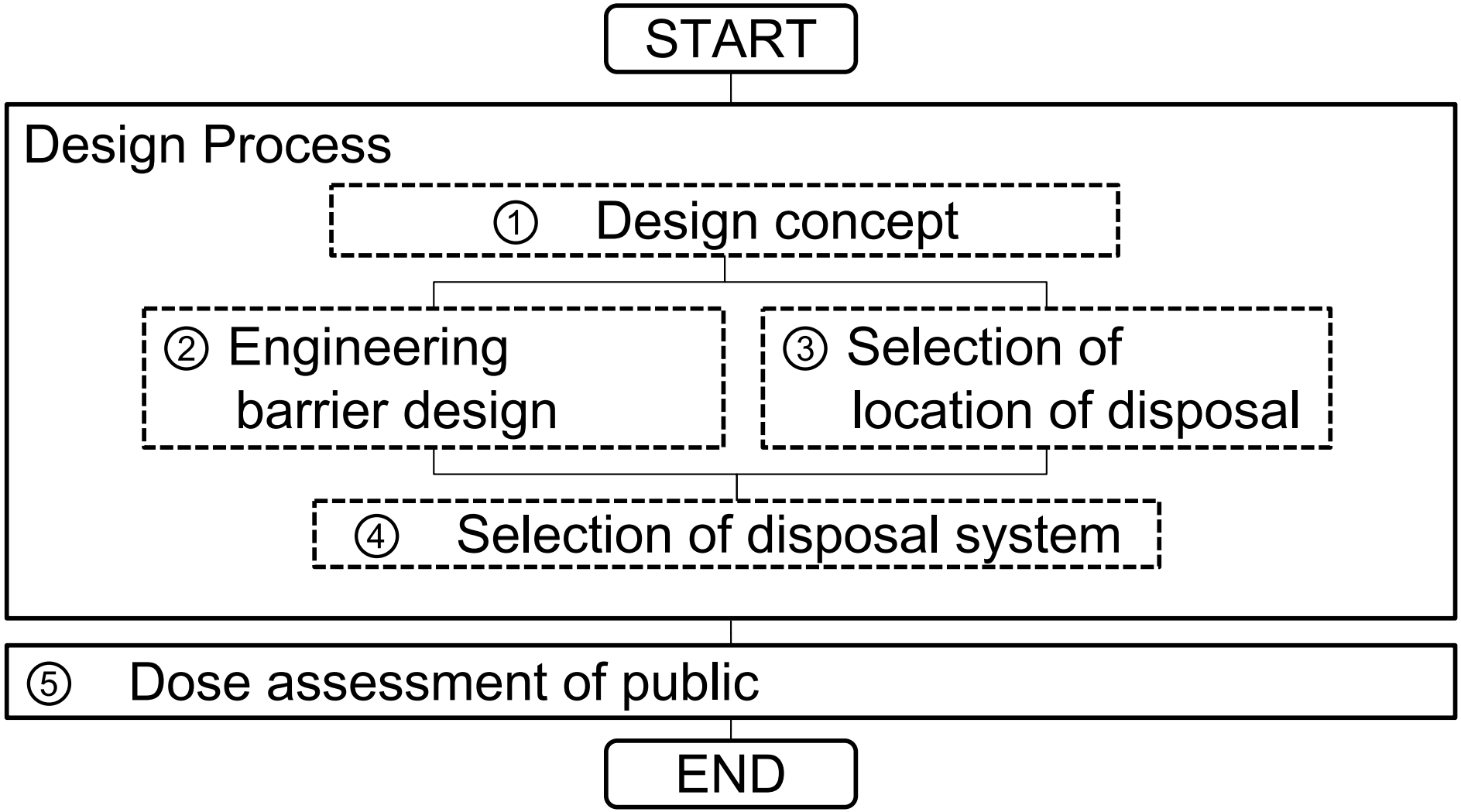
- Optimization is a frame of mind, always questioning whether best has been done in the prevailing circumstances.
- Compare and select preferable measure from available options.
- Optimization is an iterative process taking into account both technical and socio-economic development.
- Requirement not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

Radiation Protection Criteria for Waste Disposal (2/2)

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



Example of engineered barrier function

Barrier function		Barrier Performance	Related Feature
Confinement and Containment of Nuclide	Confinement	Duration of opening holes on waste package	Corrosion rate
	Retardation	Long travel time of nuclide in barriers	Kd value, solubility
	Low Release Rate	Low release rate from engineered barrier	Diffusivity, width and numbers of cracks
Stable Condition	Restrict ground water inflow	Low ground water inflow to engineered barrier	Permeability
	Stabilize Mechanical Condition	Small deformation	Young's modulus, compression strength
	Stabilize Geochemical Condition	Buffer of red-ox and chemical condition	Corrosion condition of metal, degradation condition of cement and clay material

Example of Natural Barrier Function

Barrier Function		Barrier Performance	Related Feature
Containment	Retardation	Long travel time of ground water. Long travel time of nuclide.	Kd value, ground water velocity, distance from highly conductive geological feature.
Stable Condition	Stabilize Geochemical Condition	Stagnant ground water flow. Buffer of red-ox and chemical condition	Buffer capacity of minerals. Distribution of geological formation. Distribution of geochemical condition.

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.