Decommissioning Plan of JMTR

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Contents

1. Introduction

1. Introduction

<Background to decision of decommissioning of the JMTR>

Date	Item
Aug. 2006	JMTR was shutdown temporary after 165cy operation
Dec. 2006	Refurbishment for re-start of JMTR was decided. The period of refurbishment working was from FY 2007 to FY 2010.
Mar. 2011	The Great East Japan Earthquake
Dec. 2013	New regulatory requirements were established.
Mar. 2014	Safety review of JMTR corresponding to the new regulatory requirements was submitted to Nuclear Regulation Authority (NRA).
Jan. 2016	The technical meeting, which include the external specialists, was established to evaluate the seismic reinforced of JMTR.
Aug. 2016	The technical meeting concluded that additional large-scale refurbishment for the seismic of JMTR is necessary.
Apr. 2017	Medium-to-long term plan in JAEA facilities was decided (Decision of decommissioning of JMTR).
Sep. 2019	Decommissioning plan was submitted to NRA.
Mar. 2021	Decommissioning plan was approved by NRA.

2. General description of the JMTR

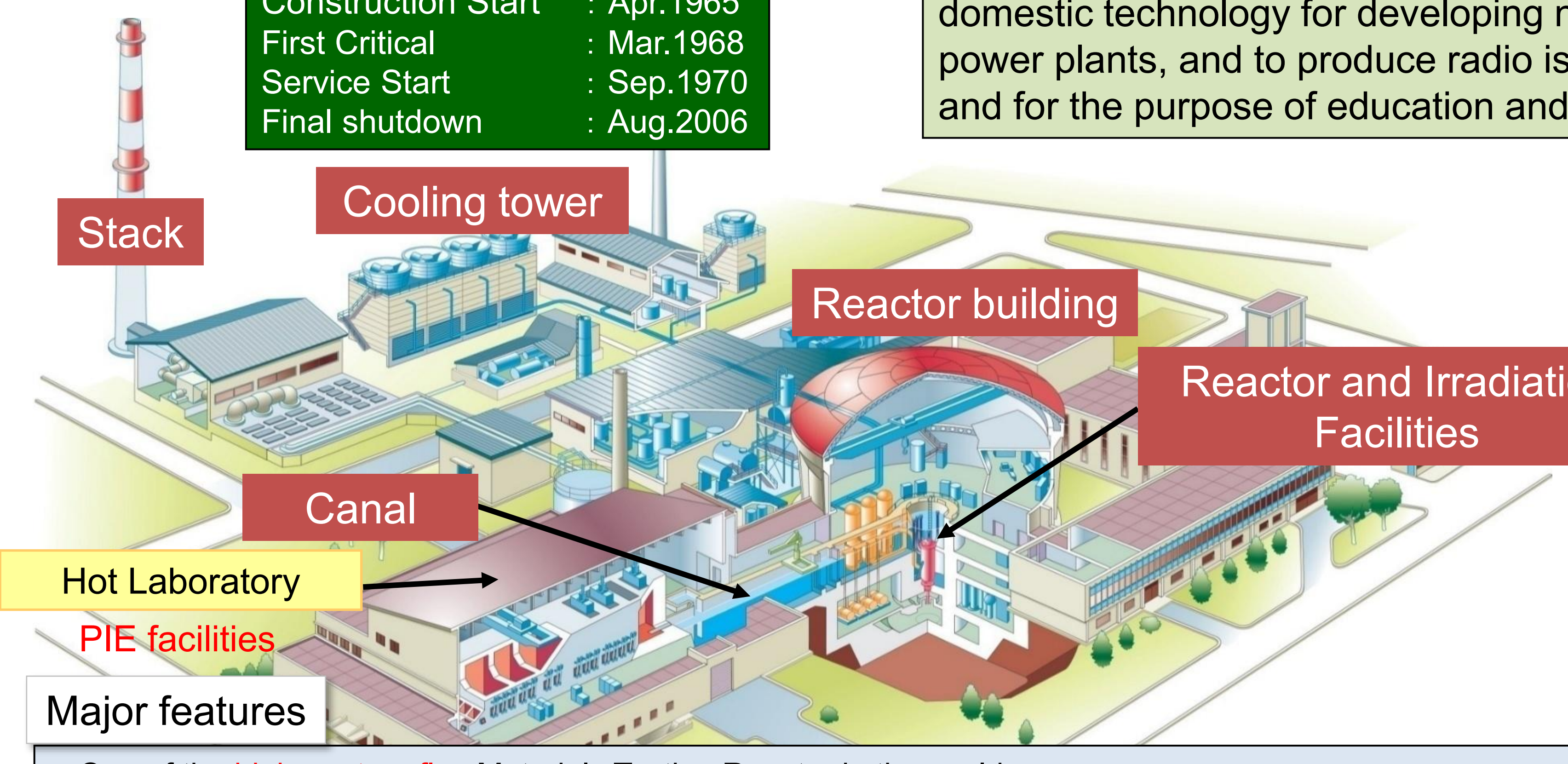
2. General description of the JMTR (1/2)

JMTR : Japan Materials Testing Reactor

Construction Start	:	Apr.1965
First Critical	:	Mar.1968
Service Start	:	Sep.1970
Final shutdown	:	Aug.2006

Purpose

JMTR was constructed to perform irradiation tests for LWR fuels and materials to establish domestic technology for developing nuclear power plants, and to produce radio isotopes, and for the purpose of education and training.



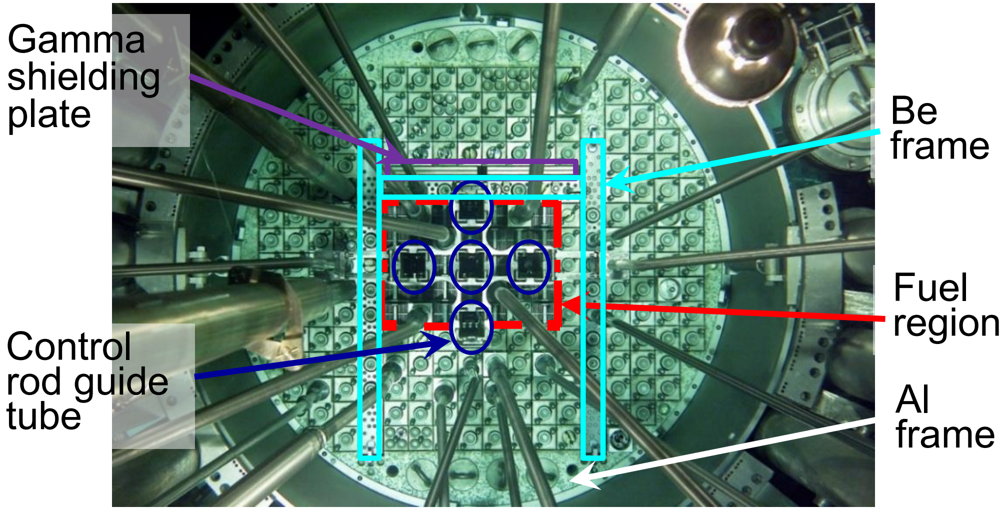
Major features

- One of the high neutron flux Materials Testing Reactor in the world
- Large irradiation area in the core region for various irradiation tests
- Flexible reactor core configuration allows various irradiation facilities to be installed to the reactor core
- The reactor building is connected to the hot laboratory by a canal for PIEs for fuels and materials.

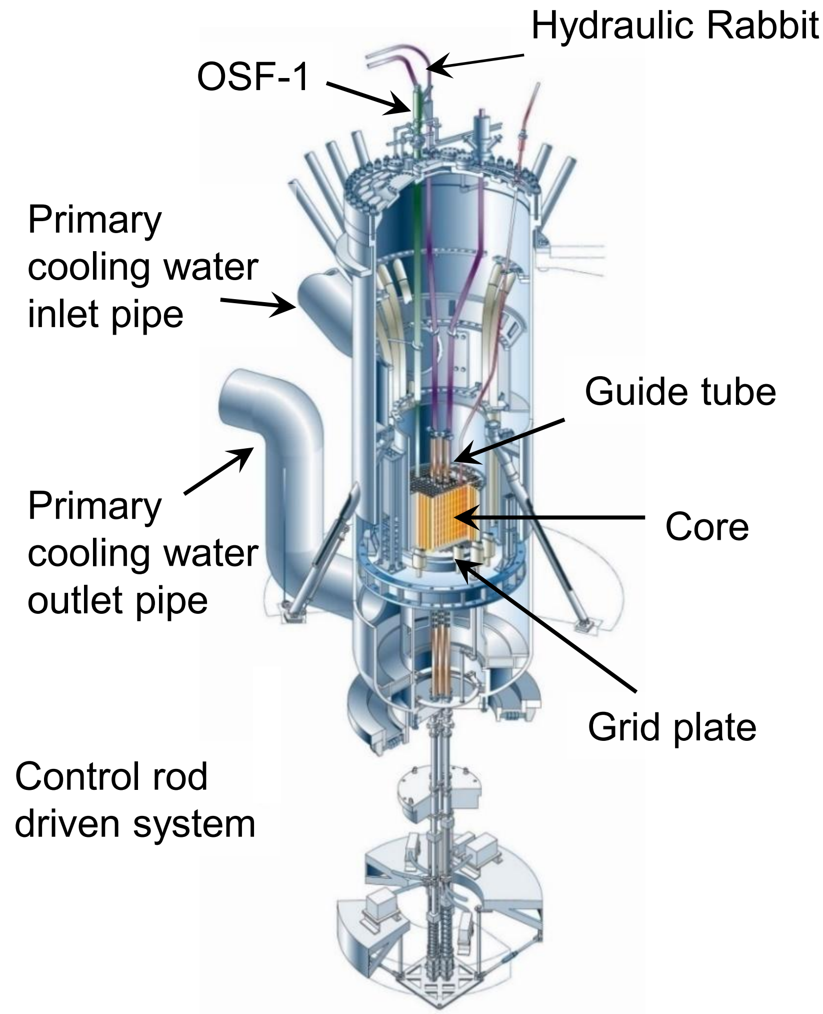
2. General description of the JMTR (2/2)

Specifications of JMTR

Reactor type		Light water moderated and cooled Tank type
Thermal power		50 MW
Fuel element	Fuel meat	U_3Si_2-Al dispersion alloy
	^{235}U enrichment	20 wt%
Control rod		Hf square tube with fuel follower
Flux (Max.)	Fast neutron	4 x 10^{18} n/m^2･s
	Thermal neutron	4 x 10^{18} n/m^2･s
Primary Coolant	Flow rate	6000 m^3/h
	Pressure	1.5 MPa
	Temperature	50℃



Reactor core



Cut view of RPV (Reactor pressure vessel)

3. Decommissioning plan and current status

3. Decommissioning plan and current status

● It is necessary to get the approval of decommissioning plan from the NRA for decommissioning research reactors in Japan.

● Decommissioning plan includes several contents

- Decommissioning schedule
- Implementation plan
- Evaluation of radioactivity
- Evaluation of total amount of waste
- Etc.

● We have submitted the decommissioning plan of JMTR to the NRA in September 2019 and have received approval of it in March 2021.

3.1 Decommissioning schedule

Decommissioning of the JMTR will be carried out dividing into 4 stages and is scheduled to be completed by FY 2039.

	FY2021～FY2027 First stage	FY2028～FY2031 Second stage	FY2032～FY2035 Third stage	FY2036～FY2039 Fourth stage
Shutdown of reactor function				
Carrying out fuel elements -Transfer of spent fuel -Transfer of unused fresh fuel				
Dismantlement and removal of equipment other than equipment to be maintained -Outside radiation controlled areas -Within radiation controlled area				
Dismantlement and removal of reactor components peripheral equipment				
Dismantlement and removal of reactor components				
Release of controlled area				
Evaluation of residual radioactivity				
Removal of contamination from nuclear fuel materials, etc.				
Treatment and disposal of radioactive waste				

3.2 Implementation plan of first stage

Implementation plan was made with a focus on the first stage of decommissioning plan of the JMTR. The following four things will be implemented.

【Shutdown of reactor function】

Control rods and the electric power cables for control rod driven system will be removed to shutdown the reactor function. Moreover, it must also be impossible to reload the fuel.

【Carrying out fuel elements】

Spent fuels will be carried out from the JMTR. The function of fuel storage facilities are maintained to store fuel elements (unused and spent) safely until all fuel elements are transferred out of JMTR.

【Dismantlement and removal of equipment】

Non-contaminated equipment outside of radiation controlled area will be dismantled and removed without affecting safety structures and equipment.

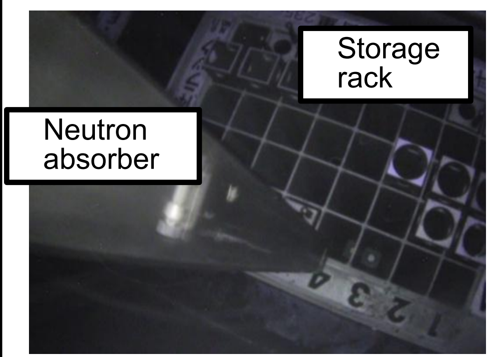
【Evaluation of residual radioactivity】

Residual radioactivity will be evaluated properly. (enough decay time has passed. Final operation finished in Aug. 2006.)

3.3 Shutdown of reactor function

Control rods consisting of the neutron absorber, fuel follower and shock section, were removed from the reactor core and the electric power cables for the CRDS(Control Rod Driven System) were removed to shutdown of reactor function in Nov.2021

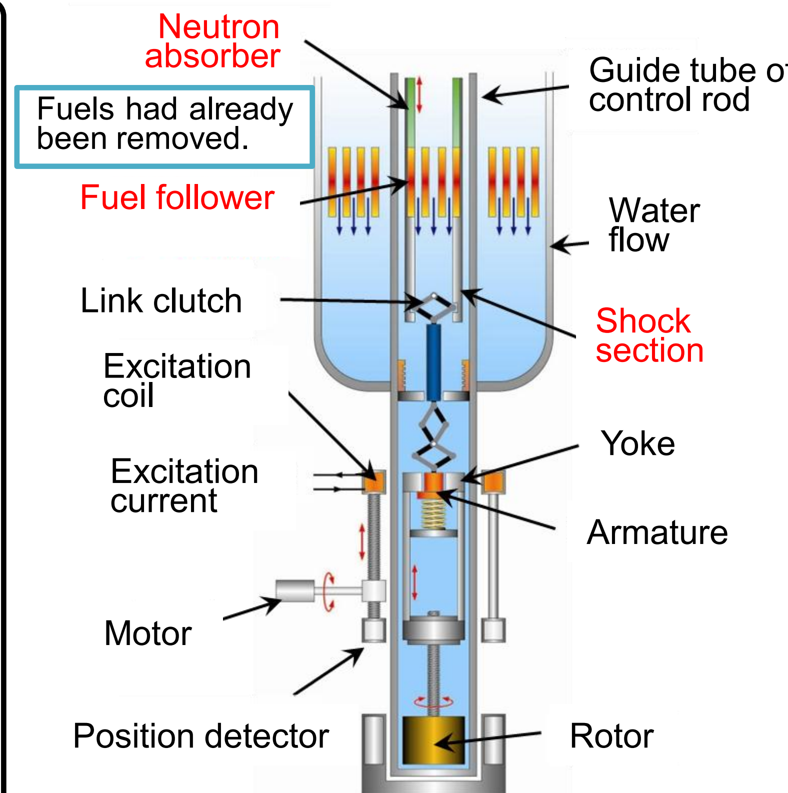
Storage work after removal of control rods



Storage rack and control rod

DC power panel for CRDS

Disconnecting power cable



Schematic diagram of Control rod

3.4 Carrying out fuel

Quantity of fuels

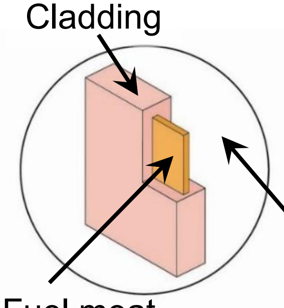
Fuel type		Quantity	
		Dec. 2020	Jan. 2025
Spent fuel	JMTR	507	297
	JMTRC*1	32	0
Unused fuel		214	214

*1: JMTRC is a critical experimental facility for JMTR. JMTRC has already been decommissioned in 2003.

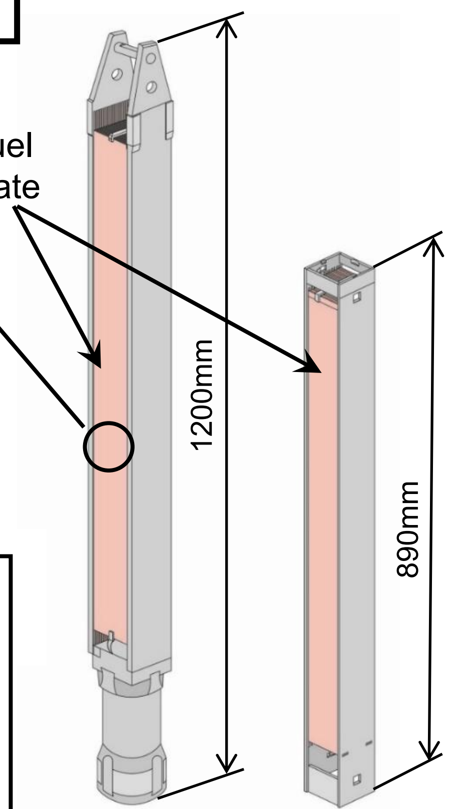
Spent fuels will be transported to the US DOE by March 2028.
The unused fuel elements will be transported to licensed domestic or foreign operators by March 2036.

The transportation of spent fuels has been carried out three times. Two more transportation of spent fuels are planed.

Structure of fuel



Structure of fuel plate



Fuel element

Fuel follower*1

Main Specifications

Size (mm)
- Fuel element: 76x76x1200
- Fuel Follower: 64x64x890

Number of fuel plate
- Fuel element:19
- Fuel Follower:16

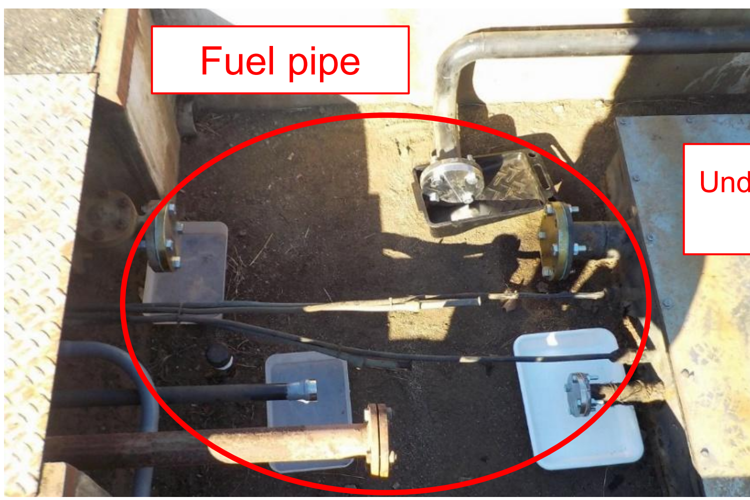
*1: Fuel follower is a part of the control rod.

3.5 Dismantlement and removal of equipment

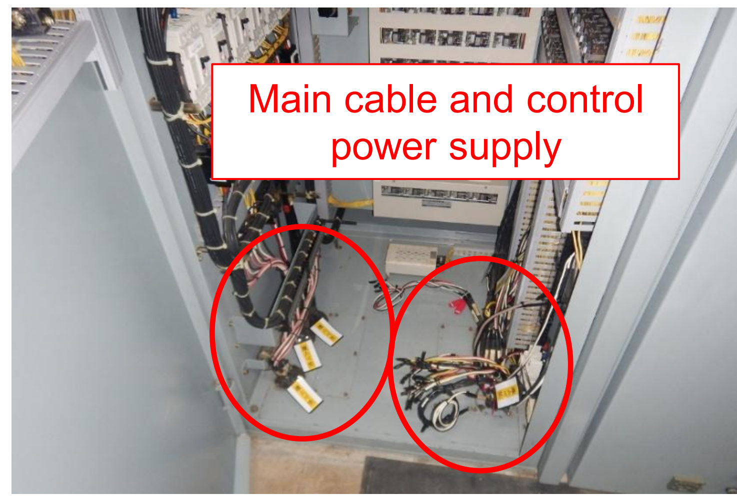
As part of the dismantlement and removal of equipment outside the controlled area, dismantlement of emergency generator (diesel generator) was started.

- Disconnecting main cable and control power supply (completion in Dec. 2023)
- Disconnecting cooling water pipe (completion in Dec. 2023)
- Disconnecting fuel pipe (completion in Jan. 2024)

Diesel Generator



Disconnecting fuel pipe



Disconnecting main cable and control power supply

3.6 Residual radioactivity & amount of radioactive waste (1/4)

● Activation radioactivity

Reactor core components such as a control rod, reflector and so on are irradiated with neutrons, causing activation radioactivity.

↓

Evaluation using MCNP5 and ORIGEN-S

● Secondary contamination radioactivity

Metal components eluted in primary cooling water were activated by irradiation in the core. These activated materials adhered some system and devices, causing contamination.

↓

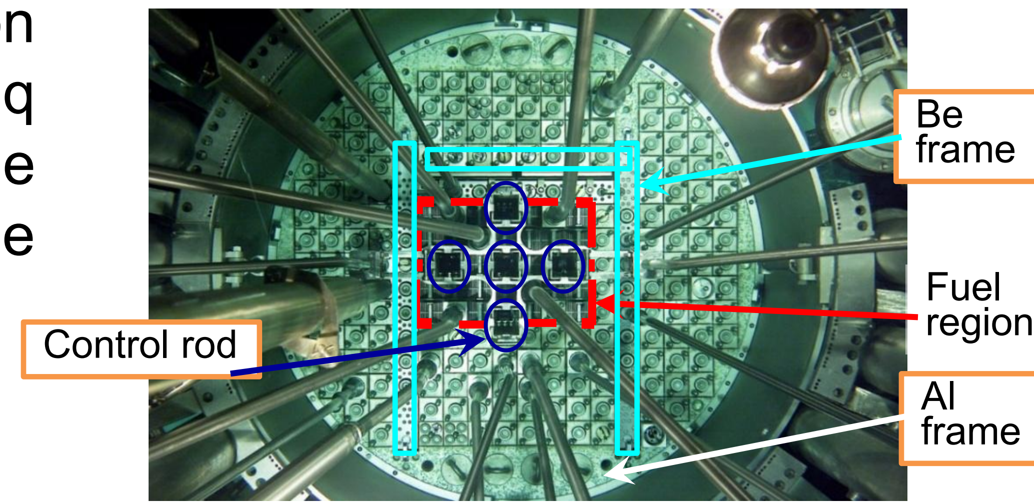
Evaluation using MCNP5 and measured dose rates

3.6 Residual radioactivity & amount of radioactive waste (2/4)

Result activation radioactivity <example> Unit : Bq

Nuclide	Control rod	Be frame	Al frame	RPV
^{3}H	1.3E+11	1.4E+16	5.0E+10	1.1E+06
^{55}Fe	1.0E+14	4.9E+15	8.8E+12	1.7E+08
^{60}Co	2.1E+14	4.6E+15	1.5E+13	3.3E+08

The estimated total activation radioactivity was ca. 5.3E+16Bq about 12 years after the shutdown of the reactor (the end of December 2018).



Reactor core

3.6 Residual radioactivity & amount of radioactive waste (3/4)

Result of secondary contamination radioactivity <example> Unit：Bq

Nuclide	Primary cooling system	Pool and canal cooling system	SFC cooling system	Irradiation facility
^{3}H	1.7E+12	8.9E+08	1.1E+08	1.4E+05
^{55}Fe	3.1E+11	1.7E+08	2.1E+07	1.7E+08
^{60}Co	3.1E+11	1.7E+08	2.0E+07	2.0E+08

The estimated total contamination radioactivity was ca 9.7E+12Bq about 12 years after the shutdown of the reactor (the end of December 2018).

Based on these results and the weight of each equipment, the amount of radioactive solid waste at each level was estimated.

3.6 Residual radioactivity & amount of radioactive waste (4/4)

Estimated amount of radioactive solid waste

Classification		material	Weight* (ton)
Low-level radioactive waste	Relatively higher-level radioactive waste (L1)	Metal	30
		Concrete	-
		Others	-
	Relatively lower-level radioactive waste (L2)	Metal	350
		Concrete	-
		Others	-
	Very low-level radioactive waste (L3)	Metal	570
		Concrete	1300
		Others	10
Waste that need not to be treated as radioactive waste (Clearance)		Metal	980
		Concrete	2310
		Others	10
Total			5540

*Total value does not match due to rounding.

(Remark)

- Radioactivity levels were classified based on the estimated radioactivity concentration approximately 21 years after the reactor shutdown (end of December 2027).
- The weight of non-radioactive (NR) waste (including waste generated from outside the controlled area) is estimated to be approximately 5220 tons

4. Major issues

4.1 Urgent issues

- Isolating the equipment to be dismantled from the equipment that will maintain its performance
  - Where should these be isolated?
  - Which pipe shutoff method should we choose?(standard or unique blank flange, welding or bolting, etc.)

- Sequence of dismantling equipment that doesn’t allow additional contamination
  - Dismantling will begin with those with the lowest levels of radioactive waste (non-radioactive⇒clearance⇒L3⇒…)

4.2 Future issues

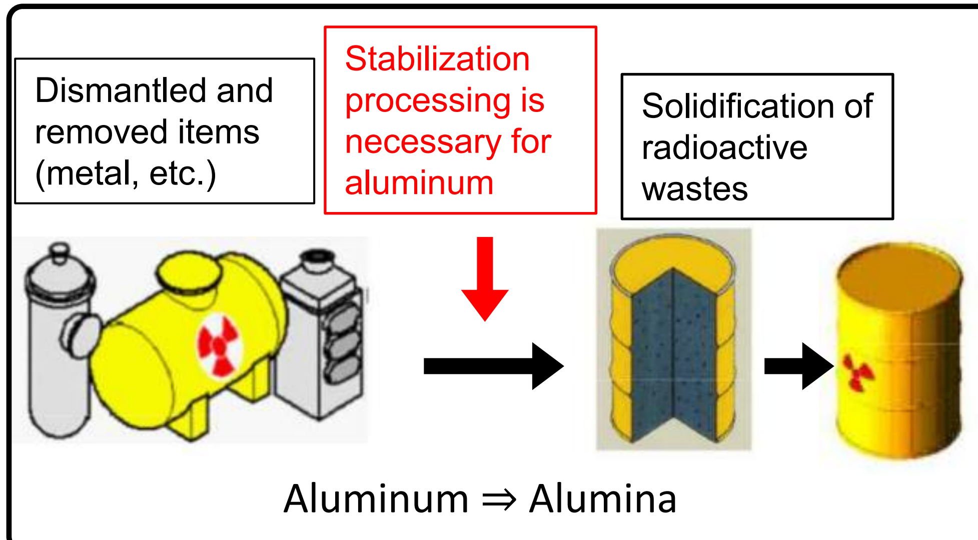
[Ion exchange resin]
We aim to reduce the amount of ion exchange resin by incineration.

Investigating the properties of spent resin in storage

Observations of the resin in the storage tank. Fluidity was maintained.

[Metallic aluminum]
When aluminum is solidified with concrete, it generates hydrogen, and there is a risk that the waste package will be broken.

Development of stabilization processing technology of aluminum



Concept on treatment of radioactive waste

5. Conclusions

- JAEA has started decommissioning of the JMTR in 2021.
- Shutdown of reactor function was completed in 2021, and transportation of spent fuel has been carried out three times.
- We are preparing for a smooth dismantlement of equipment.


Thank you for your attention!