International Conference on
Decommissioning of Nuclear Installations:
Strategies, Practices and Challenges
Moscow, Russian Federation 9-11 November 2015

Overview and Challenges in Strategy Making for Decommissioning in Japan

November 9, 2015
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Current Situation in Japan

Restart generating electricity

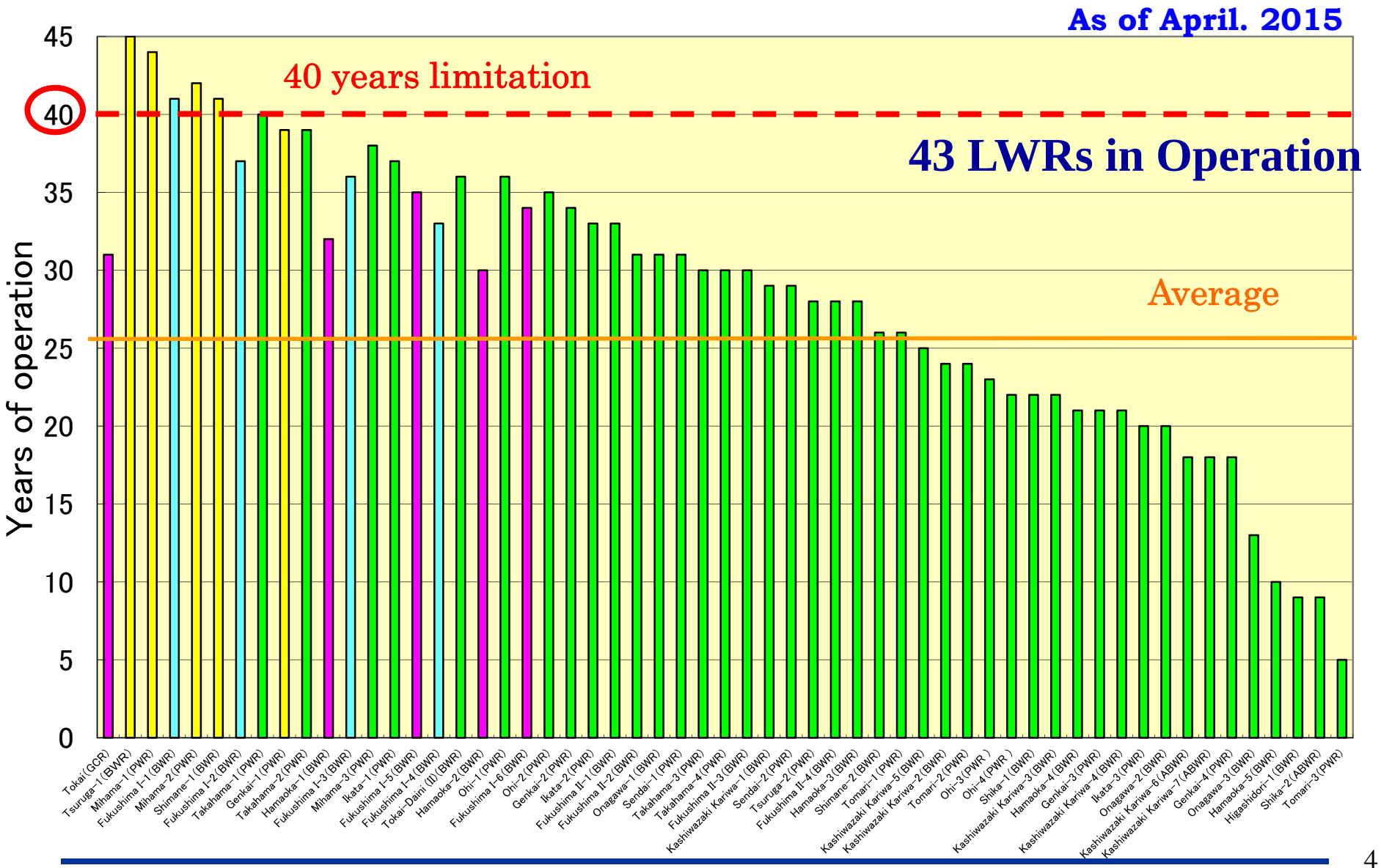
- Sendai Nuclear Power Unit No.1 (Kyusyu Electricity Power Company Inc., PWR, 890MW) had been inspected from May 10th 2011, and been conducted the adjustment operation after restarting power generation on August 14th 2015. It had returned to commercial operation on September 10th 2015.

- Sendai Nuclear Power Unit No.2 (PWR, 890MW) restarted the reactor on October 15th 2015 and currently under the adjustment operation.

Current Status of NPPs in Japan

Status	Number of NPPs	Remarks
Commercial operation	1	Sendai-1 Restarted commercial operation
Amendment of the reactor installment license is approved	5 (including Sendai-1)	Sendai-2 and Takahama-3 Under inspection before commercial operation
In the process for restart	20	Tokai No.2 and others
Under consideration	18	Tsuruga-2 and others
Permanent Shutdown	5	Shutdown on April 2015 Tsuruga-1 and others
Decommissioning	4	Tokai-1, Hamaoka-1,2, Fugen
Handling of the accident	6	Fukushima-Daiichi

Operational years of commercial NPP in Japan



Amendments to the Nuclear Regulation Act
promulgated in June 2012

- New regulation on severe accidents
  Legally-requested measures to prevent and to mitigate severe accidents.
- Regulation based on the state-of-the-art information
  Develop new regulatory standards and apply to existing nuclear facilities (backfitting).
  Introduce new systems, e.g. design certification.
- 40-years operational limit for NPPs
  Legally define the limit to 40 years.
  NRA can permit a less-than-20-years extension.
- Special regulation to disaster-experienced NPPs

The Decommissioning status in Japan (Except 1F)

- From the 1970s, examination of development of the technology relevant to decommissioning is repeated. Dismantling of JPDR of Japan Atomic Energy Research Institute (Current Japan Atomic Energy Agency) was completed in Mar,1996.
- As a commercial nuclear power plant, the JAPC started Tokai Decommissioning project for the first time on Dec, 2001.
- Subsequently, JAEA Fugen and the Chubu Electric Power Co. Hamaoka 1, 2 started decommissioning.
- Additionally five plants(Tsuruga-1, Mihama-1&2, Shimane-1, Genkai-1) were shutdown in April 2015.

Decommissioning institution in Japan

Institution for decommissioning fund

It is required to accumulate decommissioning cost while plant operation. It is fair that the user of the electricity of the plant absorb the decommissioning cost to prevent from leaving burdens to future generations.

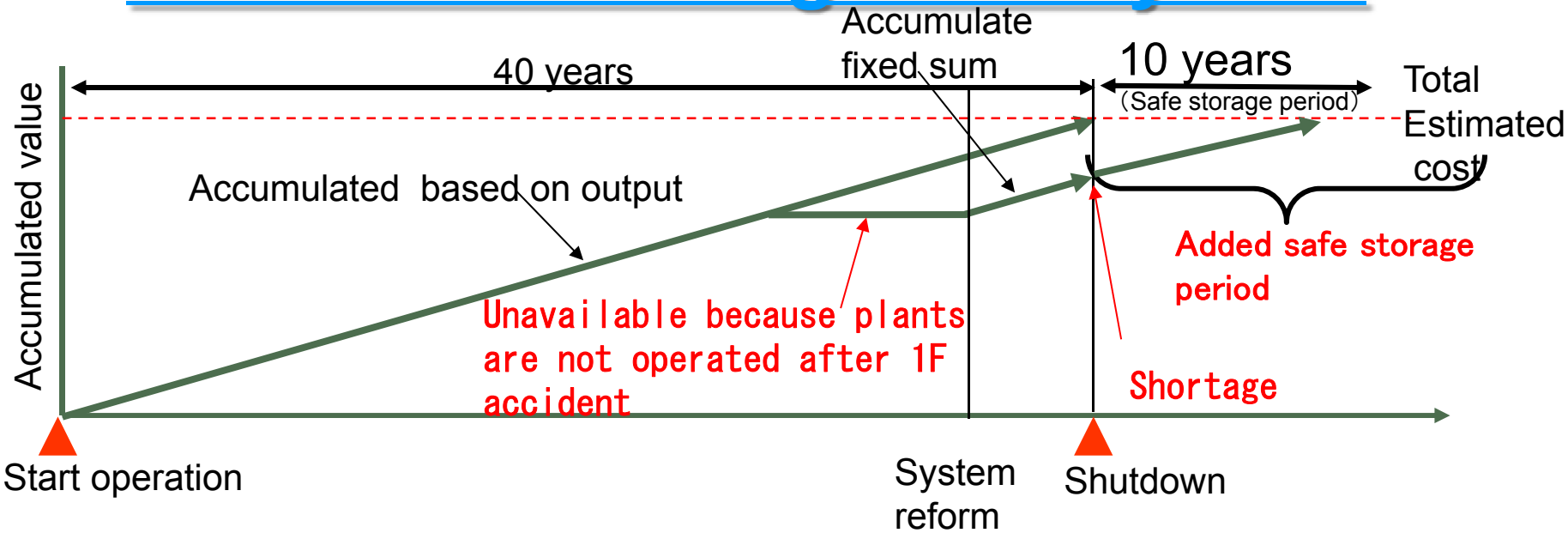
Because,

①Decommissioning cost is large sum, there is a big delay of the timing that required decommissioning cost from electric generating period,

②Decommissioning cost is required as a result of electric generation,

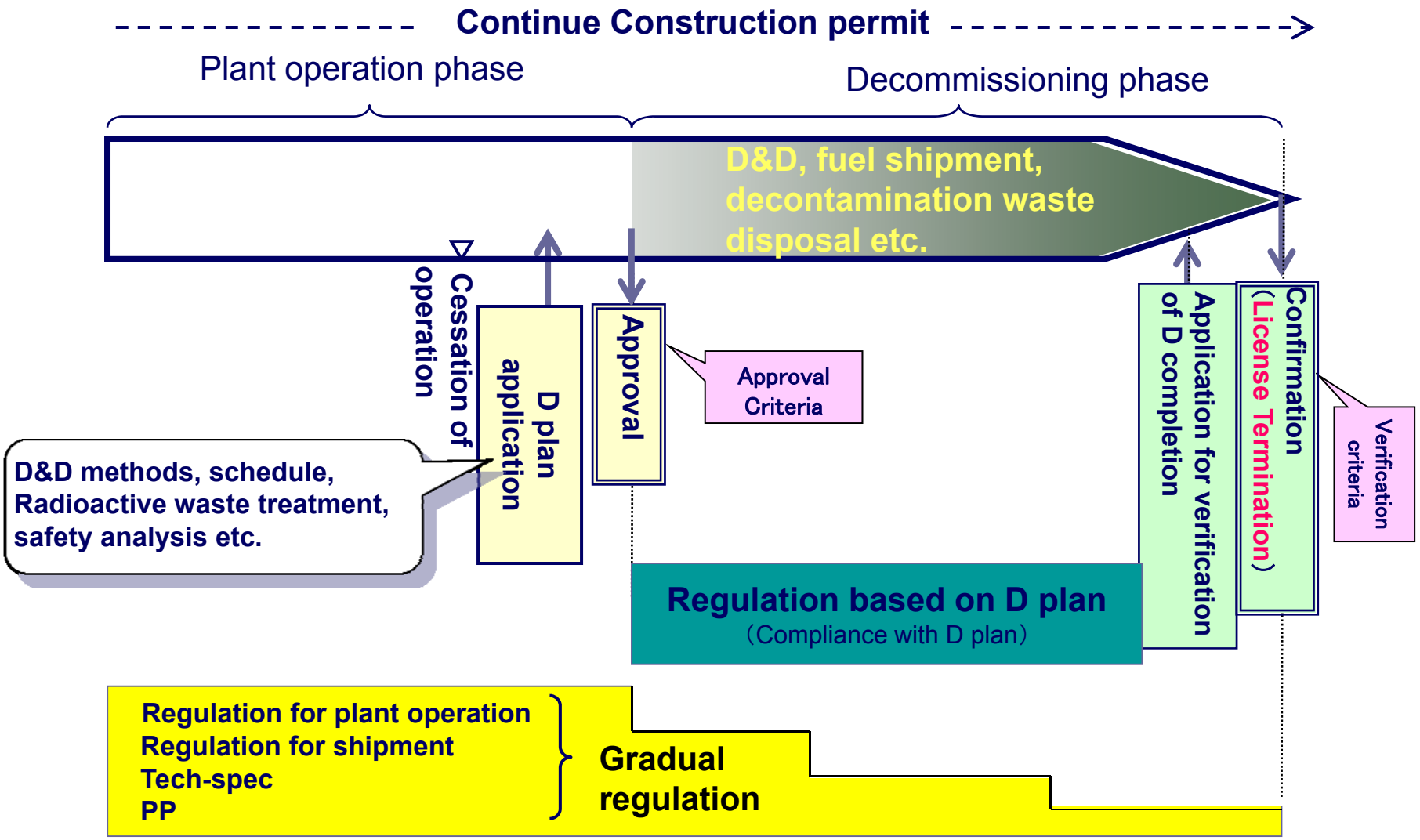
③It is possible to estimate rational decommissioning cost based on decommissioning standard process shown by Advisory Committee for Natural Resources and Energy

Decommissioning Fund system

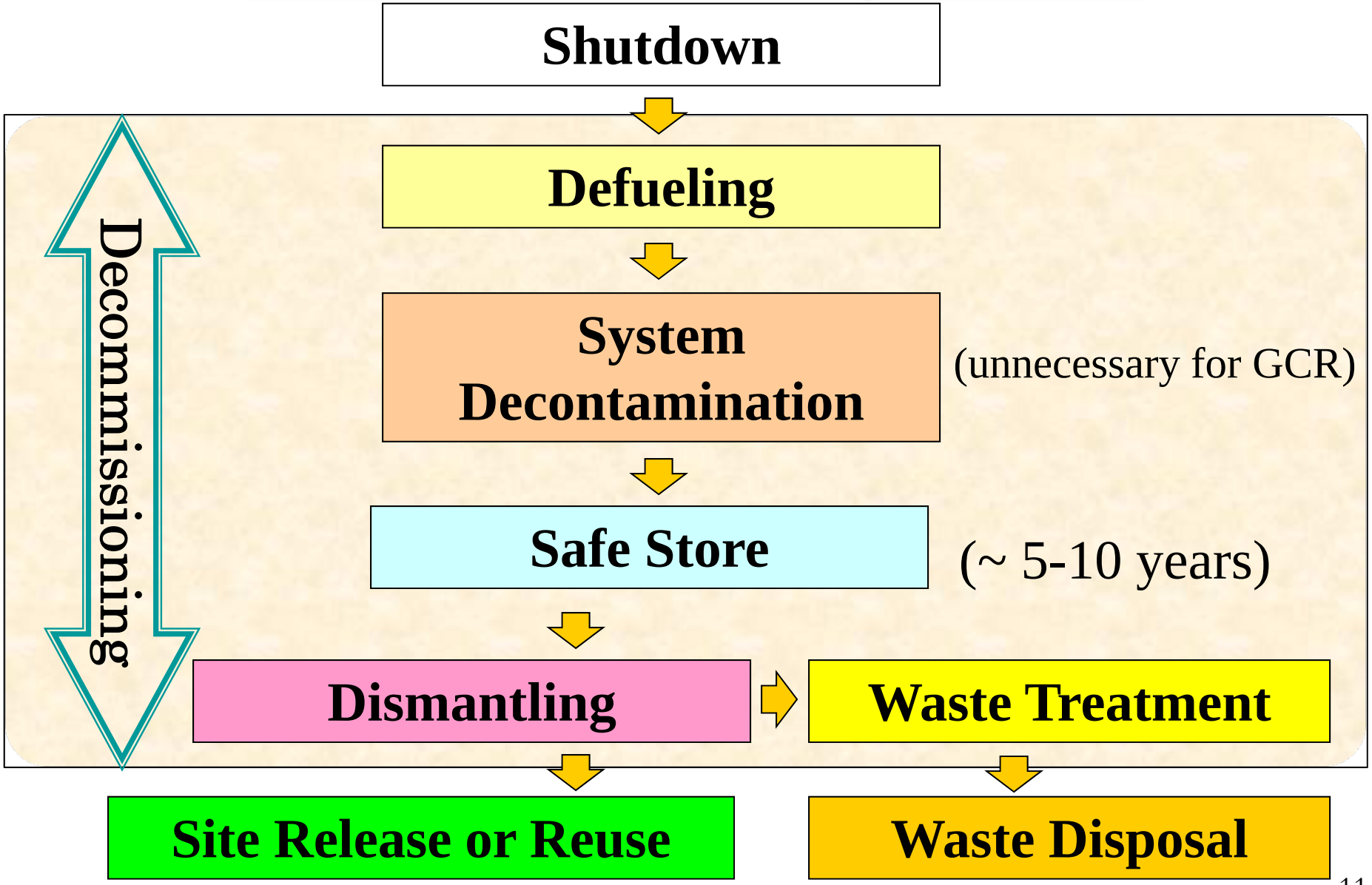


- Estimated total decommissioning cost is 57-77 billion yen (for large scale 1100MWe plant)
- Brief assessment based on linear approximate equation
- Minimum cost because it is duty free
- Directly affect to financial condition of each company because it is internal reserve

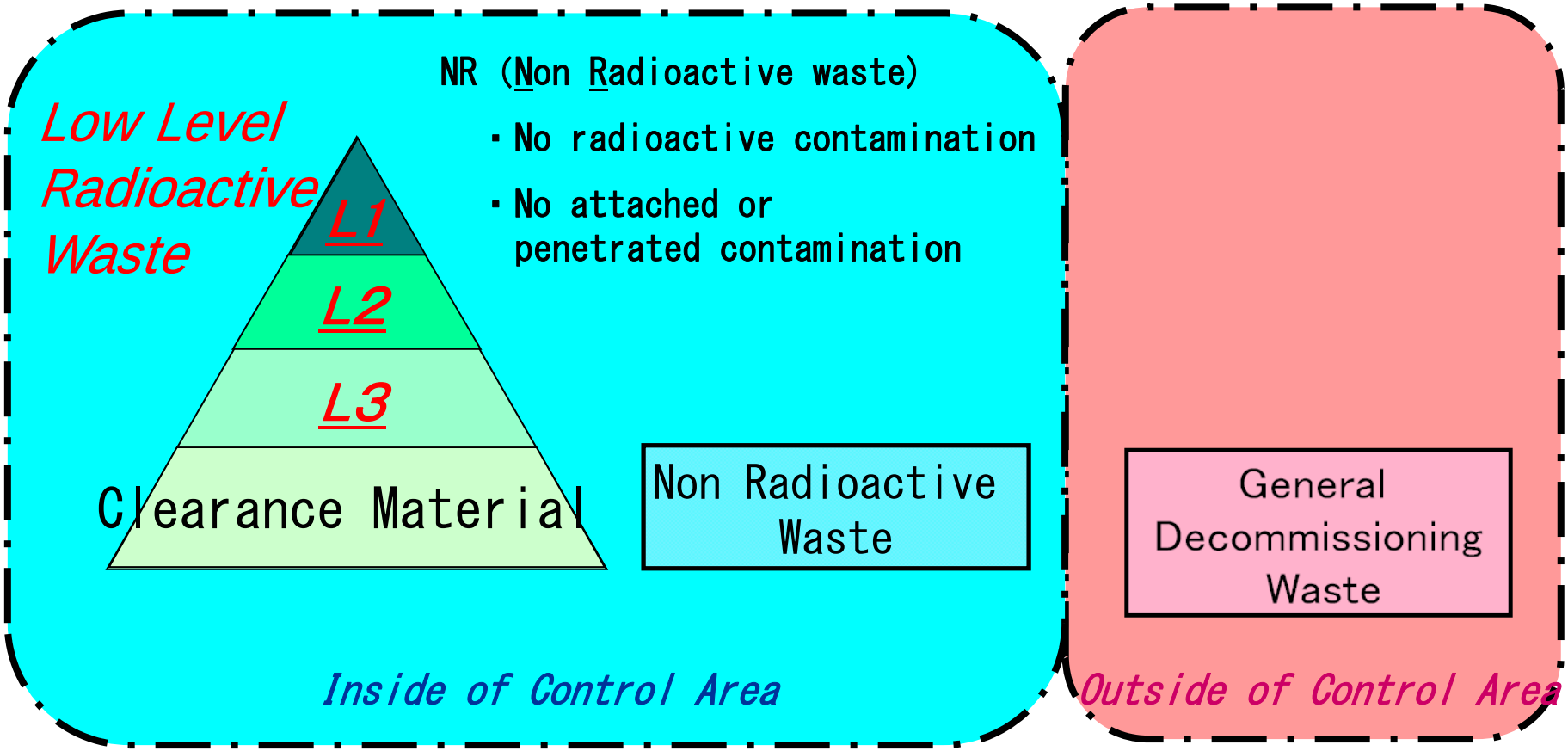
Safety regulation on decommissioning in Japan



Japanese Standard Scenario for Decommissioning of NPPs



Waste arose from decommissioning



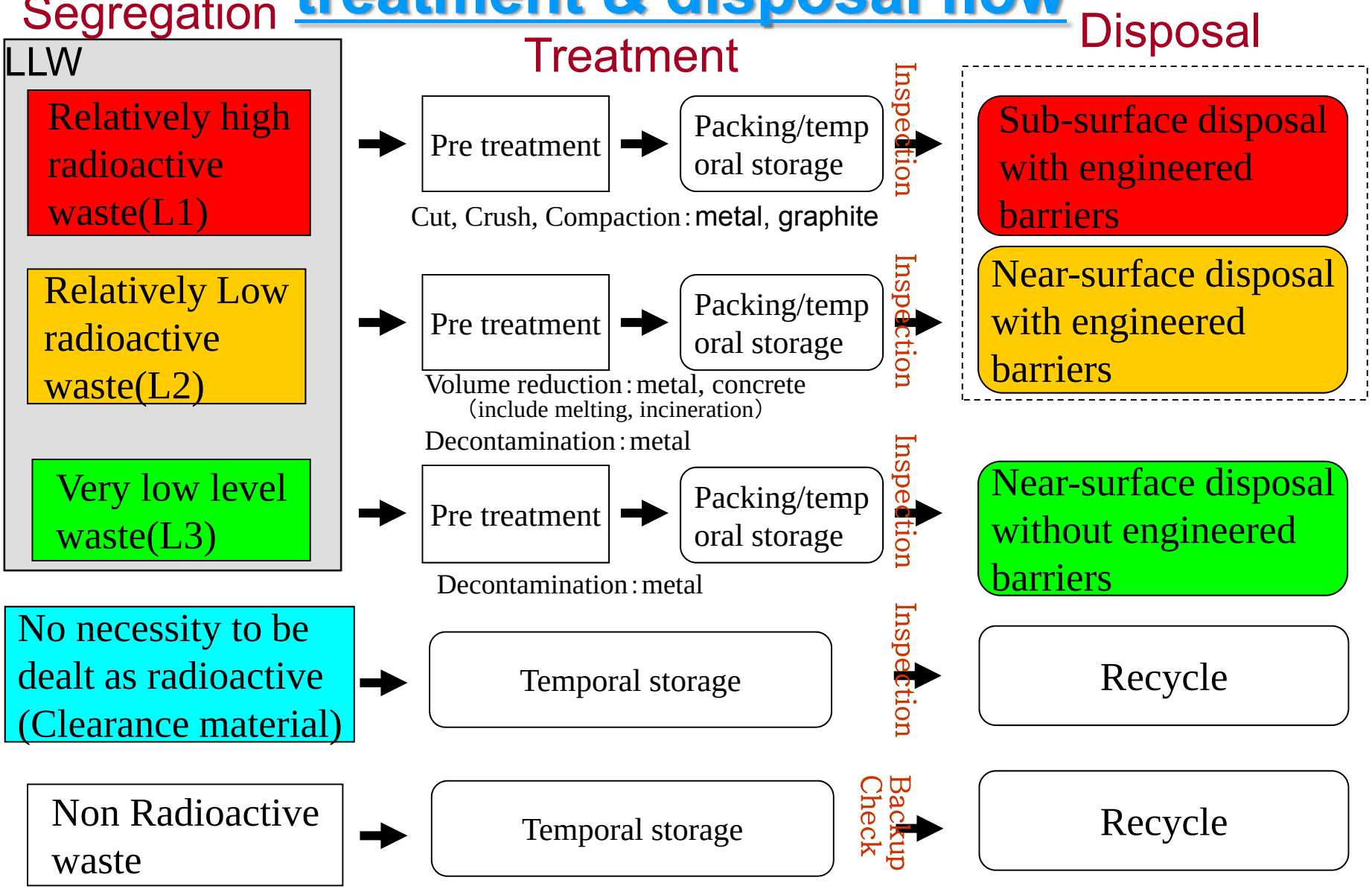
L1: Relatively high radioactive waste
L2: Relatively low radioactive waste
L3: Very low level waste
Clearance material: No necessity to be dealt as radioactive

Classification Criteria for LLW Disposal Concept

Bq/kg

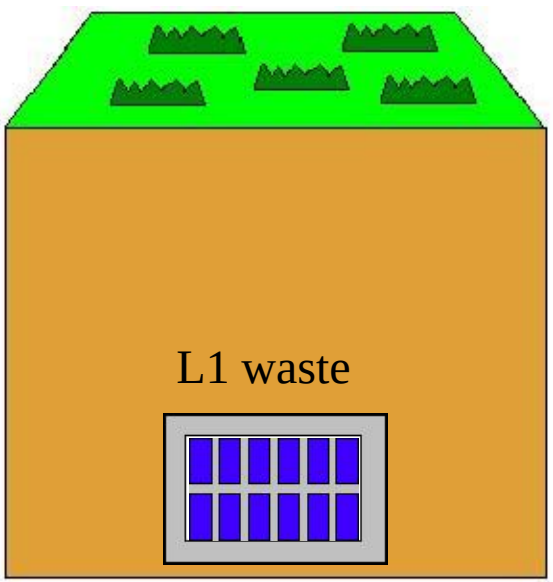
Nuclide	Limit Concentration for Intermediate Disposal	Limit Concentration for Near Surface Pit Disposal	Limit Concentration for Near Surface Trench Disposal	Clearance Concentration
H-3	—	—	—	1E+05
C-14	1E+13	1E+08	—	1E+03
Cl-36	1E+10	—	—	1E+03
Mn-54	—	—	—	1E+02
Co-60	—	1E+12	1E+07	1E+02
Ni-63	—	1E+10	—	1E+05
Sr-90	—	1E+10	1E+04	1E+03
Tc-99	1E+11	1E+06	—	1E+03
I-129	1E+09	—	—	1E+01
Cs-134	—	—	—	1E+02
Cs-137	—	1E+11	1E+05	1E+02
Eu-152	—	—	—	1E+02
Eu-154	—	—	—	1E+02
α-Nuclide	1E+08	1E+07	—	—

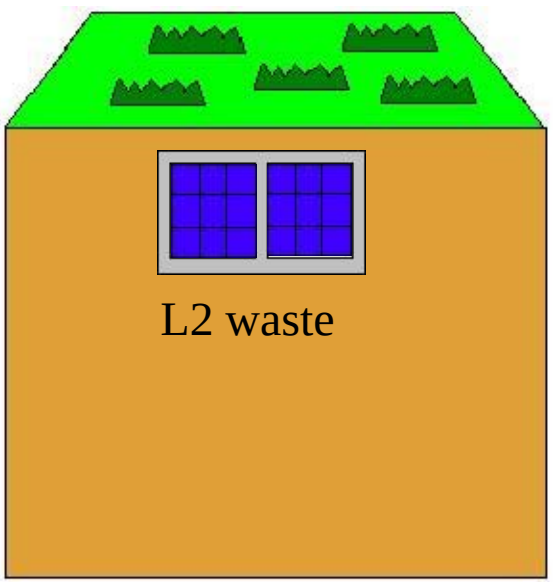
Decommissioning solid waste treatment & disposal flow

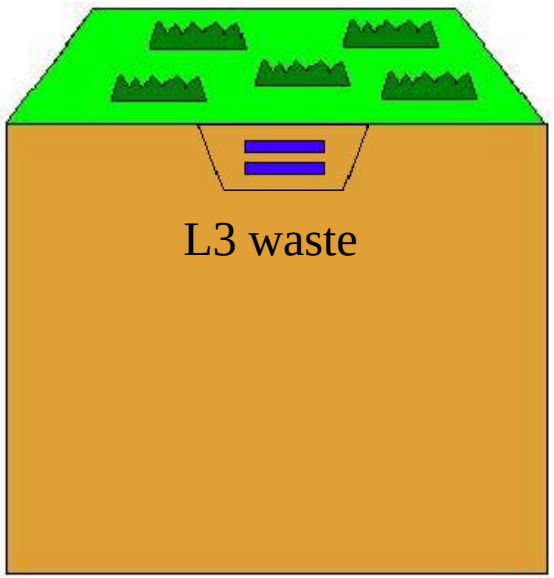


Radioactive Waste Disposal Methodology in Japan

Relatively high radioactive waste	Relatively low radioactive waste	Very low level waste
Intermediate depth disposal with artificial structure	Sub surface disposal with artificial structure	near surface trench disposal







Institutions are under consideration

Monitoring 300～400 years

Monitoring 50 years

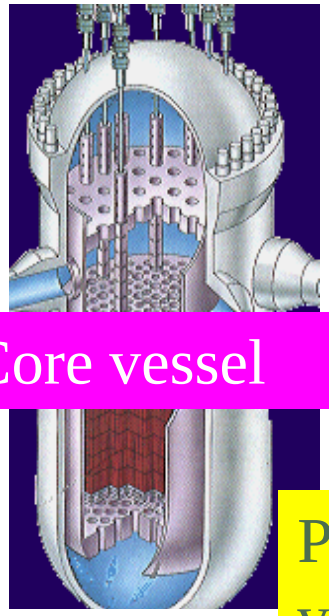
Waste arisen from large scale(1,100MW) PWR Decommissioning

Non radioactive waste; 500kton (99%)

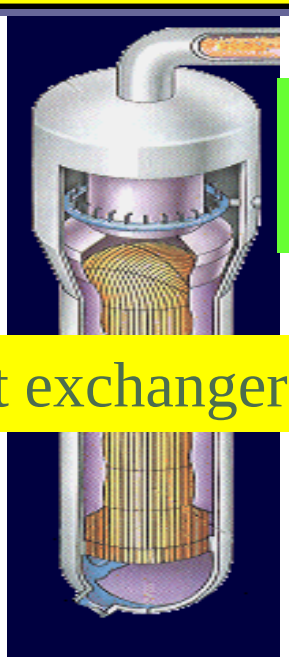
L1;200t（0.04%）

L2; 1,700t (0.3%)

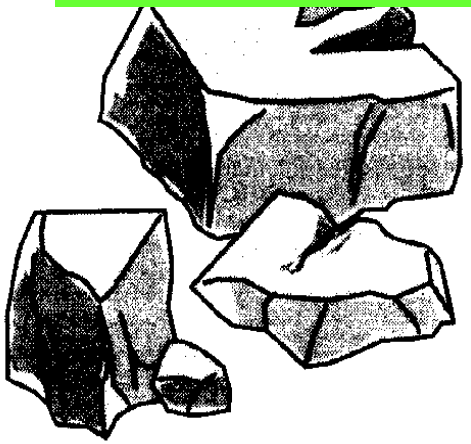
L3; 3,100t (0.6%)



Reactor

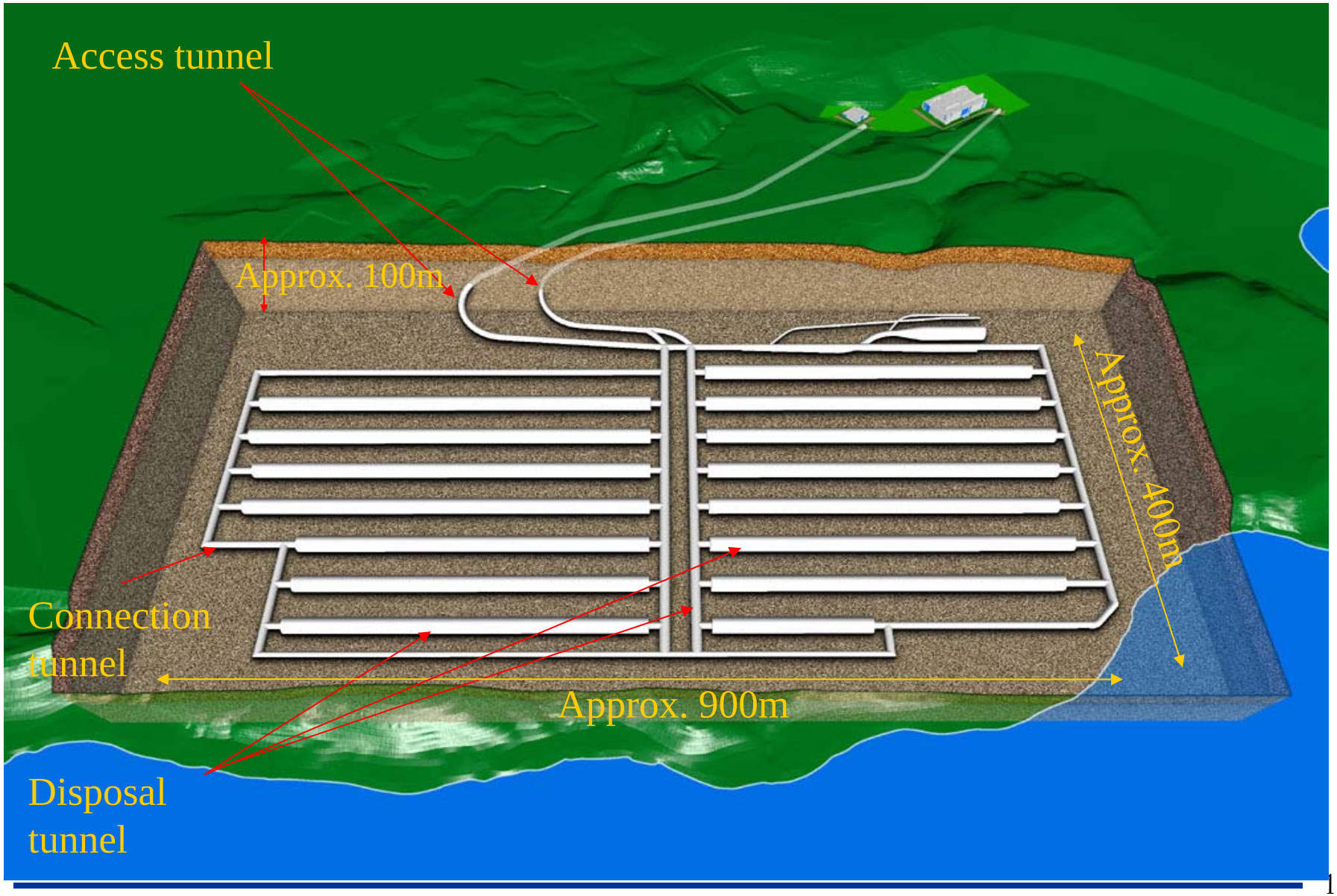


Steam Generator



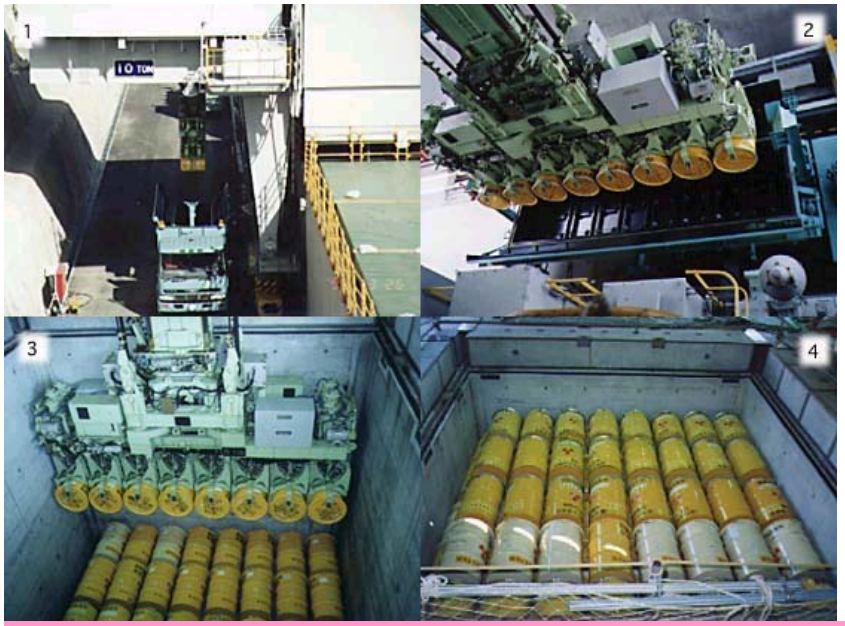
Concrete, Metal

Concept of L1 Waste Disposal Facility



Existing L2 Waste Disposal Facility (Rokkashio)

① Bird's eye view of the facility



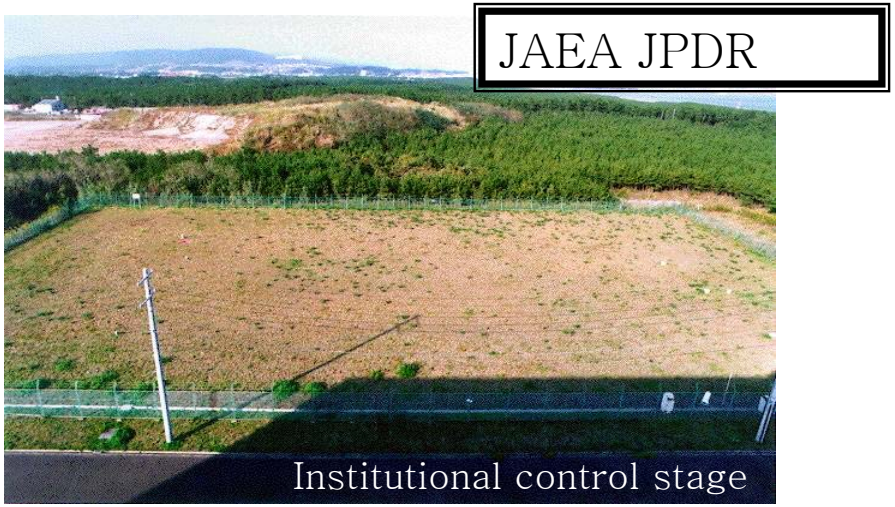
② Putting drums into concrete pit

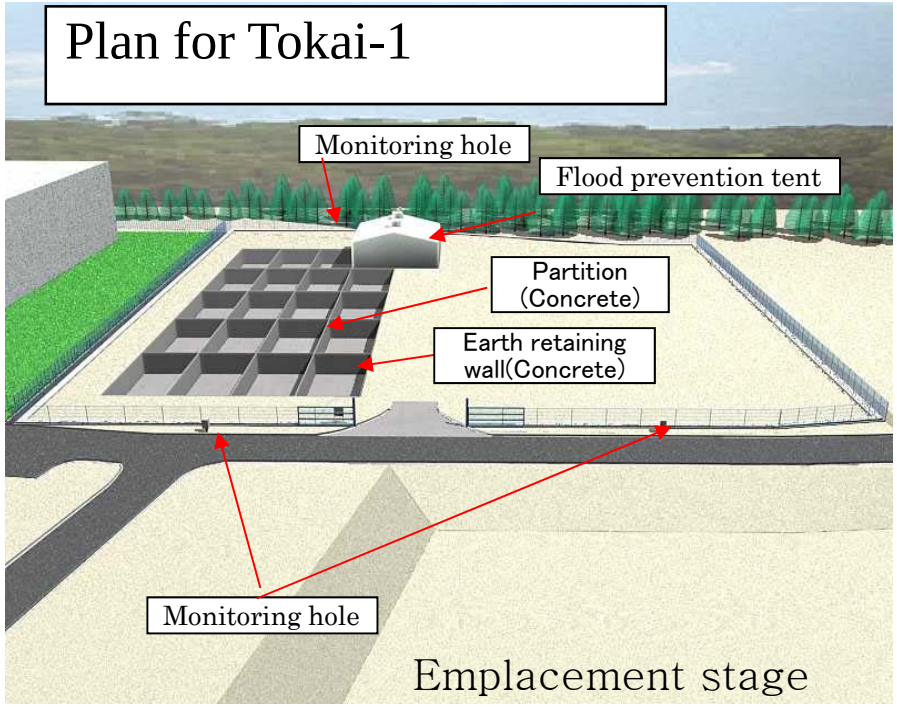
③ Cementation

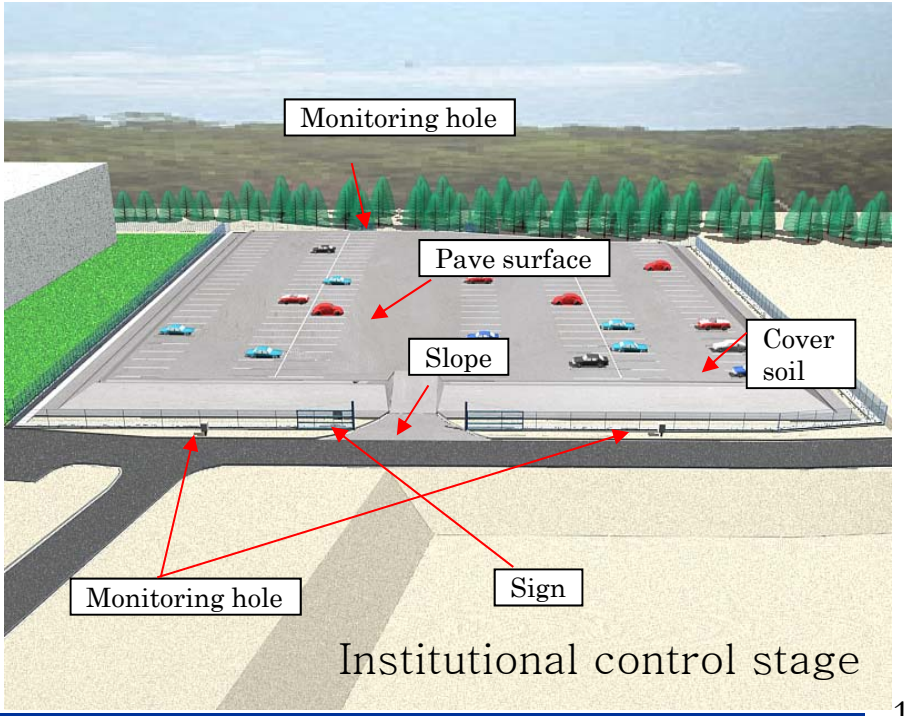
④ Covering with Concrete

Covering with Soil

L3 disposal facility (Existing JPDR and Tokai-1 plan)





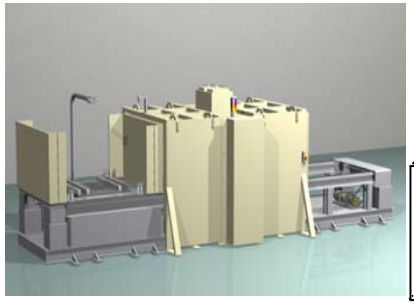


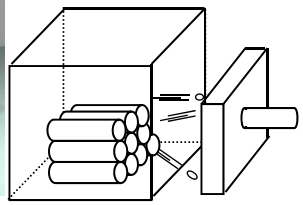
Clearance System in Japan

Clearance material is recycled as general material in Japan (free release)

- The final target is free release, however a step by step approach is necessary to obtain public acceptance.
- Clearance criteria is 10μSv/y Base.
- Clearance level for each Nuclide laid down by Ministerial Ordinance based on IAEA RS-G-1.7.

Evaluation and verification procedure for clearance

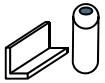




$\Rightarrow \frac{C_0 \times CF}{W(\text{ton})}$

Arrangement of radioactivity analysis data

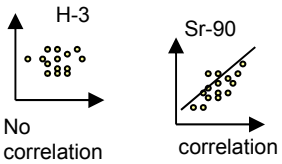
sampling



Equipment, scrap

Nuclide analysis

Nuclide composition ratio
Average radioactive density



$$\frac{\text{Radiation count rate}_{(cps)} \times \text{Radiation conversion factor}_{(Bq/cps)}}{\text{Weight}_{(ton)}}$$

Radioactive density (Cs-137※)

Total γ, Gr measurement method

$\Sigma D / C \leqq 1$

×Nuclide composition ratio (Comparisons with Co-60,Cs-137)

※ Cs-137 represent of Mn-54, Co-60, Cs-134, Eu-152, Eu-154

Radioactive density (C-14, Sr-90, totalα)

Average radioactive density

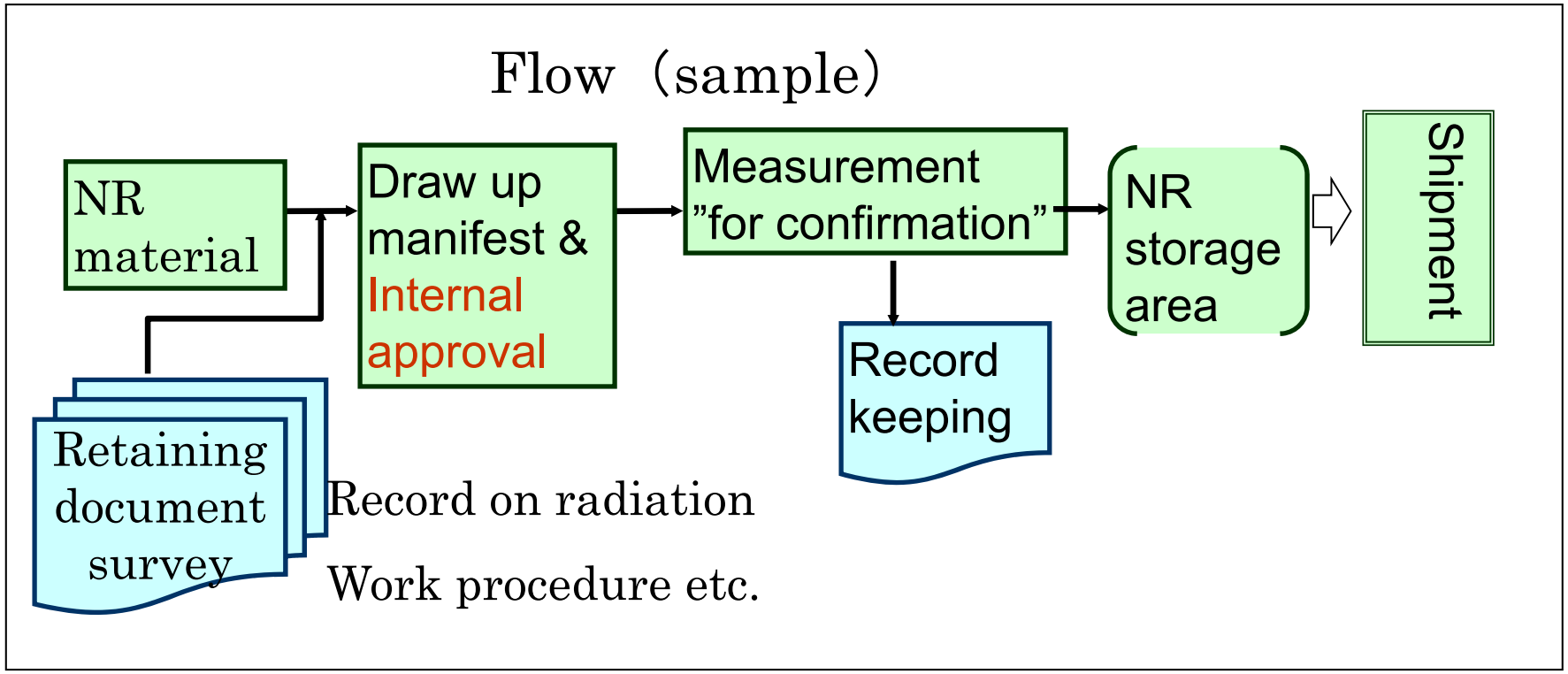
Radioactive density (H-3)

Criteria for determination

$$\frac{\text{Nuclide A density}}{\text{Nuclide A Clearance level}} + \frac{\text{Nuclide B density}}{\text{Nuclide B Clearance level}} + \cdots = \Sigma D/C \leqq 1$$

Treatment of Non Radioactive waste (NR)

- NR is judged by document, not measurement
- Process approval and periodical audit by regulatory body



Challenges and Issues in Decommissioning in Japan

Tasks to be solved in decommissioning in Japan

- Secure facility for SF shipment and waste disposal facility
- Understanding of Stakeholder(local government and regulatory body etc.)
- Revised Funding System

Cultivation of People who will become Leaders in Future D&D business in Japan

- Several universities including Tohoku University and Tokyo Institute of Technology have a short-term seminar dedicated to decommissioning of nuclear power plants (NPPs).
- JAPC dispatches their experts to these seminars as a lecturer.
- JAPC accepts university students to their Education & Training Center and NPPs to teach them outlines of decommission of NPPs.