The Future of the Fukushima Daiichi NPS Decommissioning

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Looking back on the ”key issues” for the future decommissioning of Fukushima Daiichi Nuclear Power Station

① What are the radioactive risk sources being handled?

② How to perceive the time axis

③ How will the safety of Fukushima Daiichi be ensured?

④ The status of considerations for retretrieving fuel debris

⑤ Current status and prospects of the discharge of ALPS-treated water into the sea

⑥ The prospect of radioactive waste management

⑦ Dialogue and cooperation with local residents

Decommissioning of Units 1 to 4 and other nearby facilities is proceeding in various projects.

	Spent fuel	Fuel debris
Unit 1	Existing	Existing
Unit 2	Existing	Existing
Unit 3	Recovered	Existing
Unit 4	Recovered	None

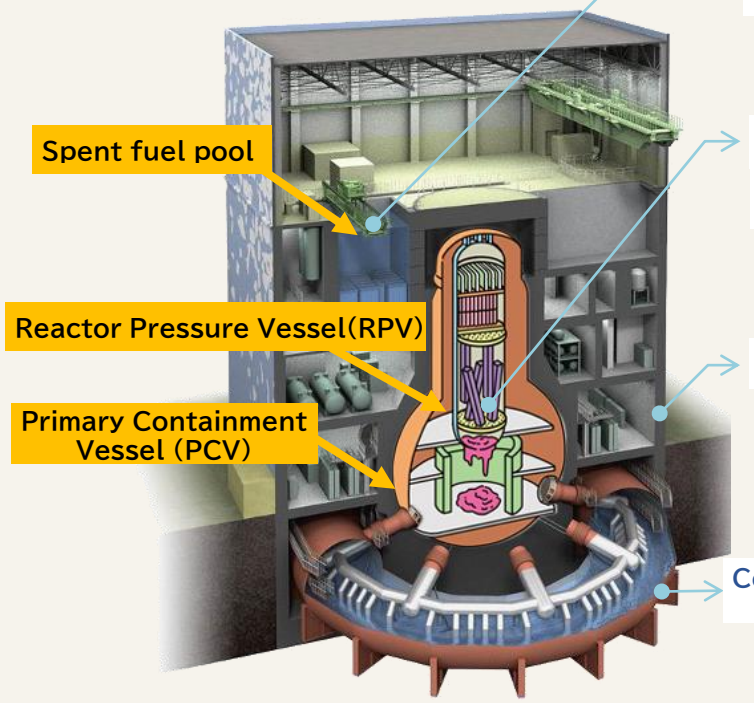
Source: TEPCO HD (Photo taken in March 2024)

Photo cited from TEPCO website

Measures for major sources of radiation risk

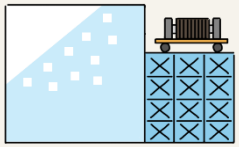
spent fuel, fuel debris, contaminated water, contamination inside buildings and solid waste

Radiation levels are very high inside the reactor



Spent fuel

2,424 units in the accident reactor
9,613 units other than those in the accident reactor

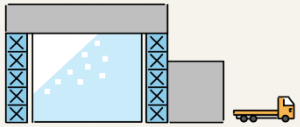


Removal

Ultimately stored in casks

Fuel debris

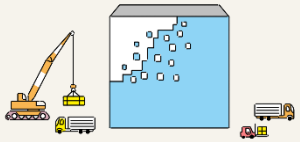
1,496 units melted or damaged in Units 1, 2, and 3



Retrieval

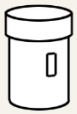
Stored in storage facilities such as casks

Buildings



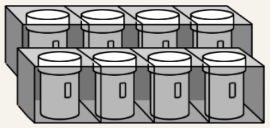
Demolition

Contaminated water



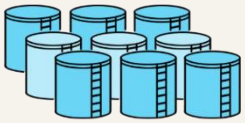
Cesium removal equipment (SARRY)

Remove radioactive cesium from contaminated water



ALPS

Remove almost all radionuclides



Tanks

ALPS-treated water (tritiated water)

The goals of decommissioning are two things: reducing short-and medium-term risks and not leaving any risks in the long-term.

Duration of radiation toxicity

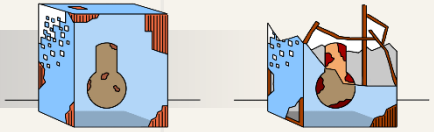
Cesium, strontium, etc.

Uranium, plutonium, etc. (fuel debris)

Decades → Hundreds of years → Tens of thousands of years →

Period during which the buildings can be maintained in a sound state

Buildings
(several decades old?)

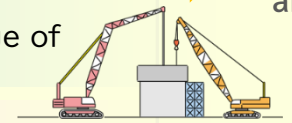


Decommissioning operation

Inspection, monitoring and reinforcement of facilities

Measures to stabilize unstable risk sources

Collection and safe storage of high-risk sources



Reduction and elimination of long-term residual risks (fuel debris)

Processing and disposal of radioactive waste

Reduction of short- and medium-term risks

Eliminating environmental impact and accelerating recovery

Elimination of long-term residual risks (fuel debris)

Don't pass risks on to the next generation

The two goals of decommissioning are:

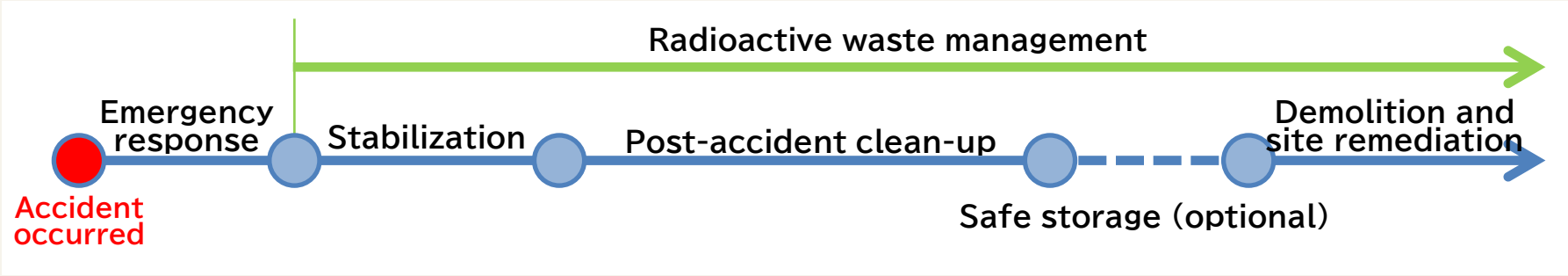
(1) Urgent measures to reduce short- and medium-term risks, and

(2) Measures to reduce long-term risks (such as debris collection

In Phase 3, the goal is to collect fuel debris and bring it to a safe storage state

Concept of decommissioning of international accident facilities

Source: "Lessons learned from the cleanup of the world and the decommissioning of nuclear facilities after the accident", IAEA Nuclear Energy Series NW-T-2.7



Progress and prospects for the decommissioning of Fukushima Daiichi NPS

The Phase 3 of decommissioning started in autumn 2024.

Phase 2
- Stable facility management
- Work as the basis for long-term decommissioning operations

Phase 3
- Completion of spent fuel recovery
- Disposal of radioactive was
- Full-scale fuel debris collection

As things stand now …
- Insufficient information on the properties of fuel debris and the conditions of the accident facilities.
- It is difficult to clearly foresee the future of this field.

Building demolition and disposal of radioactive waste

Elimination and stabilization of various risk sources

Proactive safety management and facility maintenance

Reduce impact on workers and the environment

- Recovery of highly radioactive sources
- Thorough preparation is a prerequisite
- Prioritize safety and avoid increasing short-term risks.

Decommissioning is proceeding with safety as the top priority.

A ”serious situation requiring evacuation” like that occurred in 2011 is unlikely to occur.

The heat generation and radioactivity of the nuclear fuel have decreased to less than 1/1000 of those at the time of the accident. The facility is stably managed.

On the other hand, preparations are needed for external events (natural disasters) and internal events (facility degradation and accidents) that may occur in the future.

External factors

Occurrence of natural disasters, including earthquakes, tsunamis

Internal factors

Equipment failures, misoperation, etc.
loss of power supply, etc.

Deterioration of equipment and buildings, and aging of radioactive materials

Critical events to be avoided

Fire or explosion

Leakage of radioactivity into the environment

Workers’ exposure to radiation, etc.

Accidents resulting in injury or death of workers

Reduction of stagnant water in the buildings and recovery of sludge, etc.

Decontamination inside the building

Enhanced shielding

Securing the power supply

Seismic resistance assessment for buildings

Ensuring occupational safety
Radiation control of workers

Installation of seawall waterproofing of buildings

In the reactor building

- Nitrogen filling in the PCV
- Hydrogen exhaust and monitoring
- Criticality monitoring
- Monitoring of radioactivity in exhaust gases, etc.

Maintenance and management of temporary lines and instrumentation systems

- All possible measures are taken to prevent a radioactive leakage on the premise of ensuring worker safety.
- Careful approach to reliably safe construction design and technical development

Trial retrievals of fuel debris were conducted from the bottom of the containment vessel of Unit 2.

Trial retrievals of fuel debris from Unit 2

For the first time since the accident, fuel debris samples were collected and transported out of the reactor.

First: November 7, 2024 Second: April 23, 2025

First sample collected (0.693 g)
Size: approx. 9-7 mm

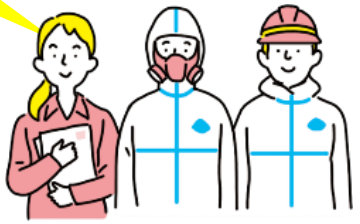
Second sample collected (0.187 g)
Size: approx. 5-4 mm

Source: Japan Atomic Energy Agency public materials

Purpose of trial retrieval of fuel debris, etc.

- ✓ Trial access **inside the reactor containment**
- ✓ Trial demonstration of **in-core operation using remote devices**
- ✓ **Confirmation of safety and operation proficiency** of remote fuel debris removal
- ✓ **Inference of fuel debris formation process** by analysis of fuel debris samples
- ✓ **Reflection** of fuel debris analysis results in **construction design (safety, tool design, storage design, etc.)**
- ✓ **Inspection of the internal condition** of the containment vessel

The trial retrieval of fuel debris from Unit 2 is the first "small but important step" toward expanding the scale of future operations.



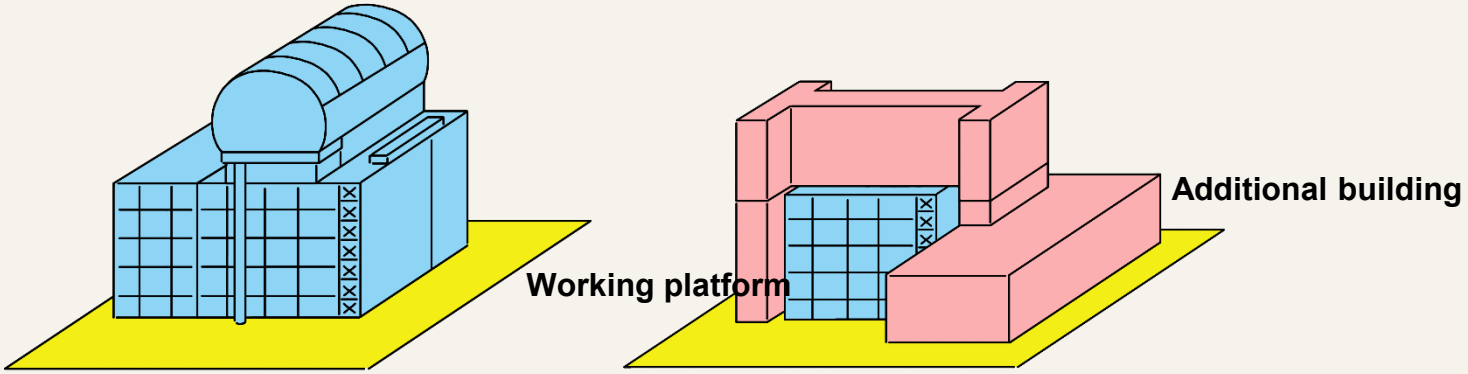
The preparatory stage for full-scale fuel debris retrieval has been taking shape through the evaluations in the Sub-Committee
It still takes some time to clarify this further.

- The latest status of design studies at TEPCO -

Trough the design study of ”full-scale fuel debris retrieval,” it has been reported that various ”preparatory work” such as

Detailed inspection of the reactor internals	Decontamination of the inside of the reactor building	Improvement of the area around the reactor building, etc.	Construction of additional buildings

will take ”12 to 15 years” for fuel debris retrieval at Unit 3.



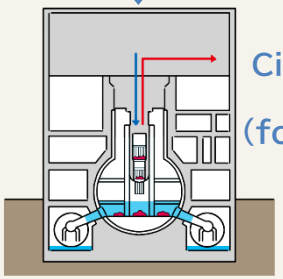
Difficult construction requirements

- Technical certainty (reliability, durability, etc.)
- Elimination of impact on the work environment
- Ensuring worker safety
- Reassurance to the local community

Discharge of ALPS-treated water into the sea has been conducted.
In the upcoming full-scale decommissioning, the challenge is to reduce the amount of treated water generated as much as possible.

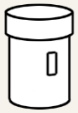
Management of water during fuel debris retrieval an issue for future consideration.

Groundwater and rainwater



Circulating water injection (for core cooling)

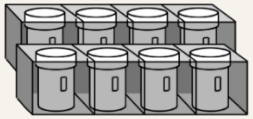
Reduce the amount of groundwater and rainwater inflow



Cesium removal

Adsorbed by sorbent

Solidified



ALPS and other radioactive material removal

Adsorbed by sorbent

Solidified

ALPS-treated water

Tritium

Discharge safely

Storage, processing, and disposal as solid waste

Amount of treated water discharged

Fiscal Year	Number of discharge	Amount of water discharged	Total amount of tritium
2023	4	31,145m^3	4.5 trn Bq
2024	7	54,999m^3	12.7 trn Bq
2025	1	7,853m^3	2.9 trn Bq
Total	12	93,997m^3	20.1 trn Bq

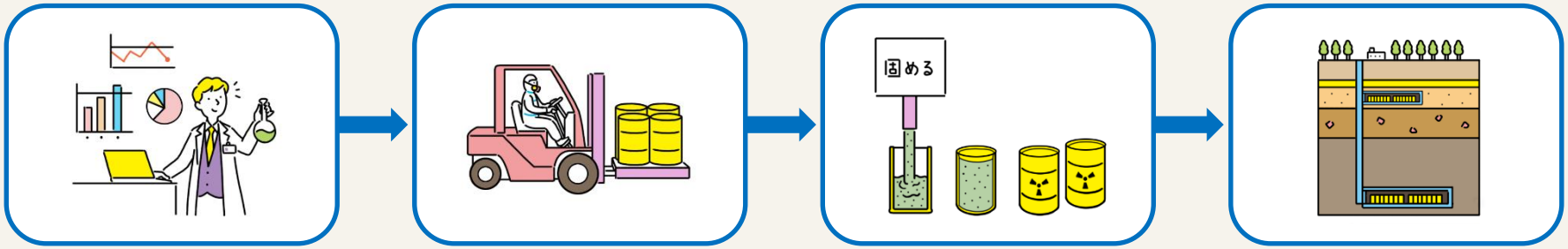
* Second discharge scheduled to end on August 1
: 7,800 m^3, 1.9 trillion becquerels

Research is being conducted to optimize the ”waste flow” process, which encompasses the final disposal of large quantities of solid radioactive waste that has been temporarily stored.

Characteristics of solid radioactive waste generated at Fukushima Daiichi

- **Properties such as physical properties and radioactivity concentration are not well known.**
- **The special nature of radioactive nuclides**
- **A wide variety of materials (concrete, resin, combustible materials, metal, felled trees, soil, etc.)**
- **The amount generated is considerably high.**

Overall optimization is required to expedite bringing them into proper storage conditions, as well as to clarify their properties, process(solidify) unstable items, and ensure safety in their final disposal in burial.



investigate
Understanding of properties and quantity

Store
Investigate

Solidify
Processing (conditioning)

Bury
Disposal methods and safety assessment

What is needed in the full-scale decommissioning in the future

① TEPCO's responsibility as the owner of the decommissioning project (responsibility to accomplish the project as the implementing entity)
② Collaboration and cooperation with related companies
③ Technological capabilities and project management / safety assurance capabilities
④ Securing sustainable funding for decommissioning (decommissioning reserve fund)
⑤ Securing human resources and maintaining employee motivation
⑥ Recognition of the national significance of this project (by the government, diet, and administration)
⑦ Strong leadership by the government and support systems provided by specialized and related organizations
⑧ Understanding from local residents and coexistence with the community
⑨ Public recognition that "the issue of Fukushima Daiichi is part of the nationwide nuclear power challenge"

The future and final form of the decommissioning should be examined in close coordination with the technical considerations of decommissioning and the future visions of the local communities.

- The long-term perspectives for decommissioning will gradually become clearer in the next one to two years in line with the understanding of on-site situation and technical study.
- It is essential to consider the end state of the decommissioning, not only from a technical perspective but also in line with the future vision of the local community
- While proceeding with the decommissioning work, it is important to work with the local community to consider the end state of decommissioning that will bring the greatest benefits to the region.
- It is important to consider the decommissioning of the Fukushima Daiichi NPS and its end state, which will generate economic revitalization and ensure safe and secure lives for the local community, through sufficient dialogue with the local community.

Open dialogues for the decommissioning