International Symposium on Present Status and Future Perspective for Reducing Radioactive Wastes
~ Aiming for Zero-Release ~

Development of The Evaluation Tool for Reduction of High Level Radioactive Waste

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1. Background

- Examination of the future reprocessing facility following the Rokkasho reprocessing plant.
  - ◆ Reprocessing of spent fuel (LWR-UO_2 fuel, LWR-MOX fuel, FBR-MOX fuel)
  - ◆ Construction of an institution preparation plan
    - ✓ The preparation plan of institutions : [Time, Demand function, Scale, etc]
    - ✓ The operation plan of a plant : [Fuel-reprocessing employment plan]
    - ✓ Process pattern : [Selection of a process and a system]
    - ✓ Plant image : [The concepts of institutions (building layout, equipment layout, etc.)]
    - ✓ Correspondence capability to change of Pu demand-and-supply balance.
    - ✓ Pliability, stability, economical efficiency, etc. of a plan
- The nuclear accident at the Fukushima Daiichi NPS in 2011 is a trigger.
  - ✓ In practical use of a nuclear system, examination of a system scenario which also took disposal of high-level radioactive wastes (HLW) into consideration in addition to the improvement in safety of an electric power plant is required.
  - ✓ In order to raise the implementability of HLW disposal, the issue in which reduction of disposal burden (streamlining of waste and reduction of the radiotoxicity) is important.

2. Purpose

- Purpose of tool
  - ✓ Suggestion of plant implementation program at the point of view of the Pu supply-demand balance during transition period from LWR to FBR
  - ✓ Suggestion of fuel cycle scenario that will be effective for reduction of the disposal burden of HLW

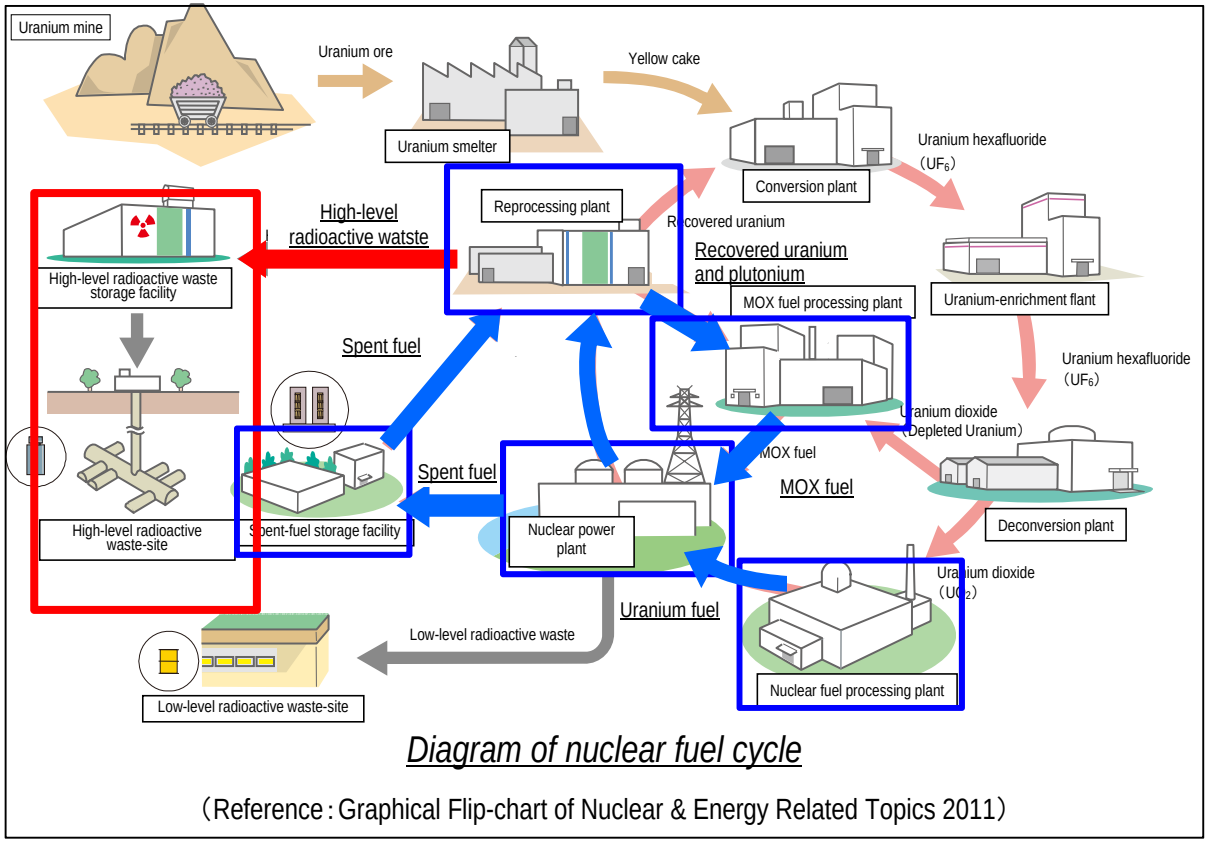
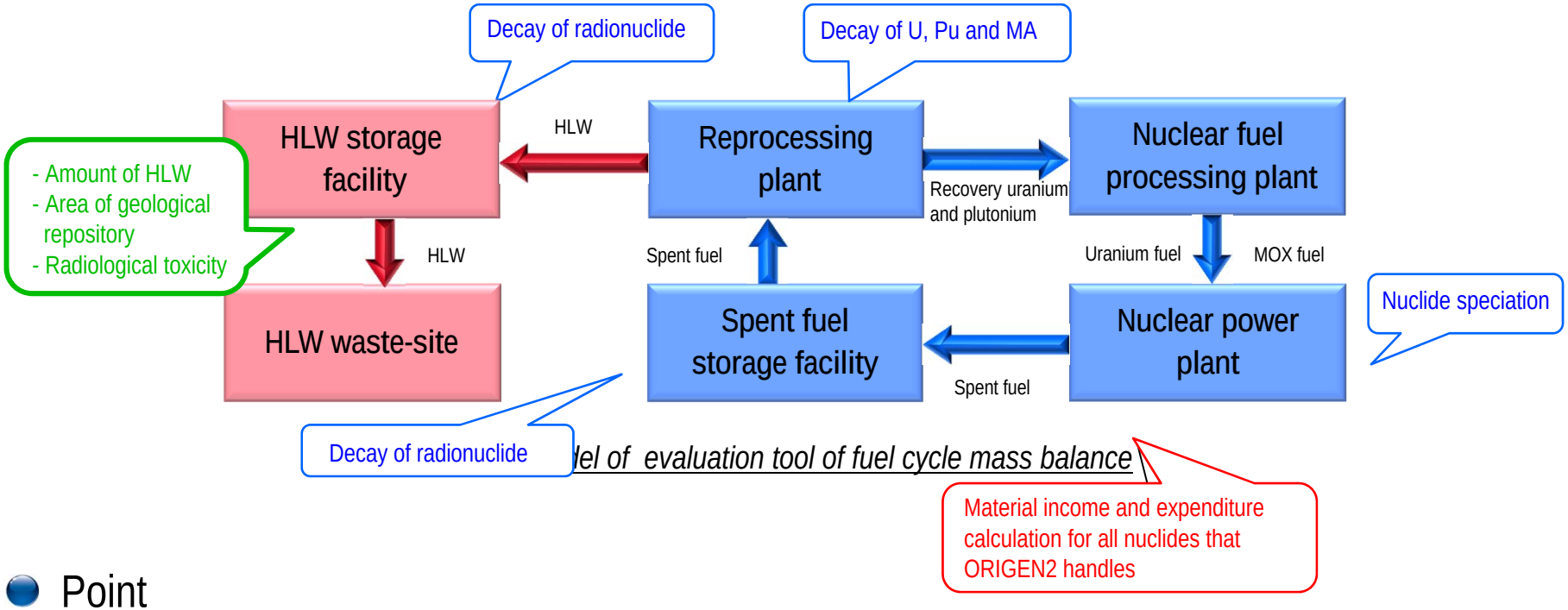


Diagram of nuclear fuel cycle

（Reference：Graphical Flip-chart of Nuclear & Energy Related Topics 2011）

3. Abstract of the tool

Calculation method



Point

① Behavior of nuclide in the nuclear facilities (burnup, decay) ⇒ ORIGEN2 code

② Mass balance ⇒ All nuclides that ORIGEN2 cord handles

③ Environmental burden of HLW

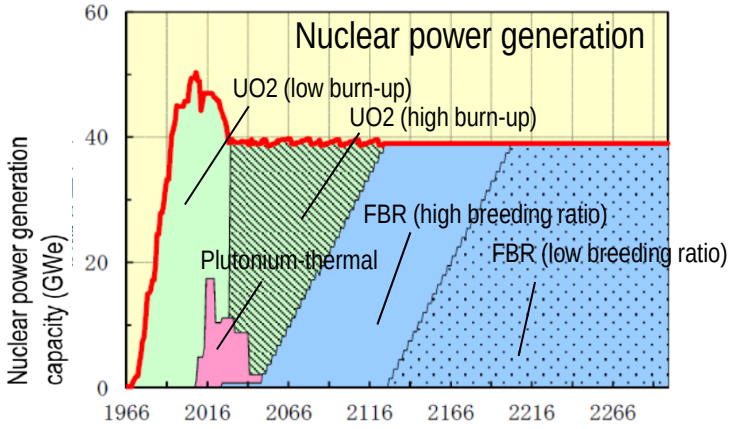
⇒ Amount of the vitrified radioactive waste, area of deep geological repository, radiological toxicity

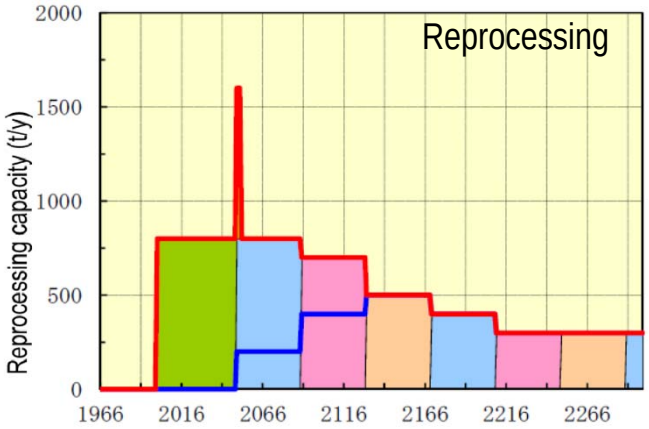
Evaluations of the HLW environmental burden in various fuel cycle scenarios was possible.

4. Trial calculation

Condition ～ Nuclear power generation, Reprocessing ～

Items		Conditions
Evaluation period		1966～2300
Nuclear power generation	Nuclear power generation capacity	39GWe (nuclear ratio of the total electric power production : 24%)
	LWR	- Nuclear power generation will reach 39GWe in 2030. - Plutonium thermal program will be implemented according to the amount of Pu from Rokkasho reprocessing plant (RRP).
	FBR	Inplementation:0.5GWe/y (1.5GWe/plant per three years)
Reprocessing	Plant	RRP, future generation plant
	Recovery elements	U, Pu, MA（recovery ratio of MA：0, 70, 90, 99, 99.9%, 2050 start）

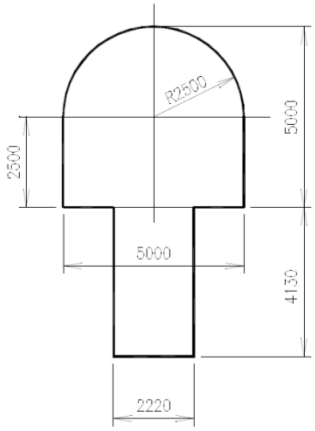
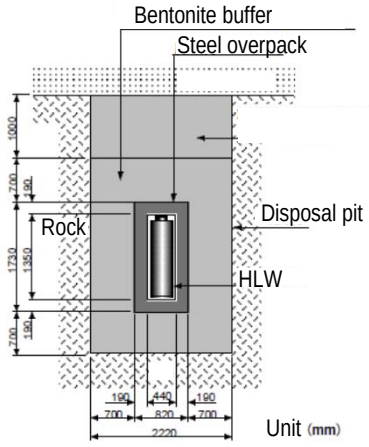




4. Trial calculation

Condition ～ Disposal ～

Items		Conditions
HLW (High level vitrified waste)	Content ratio of waste	Base：13.7wt%※, Parameter：15, 20, 40wt%
	Heat generation limit	2.3kW
	Cooling time	50years
Repository site	Repository specification	Hard rock, vertical disposal

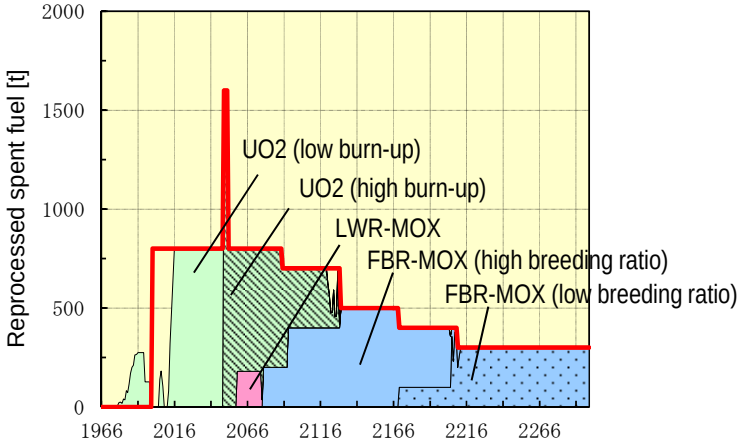
Specifications of disposal gallery and pit	Specifications of disposal pit and engineered barrier
	

(Reference：Project to establish the scientific and technical basis for high-level radioactive waste disposal in Japan: second progress report on research and development for the geological disposal of high-level radioactive waste in Japan.)

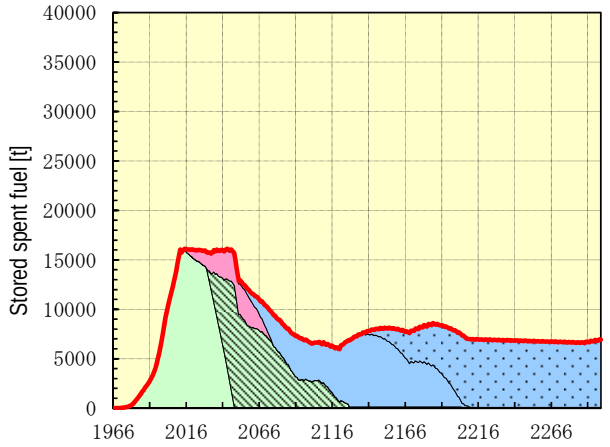
（※COGEMA'S vitrified waste specification）

4. Trial calculation

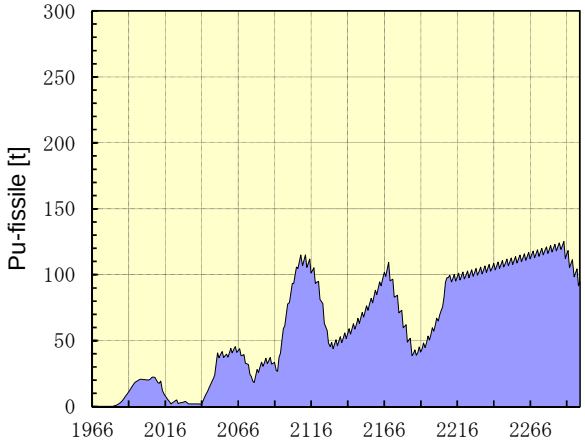
- Calculation result - mass balance of Pu, Spent fuel -



Reprocessed spent fuel



Amount of stored spent fuel



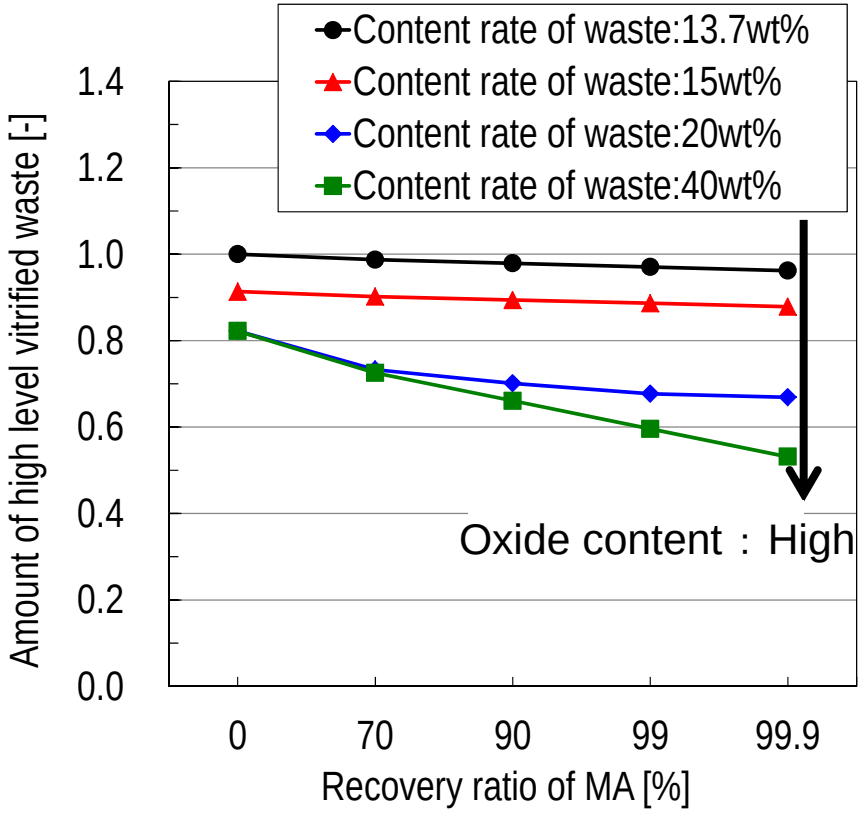
Stored amount of Pu-fissile

By such a plan, “ MA recovery”
Change “ Oxide content “ evaluate influence

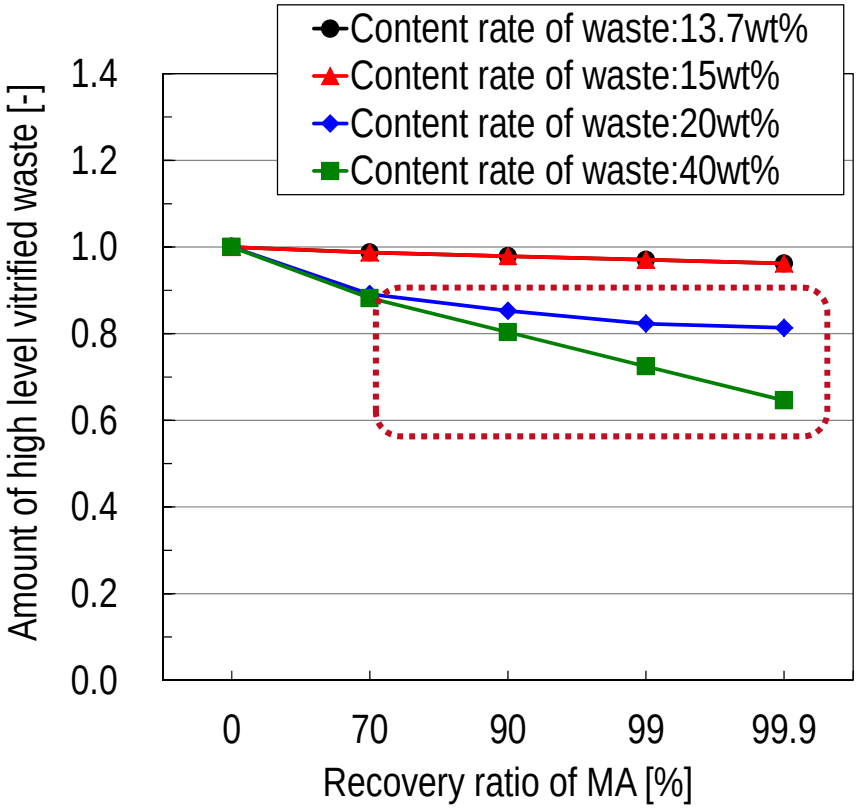
① Quantity of outbreak of the vitrified waste
② Disposal scene product of the vitrified waste
③ Radioactivity toxicity of the vitrified waste

4. Trial calculation

Example 1 : Amount of HLW



<Standardization> Oxide content :13.7wt%, Recovery ratio : 0%



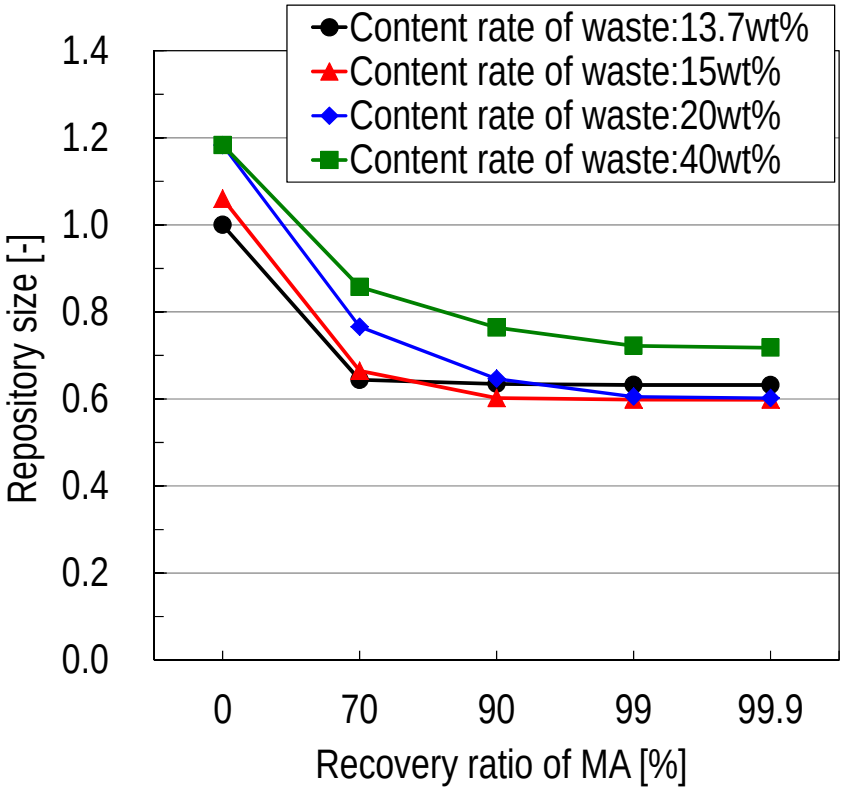
<Standardization> Recovery ratio : 0%

Reduction of amount of HLW

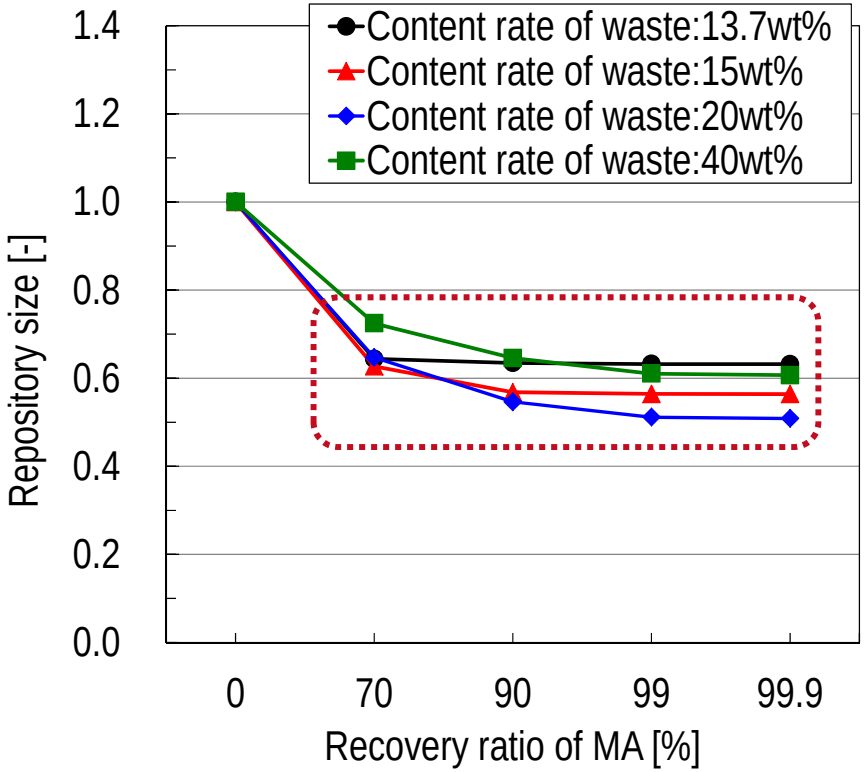
- Reduction of 10% HLW would be possible even if recovery ratio was 70%.
- At higher content rate of waste, 40wt%, it is possible to reduce them moreover.

4. Trial calculation

Example 2 : Repository size



<Standardization> Oxide content :13.7wt%, Recovery ratio : 0%



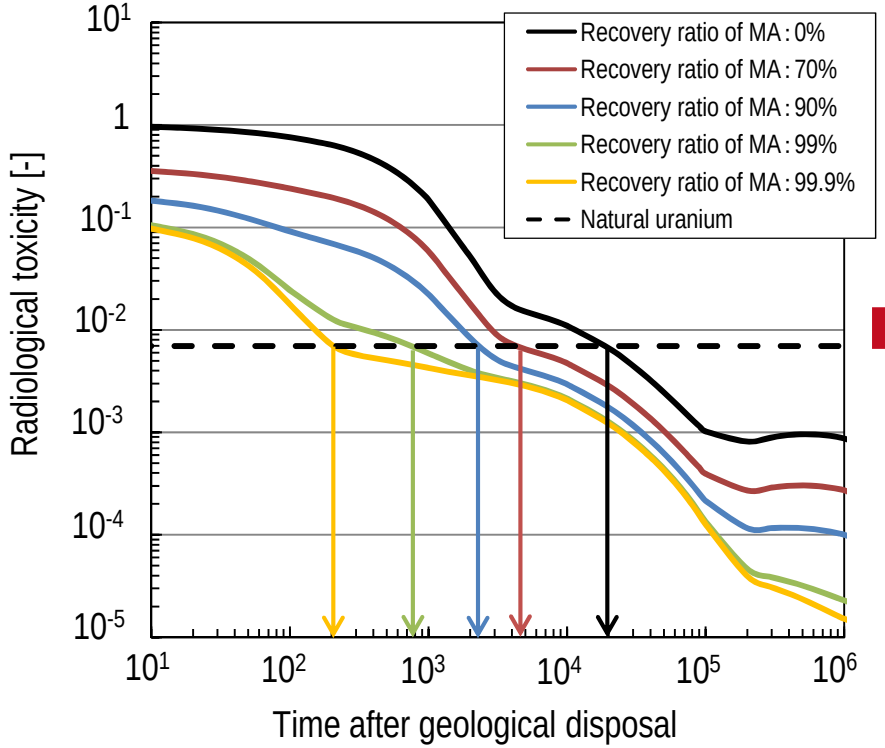
<Standardization> Recovery ratio : 0%

Reduction of repository size

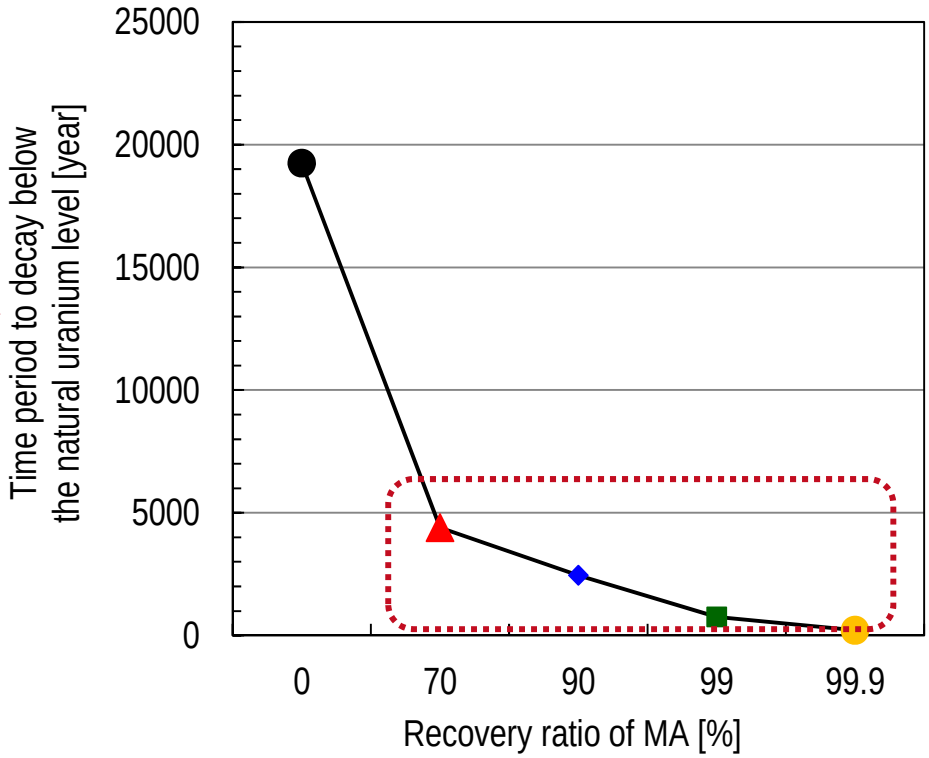
- Reduction of 25% to 40% repository size would be possible even if recovery ratio was 70%.
- Improvement of reduction effect would be only 10% even if recovery ratio was more than 70%.

4. Trial calculation

Example 3 : Radiological toxicity



<Standardization> Recovery ratio : 0%



Reduction of Radiological toxicity (below the natural uranium level)

- Administration period would be shorten about 15,000 years even if recovery ratio was 70%.
- The higher recovery ratio was, the more shorten administration period was by several hundred years.

5. Conclusion

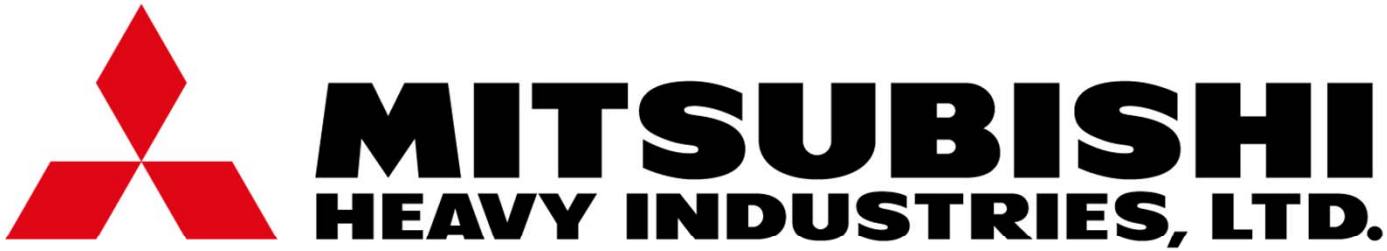
- The outline of the evaluation tool developed in order to evaluate the disposal load reduction effect of HLW was reported.
- The trial calculation of the disposal load of HLW was made using the developed tool.

Amount of HLW	Repository size	Radiological toxicity
• Reduction of 10% HLW would be possible even if recovery ratio was 70%. • At higher content rate of waste, 40wt%, it is possible to reduce them moreover.	• Reduction of 25% to 40% repository size would be possible even if recovery ratio was 70%. • Improvement of reduction effect would be only 10% even if recovery ratio was more than 70%.	• Administration period would be shorten about 15,000 years even if recovery ratio was 70%. • The higher recovery ratio was, the more shorten administration period was by several hundred years.

※ However, these results are evaluated by the limited conditions of the fuel cycle scenario.

We would like to carry out evaluation which changed various parameters (the existence of FBR introduction, introductory speed of FBR, start time of MA recovery, etc.) .

And we would like to propose an effective scenario in reduction of disposal load of HLW from now on.



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