

Decommissioning situation of Nuclear Power Plant in Japan

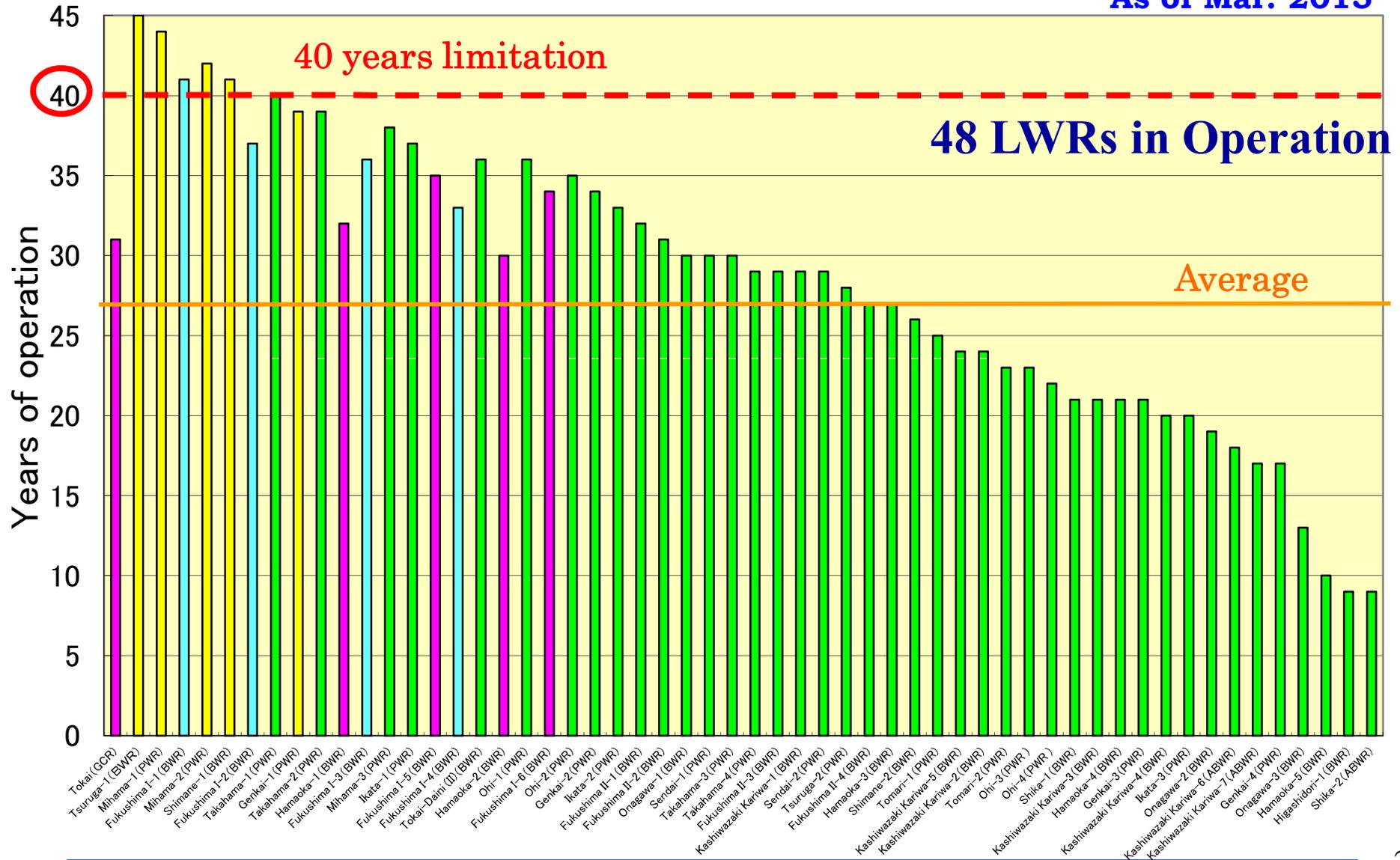
April, 2015

*The Japan Atomic Power Co.
The Kansai Electric Power Co., Inc.*

General Description

Operational years of commercial NPP in Japan

As of Mar. 2015



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 starts Tokai Decommissioning project for the first time on Dec, 2001.
- JAEA Fugen and the Chubu Electric Power Co Hamaoka 1,2 are started decommissioning.
- Additionally five plants(Tsuruga-1, Mihama-1&2, Shimane-1, Genkai-1) will be shutdown by the end of April 2015.

Decommissioning institution in Japan

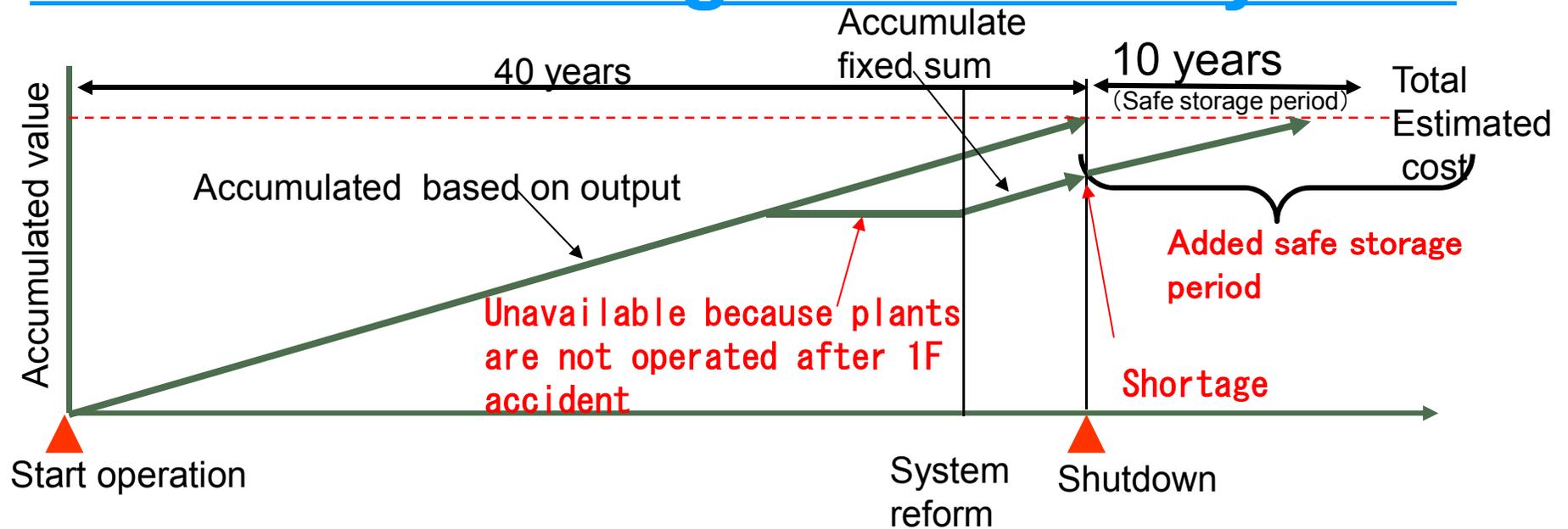
Institution for decommissioning allowance

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 leave burdens on future generations.

Because,

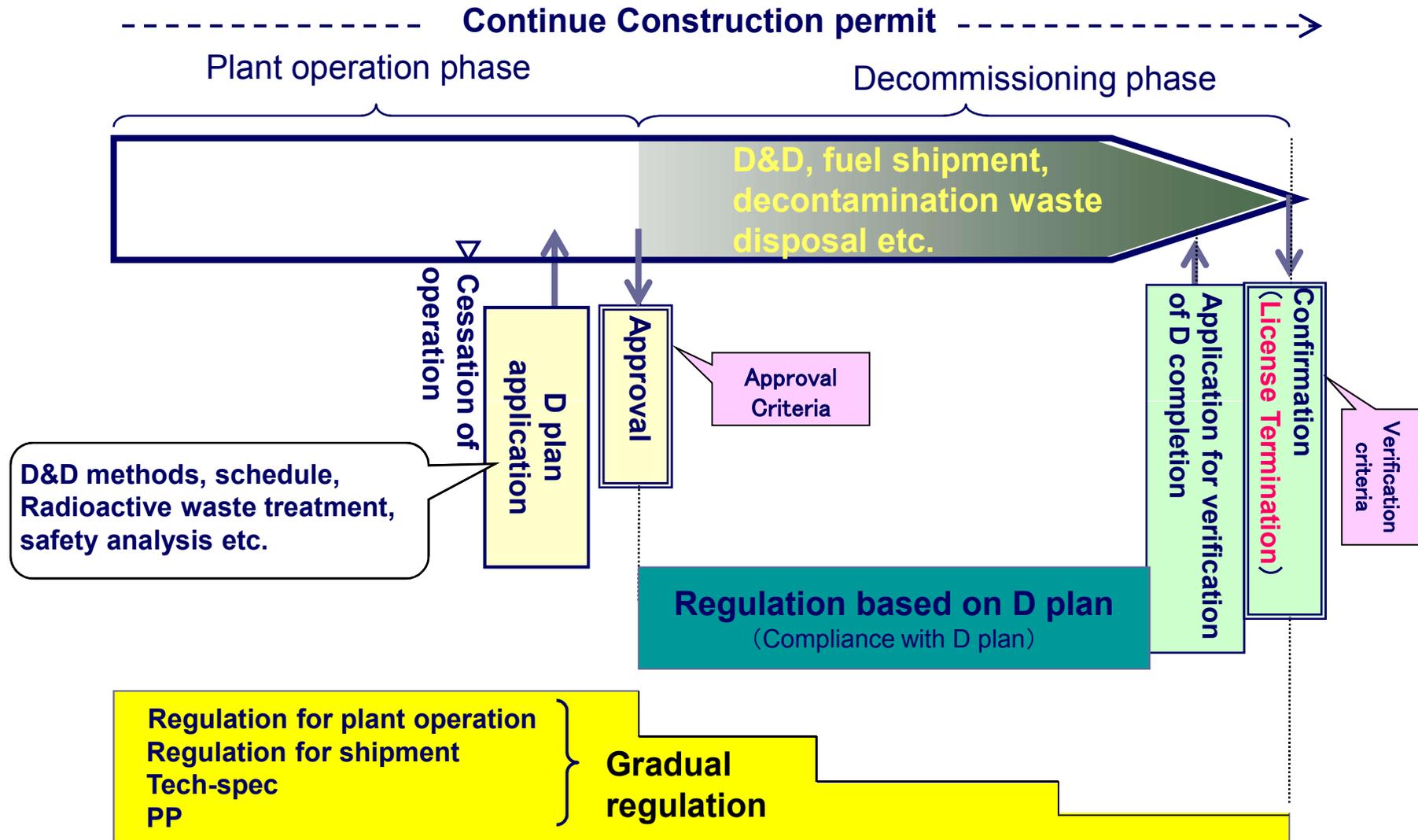
- ① Decommissioning cost is large sum, there is a big delay the timing that required decommissioning cost from electric generating period,
- ② Decommissioning cost is required result of electric generation,
- ③ It is possible to estimate rational decommissioning cost based on decommissioning standard process shown by Advisory Committee for Natural resources and Energy

Decommissioning Allowance system

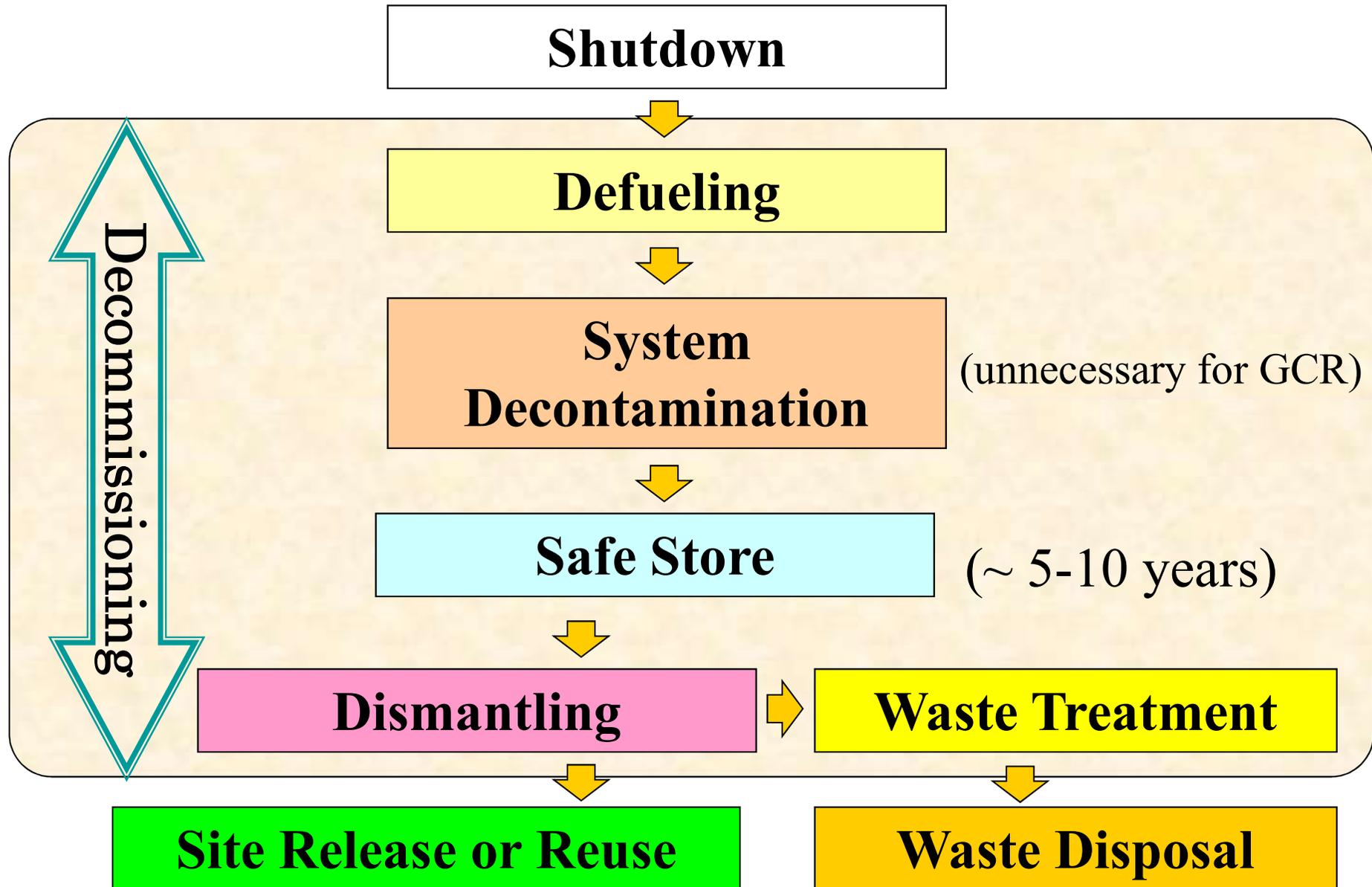


- Estimated total decommissioning cost is 57-77 billion yen (for large scale 110MWe plant)
- Brief assessment based on Linear approximate equation
- Minimum cost because it is duty free
- Directly affect to financial condition of each company because it is internal reserve

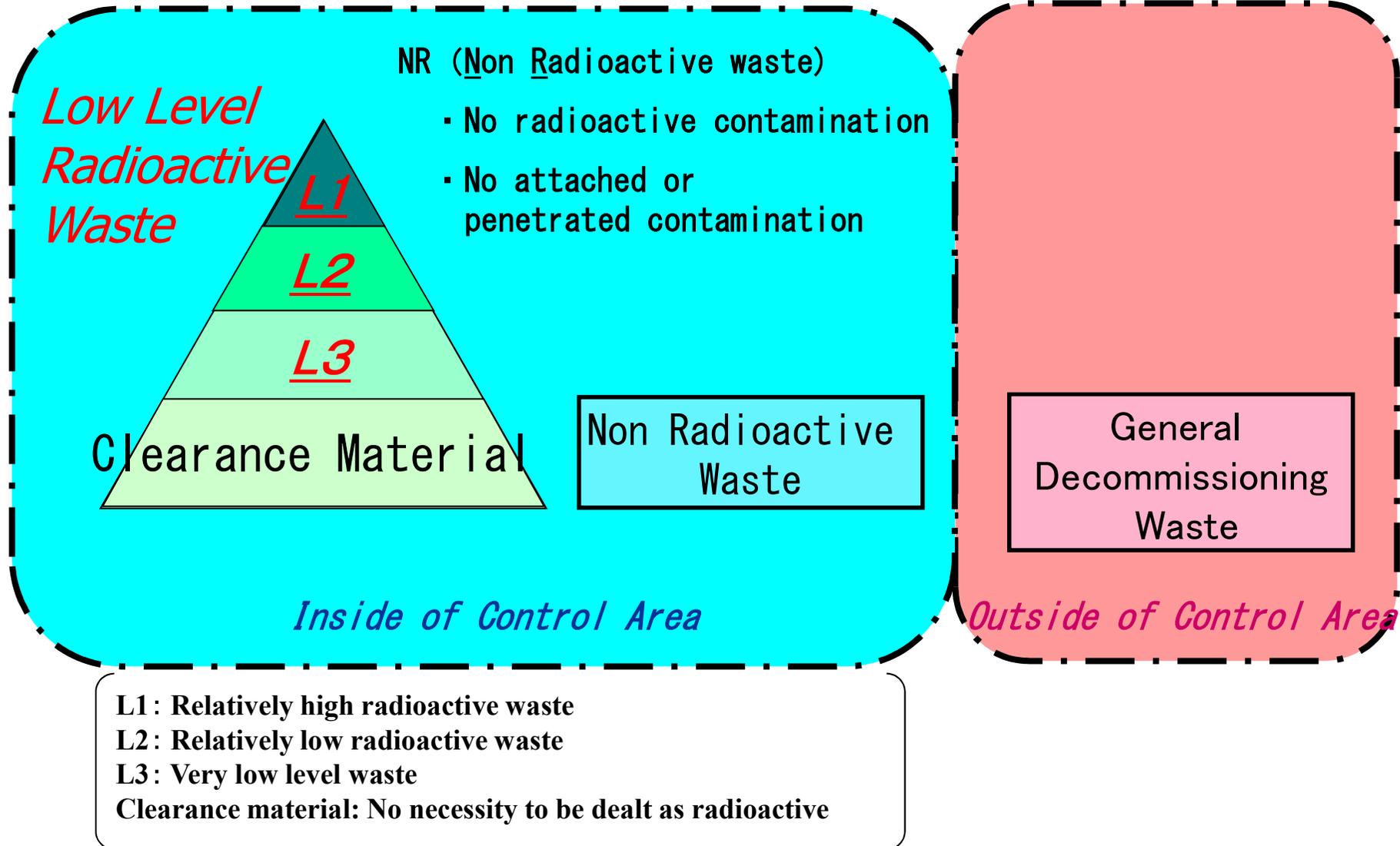
Safety regulation on decommissioning in Japan



Japanese Standard Scenario for Decommissioning of NPPs



Waste arose from decommissioning



Radioactive Waste Disposal Methodology in Japan

Relatively high
radioactive waste

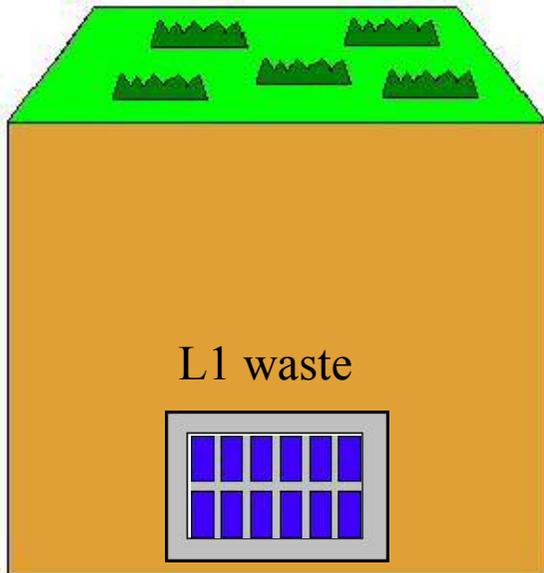
Relatively low
radioactive waste

Very low level waste

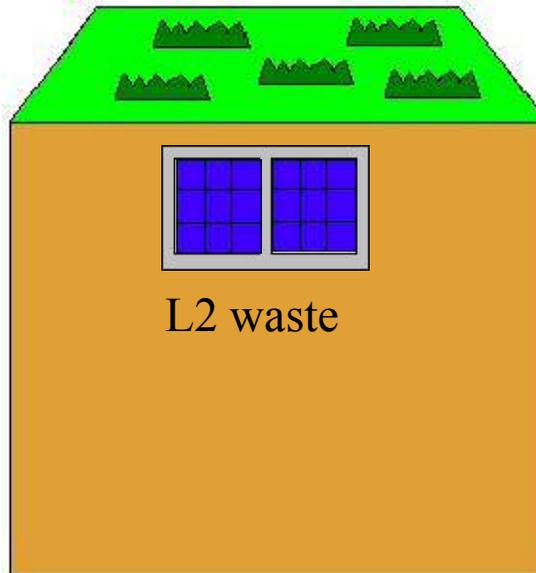
Intermediate depth
disposal with artificial
structure

Sub surface
disposal with
artificial structure

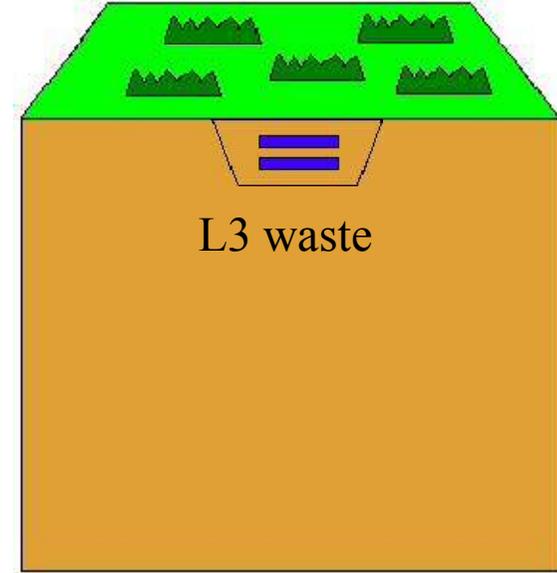
near surface trench
disposal



Institutions are
under consideration



Monitoring
300~400 years

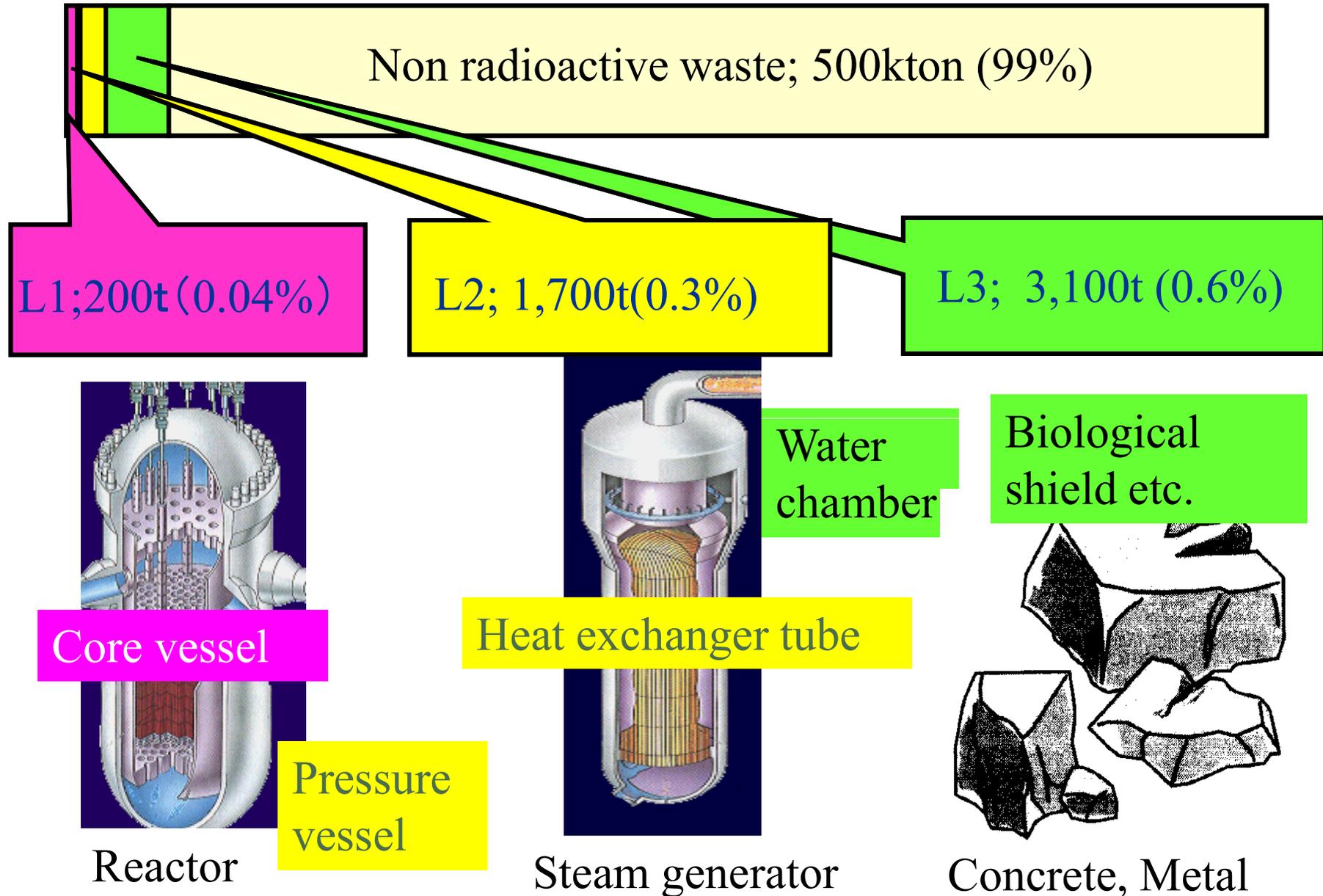


Monitoring
50 years

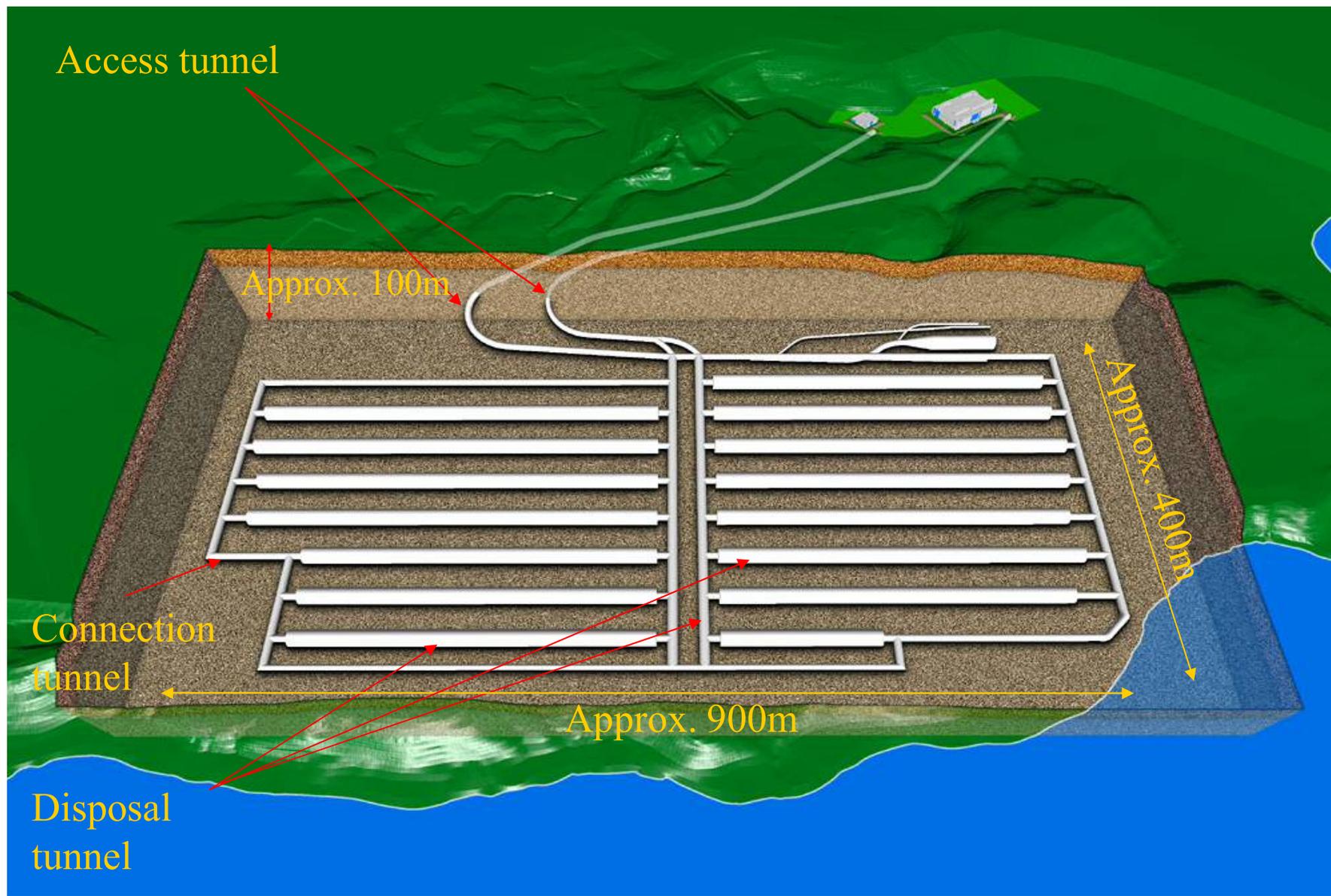
Classification Criteria for LLW Disposal Concept

Nuclide	Bq/kg			
	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	—	—

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



Concept of L1 Waste Disposal Facility



Work Flow of Disposal Facility



① Bird's eye view of the facility



② Putting drums into concrete pit



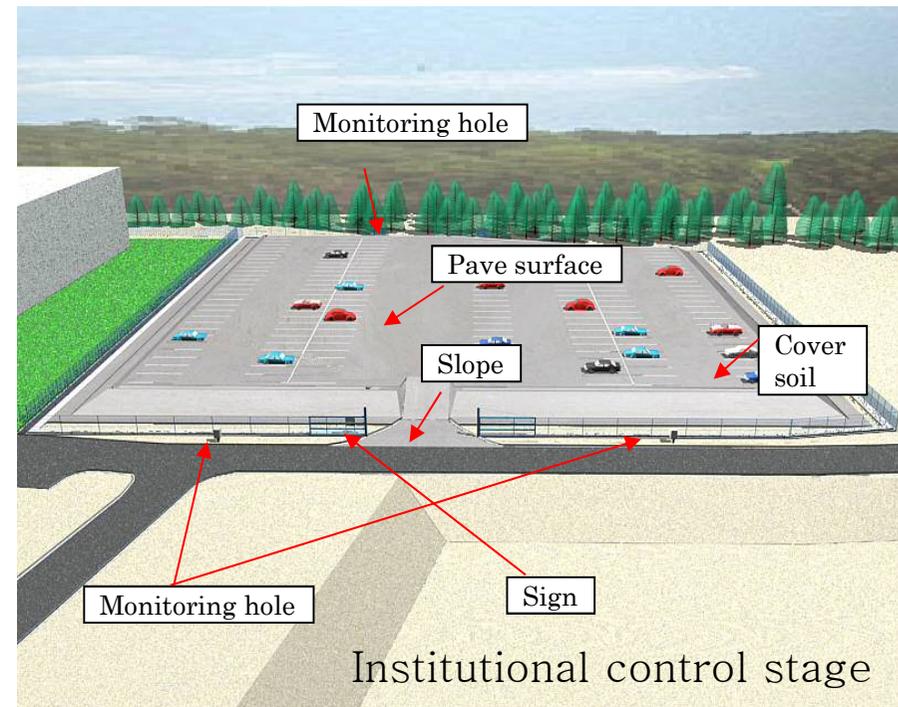
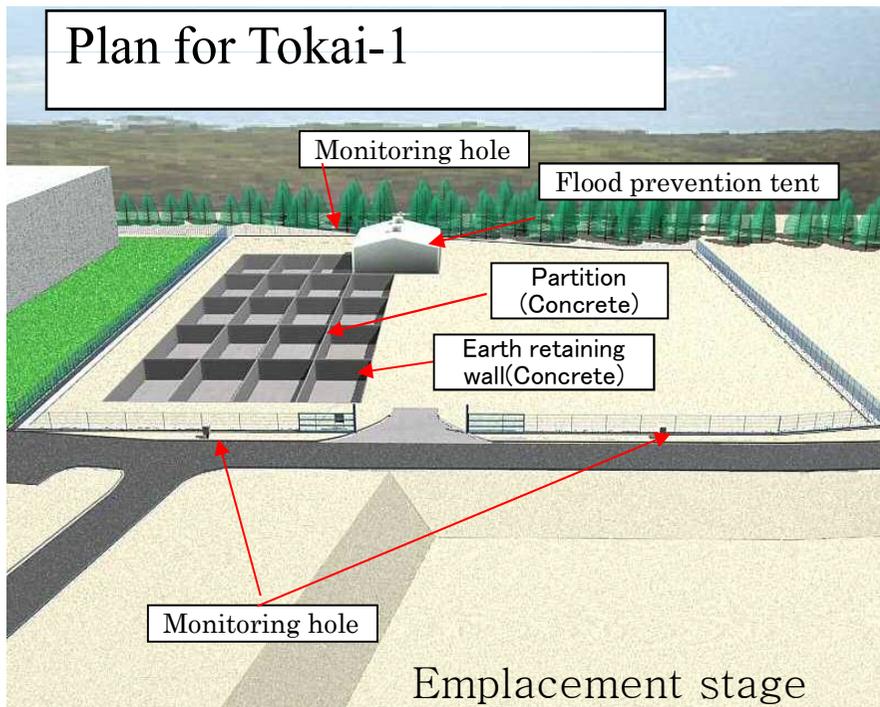
③ Cementation



④ Covering with Concrete

Covering with Soil

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

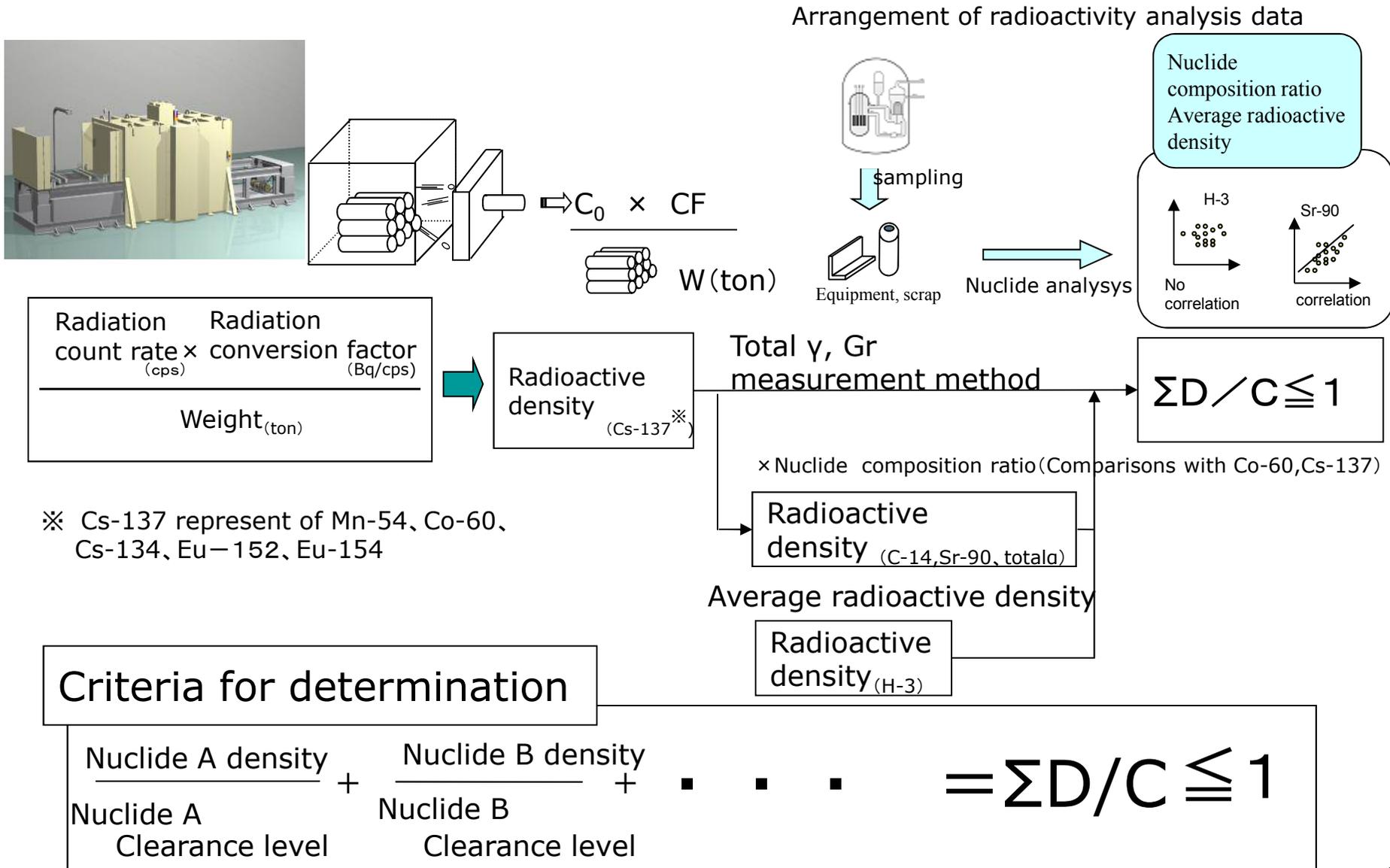


Clearance System in Japan

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 10 μ Sv/y Base
- Clearance level for each Nuclide laid down by Ministerial Ordinance based on IAEA RS-G-1.7

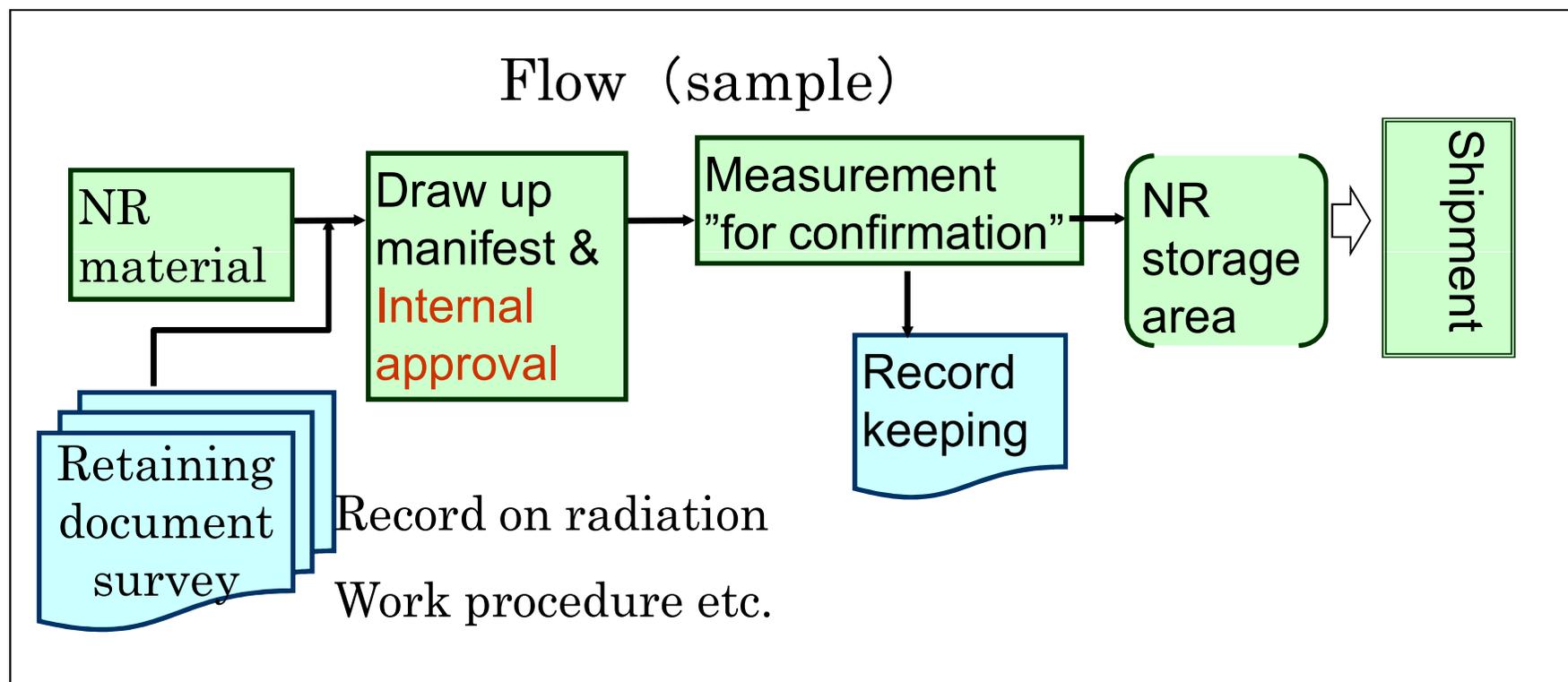
Evaluation and verification procedure for clearance



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

Treatment of Non Radioactive waste (NR)

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



Decommissioning experience in Japan

Tokai-1 NPP

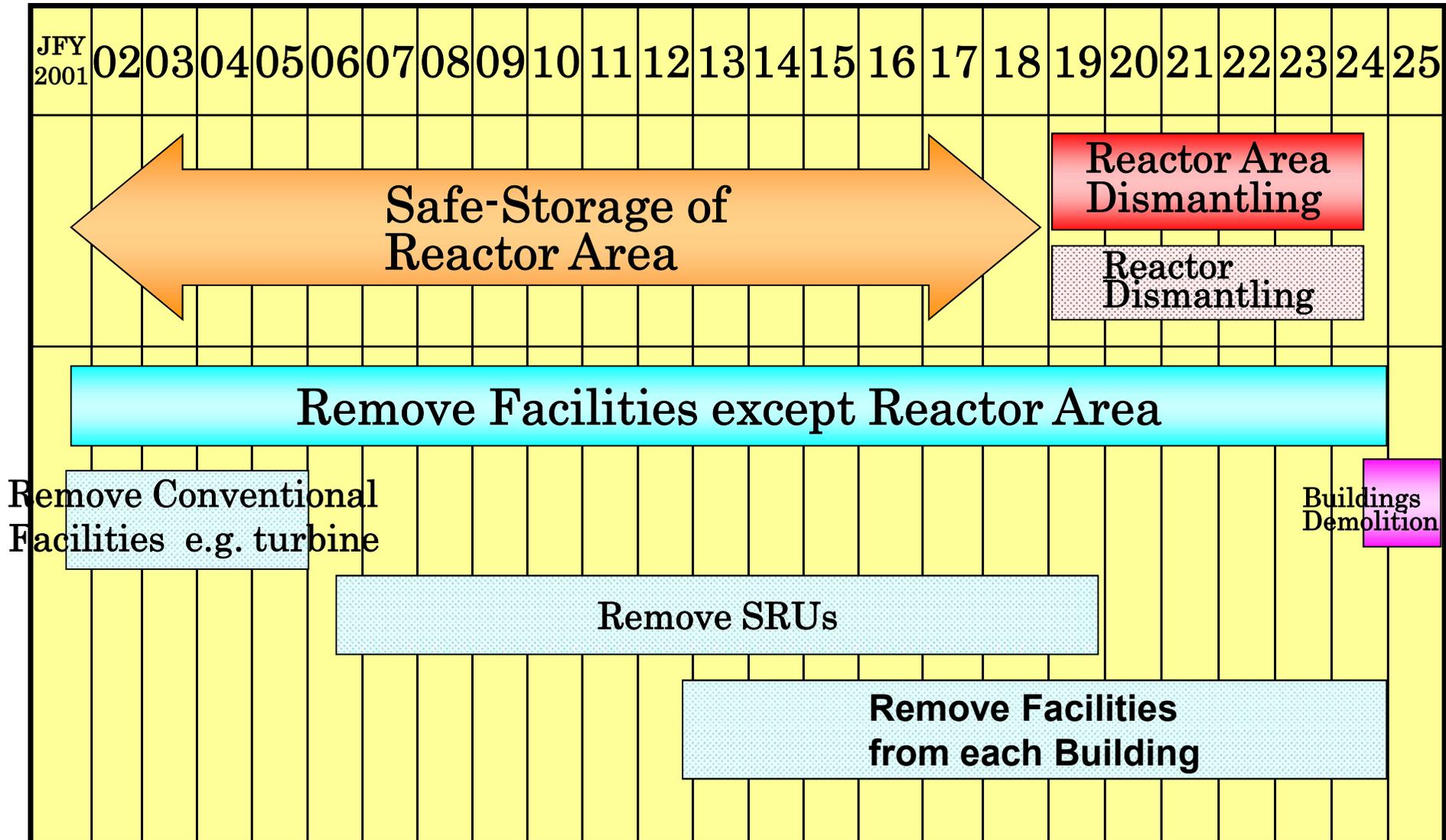
Hamaoka NPP 1&2

Fugen NPP

NPPs under decommissioning in Japan

Plant	Operator	Type	Capacity	Commercial Operation starts	Shutdown Date
Tokai-1	JAPC	GCR	166MW	1966.Jul.25	1998.Mar.31
Hamaoka-1	CHUBU	BWR	540MW	1976.Mar.17	2009.Jan.30
Hamaoka-2	CHUBU	BWR	840MW	1978.Nov.29	2009.Jan.30
Fugen	JAEA	ATR	165MW	1979.Mar.20	2003.Mar.29

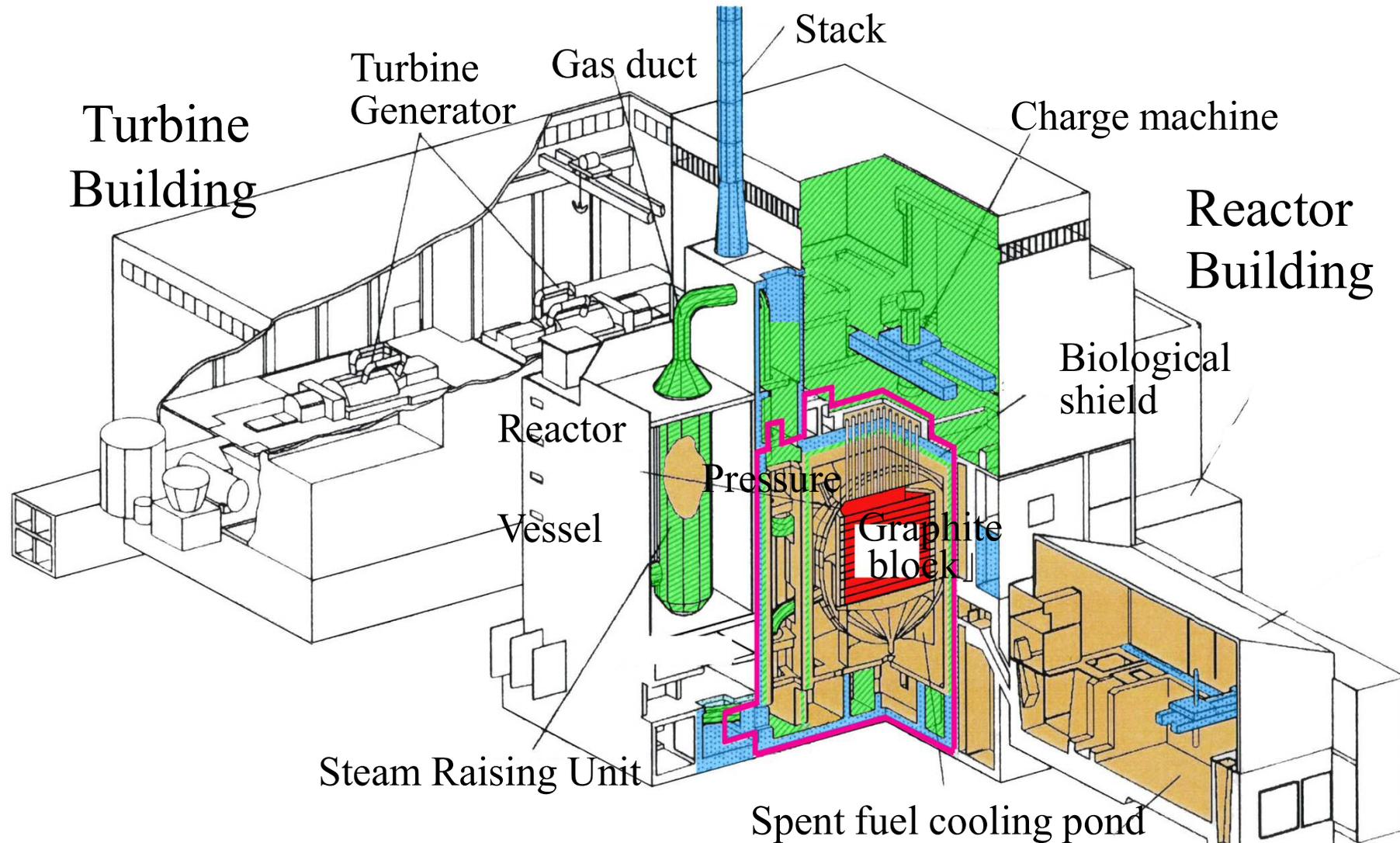
Tokai-1 Decommissioning Project Schedule



Radiological Characterization of Tokai-1

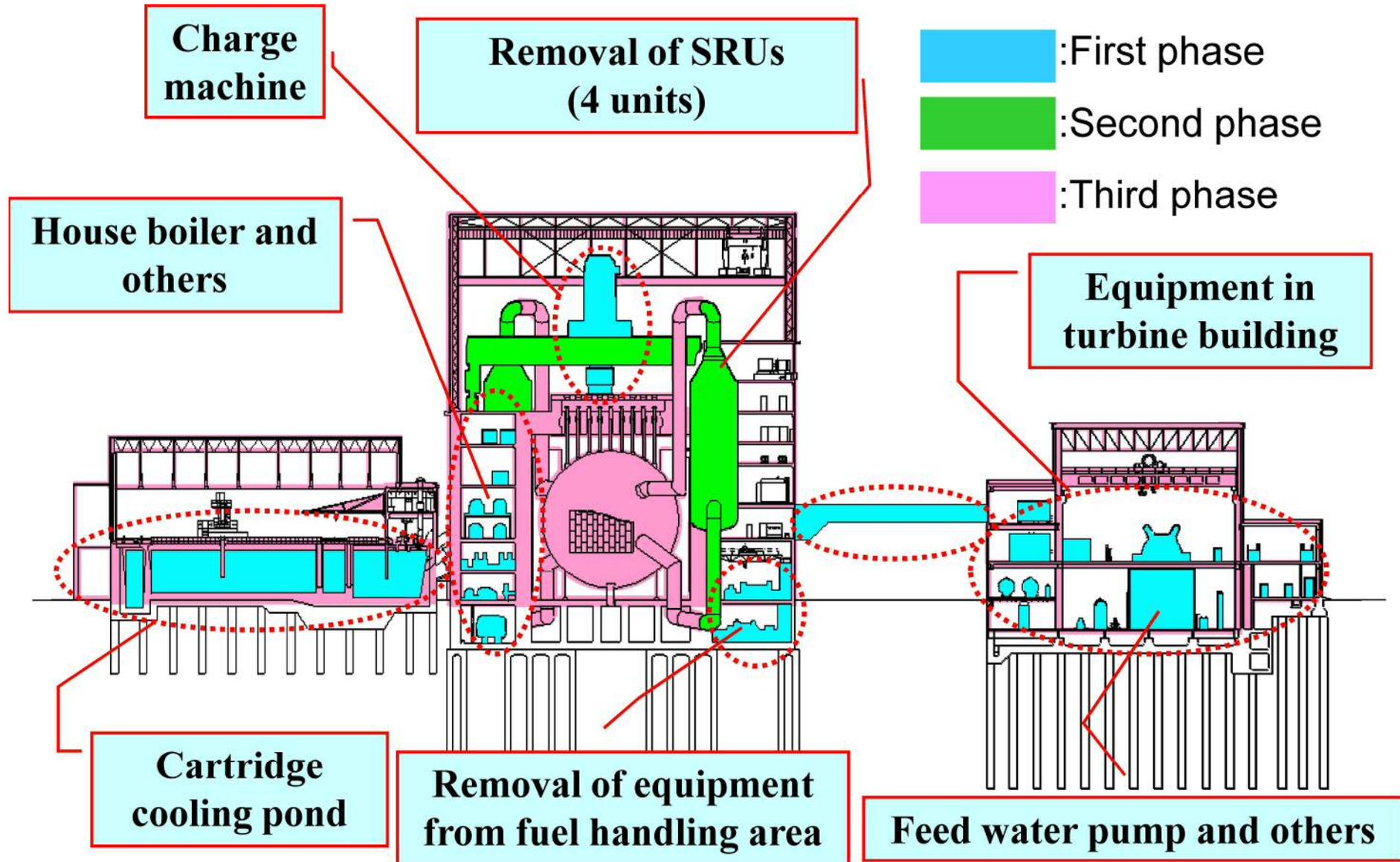
- : Level I
- : Level II
- : Level III
- : Clearance level
- : Non-radioactive

Safe Storage boundary



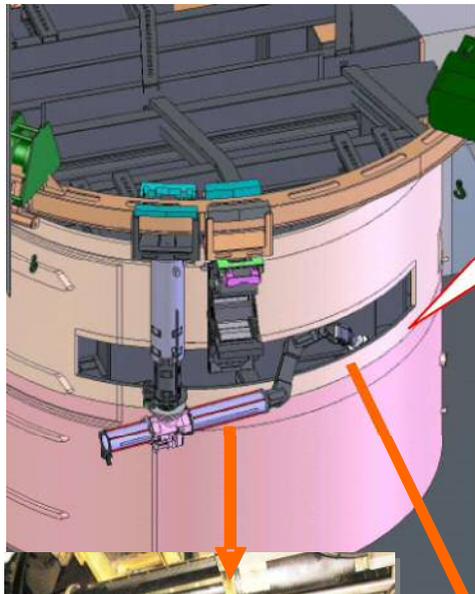
Tokai-1 decommissioning project

Scope to be dismantled for each phase



SRU removal

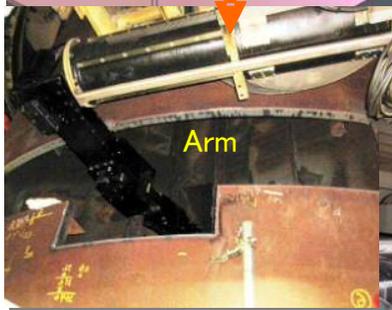
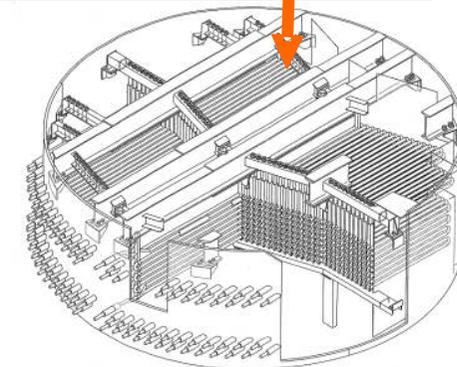
【SRU body segmentation with remote dismantling system】



Open 22 windows on SUR body.
Insert arm of remote dismantling machine and cut internal structure (joint part)



Remote control room



Arm



Cutter
(for internal cutting)

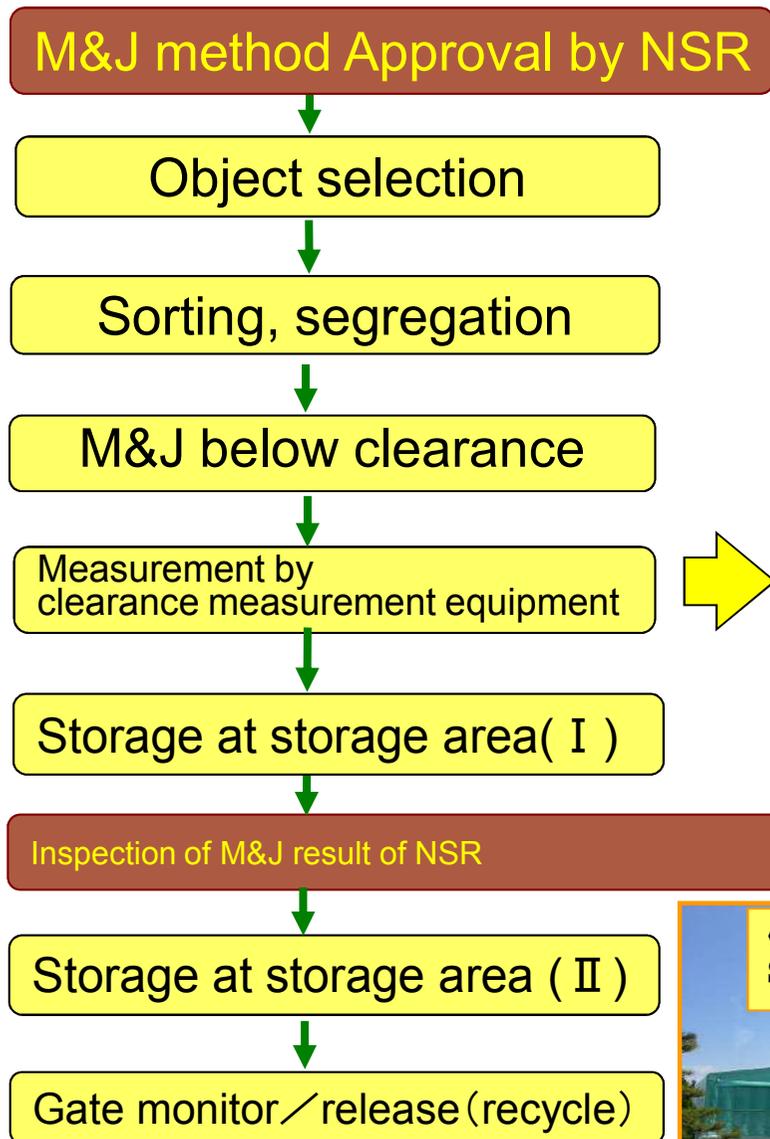


Torch
(for exterior cutting)

Arm and fore end of remote dismantling device

Complicated internal structure
(Hear exchanger tube, Baffle plate, Beam)

Flow for clearance (Current Status)



Clearance measurement equipment



Specification

measurement	Measure 6 sides of steel box
container size	1350W × 1350L × 1065H
maximum volume	1.5m ³
maximum weight	1.5ton
measurement time	12min/box (Net measurement time: 240sec)

《 Storage area(I) 》
Storage until inspection by NSR



《 Storage area(II) 》
Storage until release to manufacture



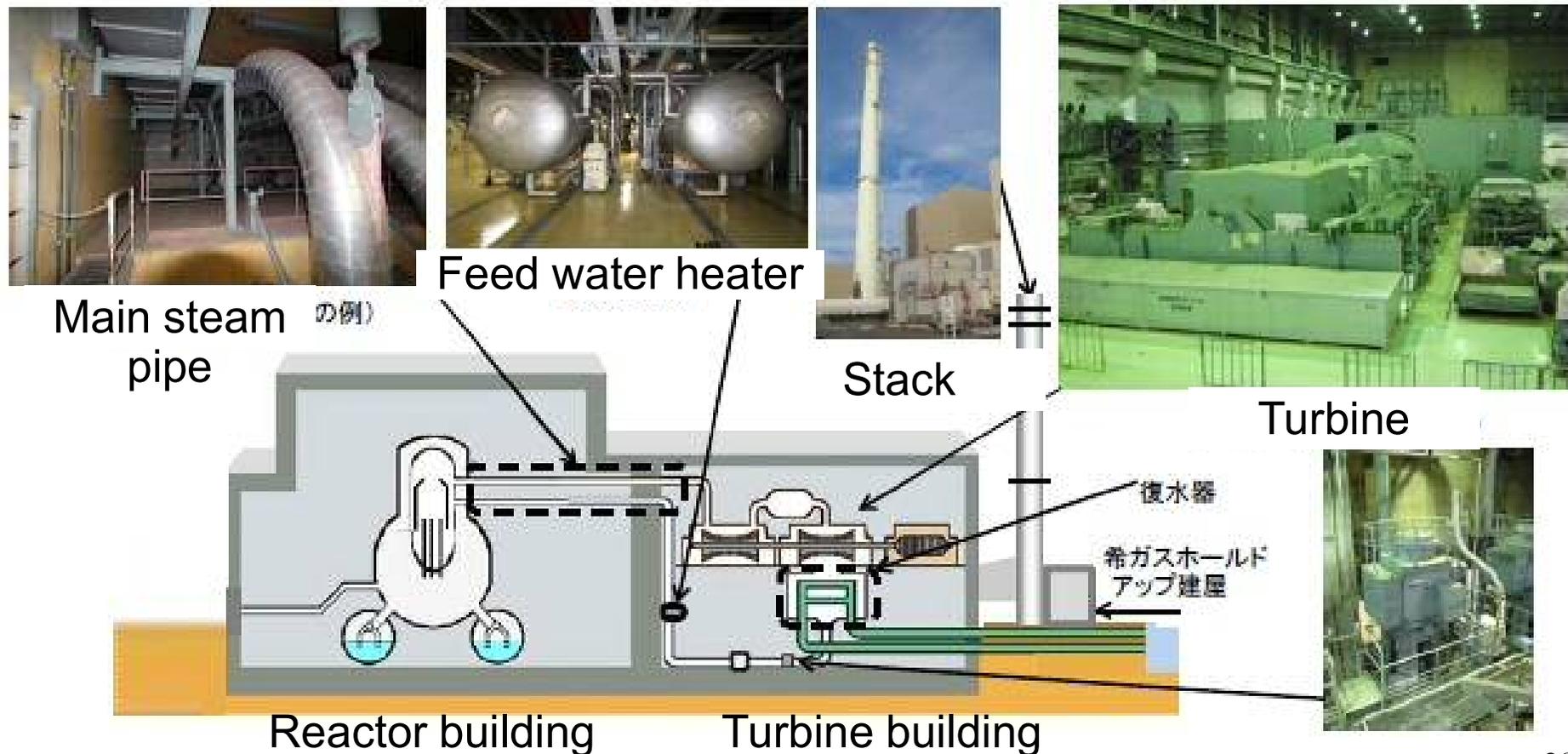
Hamaoka Unit -1,2 Decommissioning Project Schedule

2009-2014	2015-2022	2023-2029	2030-2036
Stage 1 Dismantlement preparation period	Stage 2 Reactor zone peripheral facilities dismantlement and removal period	Stage 3 Reactor zone dismantlement and removal period	Stage 4 Building dismantlement and removal period
Fuel Shipment			
	System decontamination		
	Reactor zone peripheral facilities dismantlement		
		Reactor zone dismantlement	Building dismantlement
Radioactive waste processing and disposal			
Dismantling and removal of uncontaminated facilities and equipment located outside RCA			

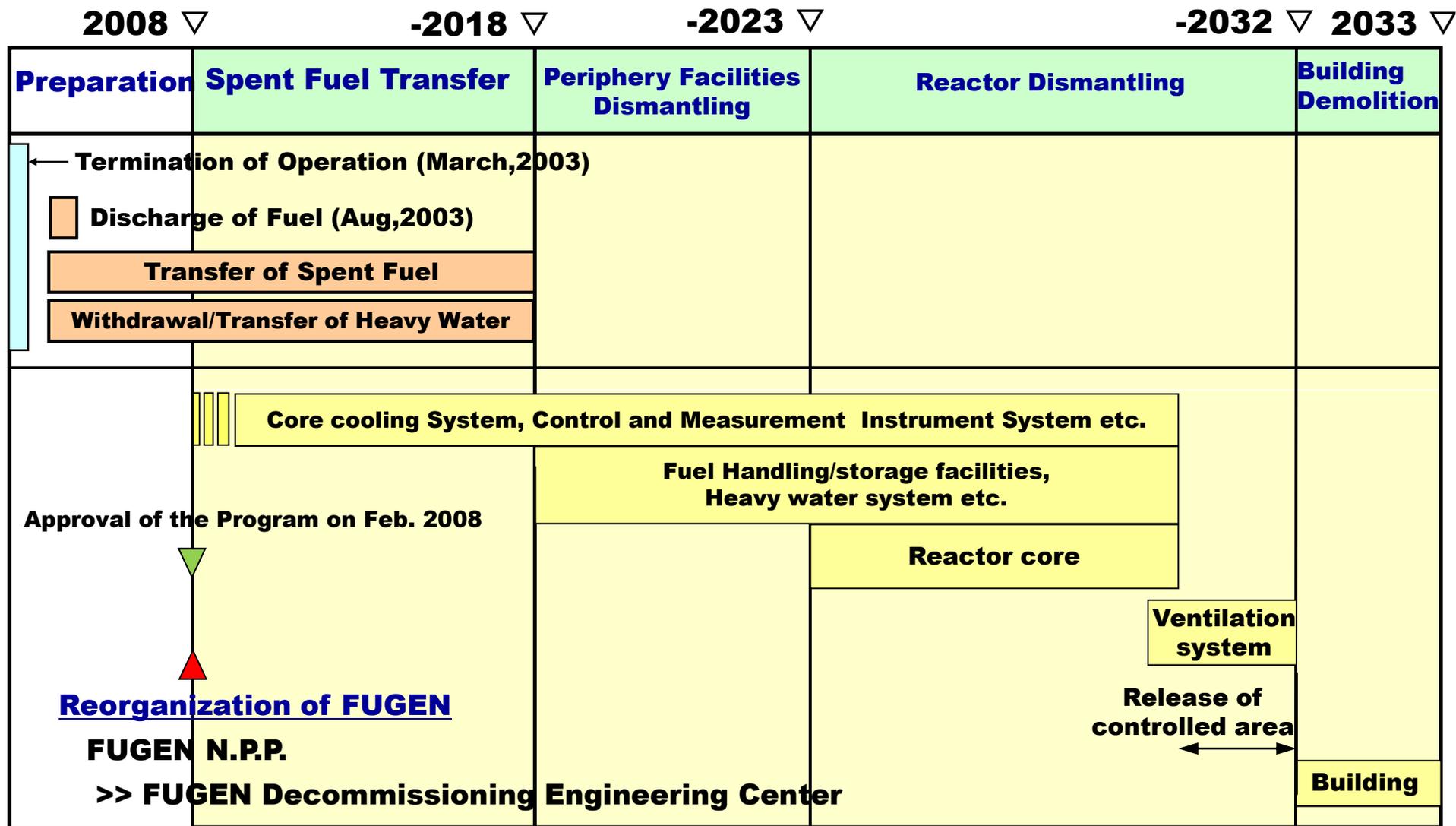
Hamaoka Unit-1,2 Decommissioning Project

All fuel (both of spent fuel and new fuel) elements were shipped out of the Hamaoka-1,2 by March 2015.

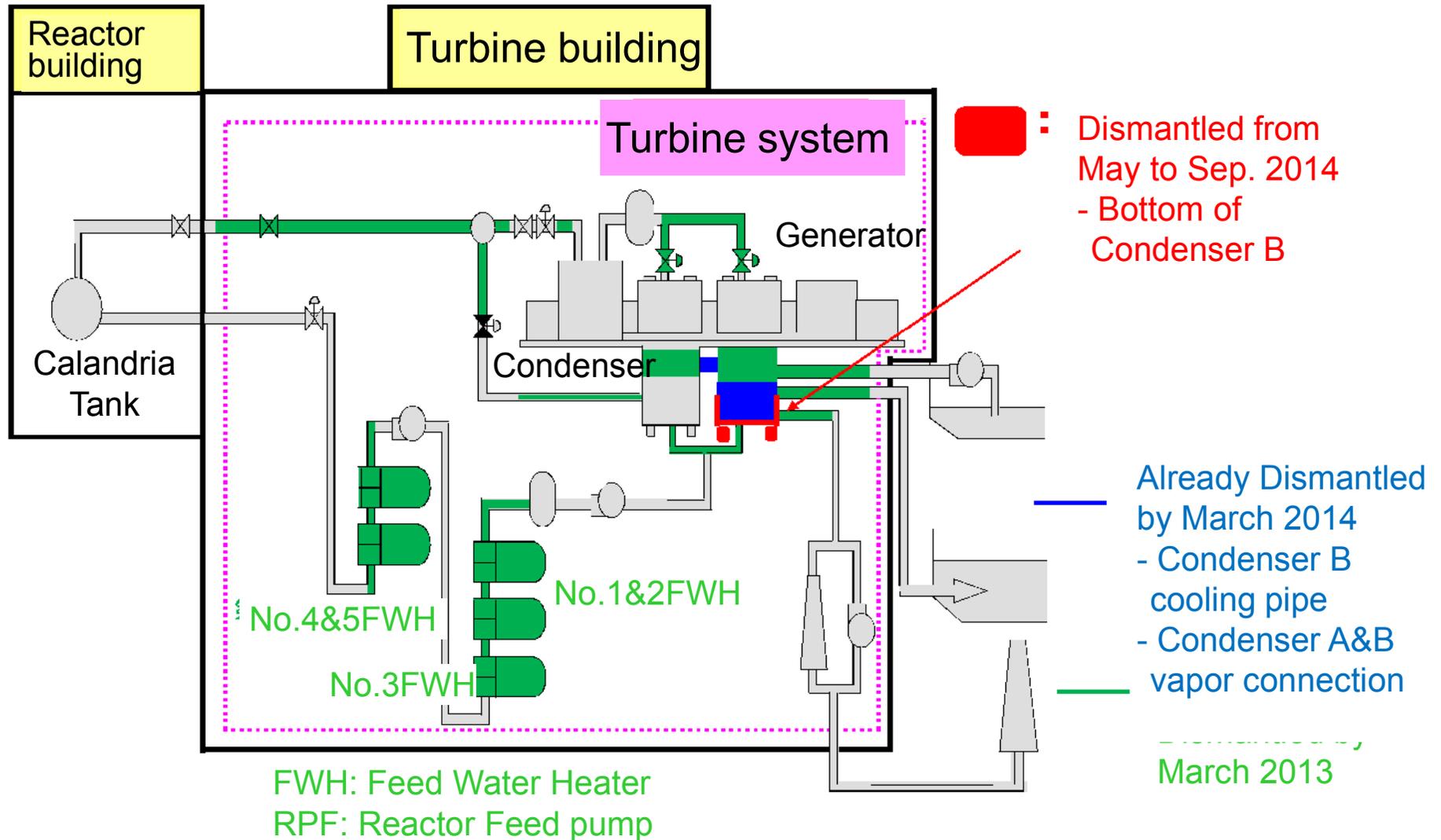
From April 2015, stage 2 is started.



Basic plan of Fugen decommissioning



Fugen Dismantling progress



Future Plan

Five NPPs to be shutdown

Plant	Operator	Type	Capacity	Commercial Operation starts	Scheduled date to be shutdown
Tsuruga-1	JAPC	BWR	357MW	1970.Mar.14	2015.Apr.27
Mihama-1	KANSAI	PWR	340MW	1970.Nov.28	2015.Apr.27
Mihama-2	KANSAI	PWR	500MW	1972.Jul.25	2015.Apr.27
Shimane-1	CHUGOKU	BWR	460MW	1974.Mar.29	2015.Apr.30
Genkai-1	KYUSHU	PWR	559MW	1975.Oct.15	2015.Apr.27

Electric Power Companies decided to shutdown Five NPPs on March 17, 2015

Tsuruga Nuclear Power Station Unit -1



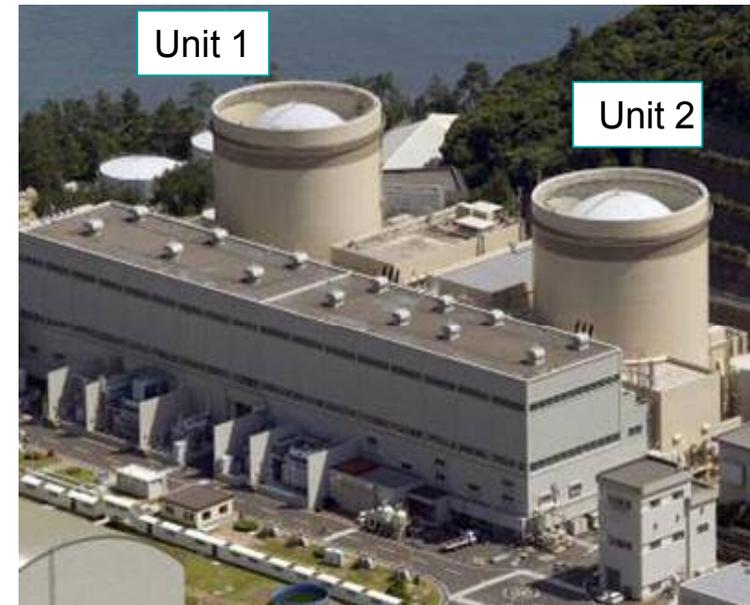
**Japan's first
LWR(BWR)**

- **Tsuruga Power Station Unit 1 is Japan's first nuclear power plant with a light water reactor. It is the most common reactor type in Japan.**
- Thermal output: 1,064,000kW
- Electric output: 357,000kW
- Start of commercial operation: March 14, 1970
- Total electric energy generated: 84.7billion kWh
- Days generate electricity: 10,365 days
- Average Capacity Factor : 60.1%

Mihama Nuclear Power Station Unit -1 &2

- ◆Mihama Unit-1 (PWR)
 - Electric output: 340,000kW
 - Start of commercial operation
: Nov. 1970
 - Long term shutdown since Nov. 2010

 - First PWR in Japan
- ◆Mihama Unit-2 (PWR)
 - Electric output : 500,000kW
 - Start of commercial operation
: Jul. 1972
 - Long term shutdown since Nov. 2011



Shimane Nuclear Power Station Unit -1

- ◆ Shimane Unit-1 (BWR)
 - Electric output: 460,000kW
 - Start of commercial operation: Mar. 1974
 - Total electric energy generated: 106.2Billion kWh
 - Average Capacity Factor: 73.1% (Average until Mar. 2010)

Shimane Unit-1 is
fifth NPP in Japan.
First domestically
-produced NPP



Genkai Nuclear Power Station Unit-1

◆ Genkai Unit-1 (PWR)

Electric output: 559,000kW

Start of commercial operation: Oct. 1975

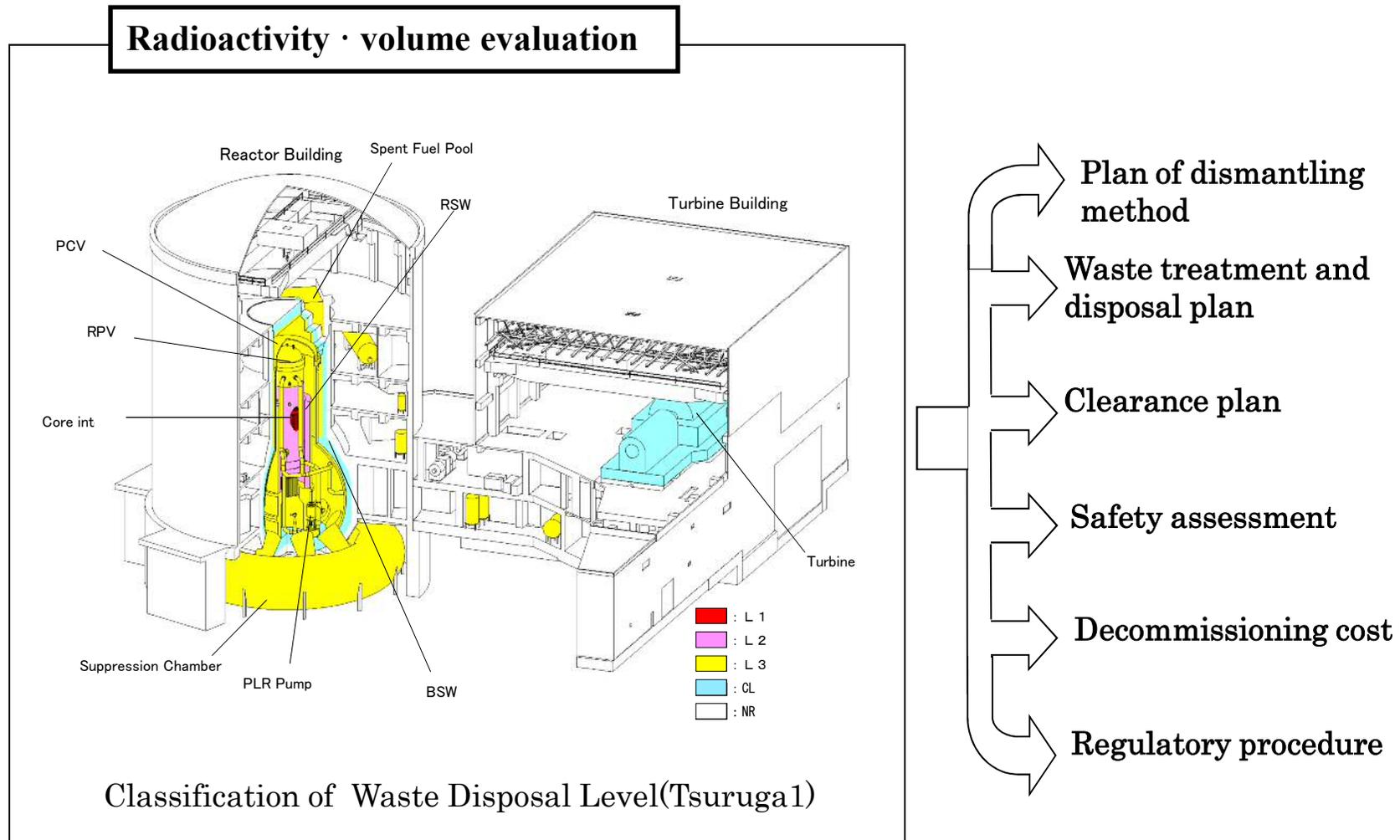
Total electric energy generated: 132.7Billion kWh

Average Capacity Factor: 74.3% (Average until Mar. 2012)

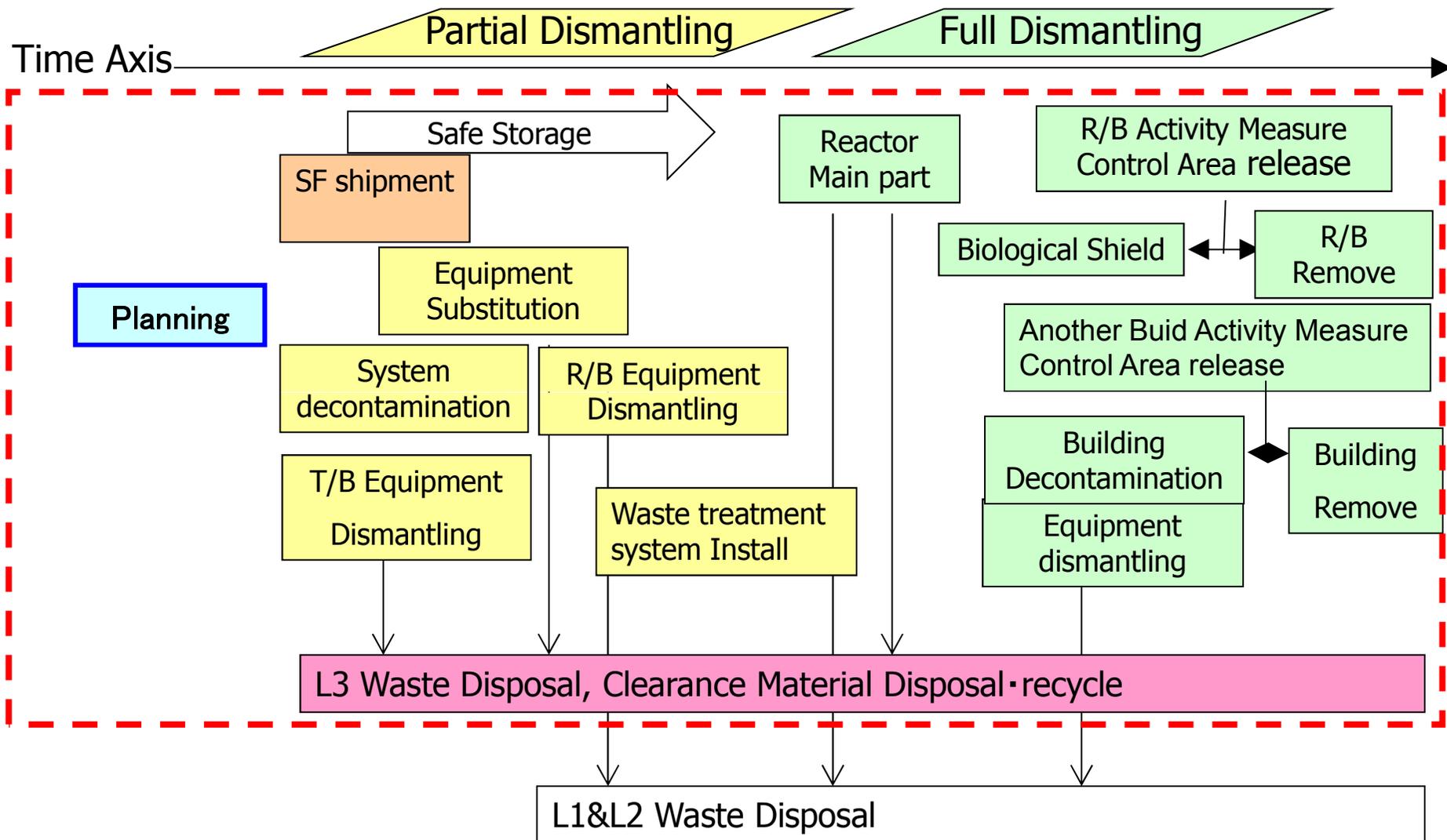


Summary of Radiological Characterization

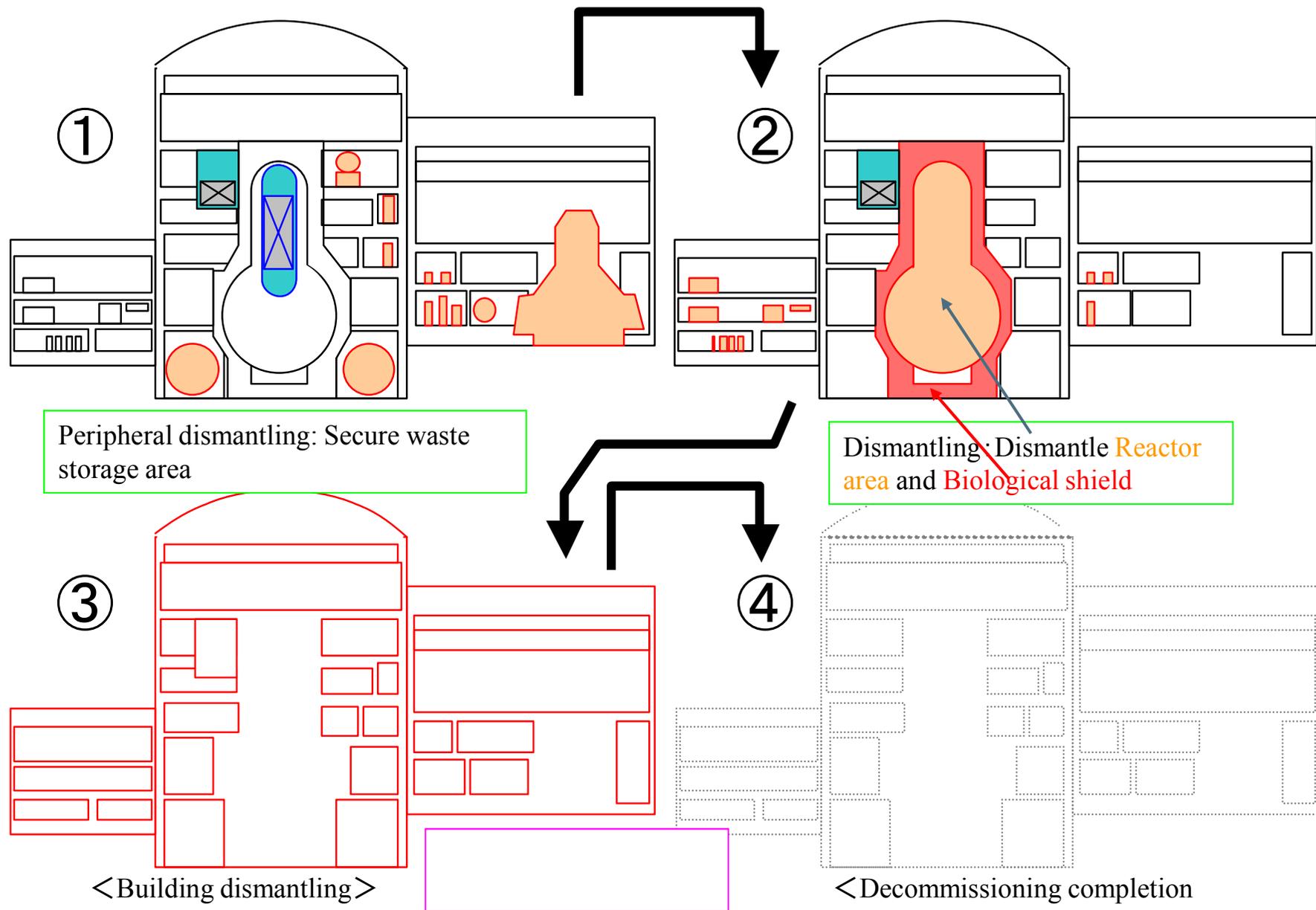
Radioactivity inventory evaluation is essential for the decommissioning preparation work. It is utilized in various studies of decommissioning.



Decommissioning Work Flow for LWR

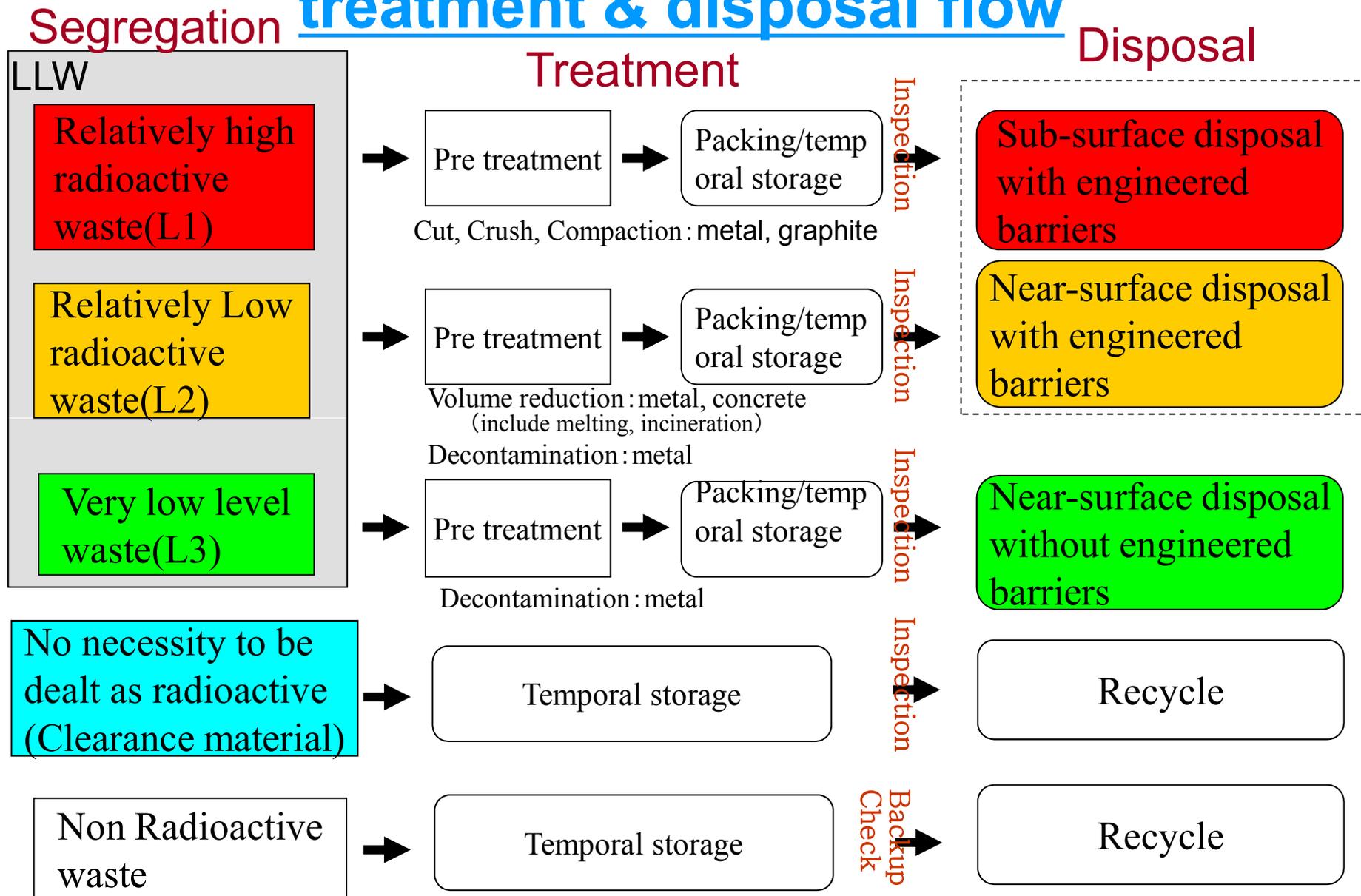


Plant dismantling flow (example)



Decommissioning solid waste

treatment & disposal flow



Tasks to be solved in Japanese decommissioning

- Secure facility for SF shipment and waste disposal facility
- Understanding from Stakeholder(local government and Regulatory Body etc)