Current status and plans of decommissioning of the Fukushima Daiichi Nuclear Power Plant

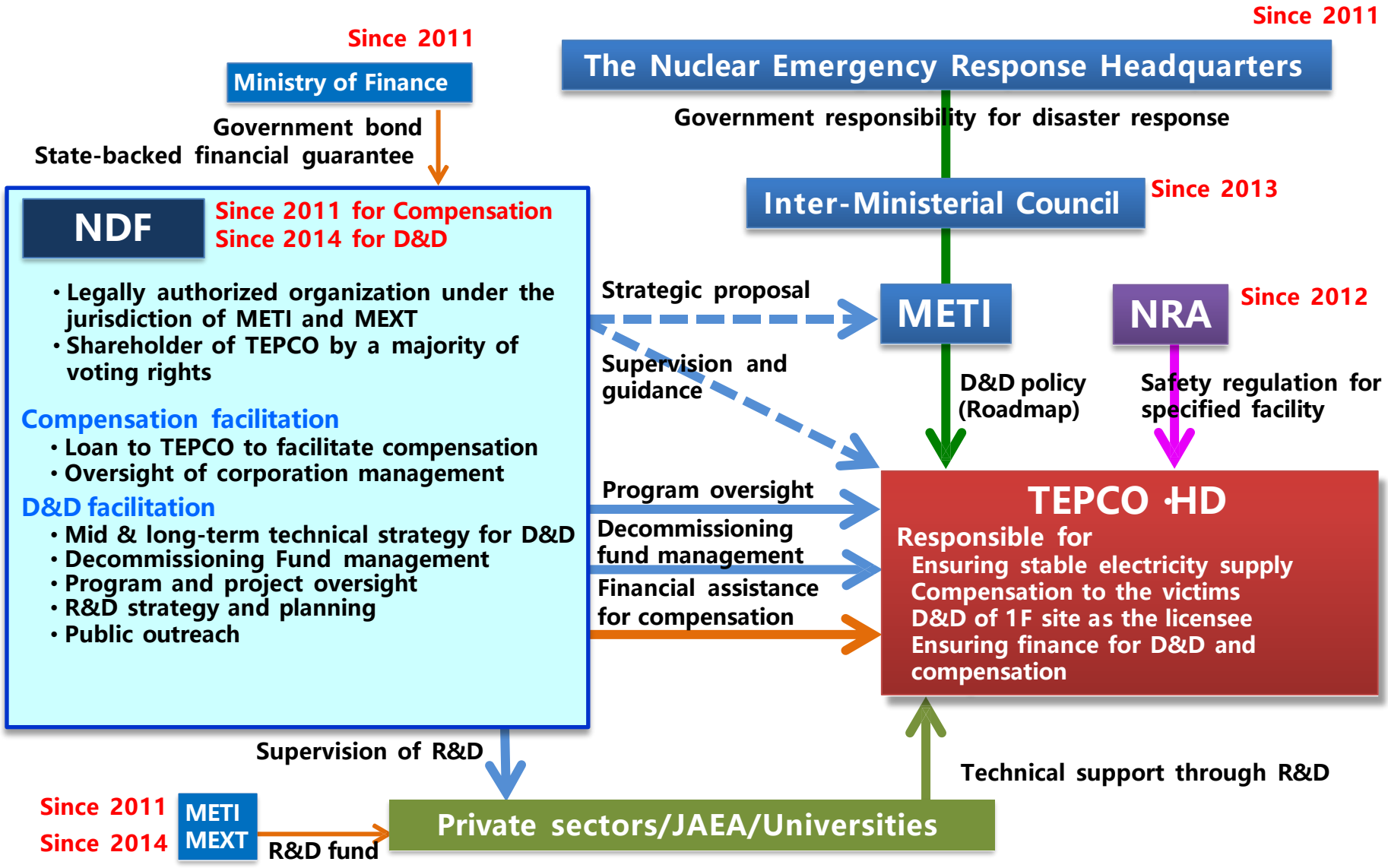
Tokuhiro Yamamoto
Executive Director
NDF, Japan

For
The Regulatory Information Conference 2023
W9 – Decommissioning in a Dynamic Environment
March 15, 2023

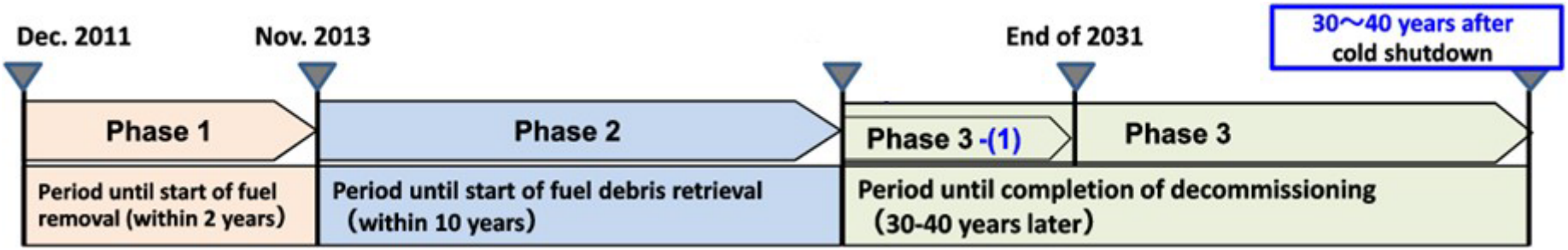
Contents

- Introduction
  - Organizational Structure for 1F Decommissioning
  - Mid-and-Long-Term Roadmap
- Current Status of 1F Decommissioning
  - State of TEPCO Fukushima Daiichi NPS
  - Contaminated and treated water management
  - Fuel removal plan for Unit 1 and Unit 2
  - Fuel debris retrieval
  - Significance and technical strategies of analysis
- Dialogues with stakeholders
- Strengthening international cooperation

Organizational Structure for 1F Decommissioning



Mid-and-Long-Term Roadmap



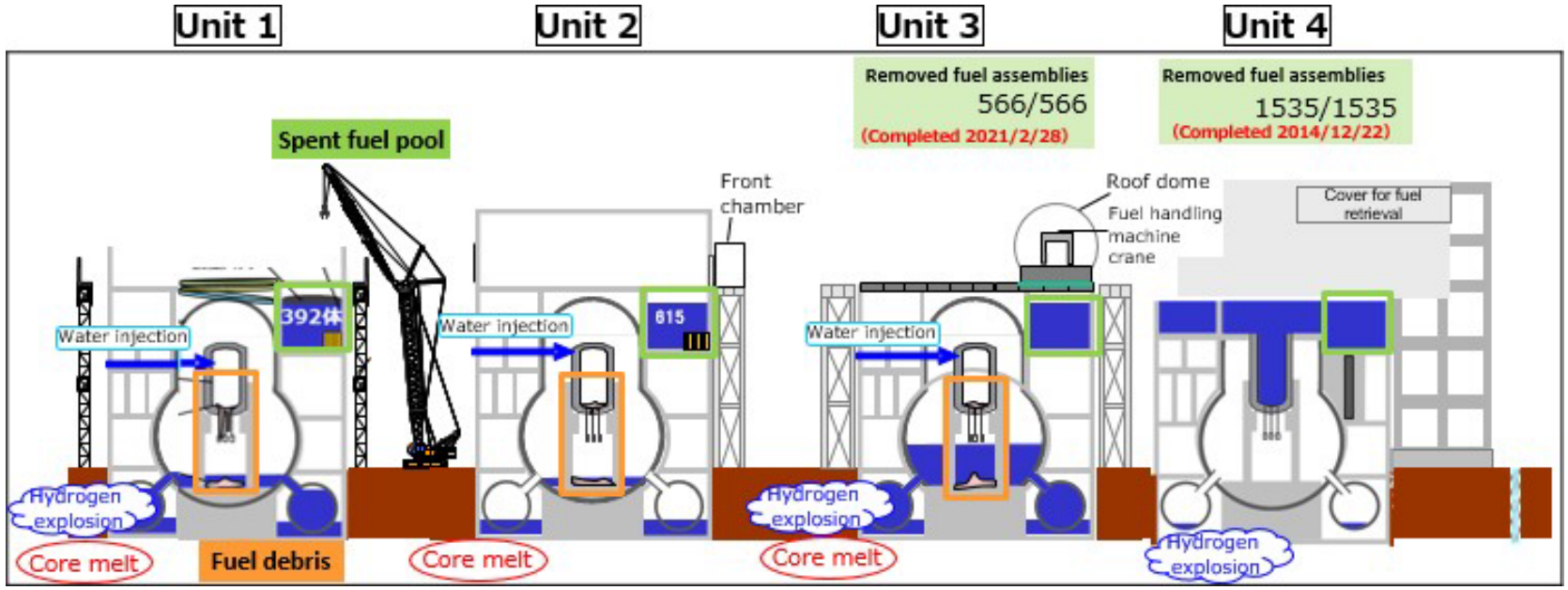
Due to safety and reliability considering the impact of COVID-19 pandemic, trial fuel debris retrieval is expected to start in late FY2023.

Major milestones

		Revised Roadmap	
Contaminated water management	Reduce to about 150 m^3/day	Within 2020	achieved
	Reduce to about 100m^3/day or less (Further reduction of generation)	**Within 2025**	**NEW**
Stagnant water removal / treatment	Complete stagnant water removal / treatment in buildings* Excluding the reactor buildings of Units 1-3, Process Main Buildings, and High Temperature Incineration building.	Within 2020(*)	achieved
	Reduce the amount of stagnant water in reactor buildings to about a half of that in the end of 2020	**FY2022 - 2024**	**NEW**
Fuel removal	**Complete of fuel removal from Unit 1-6**	**Within 2031**	**NEW**
	Complete of installation of the large cover at Unit 1	**Around FY2023**	**NEW**
	Start fuel removal from Unit 1 (Methods have changed to ensure safety and prevent dust scattering)	**FY2027 – 2028**	**REVISED**
	Start fuel removal from Unit 2	**FY2024 - 2026**	**REVISED**
Fuel debris retrieval	Start fuel debris retrieval from the first Unit (Start from Unit 2, expanding the scale gradually)	Within 2021	*Expected to be delayed by approx. 2 years
Waste management	Technical prospects concerning the processing/disposal policies and their safety	Around FY2021	achieved
	Eliminating temporary storage areas outside for rubble and other waste	**Within FY2028**	**NEW**

©METI (2022) modified by NDF (2023)

State of TEPCO Fukushima Daiichi NPS



- At the accident
  - ·Hydrogen Explosion: Unit 1 , Unit 3 , Unit 4
  - ·Core melt: Unit1, Unit 2 , Unit 3
- After the accident
  - ·Completed spent fuel removal: Unit3, Unit 4
  - ·Some investigation near the bottom of PCVs is carried out
  - ·Generation rate of contaminated water is drastically slowed down but contaminated water is still increasing

Contaminated Water Management

Principle 1. REMOVING contamination sources

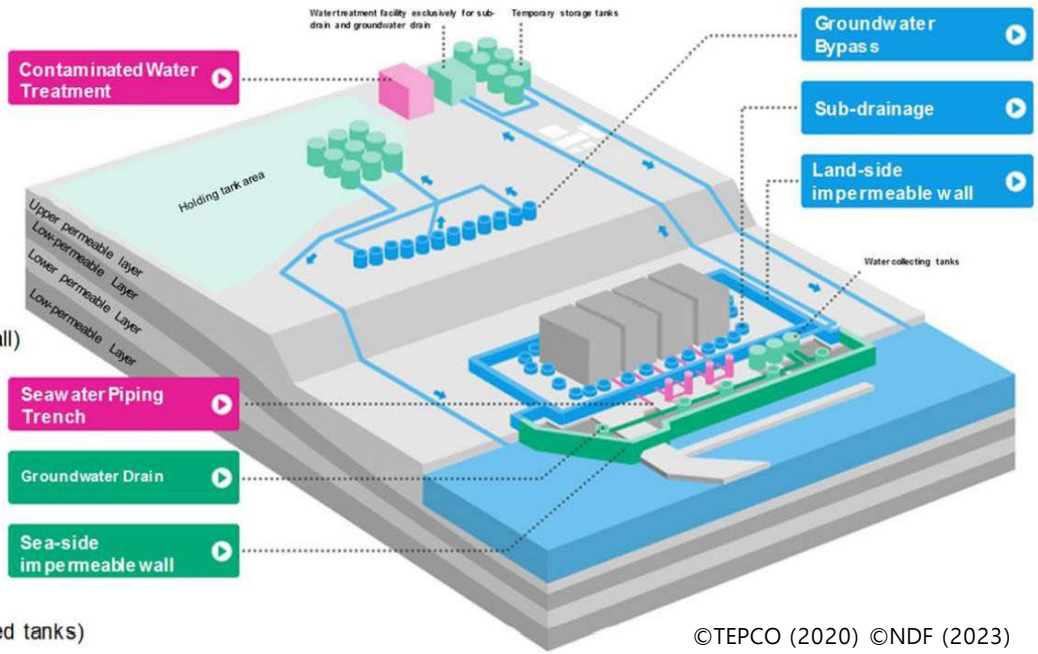
(1) Treatment of contaminated water through the multi-nuclide removal equipment (ALPS)
(2) Removal of contaminated water inside seawater piping trench(*)
(*) Underground tunnels with pipes

Principle 2. REDIRECTING fresh water from contamination sources

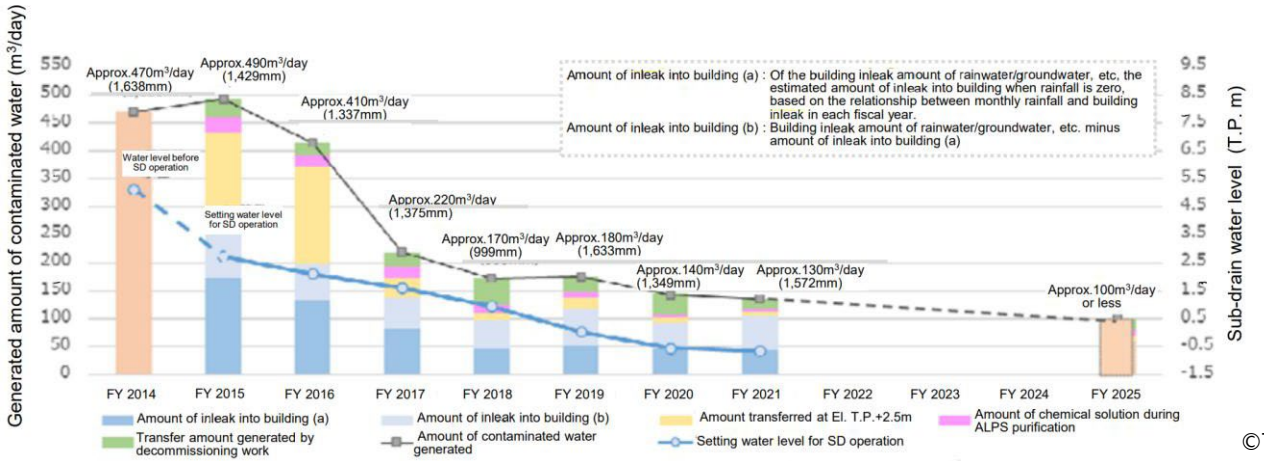
(3) Groundwater pump-up by groundwater bypass system
(4) Groundwater pump-up by subdrain
(5) Land-side impermeable wall installation (Frozen soil wall)
(6) Wide-area coating (Waterproofing of ground surface)

Principle 3. PREVENTING leakage

(7) Foundation improvement using water glass
(8) Sea-side impermeable wall installation
(9) Groundwater pump-up by groundwater drain
(10) Installation of additional tanks (replacement with welded tanks)

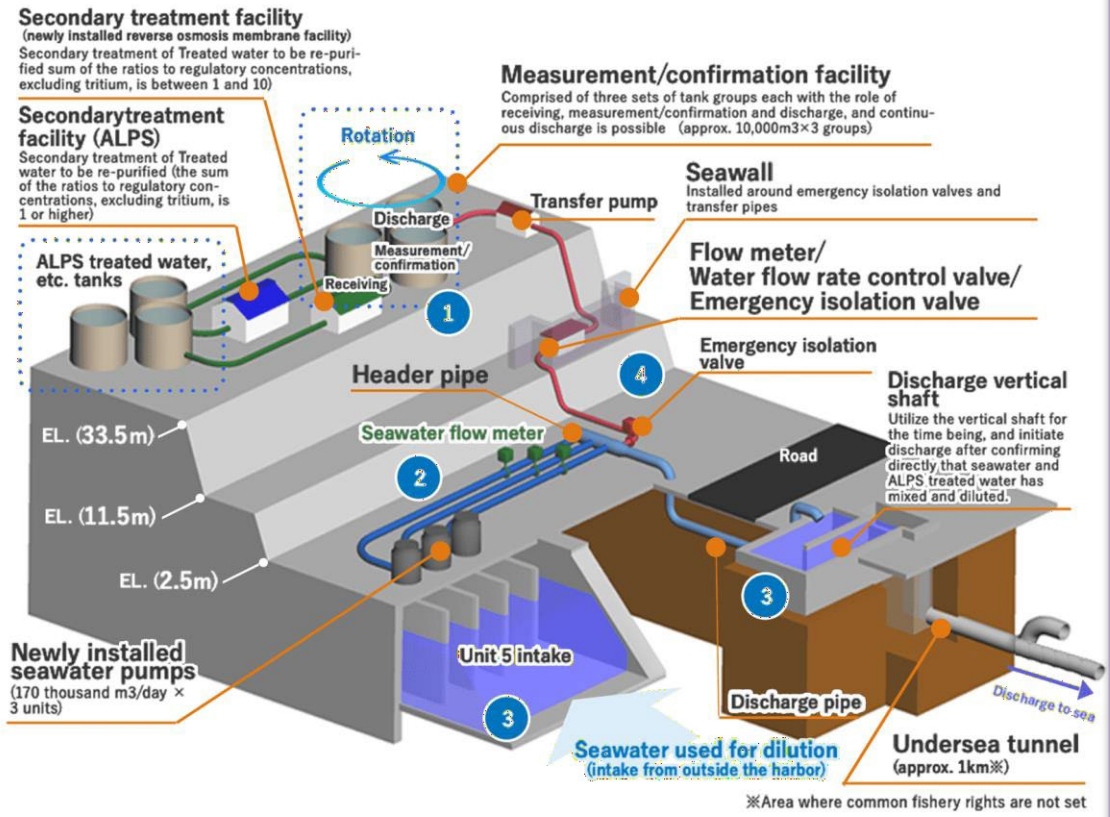


©TEPCO (2020) ©NDF (2023)



©TEPCO (2022)

Treated water discharge plan



■ Status* of ALPS treated water etc.

- Volume of storage : 1,270,000 m³
- Increase rate : 50,000 m³ per year
- Tritium inventory : 780 TBq
- Tritium average conc. : 600 kBq/L

* As of December 2021

■ Plan of the ocean discharge

- Dilution rate : > 100
- Tritium amount : < 22 TBq per year
- Tritium conc. : <1,500 Bq/L
- Conc. of other nuclides : < 0.01 of standard**

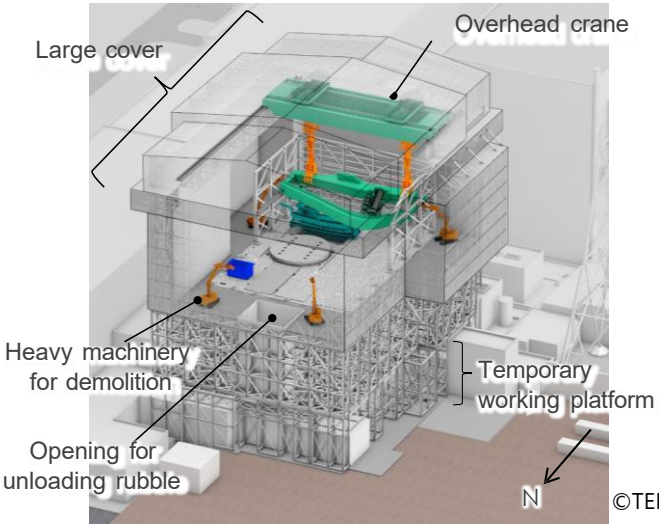
** Sum of ratios of each radionuclide concentration to the regulatory standard in ALPS treated water is reduced less than 1 and the diluted more than 100 times.

■ Facility for the ocean discharge

- Discharge method : Undersea tunnel
- Length of tunnel : approx. 1km
- Depth of discharge point : approx. 10m

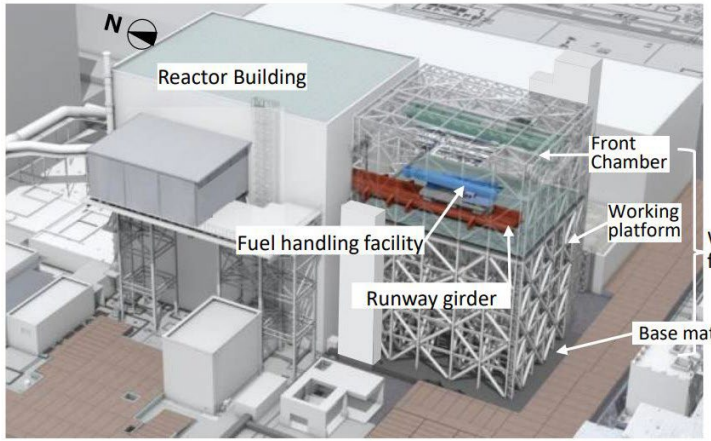
Fuel removal Plan for Unit 1 and Unit 2

- Fuel removal from spent fuel pools (Units 1 to 4)
  - The target is to complete fuel removal from all spent fuel pools of Units 1-6 within 2031.
  - Removal of fuel is expected to begin in FY 2027 to FY 2028 for Unit 1 and FY 2024 to FY 2026 for Unit 2.
- Unit 1: a new large cover will be installed. Removal of the rubble (including the displaced overhead crane) and the fuel is to be carried out inside the cover.
- Unit 2: the challenge is to ensure boom-type crane is operated remotely to handle fuel assemblies.



©TEPCO (2022)

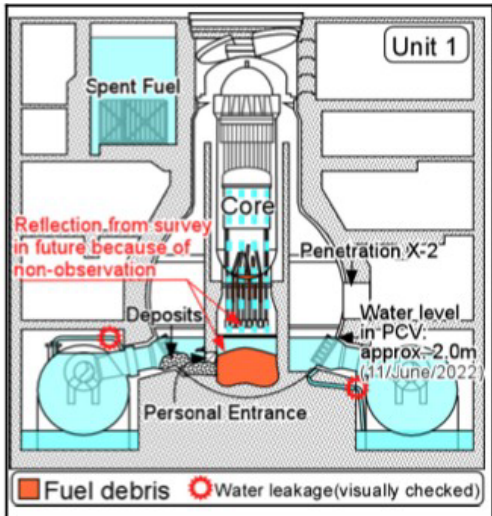
Conceptual drawing of the large cover over the reactor building of Unit 1

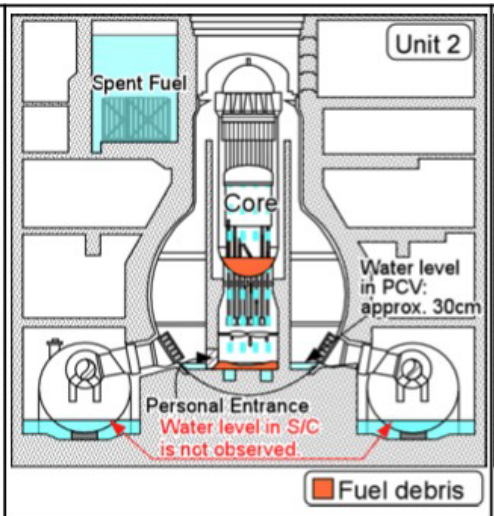


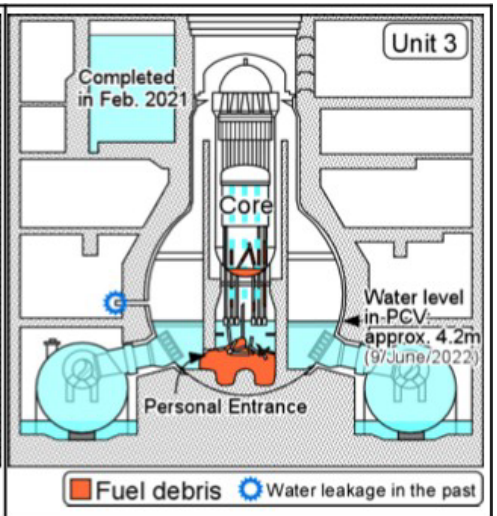
©TEPCO (2022)

Conceptual drawing of the platform and fuel handling facility of Unit 2

Estimated Fuel Debris distribution through investigation inside PCVs



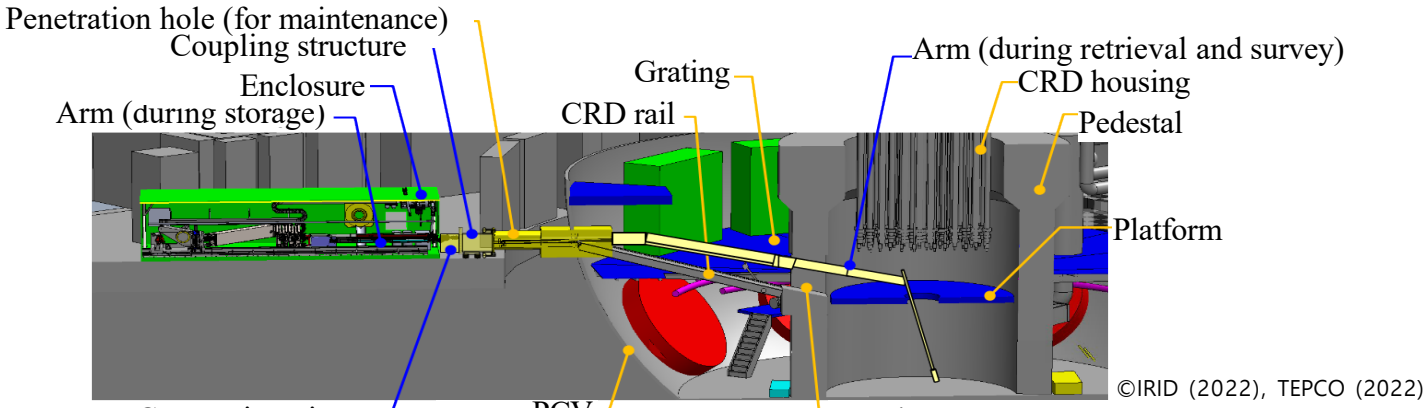




Core region	· Little fuel debris remains.	· Little fuel debris remains. (Partially intact fuel might exist in the peripheral region)	· Little fuel debris remains.
At RPV lower head	· A small amount of fuel debris is present. · A small amount of fuel debris is present inside and on the outer surface of the CRD housing.	· Large amount of fuel debris is present. · A small amount of fuel debris is present inside and on the outer surface of the CRD housing.	· Part of fuel debris is present. · A small amount of fuel debris is present inside and on the outer surface of the CRD housing.
At the PCV bottom (Inside the pedestal)	· Most of the fuel debris is present.	· A certain amount of fuel debris is present.	· Amount of fuel debris in Unit 3 is more than that in Unit 2.
At the PCV bottom (Outside the pedestal)	· Fuel debris may have spread outside the pedestal through the personal entrance(Deposits have been observed).	· The possibility of fuel debris spreading outside the pedestal through the personal entrance is low.	· Fuel debris may have spread outside the pedestal through the personal entrance.
Radiation dose in operation site*1	· Radiation dose around the penetration X-6 on the first floor of R/B is high (145 mSv/h).	· Radiation dose on the first floor of R/B had reduced to approx. 5 mSv/h as a whole.	· Radiation dose on the first floor of R/B reaches several to tens of mSv/h or higher than those, indicating a high dose level.

Trial Fuel debris retrieval in Unit2

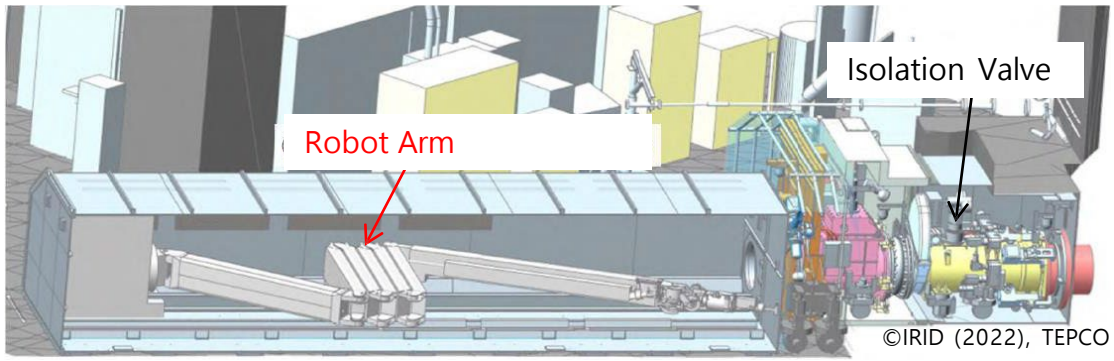
- Trial retrieval of fuel debris in Unit 2 is expected to start in late 2023 fiscal year.



©IRID (2022), TEPCO (2022)

2号機X-6ペネからのPCV内部調査のイメージ図

Image of internal investigation of unit 2 PCV through X-6 Penetration



©IRID (2022), TEPCO (2022)

©IRID (2022), TEPCO (2022)

Source: IRID and TEPCO Holdings reported at the 99th Secretariat Meeting of the Team on Countermeasures for Decommissioning and Contaminated Water Treatment, held on February 24, 2022.

Further expansion of fuel debris retrieval in Unit 3

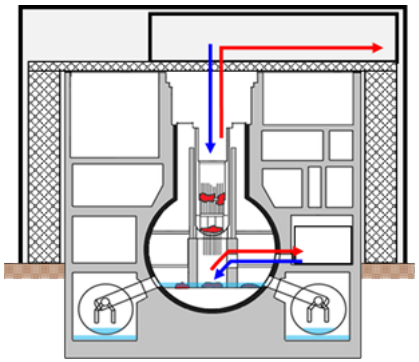
Challenges and technical strategies

- A variety of retrieval methods have been studied since FY2021, not ruling out any possibilities.
- The dry method*1 and submersion method*2 that are being discussed pose the following challenges: feasibility of on-site construction under high radiation dose, significant increase in the amount of construction materials and waste, and measures to be taken when fuel debris is retrieved.

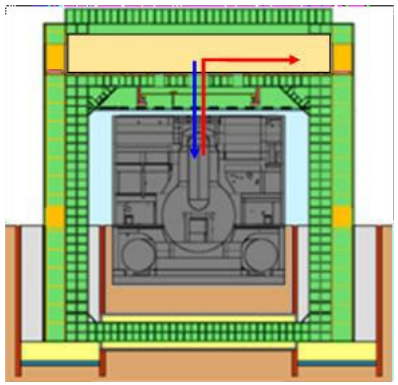
- ✓ Once feasibility has been confirmed to some extent, it will be necessary to narrow down the options step by step while proceeding with the design.
- ✓ Other retrieval methods should be studied as needed.

*1 A method combining top-access method and side-access method
*2 Unlike the conventional PCV submersion method, a method of submersing the reactor building by enclosing the entire reactor building with a new structure as a boundary (Shell method)

Direction of equipment access
Direction of fuel debris/waste carrying-out

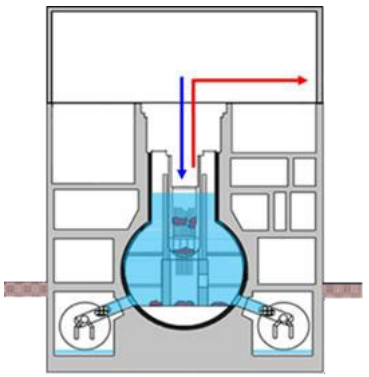


Dry method



An example of submersion methods
(Conceptual drawing of Shell method)

<Reference>



Conventional submersion method
(Diagram of PCV submersion method)

Significance and technical strategies of analysis

Significance and current state

- At present, due to the large range of uncertainty regarding fuel debris properties, safety measures should be studied conservatively.
- If the range of such uncertainty can be reduced, there is no excessive margins needed, and thus, rational safety measures can be studied, it enables the promptness and rationality of decommissioning to improve.

Challenges and technical strategies

- Since the fine fuel debris generated as retrieval of fuel debris progresses are diverse with high radiation dose, it is a challenge to establish an efficient system for analysis.

✓ It is effective to expand the analysis data under the appropriate division of roles among the facilities in the Ibaraki area, where facilities and equipment are enhanced, and the new analytical facilities.

✓ It is important to efficiently promote human resource development with the cooperation of other institutions.

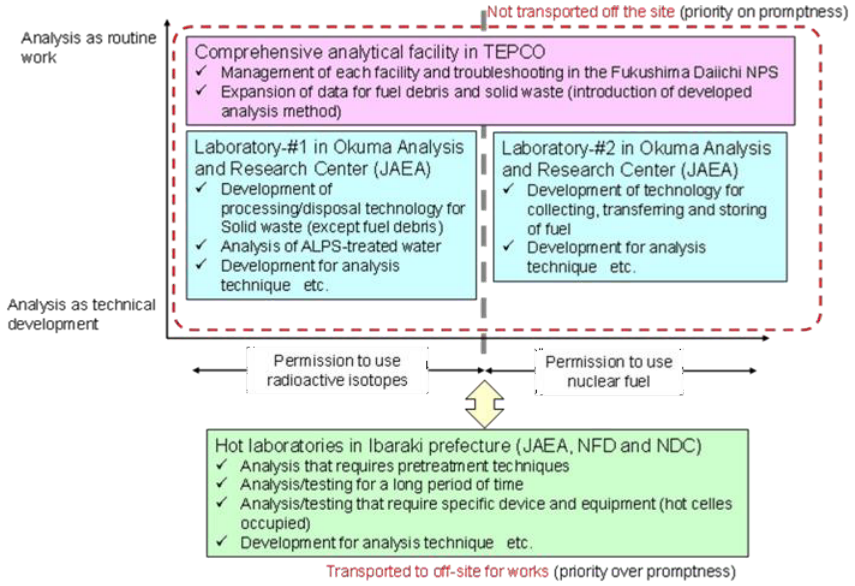


Fig. Characteristics and roles of each facility for analysis

Dialogues with stakeholders

NDF holds forums and dialogues with resident people every year in the affected municipalities of Fukushima prefecture.

NDF the 6th International Forum of Decommissioning Fukushima Daiichi, Aug. 2022 ©NDF (2022)

- The principle for the decommissioning is “Balancing between reconstruction and decommissioning”.
- Revitalizing decommissioning-related industries is an important pillar of TEPCO’s contribution to the reconstruction of Fukushima prefecture.

Strengthening international cooperation

NDF emphasizes the importance of;

- Learning lessons from precedent overseas cases
- Utilizing the world's highest levels of technologies and human resources

  E.g. Through the international joint project scheme of the OECD Nuclear Energy Agency, Japanese organizations cooperate international specialists (news in NEA web-site)

Additionally,

- Sharing the decommissioning experience in Fukushima Daiichi with the international community is Japan's responsibility.

©NEA (2022)

©NDF (2022)

Reference

There are unique information sources on the internet.
For more information, the following internet sites are very useful for various needs. They are regularly updated.

Ministry of Economy, Trade and Industry (METI)

- ″ALPS treated water″ web-site
- ″Roadmap towards the Decommissioning″ web-site

Ministry of Health, Labor and Welfare

- ″Radiation Protection at Works related to Fukushima Daiichi NPP” web-site

Nuclear Damage Compensation and Decommissioning Facilitation Corporation (NDF)

- “Technical Strategic Plan″ web-site

Japan Atomic Energy Agency (JAEA)

- “FRAnDLI”: Analytical data of waste (only in Japanese)

Tokyo Electric Power Company Holdings Inc. (TEPCO)

- Portal web-site of the Fukushima Daiichi decommissioning project
- Fukushima Daiichi nuclear power plant virtual tour web-site; Inside Fukushima Daiichi
- Latest situation at Fukushima Daiichi nuclear power plant; video presentation (version in November 2022)

Management Office for Project of Decommissioning

- Request For Information (R&D theme for 1F decommissioning) is planed around April

IAEA web-site: Fukushima Daiichi Treated Water Discharge