Technical Strategic Plan 2022 for Decommissioning of the Fukushima Daiichi Nuclear Power Station of Tokyo Electric Power Company Holdings, Inc.

(Explanatory Material)

October 11, 2022

Nuclear Damage Compensation and Decommissioning Facilitation Corporation

NDF

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Division of roles of related organizations responsible for decommissioning of the Fukushima Daiichi NPS

Local residents and communities

Bidirectional dialogue

Organizations related to decommissioning

Nuclear Emergency Response Headquarters (Director: Prime Minister)

Council for the Decommissioning of TEPCO's Fukushima Daiichi Nuclear Power Station[*1]
(Chairperson: Chief Cabinet Secretary)
- Decide the direction of decommissioning and contaminated water treatment

Mid-and-Long-Term Roadmap

Nuclear Regulation Authority
- Approval of implementation plan, pre-service inspection, welding inspection, etc.
- Providing goals for risk reduction

Target map for Reducing Medium-term Risk

The Team for Countermeasures for Decommissioning and Contaminated Water Treatment
(Head of Team: Minister of Economy, Trade and Industry)
- Progress management of each countermeasure according to Mid-and-Long-Term Roadmap

Minister of Economy, Trade and Industry

Report
Presentation of important issues
Approve
Apply for approval
Report on the outcome
Granting of project budget
Progress management
Report
Monitoring, examination

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Technical Strategic plan
- Development of a mid-to-long-term strategy
- Tech. support for progress management of important issues
- R&D planning and progress management
- Strengthen international partnership
- Management of Reserve Fund for Decommissioning

Withdrawal plan (in collaboration)

Reserve Fund for Decommissioning

R&D organization
International Research Institute for Nuclear Decommissioning (IRID)[*2]
Japan Atomic Energy Agency (JAEA), etc.
- R&D implementation

Share progress and challenges
Report
Advice, guidance, recommendations, supervision and support related to project management, etc.
Reserve
Disburse-ment
Apply for report

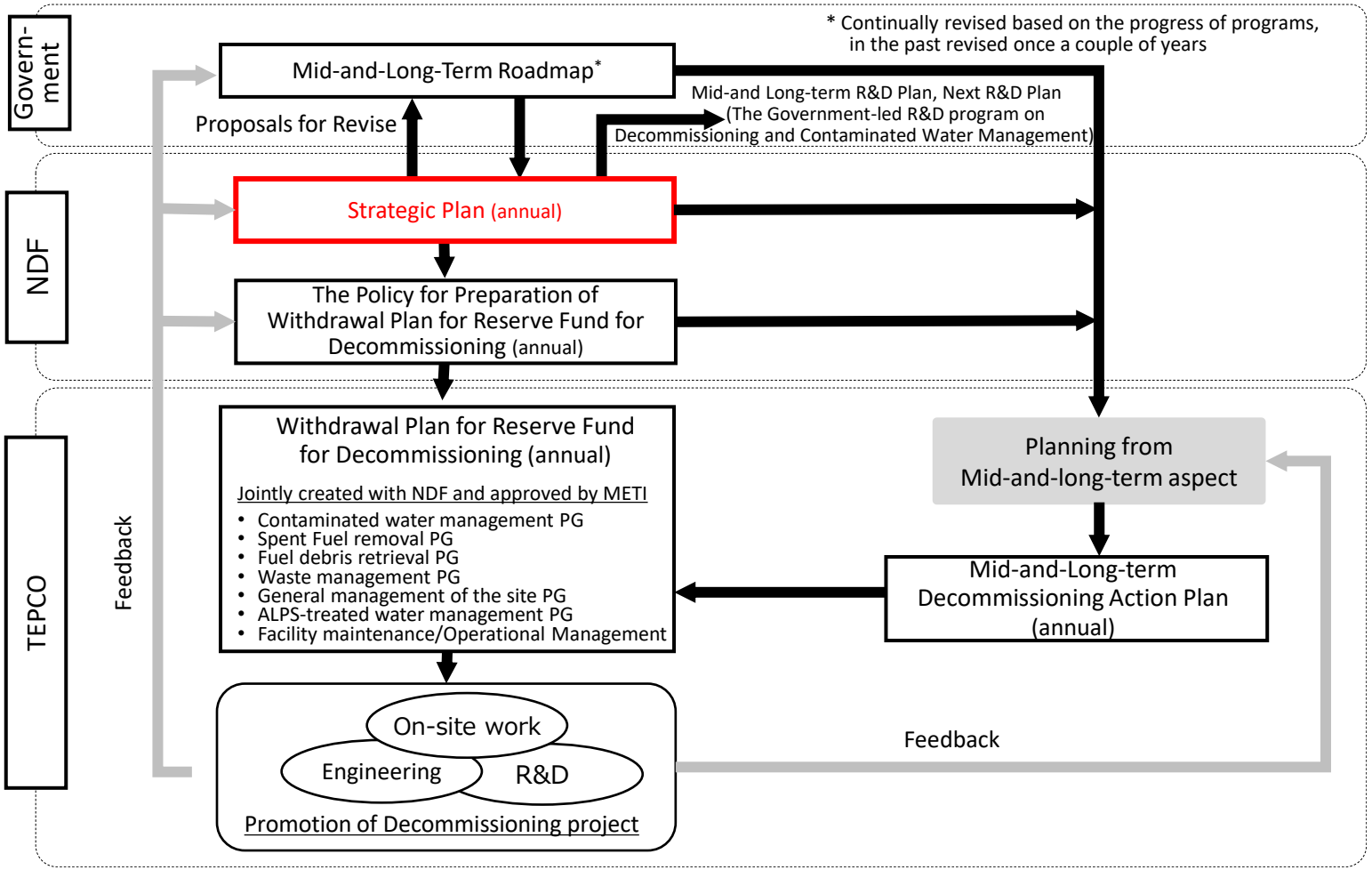
Tokyo Electric Power Company Holdings, Inc. (Fukushima Daiichi Decontamination and Decommissioning Engineering Company)
- Contaminated water and ALPS-treated water management, fuel removal from SFP, fuel debris retrieval, waste management, etc.
- Through TEPCO's management reform, the funds required for decommissioning should be reserved responsibly (Implementation of the 4th special business plan)
- Detailed measures for facility safety and protection of nuclear fuel material (Development of implementation plan for specified nuclear facility)

Mid-and-Long-term Decommissioning Action Plan

[*1] In response to the ALPS-treated water disposal policy decided on April 13, 2021, "Council for the Decommissioning of TTEPCO's Fukushima Daiichi NPS toward steady implementation of basic policy on ALPS-treated water disposal" was founded.

[*2] TEPCO, a decommissioning project operator, participates as a member of IRID and shares the needs, challenges, and results of research and development.

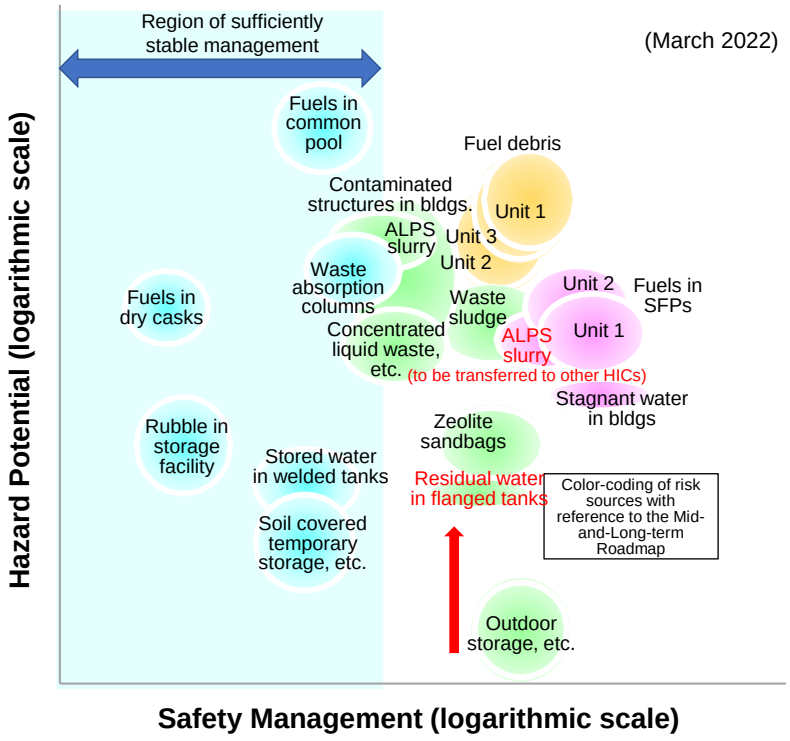
Positioning of the Technical Strategic Plan



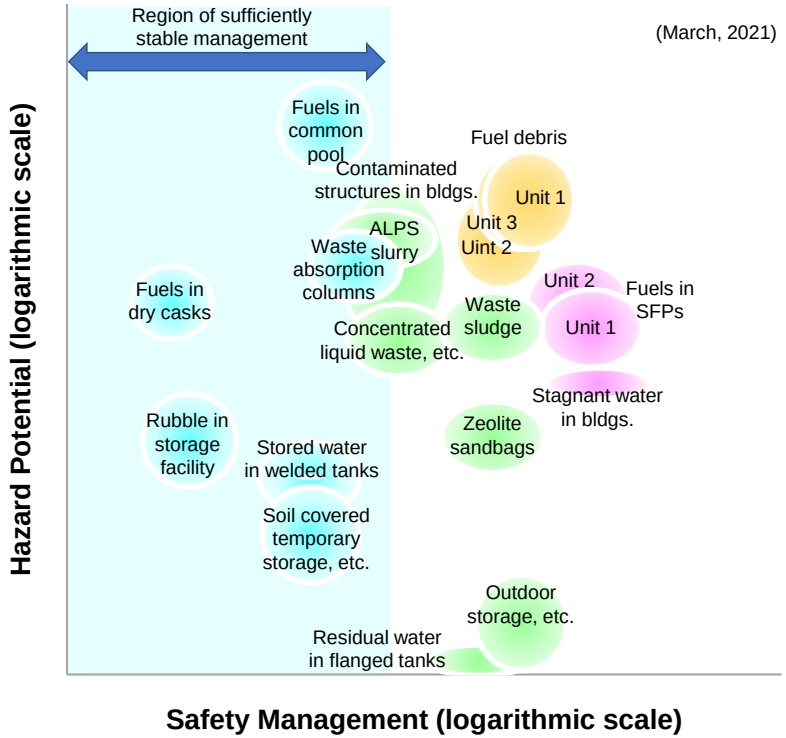
Concept on risk reduction

- The interim target of the risk reduction strategy is to bring the risk levels into the “Sufficiently stable management” region (the pale blue area)

The Technical Strategic Plan 2022



(Reference)The Technical Strategic Plan 2021



※1 The red letters present major changes from the Technical Strategic Plan 2021.
※2 The origin of the arrow indicates the location for the residual water in flanged tanks reported in the Technical Strategic Plan 2021, which has been moved upward to reflect the results of the analysis of the radioactivity concentration prior to the treatment. ALPS slurry (HIC to be transferred) was separated from ALPS slurry this time and shown in pink, as is the fuel in the pool.

Fig. Risk levels posed by major risk sources at the Fukushima Daiichi NPS

Approach to ensuring safety during decommissioning

- As for decommissioning of the Fukushima Daiichi NPS containing the reactors involved in the accident, its peculiarities regarding safety should be fully recognized to ensure safety and sufficient attention should be paid to “the safety perspective” and “the operator’s perspective”.
  - ✓ Safety perspective : Ensuring safety should be the starting point for consideration. Determining the most appropriate safety measure (ALARP※)
  - ✓ Operator’s perspective : Perspectives and judgements from the standpoint of those who are familiar with the site and perform operations on site

Peculiarities of Fukushima Daiichi NPS

- ✓ A large amount of radioactive material is in an unsealed state, and in unusual and various (atypical) forms
- ✓ Barriers for containing radioactive materials are incomplete
- ✓ Significant uncertainties exist on the state of radioactive materials and containment barriers
- ✓ Difficulty in accessing the site and installing instrumentation devices to obtain on-site information
- ✓ Since the current level of radiation is high and further degradation of containment barriers is a concern, it is necessary to take measures in consideration of the time axis without prolonging the decommissioning activities

※ Abbreviation of As Low As Reasonably Practicable. This is the principle that the radiological impact must be as low as reasonably achievable.

Major targets and progress for fuel debris retrieval

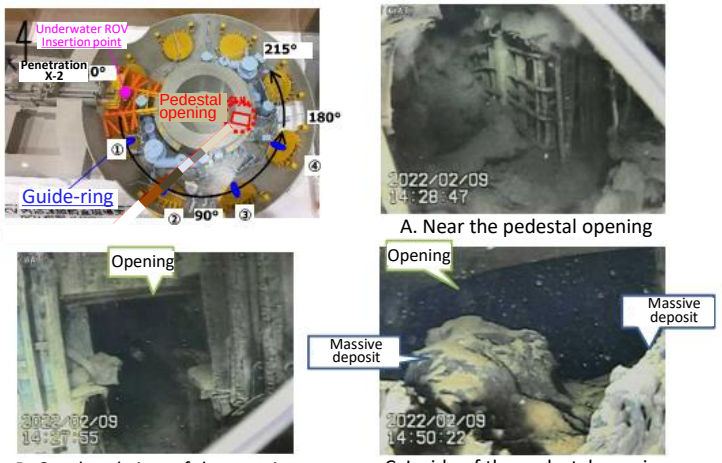
Major targets

- Trial retrieval in Unit 2 was scheduled to begin within 2021, but the process will be reviewed to improve work safety and reliability during retrieval in light of the impact of the COVID-19 pandemic, the mock-up testing that has been conducted since February 2022, and the current on-site situation. The work is expected to start in late FY2023.
- For further expansion of fuel debris retrieval in scale, consideration will be given to the methods including those for containing, transferring, and storing of fuel debris, by assessing fuel debris retrieval in Unit 2, internal investigations, research and development, and the on-site environmental improvement, etc.

Progress

Status of PCV internal investigation in Unit 1

- So far, massive deposits have been observed and it was confirmed that concrete in the pedestal was partially missing in the vicinity of the worker access opening.
- Based on the past assessment by IRID and the observations of the pedestal, for partially missing concrete, TEPCO assumes that it is unlikely to lead to large-scale damage or other problems.
- It is necessary to expand its findings through further internal investigations and to conduct the impact assessment on the plant.



(Source: The Secretariat Meeting of the Decommissioning and Contaminated water treatment team meeting, Feb.24, 2022)

Investigation results at pedestal opening

Challenges and technical strategies for trial retrieval from Unit 2 (internal investigation and fuel debris sampling)

Challenges and technical strategies

- Trial retrieval (internal investigation and fuel debris sampling) is a series of operations, and fuel debris sampling is one part of 11 steps.
- After opening the hatch of the penetration X-6 and extending the containment barrier outside the PCV, it is important to ensure containment as the inside of the enclosure becomes progressively contaminated.
- For on-site applications with uncertainty, the challenges are to ensure functionality verification under various conditions and equipment can be rescued in case of emergency.

- ✓ It is necessary to ensure that the required conditions are satisfied by conducting mock-up tests.
- ✓ Due to the uncertainty of the PCV internal situation, work must be performed safely and carefully, keeping in mind that things may not go as planned.

Work steps

1. Preparations (finished)
2. **Install the isolation chamber ← being implemented**
3. Open the hatch of the penetration X-6
4. Remove deposits inside the penetration X-6
5. Install the robot-arm
6. Enter the robot-arm
7. Internal investigation/fuel debris sampling
8. Collect from fuel debris retrieval equipment to transport container/measure dose
9. Accept into glove box/measure
10. Remove container/store in canister and carry out
11. Off-site transport and off-site analysis

Further expansion of fuel debris retrieval in Unit 3

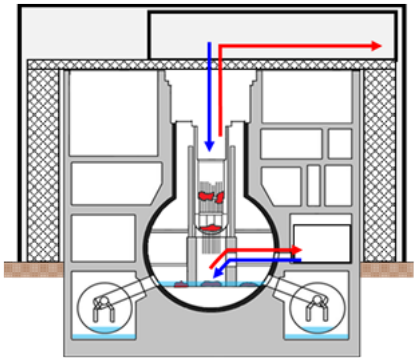
Challenges and technical strategies

- A variety of retrieval methods have been studied since FY2021, not ruling out any possibilities.
- The partial submersion 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.

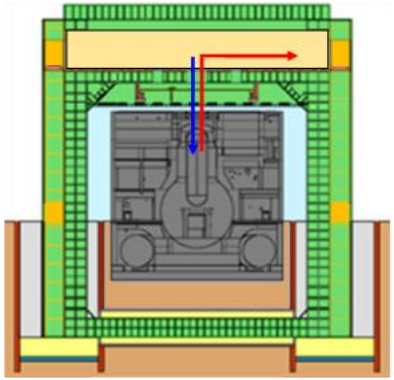
✓ Once feasibility has been confirmed to some extent, it will be necessary to narrow down the options step by step while proceeding with the design.

✓ 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)



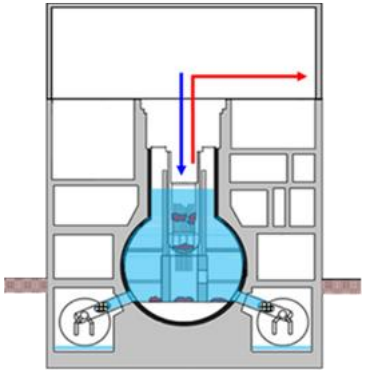
An example of partial submersion methods
(Conceptual drawing of Combination of top-access and side-access)



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

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

<Reference>



Conventional submersion method
(Conceptual drawing of PCV submersion method)

Major targets for waste management

Major targets

- The Solid Waste Management Plan (hereinafter referred to as the “Storage Management Plan”) is appropriately developed, revised and implemented, with updating the estimated amount of solid waste to be generated in the next ten years periodically. According to this Plan, temporary outdoor storage of the solid waste will be eliminated completely by FY 2028 (except for secondary waste generated by water treatment and targets of reuse/recycling).
- Given the prospects of processing/disposal methods and technology related to their safety presented in FY 2021, appropriate measures should be studied as management approaches for overall solid waste to establish a waste stream* according to the properties of solid waste.

*A series of handling procedures for each type of waste, from generation/storage to processing/disposal.

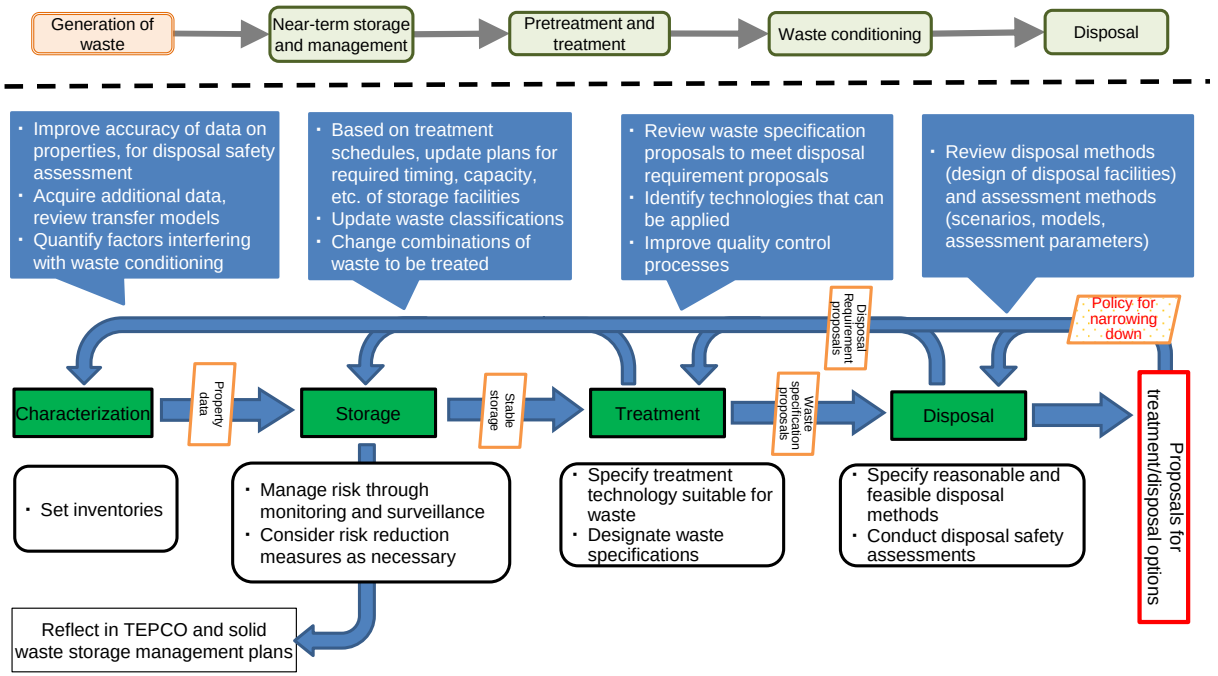


Fig. Procedure to reasonably select safe processing/disposal methods of solid waste

Major challenges and technical strategies for waste management

Challenges and technical strategies

Characterization

- For a variety of solid waste, it is needed to develop a medium-to-long-term analysis strategy that defines its priority, the objective of the analysis, and quantitative targets, etc., and to proceed with analysis/evaluation accordingly.

→

- ✓ Accumulate trial results and verify their validity in order to establish a development flow of the medium-to-long-term analysis plan with an analysis project approach using statistical methods,.

Storage/management

- Storage/management of solid waste according to the progress of decommissioning work in the future should be advanced in a safe and reasonable manner, including temporary outdoor storage of the solid waste (except for secondary waste generated by water treatment and targets of reuse/recycling) will be eliminated (by FY 2028), that is stated in the Mid-and-Long-term Roadmap.

→

- ✓ Examine further possibilities by referring to advanced cases of overseas, while steadily continuing approach for volume reduction.
- ✓ Promote volume reduction through incineration, and cutting/crushing, and steadily consolidate storage inside buildings.

Processing/disposal

- The Mid-and-Long-term Roadmap stated that the specifications of waste form and their production methods will be determined in Phase 3, the study on appropriate overall measures should be initiated for specific management for solid waste.

→

- ✓ Create processing/disposal options for solid waste by examining pending issues related to processing technology and disposal options.
- ✓ Compare and evaluate options using the property data that are becoming clear, and examine to establish a waste stream that is suitable for the characteristics of solid waste.

Major targets and technical strategies for contaminated water management

Major targets

- To arrange the relationship with a decommissioning process including full-scale fuel debris retrieval beginning in the near future, and to promote examination of the measures of the contaminated water management for medium-and-long term prospects.

Challenges and technical strategies

- The water quality of contaminated water depends on the cutting and fabrication method (forms of α-nuclides)
- It is difficult to assume the water quality in a situation where the fuel debris retrieval method has not been determined. The water treatment systems should have a system configuration to cope with a wide range of water quality.

✓ It is necessary to determine the required specifications for the water treatment systems when retrieving fuel debris, then incorporate into basic design promptly in order to review the overall picture in considering the share of functions with the existing systems and to promote planned replacement of the existing systems.

Major targets and technical strategies for discharging ALPS-treated water into the ocean

Major targets

- For the ALPS-treated water currently stored in tanks, measures will be taken for discharging the treated water about two years after the Basic policy (released in April 2021)

Challenges and technical strategies

- In addition to “reliably” operate a series of plans including system operation, analysis of ALPS-treated water, maintenance and response measures in the event of trouble, TEPCO must review and expand the plans as needed and ensure its transparency.

✓ It is necessary to reassess radiation impacts on human and environment based on the nuclides to be analyzed, and disseminate the assessment results with high transparency.

Major targets and technical strategies for fuel removal from spent fuel pools

Major targets

- The aim is to complete fuel removal from all spent fuel pools of Units 1 to 6 within 2031.
- To start removal of fuel in SFPs in FY 2027 to FY 2028 for Unit 1 and FY 2024 to FY 2026 for Unit 2.

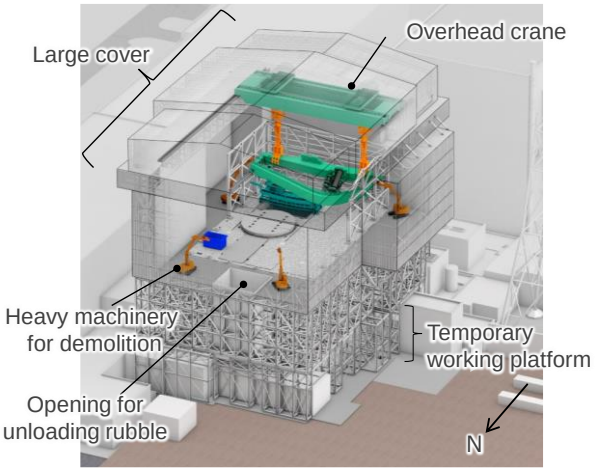


Fig. During rubble removal from Unit 1 (Conceptual drawing)

Challenges and technical strategies

Unit 1

In order to remove the overhead crane in an unstable state, a thorough investigation is needed.

→ It is important to promptly investigate it as soon as investigation becomes possible, and incorporate into safety assessment and rubble removal plans.

Unit 2

The challenge is to ensure that a fuel handling machine with a boom-type crane, which has not been used for nuclear facilities in Japan, is operated remotely.

→ It is important to be sufficiently familiar with the operation and functionality of systems beforehand.

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 analysis facilities.

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

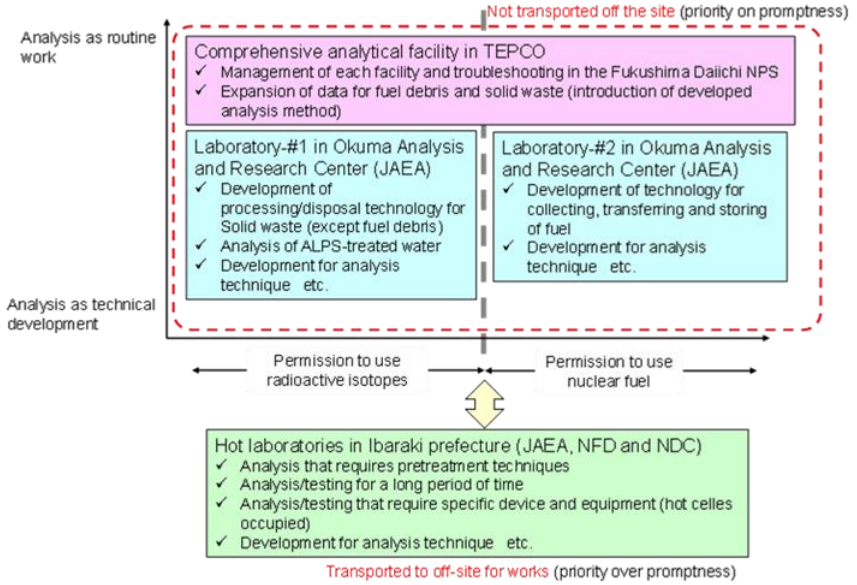


Fig. Characteristics and roles of each facility for analysis

Improvement of the quality of sample analysis results and use of non-destructive assay

Challenges and technical strategies

- Sample analysis can perform many analysis items, but the time required is long and the amount analyzed is small. So, it is difficult to measure a larger quantity analyzed.

- ✓ For non-destructive assay, time measured is shorter than that of sample analysis, and a larger quantity can be measured per measurement.
- ✓ In order to improve the accuracy of fuel debris characterization, application methods of non-destructive assay should be studied in the process from retrieval to storage.

Table. Relative comparison of principal specifications between the sample analysis to be performed in the analysis facility and non-destructive assay to be performed outside the analysis facility

	Analysis of samples performed in analysis facility*	Non-destructive assay performed out of analysis facility**
Time for analysis/ measurement	Long (△)	Short (○)
Items for analysis/ measurement	Many (◎)	Few (△)
Amount per analysis/ measurement	Small (△)	Large (◎)
Generation of liquid waste	Generated (△)	None (○)
Confinement during analysis and measurement	Unsealed	Unsealed or sealed
Dust prevention	Necessary	Necessary
Radiation shielding facility	Necessary	Necessary

◎ : Excellent　○ : Good　△ : Acceptable

* : The analysis will be conducted in a facility dedicated to analysis, such as a hot laboratory suitable for dealing with fuel debris samples.

** : The facility will be used in the process from retrieving to storing fuel debris. The analysis will be conducted in a facility not dedicated to analysis.

5. Efforts to facilitate research and development

Significance and current state

- There are many difficult technical issues requiring research and development to promote the decommissioning from the perspectives of safe, proven, efficient, timely, and field-oriented.
- Eleven years have passed since the accident, the stage is currently shifting to promote development based on the engineering work by TEPCO.

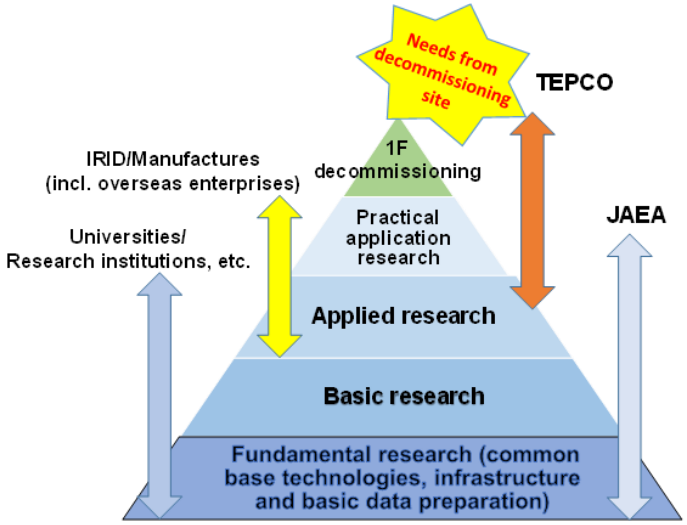


Fig. Scope of studying decommissioning R&D and implementation entities

Strategy

- NDF plans to further strengthen the functions related to R&D planning and proposals and efforts to ensure operation quality.
  - ✓ Starting in 2022, a request for information (RFI) was made to widely solicit information on technical issues to be resolved (planning and proposals).
  - ✓ Review System will be established for all Projects of Decommissioning and Contaminated Water/Treated Water Management to ensure the actual site applicability of the Project and to improve the quality of R&D (ensuring the quality of the Project).
- TEPCO needs to be committed to decommissioning research more proactively including independent technology development by TEPCO, uniting with a new company*.

＊ *"Toso Mirai Technology Company"* established in October 2022

Project management approach

Significance and current state

- In order to facilitate decommissioning, establish and enhance the management system for achieving the goal of the project.
- Project management allows efficient risk reduction of the project by evaluating from the viewpoints of safety, quality, cost, time, technical feasibility and other visions.

Strategy

- Further enhancement of owner's engineering abilities
  - ✓ In facing unprecedented fuel debris retrieval, engineering judgments should be made and “project management capability“ and “engineering based on safety and operator’s perspectives” that are responsible for the results are needed.
- Developing and securing human resources for smooth implementation of decommissioning projects
  - ✓ Human resource allocation including required capability/competence and workforce count should be planned, and human resource development plan should be provided to achieve it.
  - ✓ Number of experts and time needed by technical field should be assumed, including human resource with higher expertise.

Strengthening international cooperation

Significance and current state

- Learn lessons from precedent overseas cases, and utilize the world's highest level of technology and human resources
- Sharing our decommissioning experience in Fukushima Daiich with the international community is Japan’s responsibility.
- As an intergovernmental framework, annual dialogue has been held to share information with other countries. The relevant domestic organizations have concluded cooperative agreements with overseas organizations and have disseminated information at international conferences.

Strategy

- It is important to maintain and develop the international community’s continuous understanding of and interest in decommissioning and cooperative relationships.
  - ✓ Continuing dissemination of accurate information on the decommissioning progress with ensuring transparency of information.
  - ✓ Eleven years have passed since the accident, it is important to deepen the mutually beneficial relationship while also working to return the know-how and accumulated lessons learned so far to the internal community.

Fig. Exchanging opinions with experts overseas through face-to-face meeting and online (held in June 2022)

Local community engagement

Significance and current state

- The fundamental principle for the decommissioning of the Fukushima Daiichi NPS is “Balancing between reconstruction and decommissioning”. Revitalizing decommissioning-related industries is an important pillar of TEPCO’s contribution to the reconstruction of Fukushima.
- Based on TEPCO’s "Commitment to the people of Fukushima to achieve both reconstruction and decommissioning” established at the end of March 2020, efforts for the accumulating decommissioning industries need to be made with a view to creating opportunities for local enterprises to participate in the Fukushima Daiichi decommissioning project and a foundation for the local economy .

① Increased participation of local enterprises
② Support for local enterprises to step up

→ Opening prospects of placing orders to local enterprises, 1F inspection tours, holding matching sessions for specific business negotiations, etc.

➢ Efforts need to be made to further create participation opportunities.

③ Creation of new local industries → Establishing joint ventures with partner companies for accumulating decommissioning industries in the Hamadori region.

➢ Creating new industries is desirable for accelerating the reconstruction of the local community

Strategy

* TEPCO Press release April 27/October 3, 2022
- *Toso Mirai Technology Company* (In collaboration with IHI Corporation)
- 【Tentative name】Hama-dori decommissioning-related product plant (in collaboration with Hitachi Zosen Corporation)

- It is important to consider initiatives that will enable local companies to receive constant and a certain scale of orders.
- Further strengthening of cooperation and collaboration with local governments, including Fukushima Prefecture, and local related organizations, including the Fukushima Innovation Coast Framework Promotion Organization and the Fukushima Soso Recovery Promotion Organization.