Regulation of Radioactive Waste Management Business and Waste Acceptance Criteria in Japan

Dr. Hiroyuki Sanada

Division of Licensing for Research Reactors, Use of Nuclear Material

NRA, Japan

(sanada_hiroyuki_5mc@nra.go.jp)

NRA, Japan
Nuclear Regulation Authority

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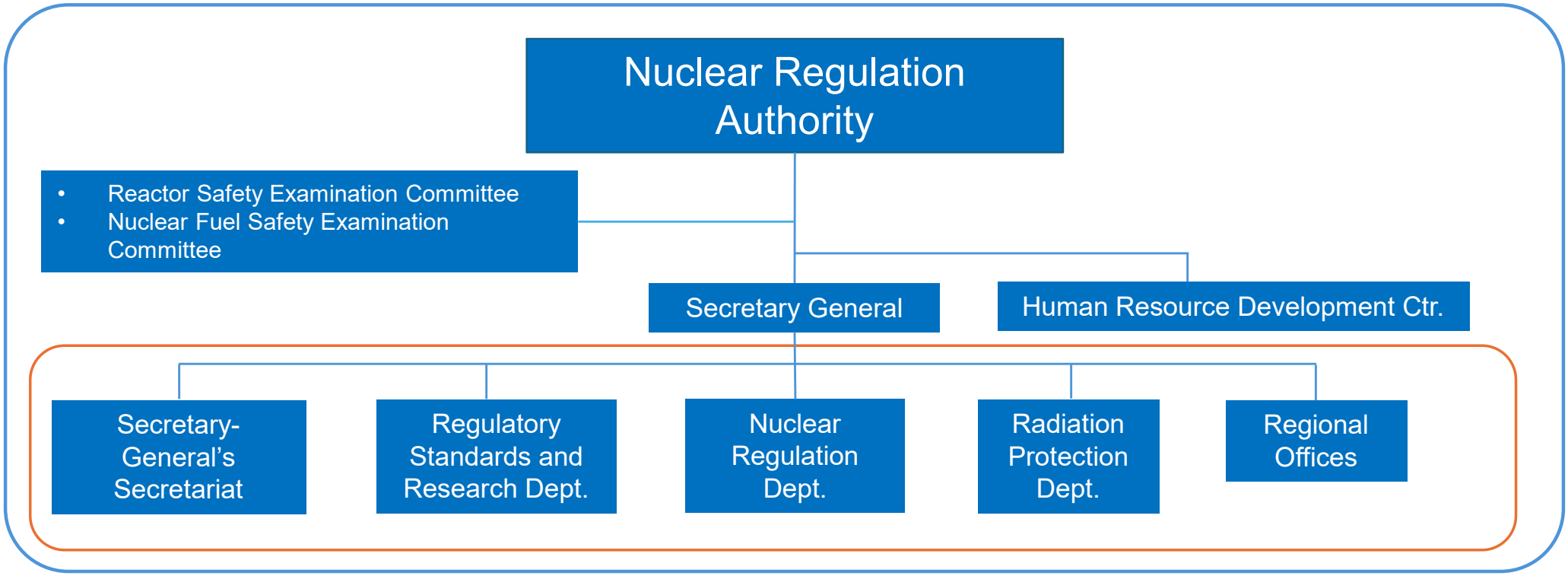
Overview of NRA, Legal Framework etc.

Nuclear Regulation Authority (NRA)

- Established in September 2012
- External organization of Ministry of the Environment (MOE)
- Composed of **a Chairman and four Commissioners** appointed by the Prime Minister with approval of the Diet
- Supported by **approximately 1,000 secretariat staff**
- Ensures **high degree of independence**
- Specialized in regulation: **safety, security and safeguards**

Organization Structure of the NRA

- The NRA has approximately 1,000 staff members in the **4 major departments** with **one training center** and **22 regional offices**.

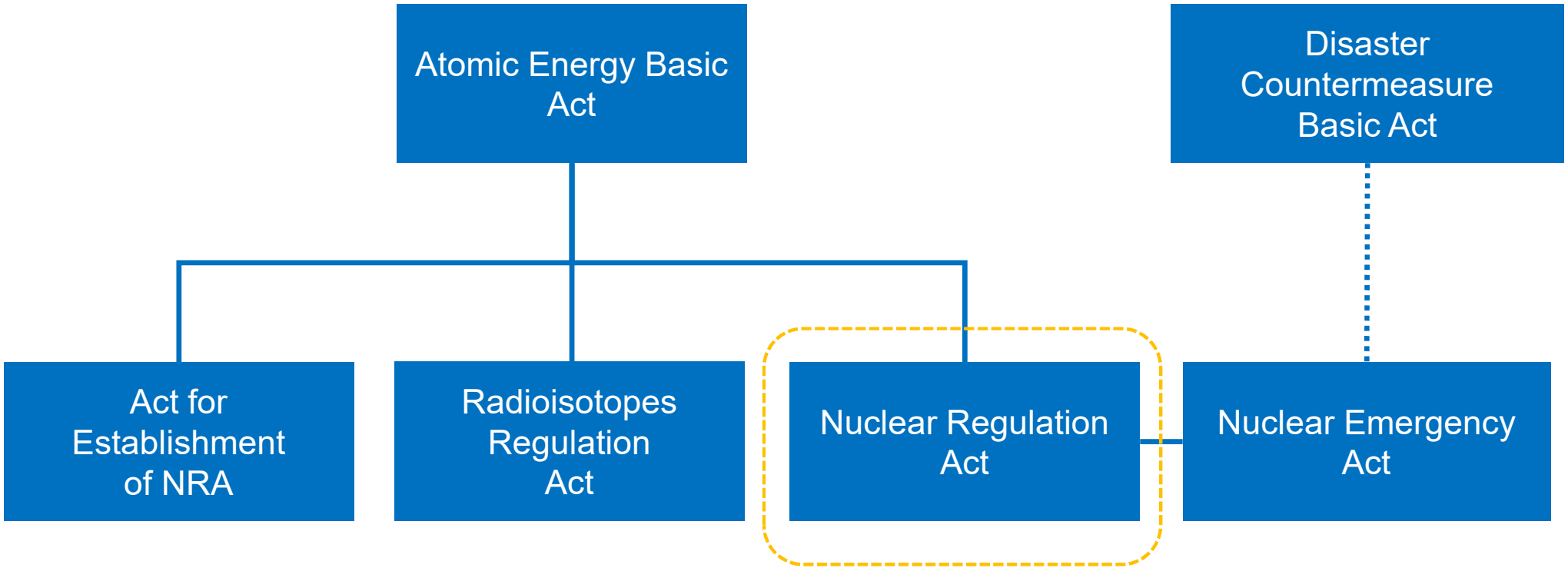


External Technical Support Organizations (TSOs)

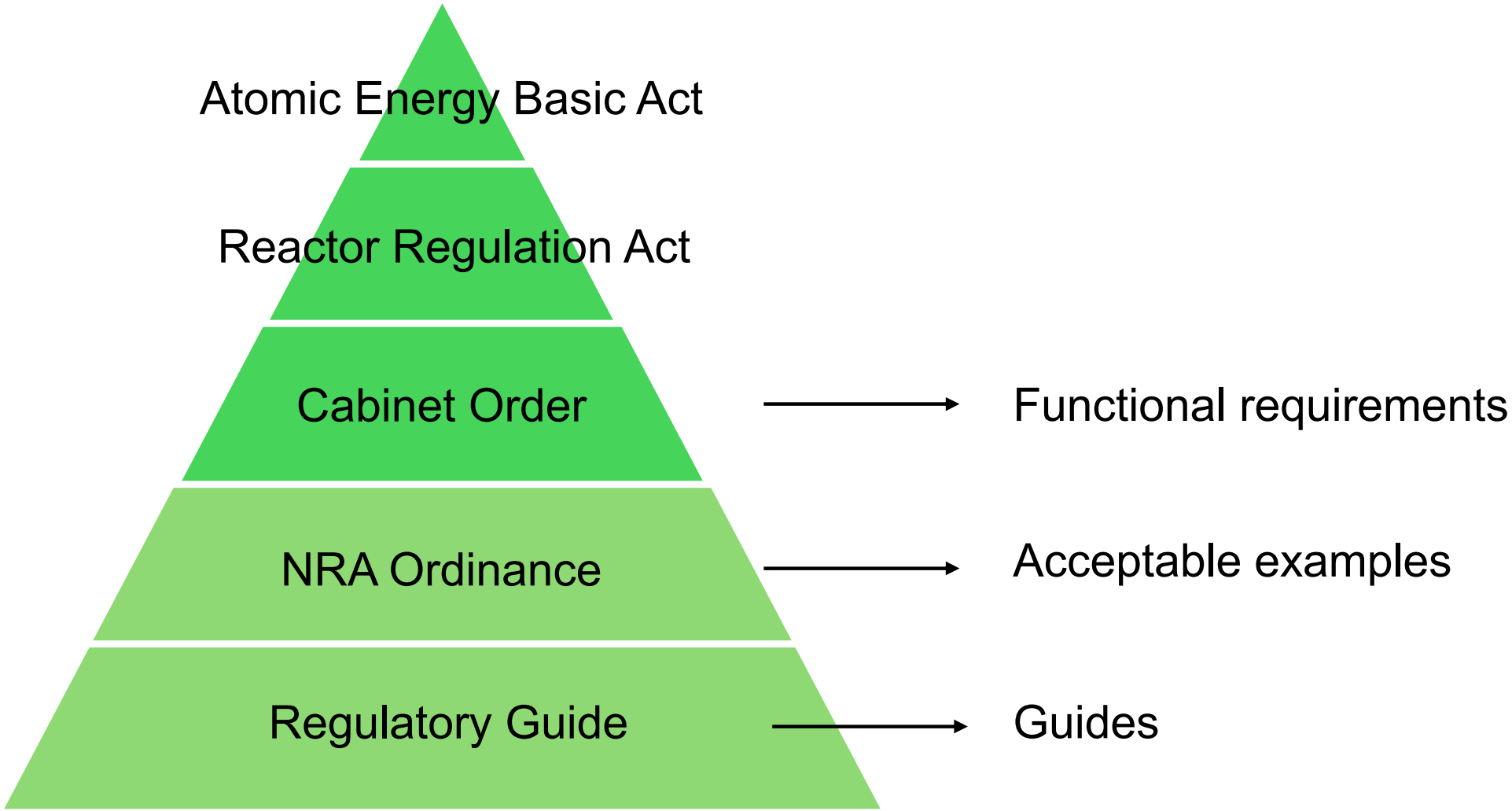
Japan Atomic Energy Agency

National Institute for Quantum and Radiological Science and Technology

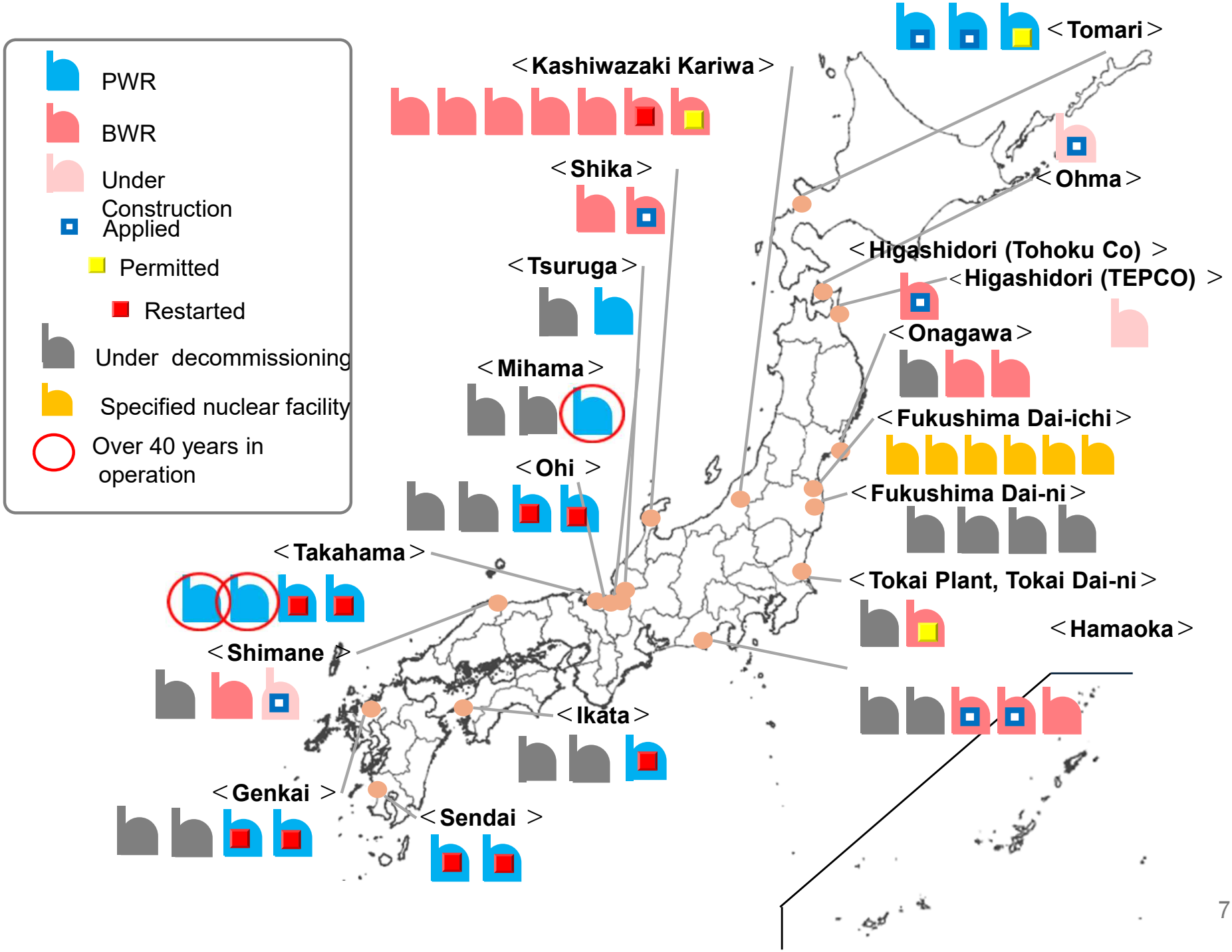
Legal Framework



Regulatory System

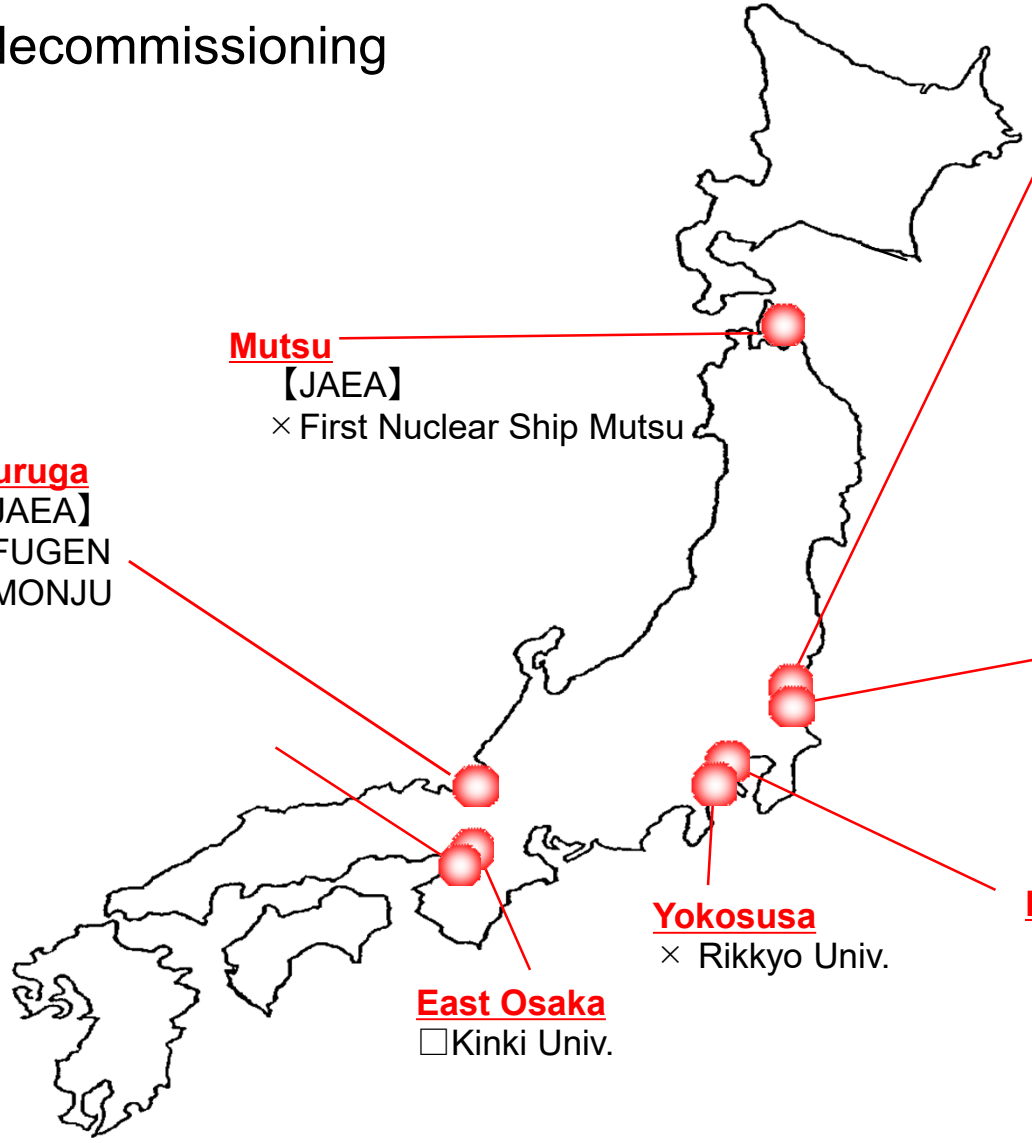


Nuclear Power Plants in Japan



Research Reactors

×:under decommissioning



Tokai
【University of Tokyo】
×YAYOI

【JAEA】
□STACY
×TRACY
□NSRR
□JRR-3
×JRR-4
×FCA
×TCA
×JRR-2
□A radioactive waste management facility serving as a shared facility

Mutsu
【JAEA】
×First Nuclear Ship Mutsu

Tsuruga
【JAEA】
×FUGEN
×MONJU

Kumatori
【Kyoto Univ.】
□KUR
□KUCA

Oarai
【JAEA】
□HTTR
□JOYO
×JMTR
×DCA

Yokosusa
× Rikkyo Univ.

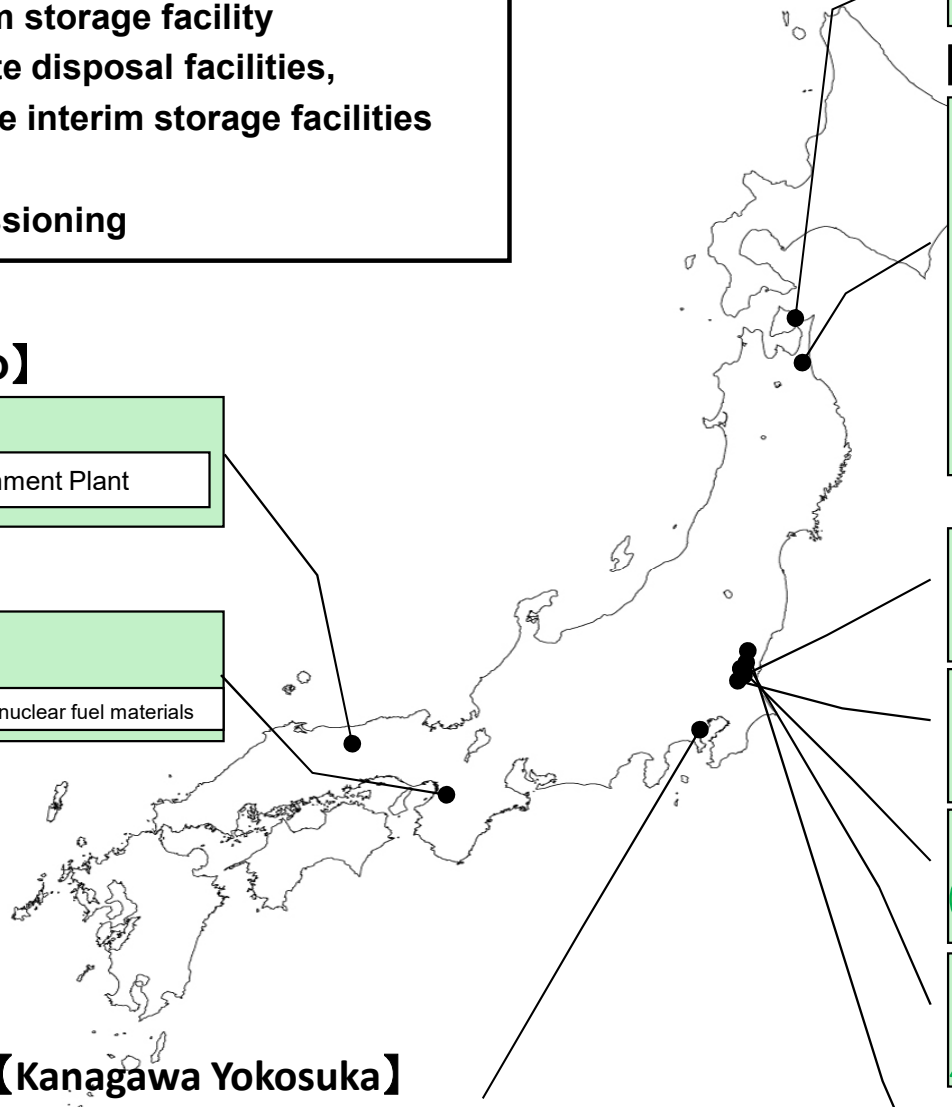
Kawasaki
【Toshiba】
×NCA
×TTR-1
【 Tokyo City University Institute of Technology 】
×Furnace of Musashi Institute of Technology
【Hitachi】
×HTR

East Osaka
□Kinki Univ.

Nuclear Fuel Facilities

□ : Nuclear fuel processing facilities
○ : Reprocessing facilities
◇ : Spent fuel interim storage facility
△ : Radioactive waste disposal facilities,
Radioactive waste interim storage facilities

× : under decommissioning



【Aomori Mutsu】

RFS
- Recyclable-Fuel Storage Centre

【Aomori Rokkasho】

JNFL
- Reprocessing Facility
- MOX fuel fabrication plant
- Facility for uranium enrichment
- Waste storage facility
- Waste disposal facility

【Okayama Kagamino】

JAEA
- × Prototype Uranium Enrichment Plant

【Osaka Kumatori】

NFI
- Kumatori works, Facility for fabricating nuclear fuel materials

【Ibaraki Tokai】

NFI
- Tokai works, Facility for fabricating nuclear fuel materials

MNF
- Facility for fabricating nuclear fuel materials

JAEA
- × Tokai reprocessing plant

JAPC
- Waste disposal facility (under review)

【Kanagawa Yokosuka】

GNF-J
- Facility for fabricating nuclear fuel materials

【Ibaraki Oarai】

JAEA
- Waste storage facility

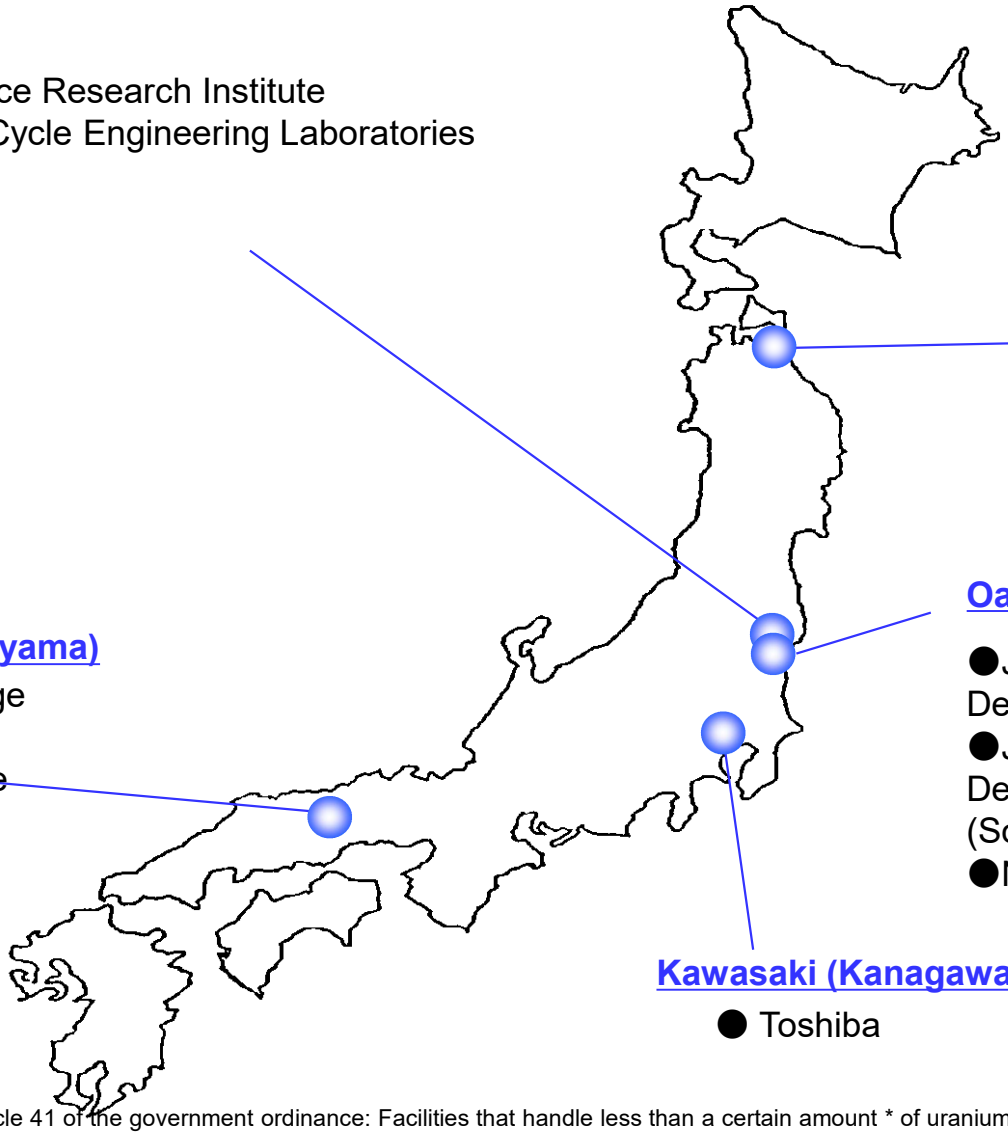
Facilities which use more than a certain quantity of uranium or other nuclear material (hereafter Facilities for use of nuclear material)

- Used, stored, and managed for activities such as research and development, technology development, and various analytical work.

○ **Facilities for use of nuclear material** ：approx. 200

Tokai (Ibaraki)

- JAEA Nuclear Science Research Institute
- JAEA Nuclear Fuel Cycle Engineering Laboratories
- NMCC Tokai
- MHI



Rokkasho (Aomori)

- NMCC Rokkasho

Oarai (Ibaraki)

- JAEA Oarai Research and Development Institute (North Area)
- JAEA Oarai Research and Development Institute (South Area)
- NFD

Ningyo-toge (Okayama)

- JAEA Ningyo-toge Environmental Engineering Centre

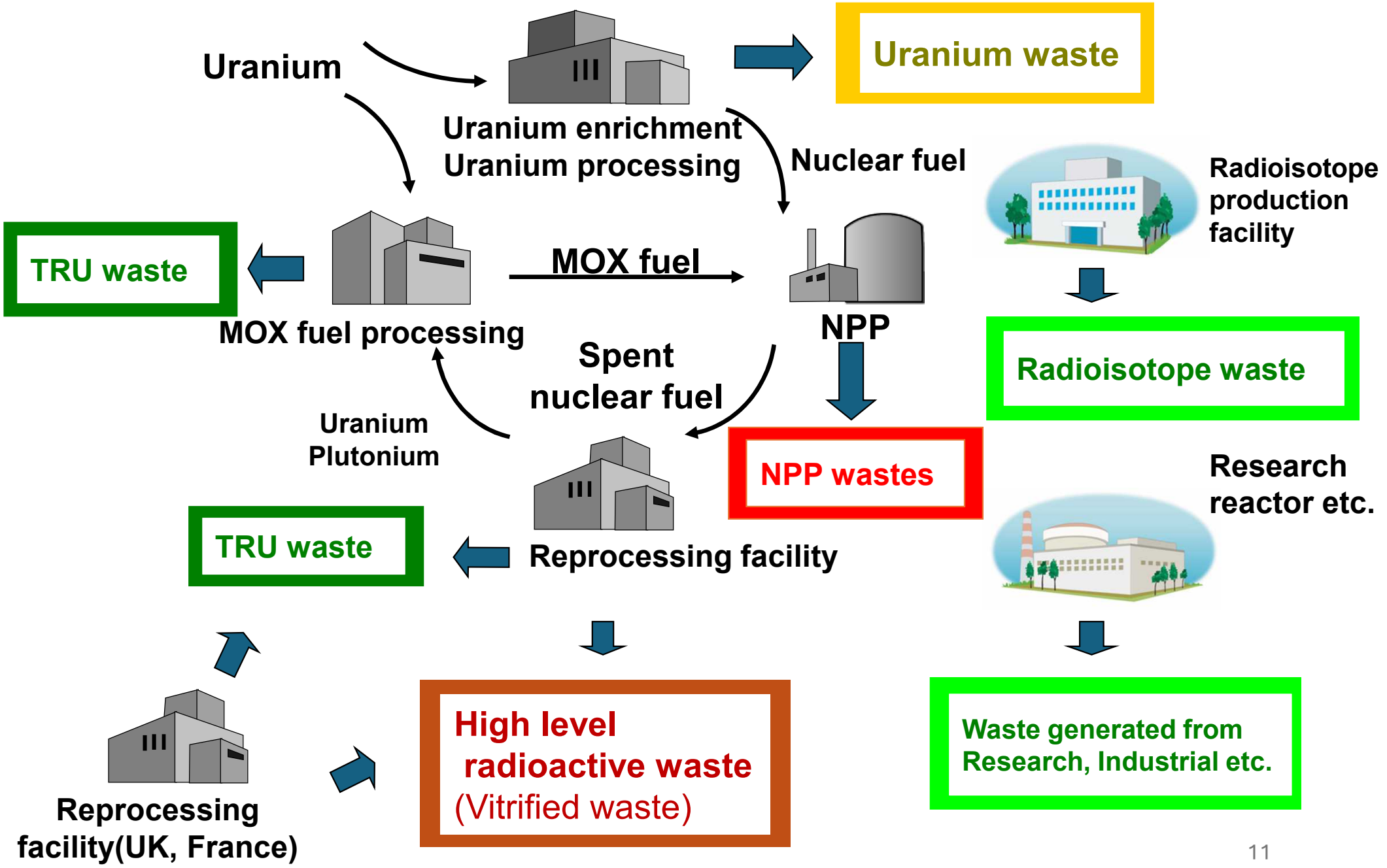
Kawasaki (Kanagawa)

- Toshiba

Facilities that do not fall under Article 41 of the government ordinance: Facilities that handle less than a certain amount * of uranium or plutonium, such as hospitals and pharmaceutical companies. This figure doesn't describe them.

*1 g of plutonium, 1,200 g of uranium 235 amount of enriched uranium less than 5%, etc.

Nuclear Fuel Cycle Facilities and Radioactive Wastes in Japan



Overview Matrix

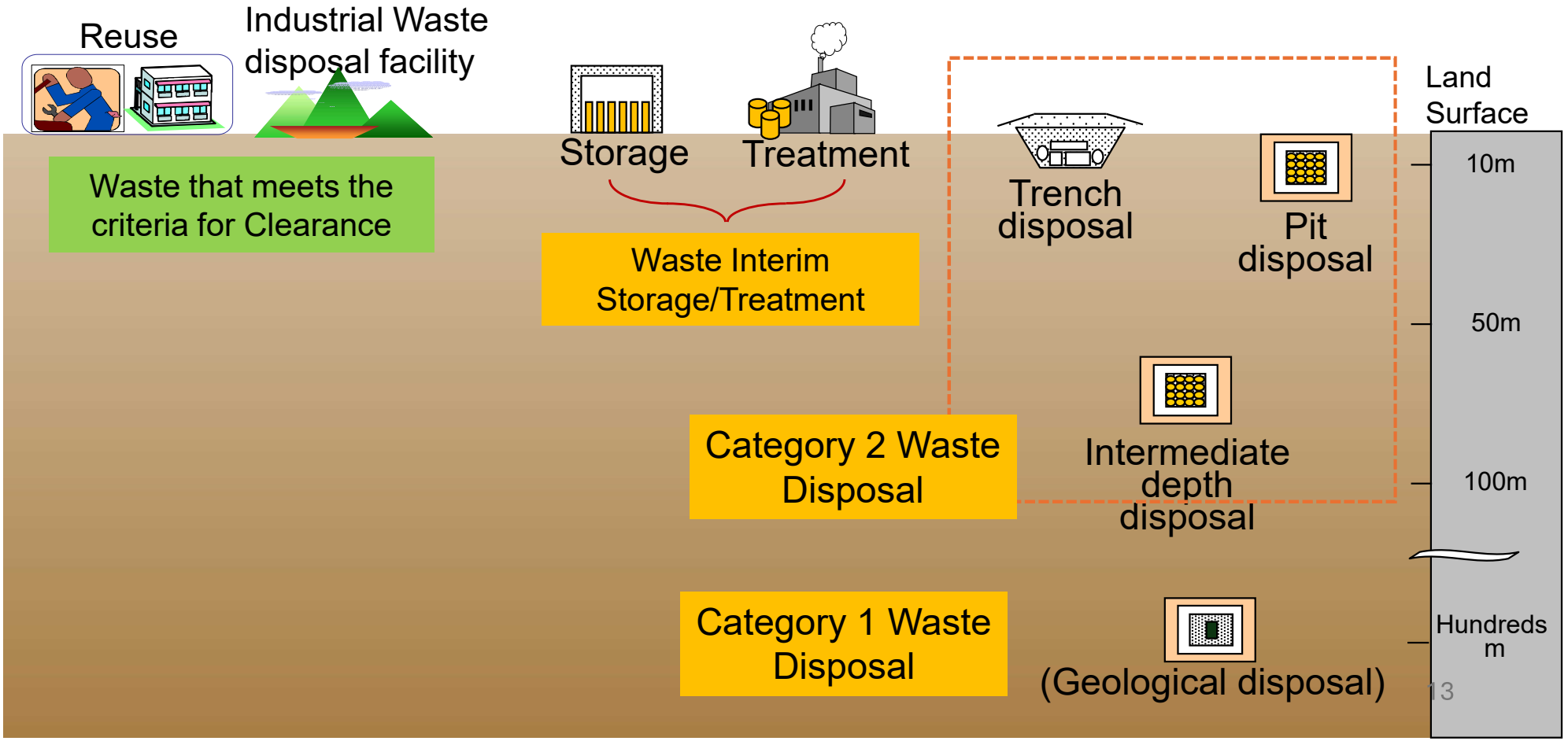
	Long-term management policy	Funding of liabilities	Current practices / facilities	Planned facilities
Spent fuel	Reprocessing	Utilities shall pay contributions into fund management organization for reprocessing	Overseas Reprocessing	Japan Nuclear Fuel Ltd. (JNFL) Rokkasho Reprocessing facility. Recyclable-Fuel Storage Co. (RFS) Spent Fuel Storage Facility
Nuclear fuel cycle wastes	Geological disposal, intermediate depth disposal and near surface disposal	Utilities shall pay contributions into fund management organization for disposal	Low Level Radioactive Waste (LLW) disposal facilities. High Level Radioactive Waste (HLW) storage facilities	Geological disposal and intermediate depth disposal
Radioactive waste from research facilities, etc.	Near surface disposal	Waste generator pays for the storage and disposal	On site storage	On site storage
Decommissioning liabilities	Decommissioning of NPP	Utilities shall pay deposits into the Reserve Fund	Tokai Hamaoka (1,2) Genkai (1,2) Tsuruga (1) Mihama (1,2) Shimane (1) Ikata (1, 2) Ohi (1,2) Onagawa (1) Fukushima Daini (1-4) Monju ,Fugen	Fukushima Daiichi (1-6)
Disused sealed sources	Return to manufacturers, Long-term Source user storage	Source user	Return to manufactures, Storage in facility	-

Source: National Report of Japan for the eighth review meeting Joint convention on the safety of spent fuel management and on the safety of radioactive waste management, Aug. 2024

Waste Disposal;
Disposal of radioactive waste through the disposal method, categorizing these as **“Category 1”** and **“Category 2”** according to the radioactive concentration of waste to be disposed of.

Waste Interim Storage/Treatment;
Storing radioactive waste outside of plants or processing radioactive waste forms suitable for storage or final disposal until the commencement of final disposal through the disposal method or other methods.

Clearance;
When the NRA confirms that the radioactivity concentration of the material generated from nuclear facilities is **below the clearance level** defined by the NRA, it can be handled as **conventional industrial waste or valuables**.



Radioactivity concentration limits for waste classification

Carbon14	10PBq per ton
Chlorine36	10TBq per ton
Technetium99	100TBq per ton
Iodine129	1TBq per ton
α emitters	100GBq per ton

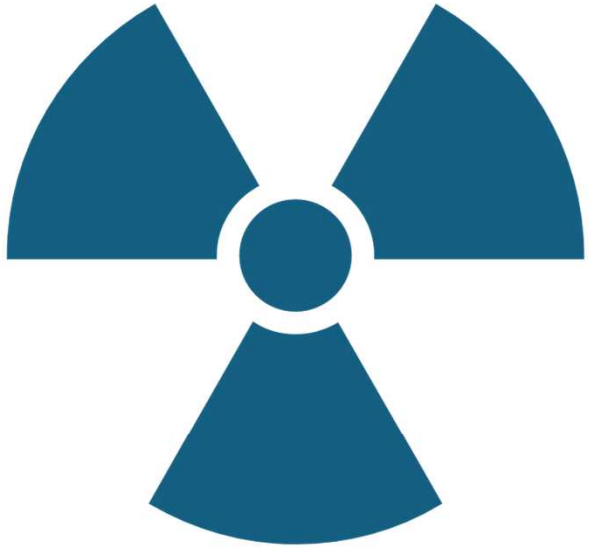
Table 1 **Classification standards** based on the kind and quantity of each radioactive substance included in radioactive waste described in the Cabinet Order for Enforcement of the Reactor Regulation Act

Carbon14	100GBq per ton
Cobalt60	1PBq per ton
Nickel63	10TBq per ton
Strontium90	10TBq per ton
Technetium99	1GBq per ton
Cesium137	100TBq per ton
α emitters	10GBq per ton

Table 2 Concentration (upper) limit of **pit disposal** for each radionuclide stipulated in the NRA Ordinance on Cat-2 Waste Disposal Business for Nuclear Fuel Material or Objects Contaminated with Nuclear Fuel Materials

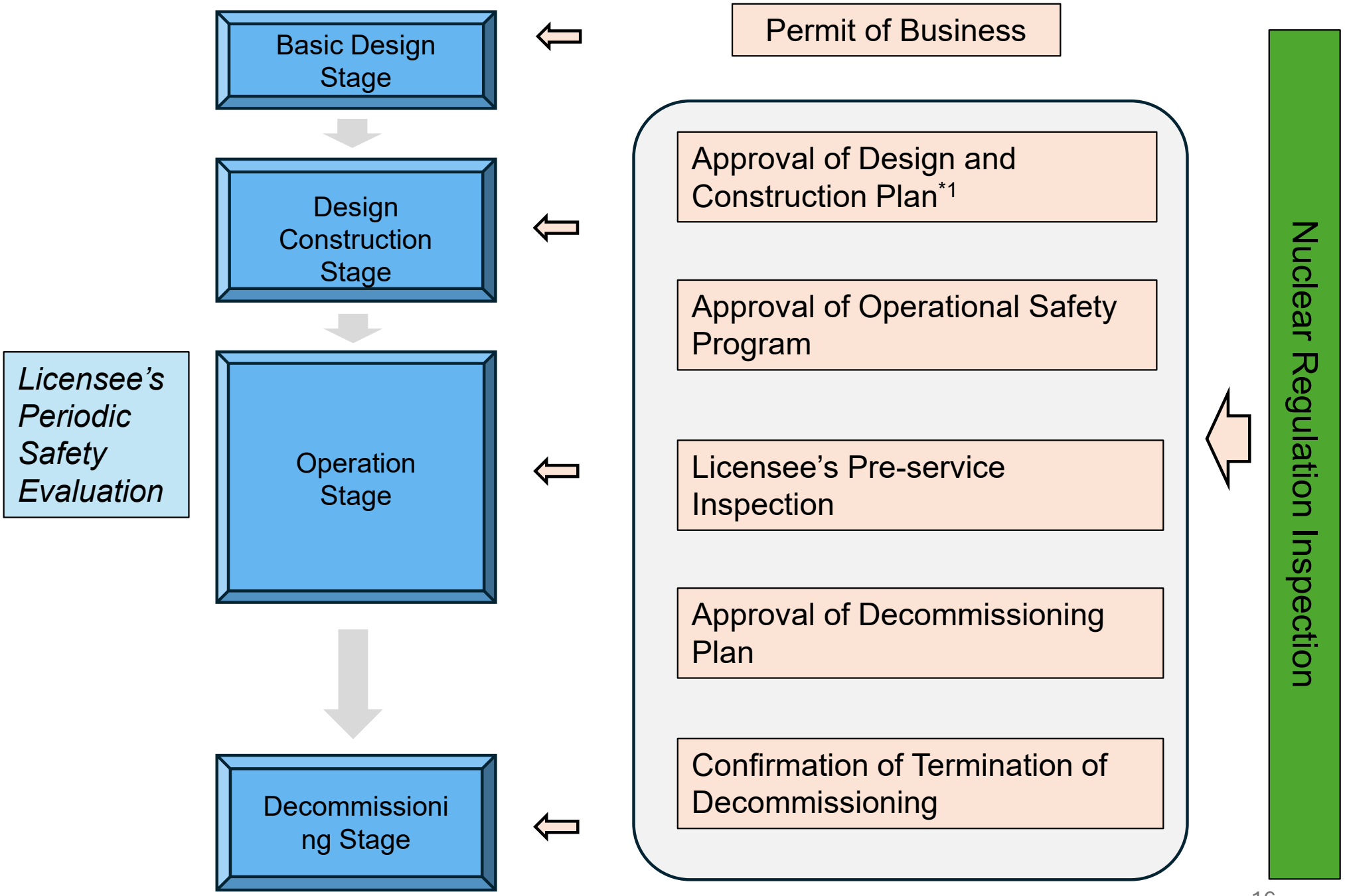
Cobalt60	10GBq per ton
Strontium90	10MBq per ton
Cesium137	100MBq per ton

Table 3 Concentration (upper) limit of **trench disposal** for each radionuclide stipulated in the NRA Ordinance on Cat-2 Waste Disposal Business for Nuclear Fuel Material or Objects Contaminated with Nuclear Fuel Materials



Radioactive waste interim storage facilities

Radioactive Waste Interim Storage Facilities



*1: A specified waste interim storage facility is required to obtain Approval of the Design and Construction Plan before commencing construction work. A facility that handles over 3.7 TBq of nuclear fuel material or material contaminated with nuclear fuel material is defined as a specified waste storage facility.

Permit of Business

- When giving a Permit for the relevant business, the NRA shall not **issue a Permit** unless it conforms to the Licensing Requirements:

  - ✓the applicant has sufficient **technical capability** and **financial basis** to properly to execute the business;
  - ✓the **location, structure, and equipment** of the radioactive waste storage facility are such that they will not hinder the prevention of disasters resulting from nuclear fuel material or material contaminated with nuclear fuel material under the Licensing Requirements;
  - ✓it is found that the **system necessary for quality control of operations** for safety conforms to regulatory requirements.

NRA Ordinance on Standards for the Location, Structure and Equipment of Waste Storage Facilities (Licensing Requirements)

Article 1	Definition
Article 2	Shielding
Article 3	Confinement functions
Article 4	Prevention of damage from fire
Article 5	Ground of waste storage facilities
Article 6	Prevention of damage from earthquakes
Article 7	Prevention of damage from tsunami
Article 8	Prevention of damage from external impact
Article 9	Prevention of unauthorized access, etc. to waste storage facilities
Article 10	Prevention of criticality of nuclear material
Article 11	Equipment with safety function
Article 12	Prevention of radiation hazards at the maximum design-base accident
Article 13	Waste treatment facilities
Article 14	Waste management facilities
Article 15	Instrumentations and control systems
Article 16	Radiation control facility
Article 17	Disposal facility
Article 18	Backup power supply
Article 19	Communication equipment

Long-Term Facility Management Policy

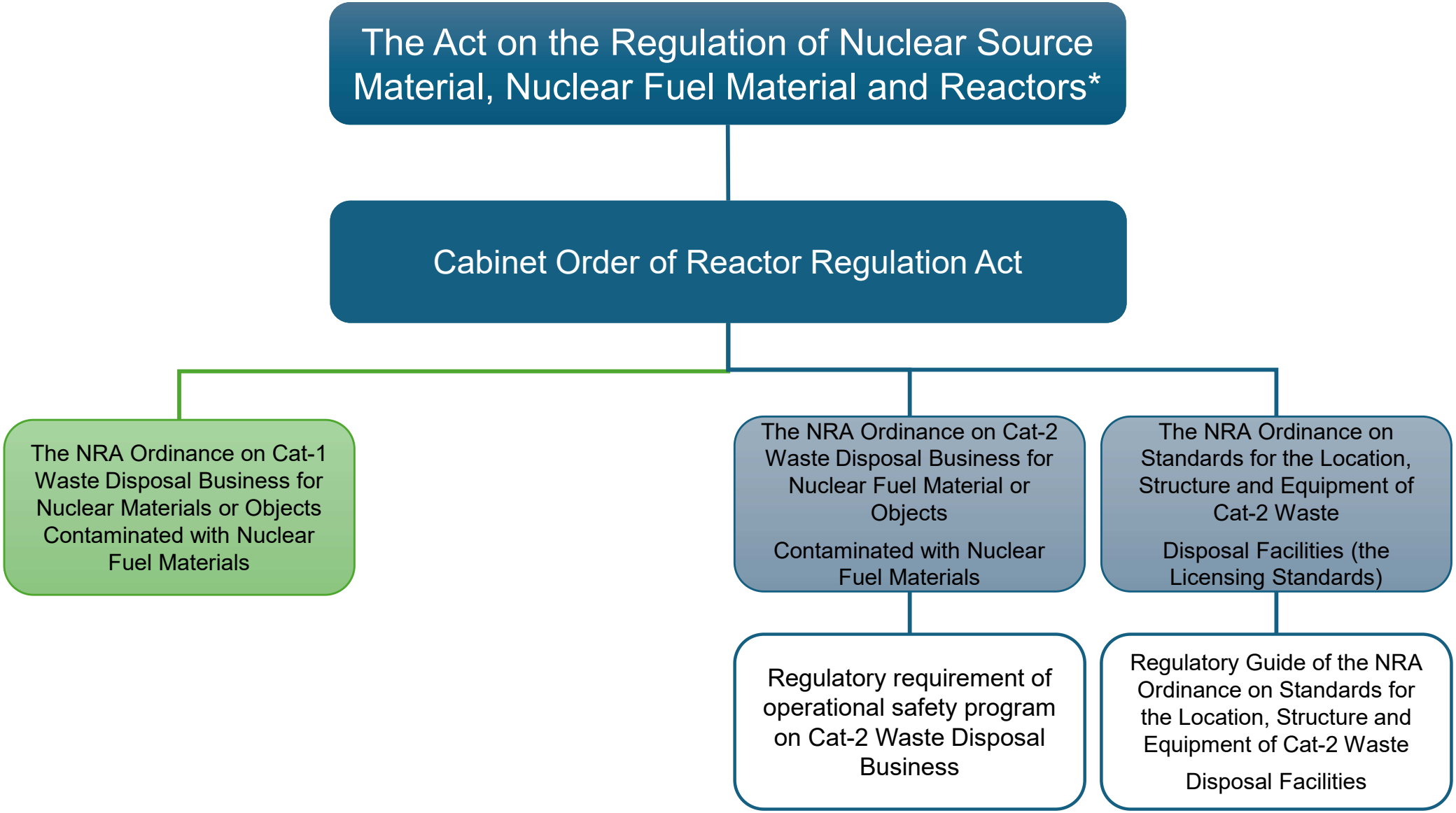
- **Aging assessments** must be conducted within 20 years of operation and **every 10 years** thereafter, with a 10-year long-term management policy developed based on the results.
- For safety-related SSC (structures, systems, and components), aging effects must be analyzed and it must be evaluated whether current maintenance can prevent functional failure.
- Preparation of a **technical evaluation report**

Example of Aging Management Technical Evaluation in technical evaluation report

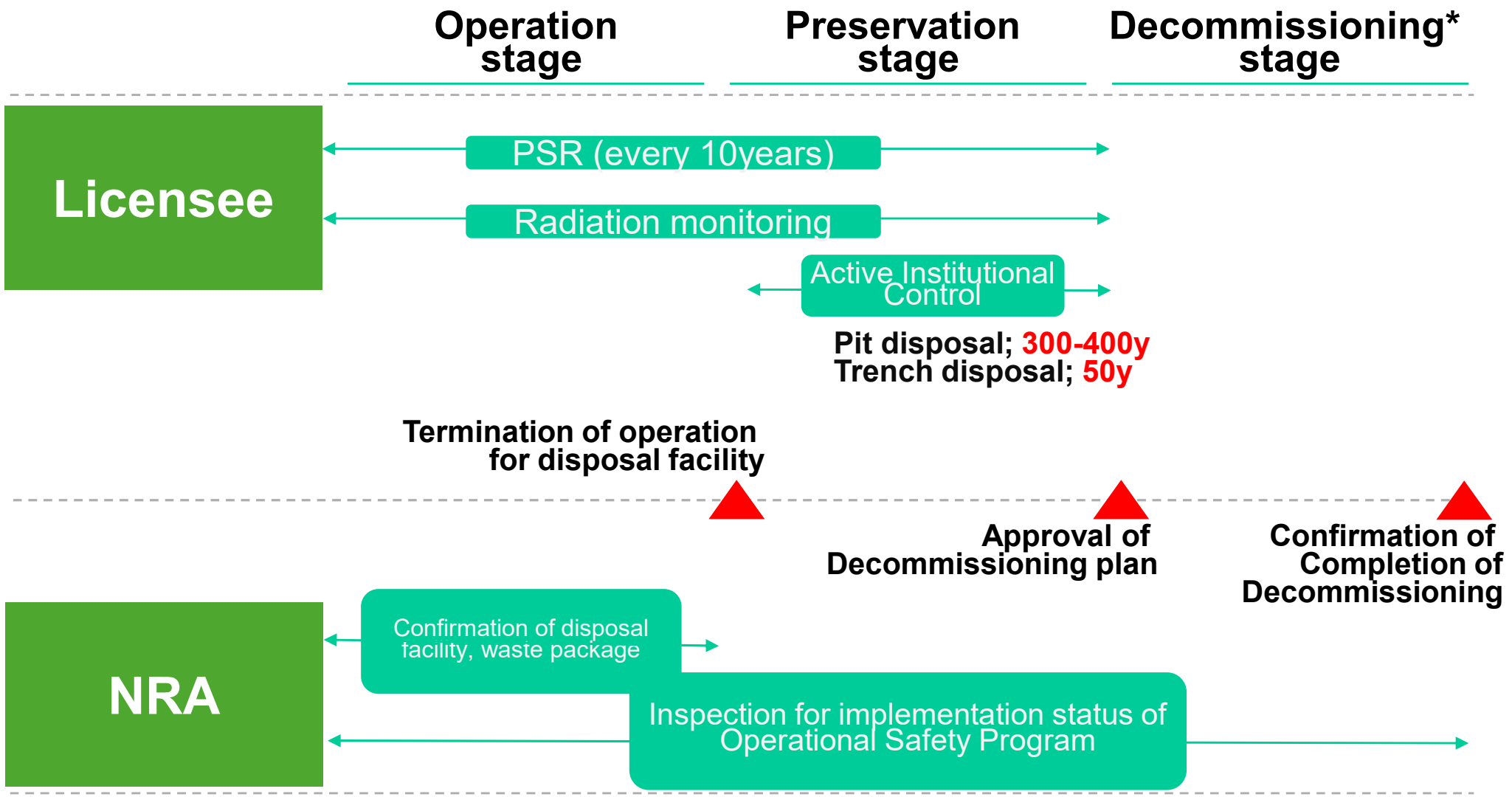
- Organizational framework, methods, and evaluation process
- Equipment and structures subject to evaluation (e.g. supporting structures and anchor bolts)
- Identification of aging degradation mechanisms based on structure, materials, and operating conditions
  - **Degradation of concrete strength** (salt attack, carbonation, compressive strength reduction, alkali–aggregate reaction (AAR), radiation-induced degradation)
  - **Mechanical corrosion** (visual inspection, leak inspection, thickness measurement and wall thinning evaluation using test pieces, pinhole testing)
  - **Corrosion, fatigue, and loosening** (support frames / supporting structures, anchor bolts)
- **Assessment** of the ability of safety-related SSCs subject to evaluation to maintain their safety functions **over the ten-year period** until the next aging management technical evaluation
- **Development of a long-term facility management policy**

Radioactive Waste Disposal Facilities

Regulatory System on Radioactive Waste in Japan

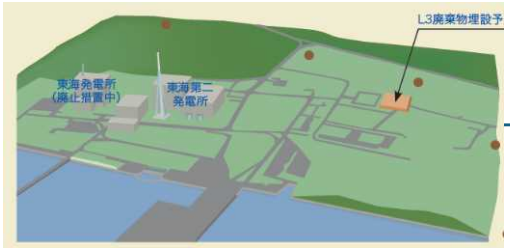


* hereafter called “Reactor Regulation Act”



* ; Removal of monitoring equipment and other equipment on the ground, etc..

Low Level Radioactive Waste Disposal Facilities in Japan



JAPC, Trench disposal
(Tokai, Ibaraki)
Under review
Source: The Japan Atomic Power Company webpage

JNFL, Pit disposal
(Rokkasho, Aomori)
In operation (No.1,No.2,No.3 disposal facility)
Source: Japan Nuclear Fuel Limited webpage

JAEA, Trench disposal
(Tokai, Ibaraki)
Post-Closure phase
Source: Japan Atomic Energy Agency webpage

Category 2 Waste Disposal (Trench, Pit and Intermediate Depth Disposal)

NRA Ordinance on Standards for the Location, Structure and Equipment of Cat-2 Waste Disposal Facilities (the Licensing Standards)

Article 1	Scope of application
Article 2	Definition
Article 3	Ground stability
Article 4	Seismic
Article 5	Tsunami
Article 6	External events (natural events except seismic and tsunami, and human events)
Article 7	Fire
Article 8	Radiation shielding
Article 9	Maintenance
Article 10	Retrievability of waste
Article 11	Accidental events
Article 12	Disposal facility of intermediate-depth disposal
Article 13	Disposal facility of near-surface disposal
Article 14	Radiation protection facility
Article 15	Monitoring equipment
Article 16	Water discharge equipment
Article 17	Waste management facility
Article 18	Standby power supply
Article 19	Communication equipment

Guideline for disposal facility of category 2 waste disposal*

Location

Operational safety

Design and location (long-term safety)

Structure and equipment

*https://www.nra.go.jp/data/000388538.pdf (in Japanese)

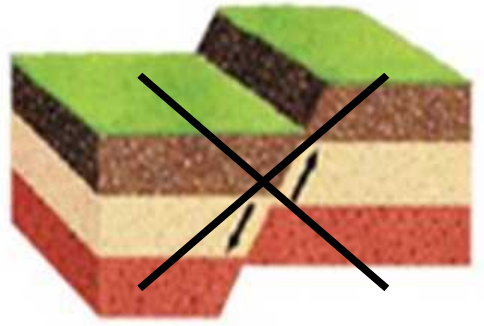
Intermediate Depth Disposal

Location of Disposal Facility (Intermediate Depth Disposal)

Examples of regulatory requirements (faults etc., volcanoes, erosion, mineral resources and geothermal resources) for the location of the disposal facility of intermediate depth disposal waste described in the Guideline are shown below.

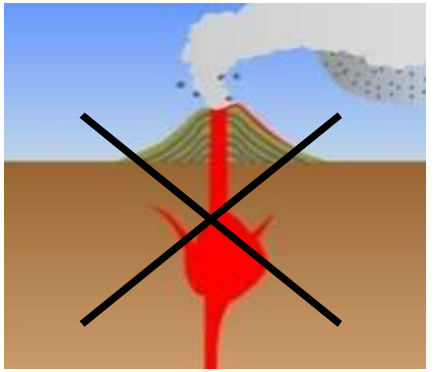
Faults etc.

- Engineered Barriers shall be installed to avoid the following faults etc.
  - Active faults that are considered to be the epicenter of faults whose activities cannot be denied after the late Pleistocene (after approx. 120,000 to 130,000 years ago)
  - The area damaged by active fault activity (e.g., within approximately 1/100 of the active fault length)



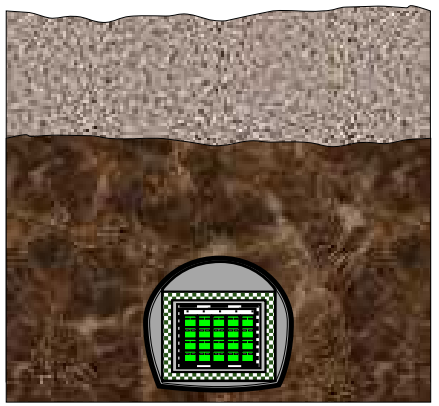
Volcanoes

- Disposal facilities shall be selected to avoid the following;
  - Locations where the histories of volcanic conduits, dikes, etc. pertaining to volcanic activity in the Quaternary (from present to about 2,580,000 years ago) exist (*considering that destruction of Engineered Barriers occurs due to the penetration of magma)
  - **Approx. 15 kilometers** or less from the center of volcanic activity in the Quaternary



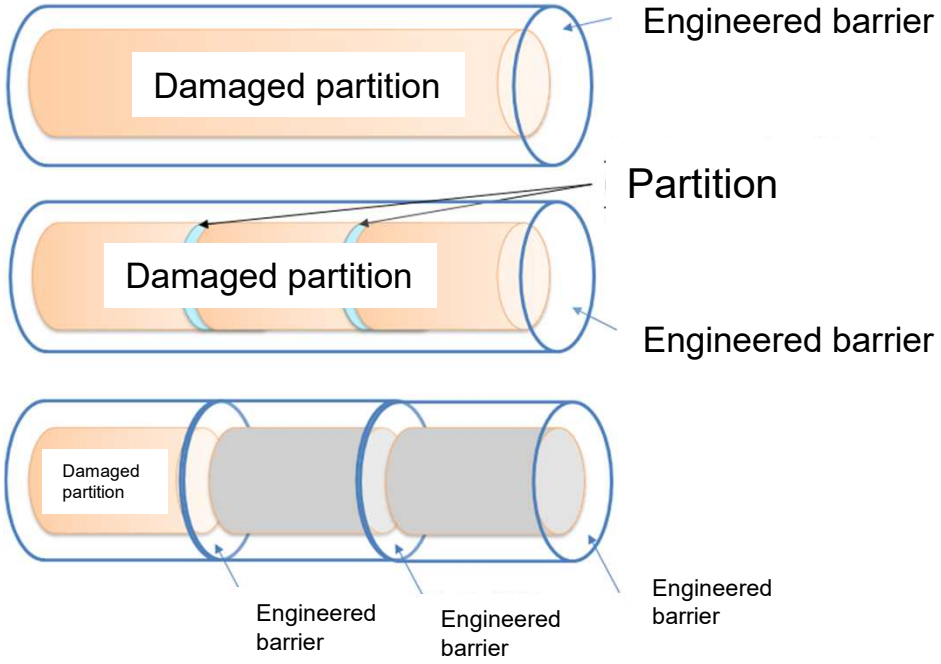
Erosion

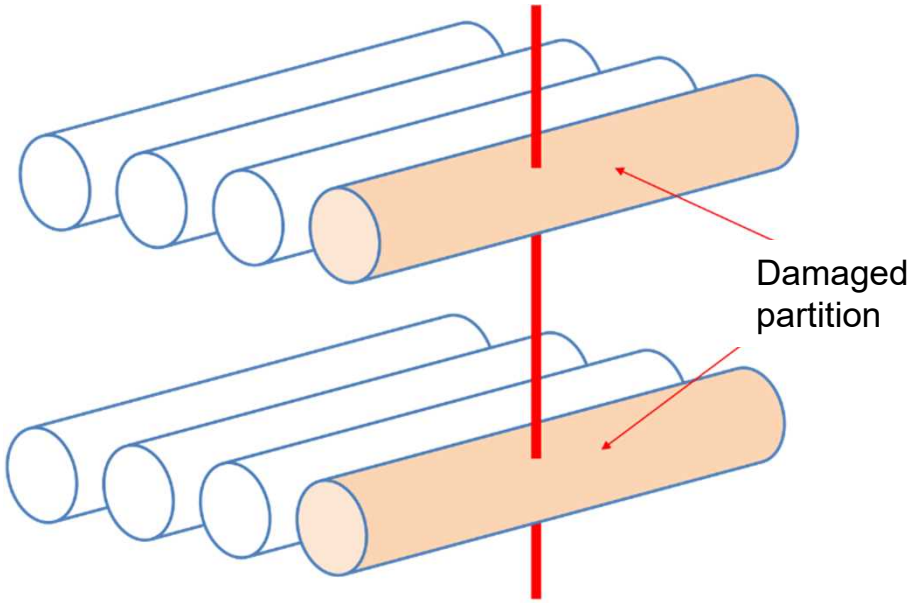
- Considering the depth reduction due to erosion taking into account uplift, sedimentation and sea level fluctuations for 100,000 years, it is required that the distance to the top of the waste disposal site be 70 meters or more after 100,000 years.



Scenarios assessment to drill borehole

- The dose to be evaluated by the public shall not exceed **20 mSv/year**, based on the setting, assuming that a single vertical borehole immediately after the end of regulation will damage the disposal facility and leak radioactive material in the area partitioned by an engineered barrier etc.
- To assume that the area with the greatest amount of radioactivity in the partitioned area is damaged.

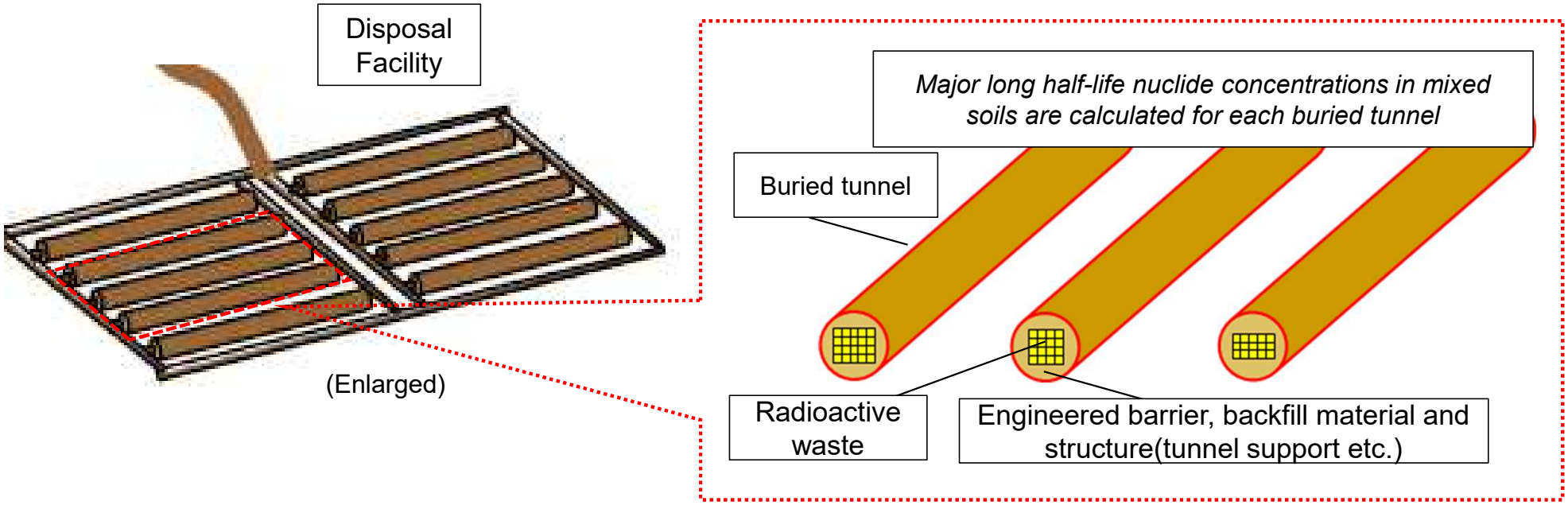




** If there are multiple buried tunnels in the vertical direction, multiple damage zones shall also be set.*

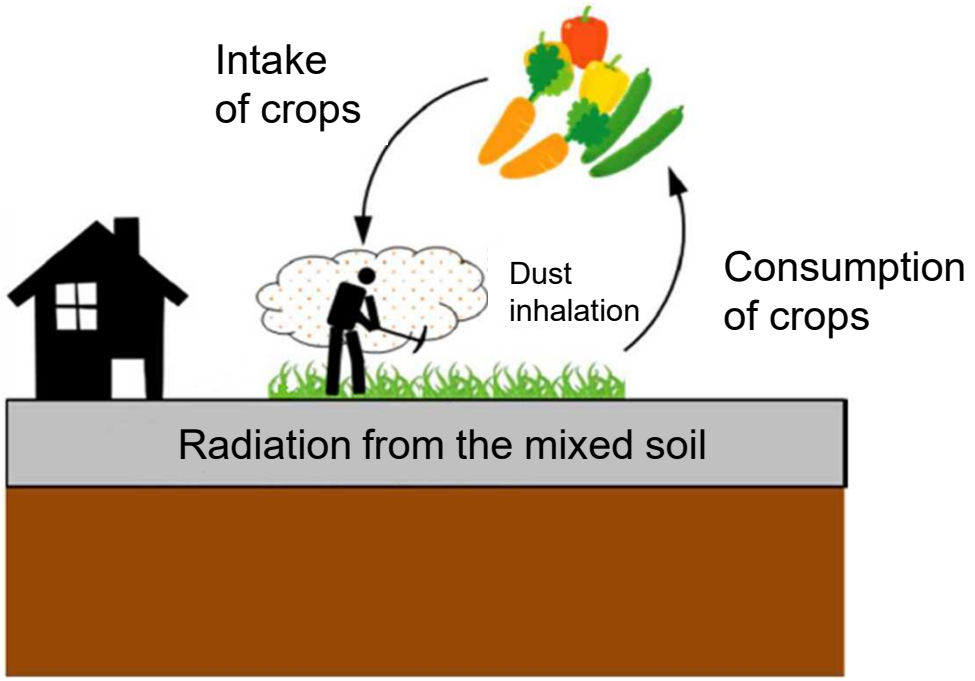
Scenarios Assessment Assuming Approach to Disposal Facility and the Public(1/2)

- In the case where a waste disposal site is to be installed in a place where there is a risk of erosion caused by sea level fluctuations during the period from the end of regulation to several 0.1 million years, the dose to be evaluated by the public shall not exceed **20 mSv/year** at the time 0.1 million years after the end of regulation, based on the setting assuming the approach of the public with the mixture of the materials buried or installed in the radioactive waste, engineered barriers, sediment etc.



Scenarios Assessment Assuming Approach to Disposal Facility and the Public(2/2)

- External exposure received from radioactive materials contained in mixed soil which lives in a house
- Internal exposure due to dust inhalation during agricultural work on mixed soil and intake of agricultural crops



Residence etc. on the mixed soil
(Resident to do agricultural work)

- Residence
  (incl. agricultural work)
  - External exposure
  - Dust inhalation
- Consumption of crops
  - Intake of crops

Pit and trench disposal

Dose Assessment to the Public

1. Natural Event Scenario

Scenarios that take into account the leakage of radioactive materials from disposal facility due to natural phenomena, the migration of radioactive materials into natural barriers, the migration of radioactive materials into rivers etc., and the lifestyles of people around the current disposal facility

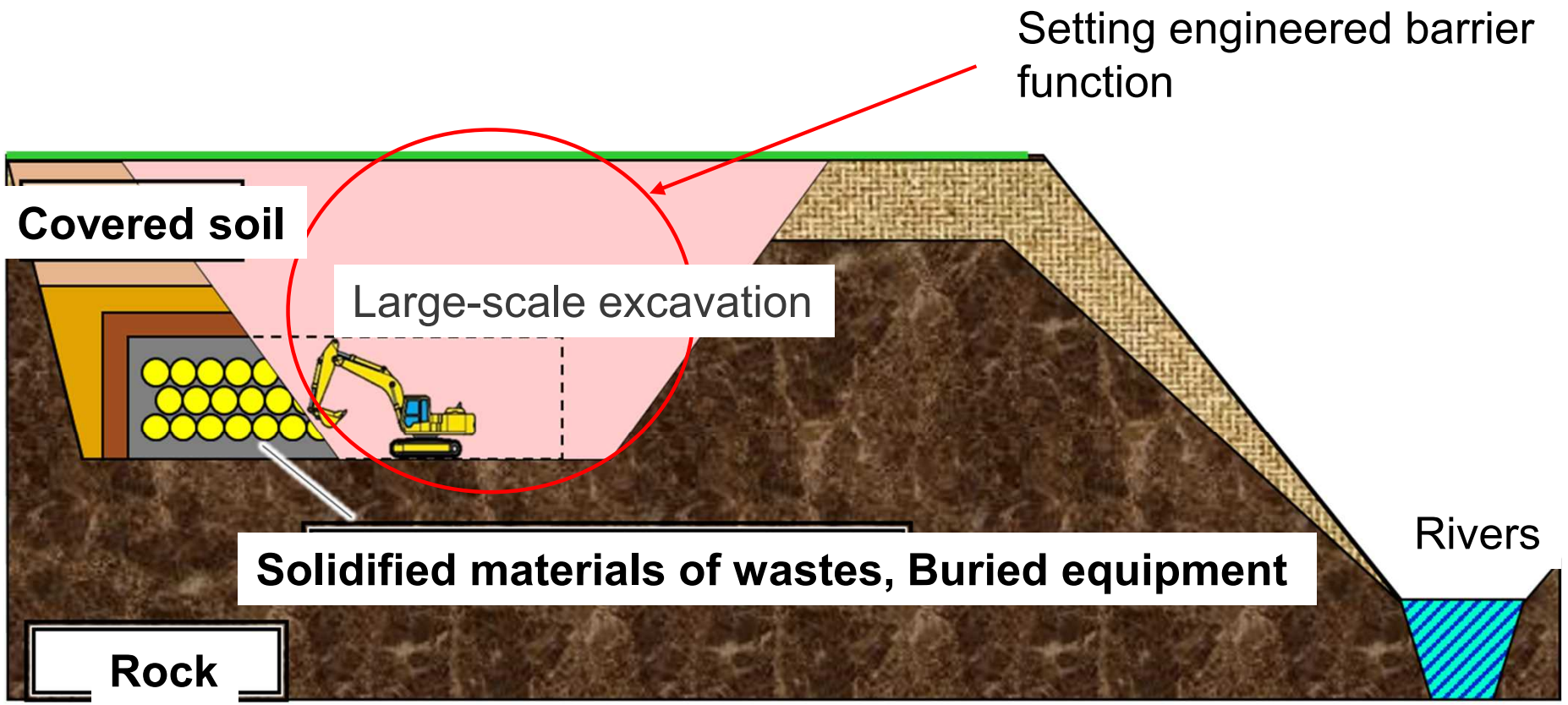
- ✓ Most severe natural event scenario:300μSv/y
- ✓ Most likely natural event scenario:10μSv/y

The period of dose evaluation is 1000 years after the end of regulation.
*Confirm that the dose evaluation to the public will not be significantly higher after 1000 years.

2. Human intrusion scenario

Scenarios that take into account land use involving excavation of disposal facility immediately after the end of regulations

Human intrusion scenario



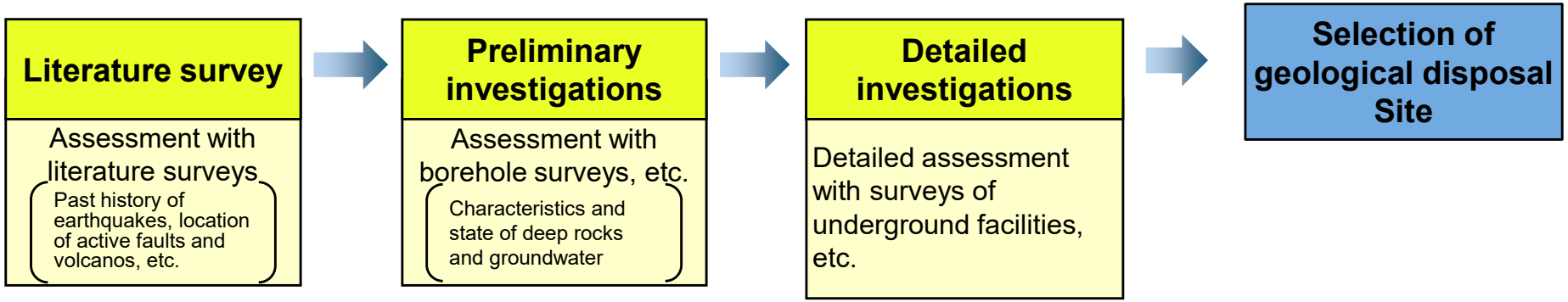
Geological disposal

Regulatory Involvement in the site selection process

In the Basic Policy on Final Disposal of Specified Radioactive Waste decided by the Cabinet Office in May 2015, it is stipulated that in order to rationally proceed with the selection of outline survey areas, etc., it is **appropriate for the NRA to show considerations according to the progress for ensuring safety in site selection phases** under the major premise that there will be no prejudice to the specific review of license application in the future safety regulations, etc.

◆Selection process outlined in the "Final Disposal Act"

NUMO



Overview of Considerations to Ensure Nuclear Safety in Site Selection for the Final Disposal of Specified Radioactive Waste(1/2)

As a result of the deliberations, the NRA decided in August 2022 that the following 1. to 4. should be considered as "**Considerations to Ensure Nuclear Safety in Site Selection for the Final Disposal of Specified Radioactive Waste**" for events that are difficult to deal with by designing final disposal facilities and that need to be dealt with by avoiding the establishment of final disposal facilities when selecting final disposal facilities.

The " Considerations to Ensure Nuclear Safety in Site Selection for the Final Disposal of Specified Radioactive Waste " should be appropriately considered based on the information obtained at each time point in the selection of the Preliminary investigations area, etc.

Overview of Considerations to Ensure Nuclear Safety in Site Selection for the Final Disposal of Specified Radioactive Waste(2/2)

1. Faults etc.

It is similar to intermediate depth disposal from the viewpoint of preventing damage to engineered barriers and promoting the migration of radioactive materials through the groundwater flow path.
Considerations to Ensure Nuclear Safety in Site Selection for the Final Disposal of Specified Radioactive Waste are the same as the regulations for intermediate depth disposal.

2. Volcanic Phenomenon

As with intermediate depth disposal, it is necessary to sufficiently reduce the likelihood of destruction of the disposal facility due to eruption or magma intrusion.
In addition, the possibility of new volcanoes should be considered based on the radioactive properties of HLW.

3. Erosions

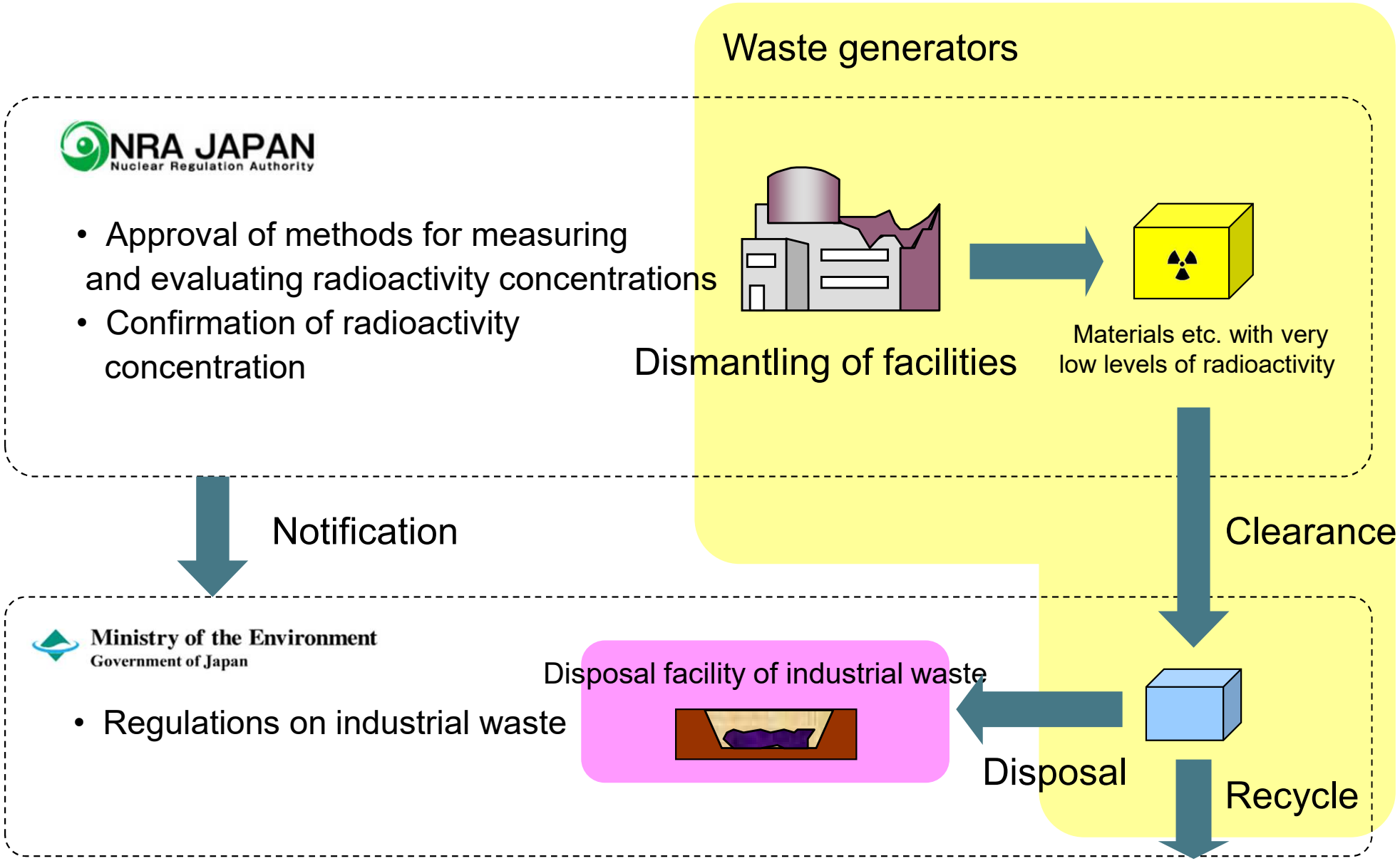
It is appropriate to ensure deeper depths than intermediate depth disposal.

4. Mining of mining resources etc.

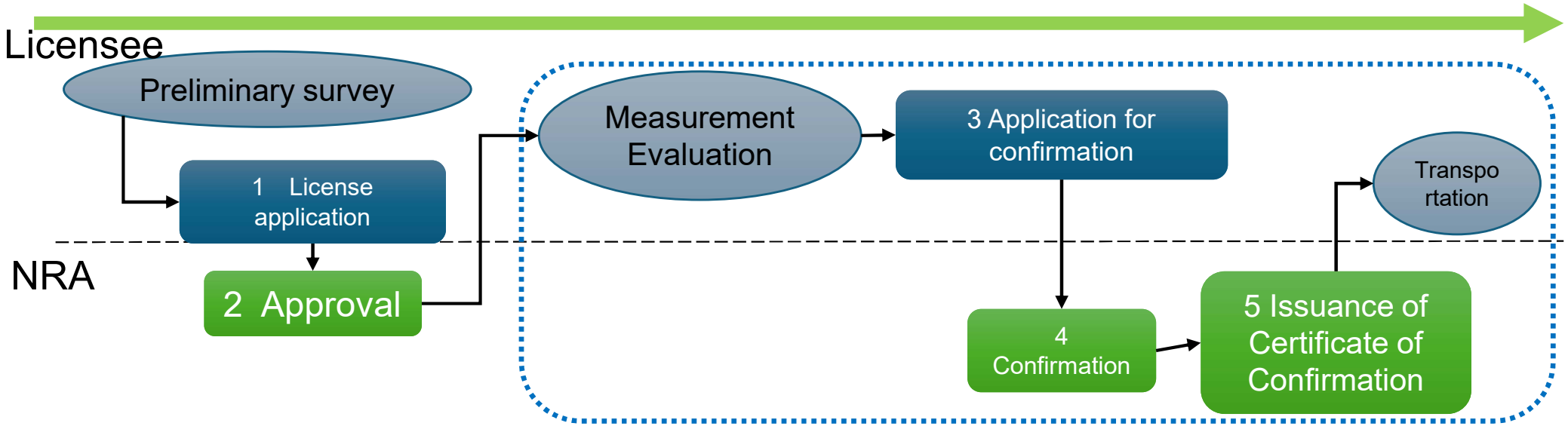
Mining of mineral resources etc. as an artificial event does not differ between intermediate depth disposal and geological disposal.
Considerations to Ensure Nuclear Safety in Site Selection for the Final Disposal of Specified Radioactive Waste are the same as the regulations for intermediate depth disposal.

Clearance

Flow of Clearance system(1/2)

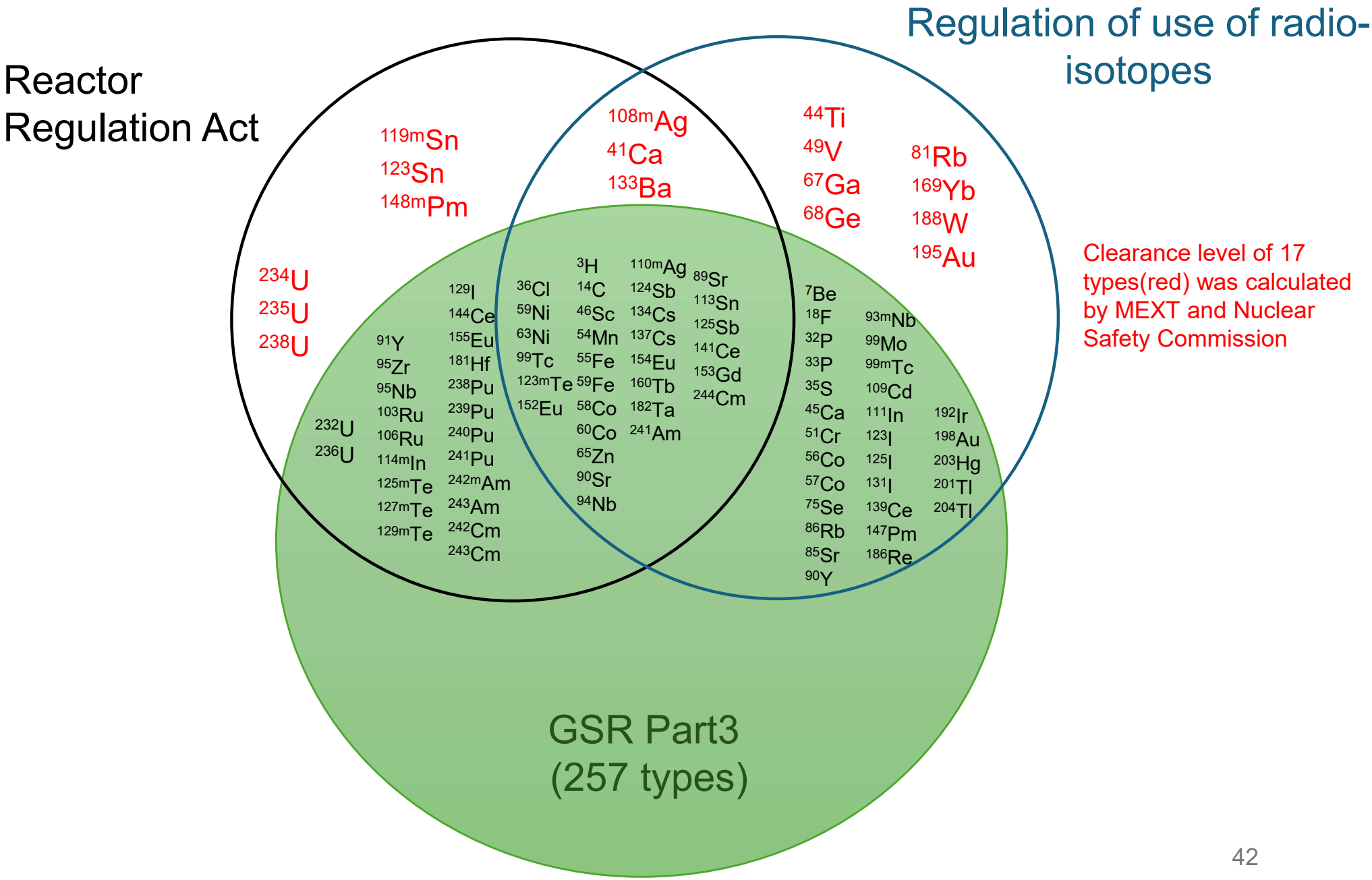


Flow of Clearance system(2/2)



1. Application for Approval of Method of Measurement and Evaluation of Radioactive Concentration (Article 5)
2. Criteria for Approval of Measurement and Evaluation Methods (Article 6)
3. Application for confirmation (Article 3)
4. Issuance of Certificate of Confirmation (Article 4)

Types of radioactive substances (274 types in total)



Clearance level of 17 types(red) was calculated by MEXT and Nuclear Safety Commission

Flow to confirm clearance level requirement

Selection of radioactive materials used for evaluation

Evaluation unit settings

Setting of radiation measurement devices and measurement conditions

Determining radioactivity concentration by radiation measurement

Determining radioactivity concentration by composition ratio of radioactive material, code calculation and other methods (e.g. radiochemical analysis)

Determination of radioactivity concentration in evaluation units

Radiation measurement

Composition ratio

Code calculation

Radiochemical analysis

Foreign matters (e.g. radioactive material)

Prevention measures such as contamination of foreign matter

Criteria for determining whether the clearance level is satisfied when multiple nuclides are present :

$$\sum_{i=1}^{n} \frac{D_i}{C_i} \leq 1$$

D_i : Concentration of ***i*** th nuclide

C_i : Clearance level of ***i*** th nuclide

Regulatory guide for clearance

- **Selection of radionuclides**: radionuclides significant to estimate radiation dose shall be selected to satisfy over **90%** of the summation of D/C in descending order of D/C.
- **Maximum weight for evaluation unit**: the maximum weight of the evaluation unit shall **not exceed 10 tons**.
- **Determination of radionuclide concentration**: Upon the determination of the radionuclide concentration contained in the clearance material, measurement of radiation, utilization of nuclide composition, sampling analysis, and statistic processing are conducted. With appropriate evaluation of uncertainties in the above work, the upper limit of $\sum D/C$ shall **not exceed 1** when the one-sided level of confidence is 95%.
- **Selection of measurement equipment and condition of measurement**: The appropriate measurement efficiency of measurement equipment shall be set. When a reference source is used, appropriate geometry shall be maintained at the measurement.
- QMS

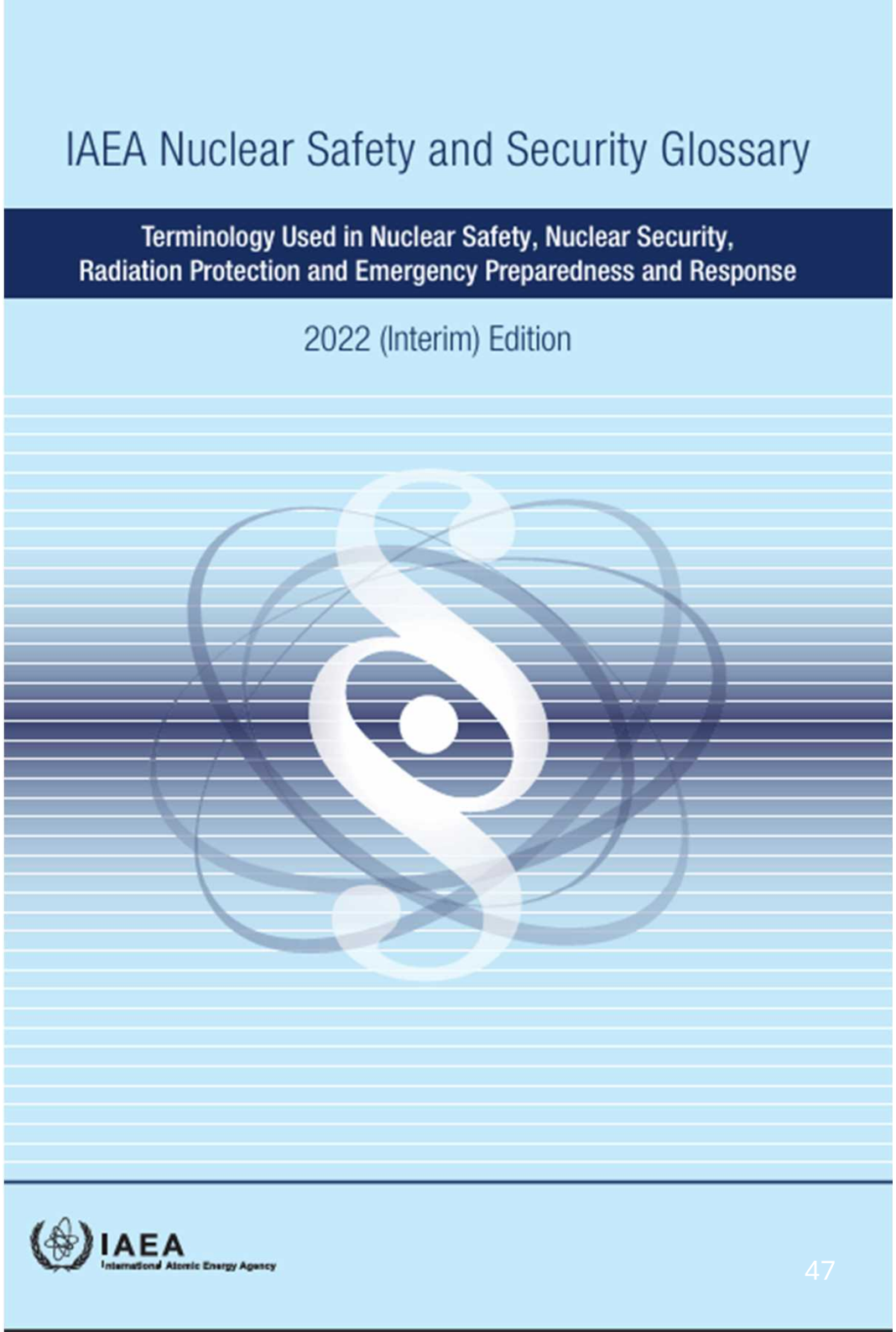
Experience in the implementation of the clearance system

- Hamaoka NPP Unit5 (low-pressure turbine shaft and blade)
- Hamaoka NPP Unit 5 (low-pressure turbine diaphragm and pressure plate) under review
- Hamaoka NPP Unit 1,2
- Hamaoka NPP Unit 4 (low-pressure turbine rotor shaft)
- Shimane NPP Unit 1,2 (Low-pressure turbine diaphragms and inner casing)
- Ohi NPP Unit 1,2 (Refueling Water Storage Tank)
- Tokai NPP
- Tsuruga NPP Unit 1 (Accumulator)
- JRR-3 (concrete)
- Fugen, partly approved, partly under review
- JAEA Ningyo-toge Environmental Engineering Centre (dismantled centrifuge)
- Tokyo Univ. Yayoi, under review

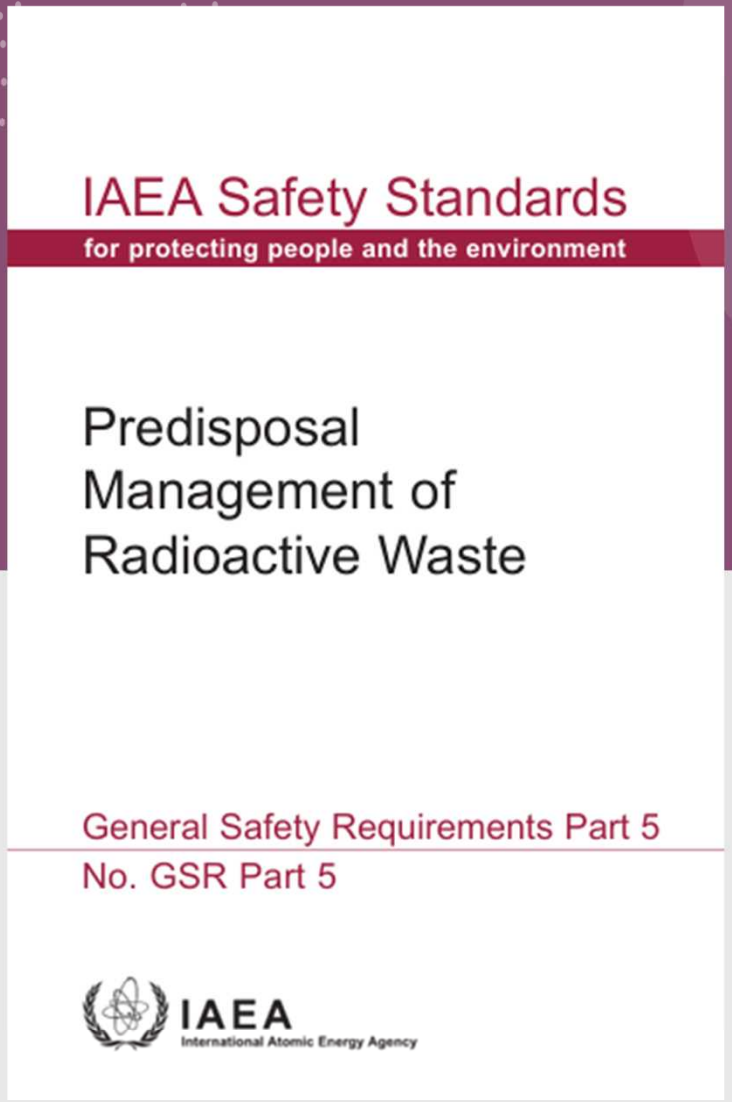

Waste Acceptance Criteria

What is Waste Acceptance Criteria?

- 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.



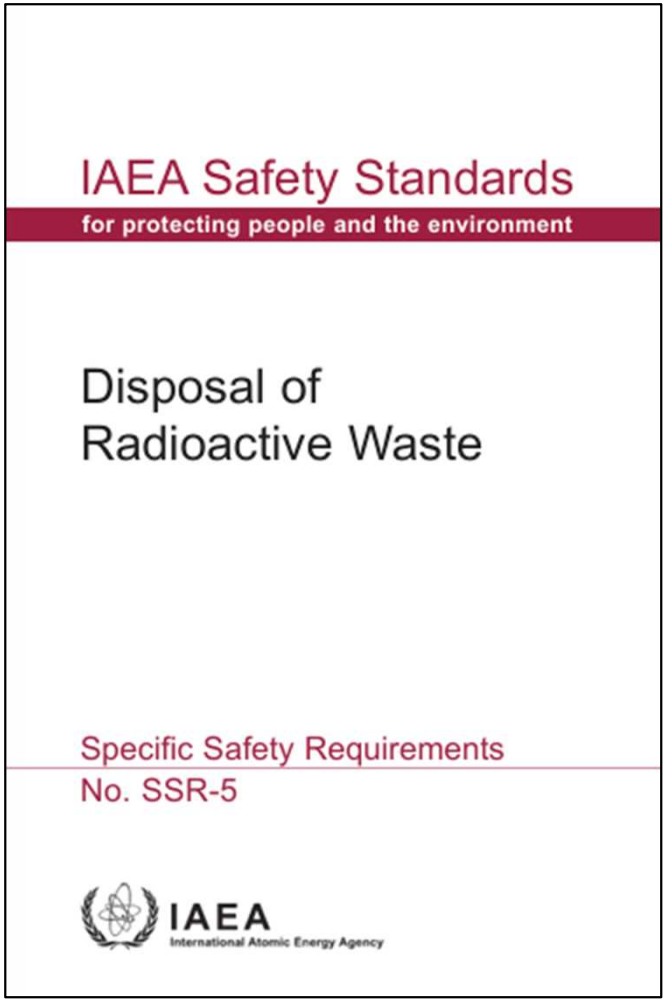
IAEA GSR Part 5: Predisposal Management of Radioactive waste



- ***Requirement 12: Radioactive waste acceptance criteria***
- Waste packages and unpackaged waste that are accepted for **processing**, **storage** and/or **disposal** shall conform to criteria that are consistent with the safety case.

IAEA SSR 5: Disposal of Radioactive Waste

- ***Requirement 20: Waste acceptance in a disposal facility***
- Waste packages and unpackaged waste accepted for emplacement in a **disposal facility** shall conform to criteria that are fully consistent with, and are derived from, the **safety case** for the disposal facility in operation and after closure.



WAC's Shift from Specification-based to Performance-based Regulations

- In 2016, the NRA underwent an IRRS review.
- One of the key issues identified during this process was the necessity for transitioning WAC for near-surface disposal into performance-based regulations.
- Subsequently, in 2019, the NRA amended its regulations to accommodate the diverse characteristics of radioactive waste generated during the future decommissioning of various nuclear facilities.

Previous and Revised Provisions

Specification-based Regulation

Permit of Business

Notification on Technical Details for Category 2 Waste

(Encapsulation methods and solidification techniques)
- ✓ Solidification materials (e.g. JIS cement & asphalt)
- ✓ Container (e.g. JIS)
- ✓ Cement (e.g. UCS of 1470 kPa or above)
- ✓ Hardness of solidified unsaturated polyester resin (hardness value of 50 or above)

and other items.

Confirmation of Radioactive Waste

Performance-based Regulation

Permit of Business

Examination Standard for the Operational Safety Program
- ✓ **Waste Acceptance Criteria** NEW
  - *Solidification methods*
  - *Types of RW*
  - *Radioactivity concentration*
  - *Surface radioactive material density*
  - *Properties and quantities of substances that may compromise the integrity of the waste package or the safety functions of the disposal site*
  - *Load-bearing strength*
  - *Scattering and leakage caused by falling*
  - *Sign*
  - *Satisfy the requirements related to the waste package as described in the license application*

and other items.

Approval of Operational Safety Program
- ✓ **Waste Acceptance Criteria** NEW

Abolition
Notification on Technical Details for Category 2 Waste

Confirmation of Radioactive Waste

A Partial Excerpt of WAC for Homogeneous Solid Waste Packages in No.1 Disposal Facility in JNFL

Surface density limits:
- Radioactive materials emitting alpha rays: 0.4 Bq/cm^2 or less.
- Materials not emitting alpha rays: 4 Bq/cm^2 or less.

Container:
- Strength and sealing performance equivalent to or superior to JIS Z 1600 steel open drums.

Waste container weight:
- Must not exceed 500 kg per unit.

Labeling:
- Serial number.
- Mark indicating radioactive material.

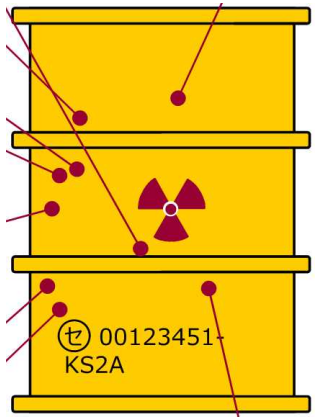
Elapsed period:
Solidification must have been completed at least 6 months prior to acceptance.

Surface dose equivalent rate:
- Must not exceed 10 mSv/h.

Substances that may compromise integrity :
- Must not contain materials with properties such as explosiveness or volatility.

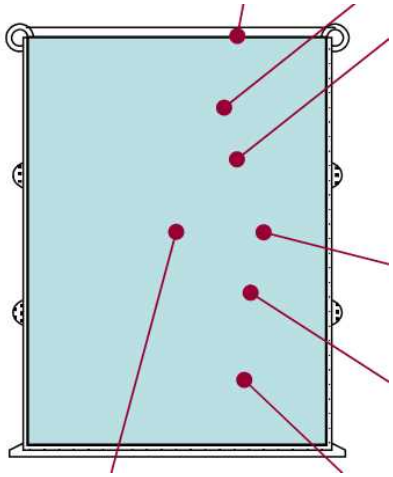
Significant damage:
- No leakage or exposure of waste from the waste package.
- No deterioration of the surface of the waste package.
- No deformation of the container that hinders transportation of the waste package.

This includes deformations that make handling with waste package equipment impossible.



Maximum Radioactivity Concentration:
- It must be confirmed that the maximum radioactivity concentration at the time of acceptance does not exceed the standard value, as verified using methods such as the scaling factor method or the average radioactivity concentration method.

Mixing ratio:
- Asphalt: Over 50% by weight
- Plastic: Over 30% by weight



Mixing and blending:
- Solidification must be carried out using equipment verified to uniformly mix solidification materials, admixture materials, and radioactive waste.

Solidification Materials:
- Cement: JIS R 5210 or 5211 or equivalent or higher quality.
- Asphalt: JIS K 2207 or equivalent or higher quality.
- Plastic: Unsaturated polyester.

Sorption properties of cement-based grouting materials :
- Ordinary Portland cement or cement with equivalent chemical composition.
- Blast furnace cement Type B (Type C) or cement with equivalent chemical composition.

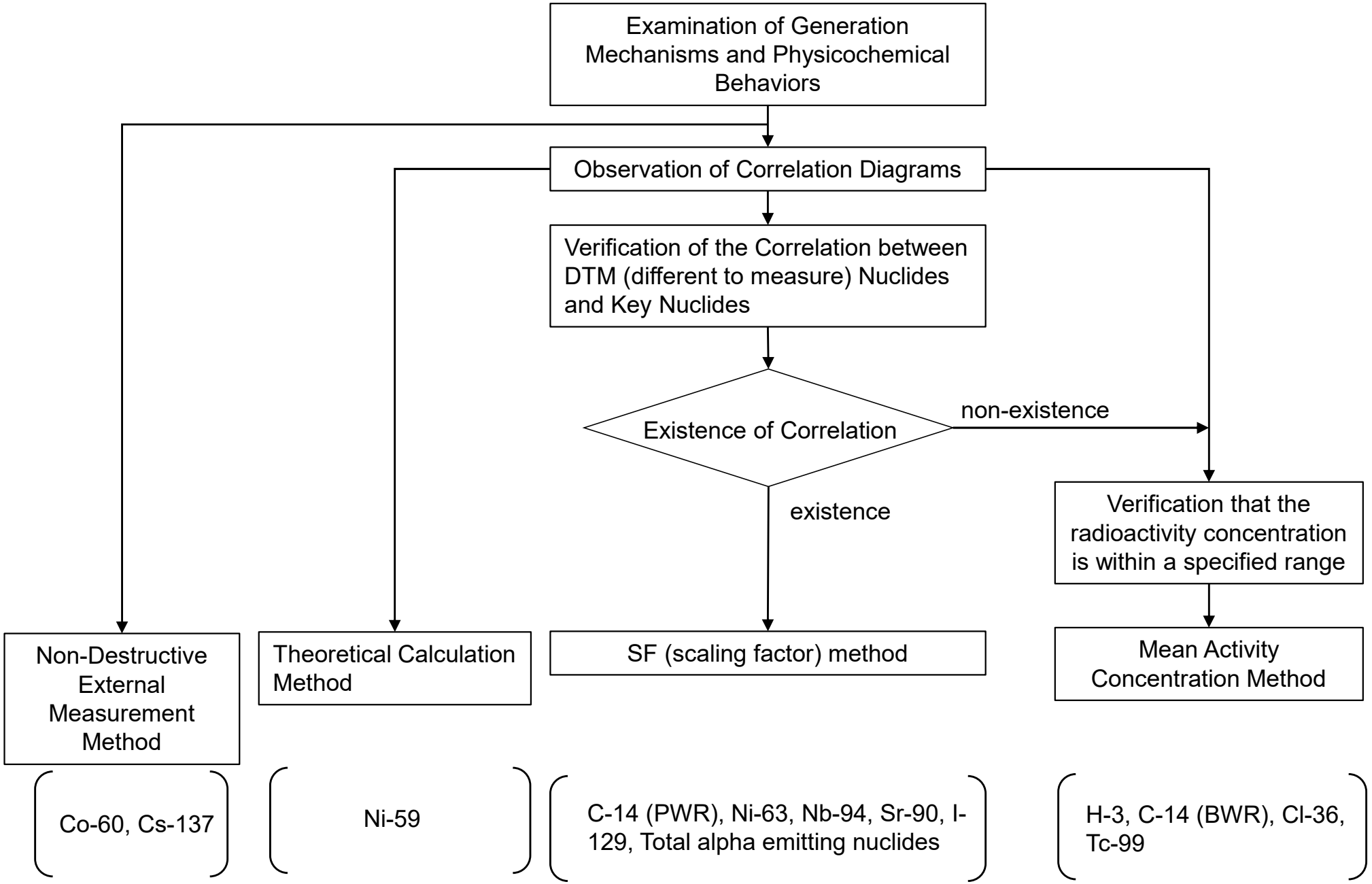
Hardness value:
- Plastic: Hardness value of 25 or more.

Uniaxial compressive strength (UCS):
- Cement: UCS of 1470 KPa or more.

Harmful voids:
The upper void must not exceed 30% of the volume.

Referred to JNFL (2025) , https://www.da.nra.go.jp/view/NRA100010199?contents=NRA100010199-002-003#pdf=NRA100010199-002-003 (in Japanese)

Procedure for Determining Radioactivity Concentration of Homogeneous Solid Waste Packages in No.1 Disposal Facility in JNFL



Referred to STA (1991) , JNFL (2025) , https://www.da.nra.go.jp/view/NRA100010199?contents=NRA100010199-002-003#pdf=NRA100010199-002-003 (in Japanese)

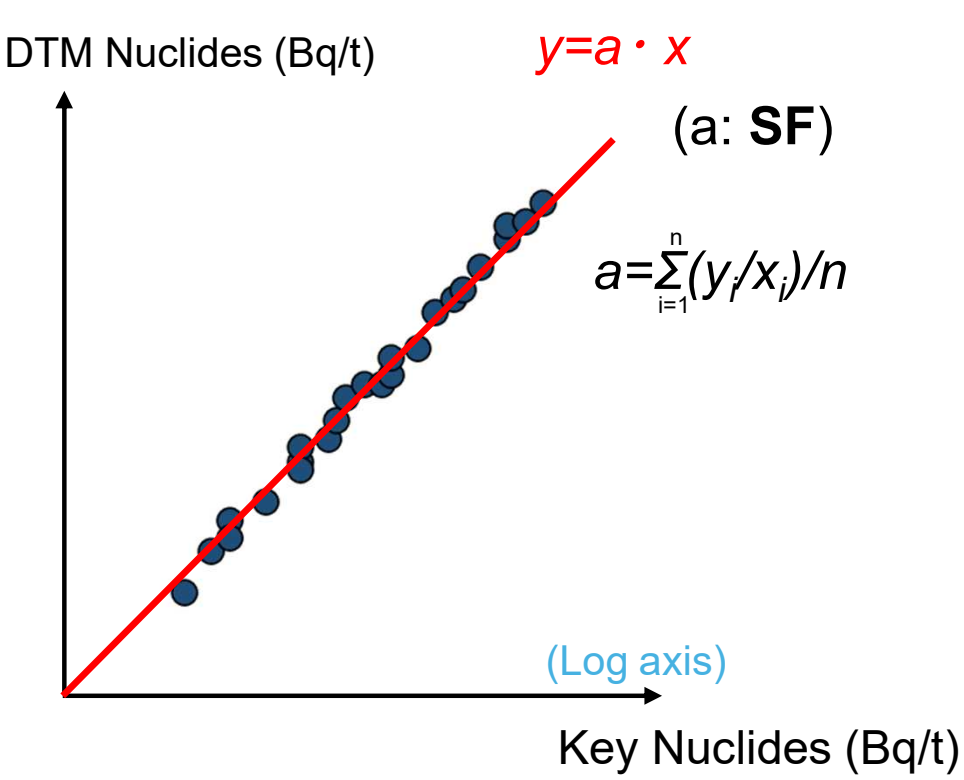
Scaling Factor Method
Mean Activity Concentration Method

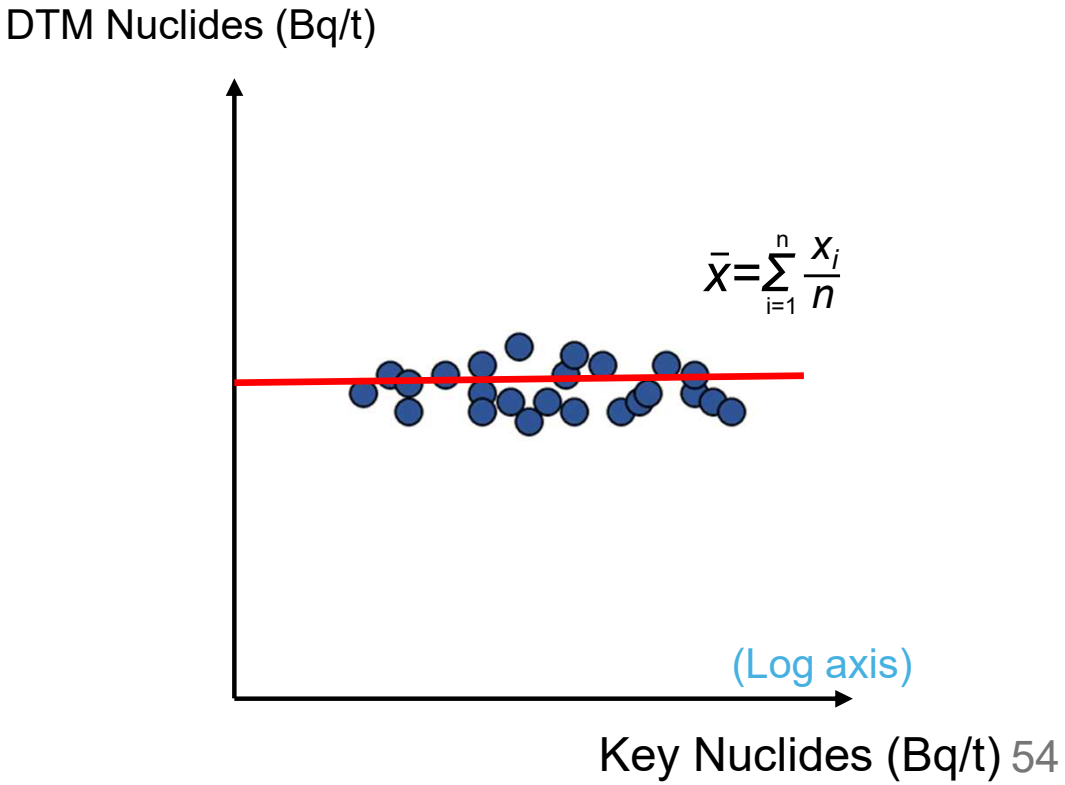
Scaling Factor Method

- The SF method for determining the radioactive concentration in the waste involves combining the correlation between DTM (difficult to measure) nuclides and key nuclides obtained from radiochemical analysis of representative samples with non-destructive measurement results taken externally from each waste form.

Mean Activity Concentration Method

- The Mean Activity Concentration Method for determining the radioactive concentration in waste involves utilizing the average radioactive concentration obtained from radiochemical analysis of representative samples to assess the radioactive concentration within the waste.



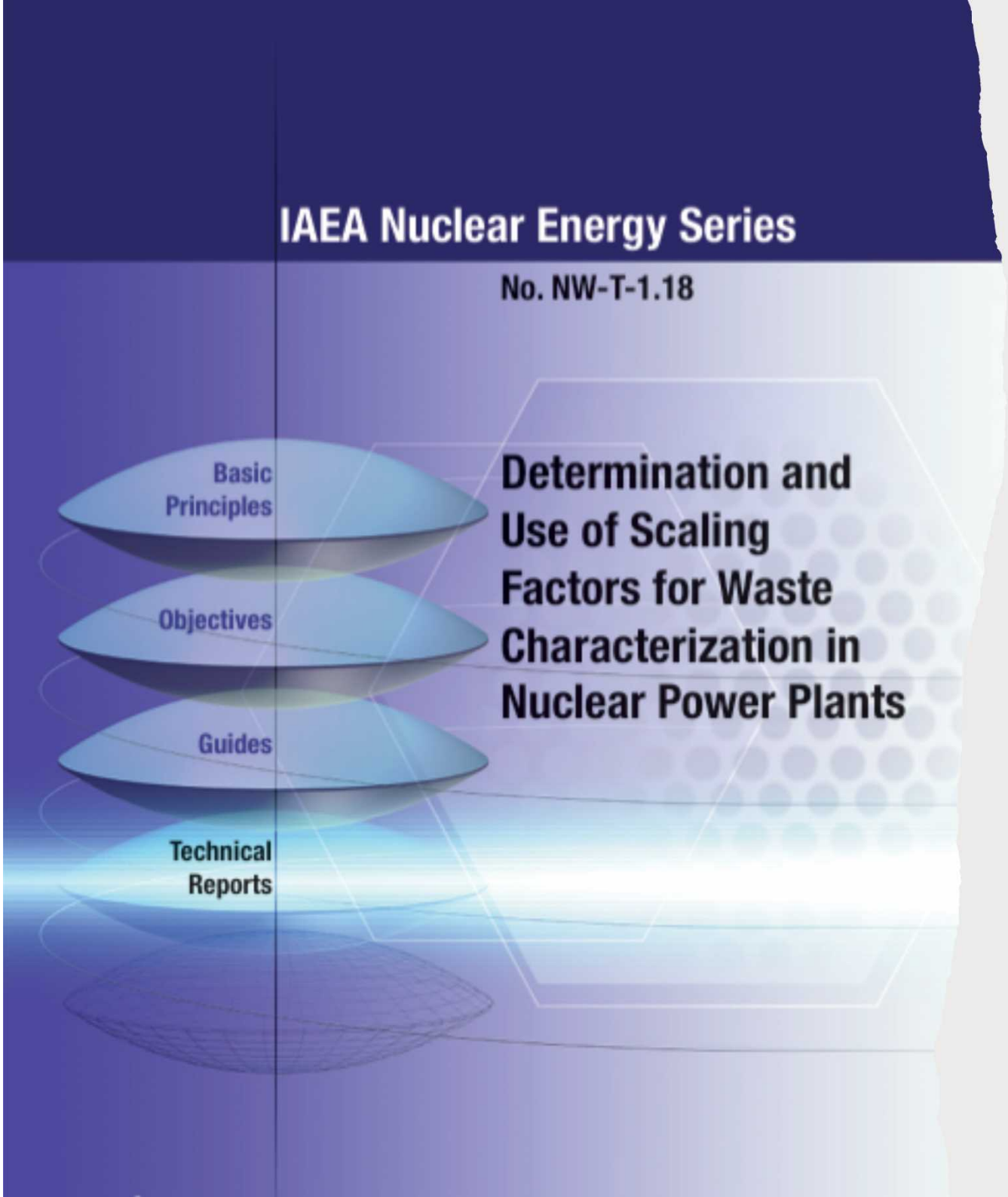


Regulation of Continuous Use of the Same Scaling Factor in JNFL

- To verify continuous usage of the same SFs for newly generated waste prior to accepting waste into a disposal facility, **annual sampling** has been carried out every year in every NPP plant.

- The condition under which **continuous use of the same SF** (incl. Mean Activity Concentration) can be applied is that the newly measured data does **not exceed ten times** the value calculated by the previous SF.

- In cases where newly measured data exceeds the value calculated by the previous SF by **more than tenfold** due to fuel damage or other factors, or if there is a new type of waste that has not been previously produced and for which an SF has not been determined, **a new SF shall be established**. This SF, to be included in the WAC, will be reviewed by the NRA.



Scaling Factors for Waste Characterization in the other countries