

**Technical Strategic Plan 2024
for Decommissioning of the Fukushima
Daiichi Nuclear Power Station of
Tokyo Electric Power Company Holdings, Inc.
(Explanatory Material)**

September 27, 2024

**Nuclear Damage Compensation and
Decommissioning Facilitation Corporation**

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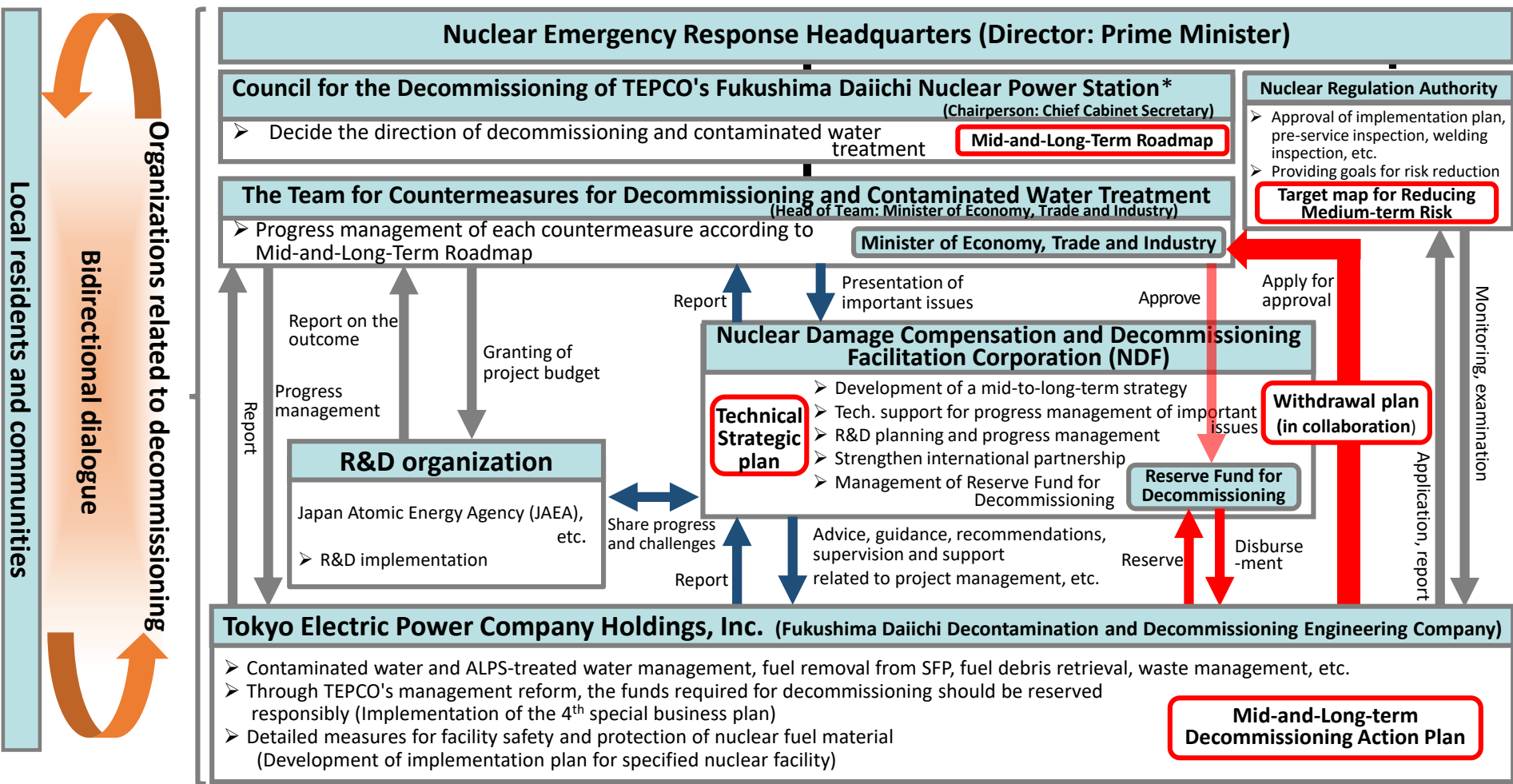
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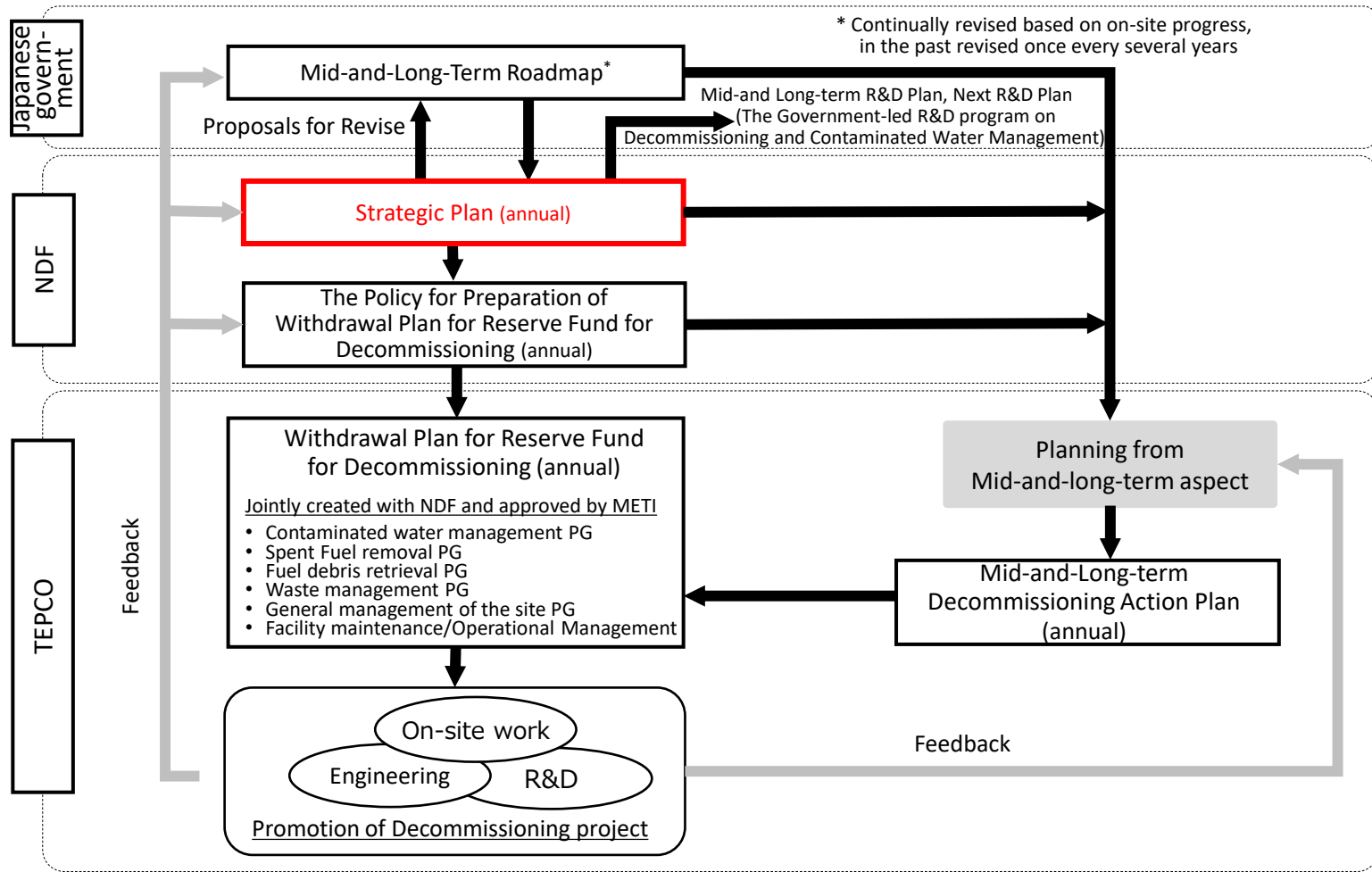
Division of roles of related organizations responsible for decommissioning of the Fukushima Daiichi NPS



* 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.



Positioning of the Technical Strategic Plan



Matters to be discussed in Phase 3

Decommissioning of the Fukushima Daiichi NPS enters a new stage toward the retrieval of fuel debris.

Issues and strategies

To accomplish unprecedented retrieval of fuel debris



- TEPCO works together with partner companies to advance step by step with safety first in design, construction and retrieval works.

Handling of fuel debris



- Debris samples are characterized and analyzed to determine the technical storage conditions and will be placed in a stably stored state.
- Specific technical requirements will be presented once fuel debris retrieval, analysis, and studies have progressed to a certain degree.

Dialogue with local community



- Honest and transparent dialogues with local communities will be continued until understanding is gained. (NDF continues direct dialogues with local residents about twice a year.)

Concept on risk reduction

Target

Bringing the risk levels into the “Sufficiently stable management region” (the pale blue area)

Red arrows present major changes from the Technical Strategic Plan 2023.

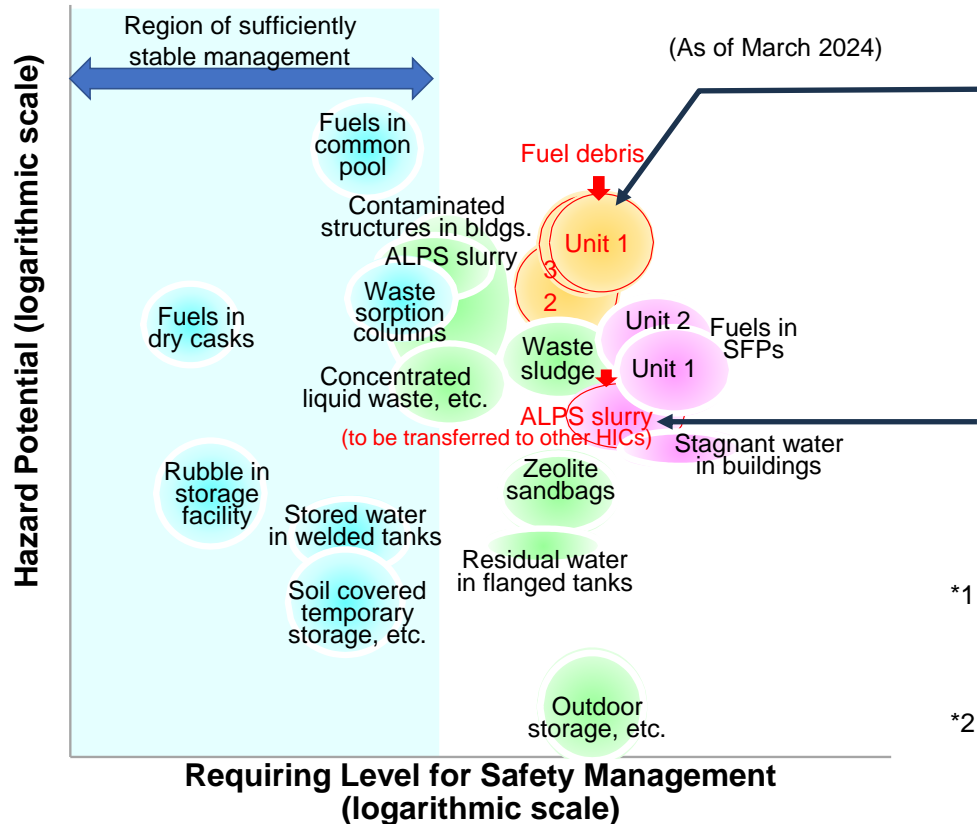


Fig. Risk levels posed by major risk sources at the Fukushima Daiichi NPS

Major change (1) Fuel debris

“Hazard Potential” has decreased

As a result of the evaluation of the changes in the hydrogen concentration after the suspension of nitrogen filling, which affects the time allowance, considering decay of radioactivity and distribution of fuel debris, Hazard Potential of fuel debris decreased and moved downward. (*1, 2)

Major change (2) ALPS slurry (to be transferred to other HIC)

“Hazard Potential” has decreased

As the transfer operation has progressed, the hazard potential of the ALPS slurry has decreased.

- *1 Time allowance is a factor of Hazard Potential. The time to reach the flammable limit of hydrogen concentration after nitrogen filling has suspended is considered as the time allowance in the case of fuel debris.
- *2 The time allowance is roughly categorized into “several days,” “several weeks,” “several months,” etc., and its category affects the assessment of Hazard Potential. In the previous assessments, the time allowance has been evaluated into “several weeks” being more likely, but the latest assessment changed it to “several months” being more likely, resulting in a major change from the previous reports.”

Approach to ensuring safety during decommissioning

Issue

The peculiarities of Fukushima Daiichi should be fully recognized to ensure safety.

As for decommissioning of the Fukushima Daiichi NPS containing the reactors involved in the accident, safety perspective and operator's perspective should be reflected to address safety peculiarities.

Peculiarities of Fukushima Daiichi NPS

Atypical & unsealed

A large amount of radioactive material is in an unsealed state, and in unusual and various (atypical) forms

Incomplete barriers

Barriers for containing radioactive materials are incomplete

Large uncertainty

Significant uncertainties exist on the state of radioactive materials and containment barriers

Difficult to measure

Difficulty in accessing the site and installing instrumentation devices to obtain on-site information, due to constraints such as high radiation levels

Need to be aware of timeframes

Further degradation of containment barriers is a concern

Time available for response

Small intrinsic energy and slow state change, allowing a large time available for responding to failures, etc.

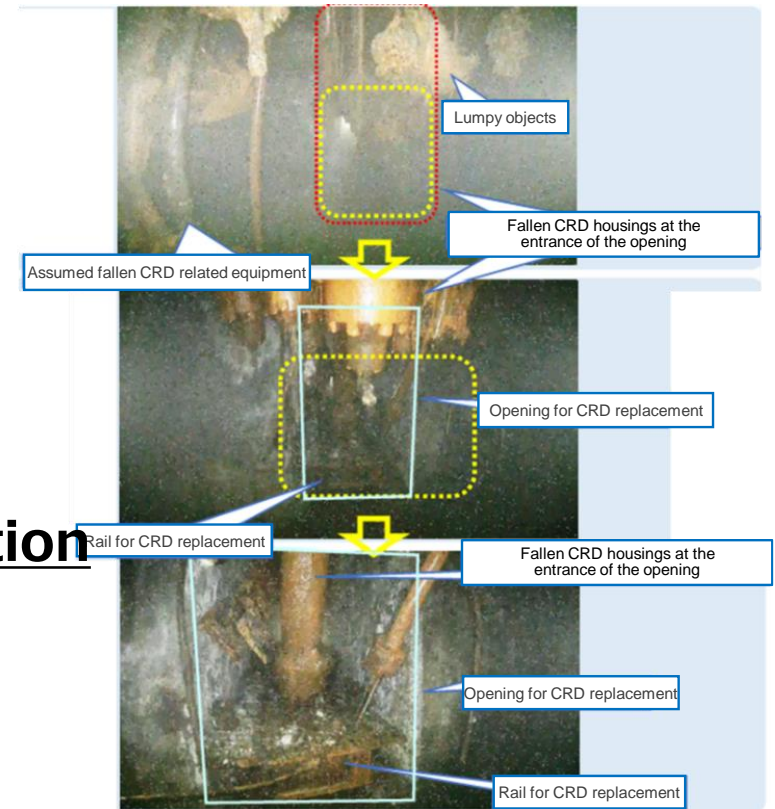
Major targets and progress for fuel debris retrieval

Major Targets

- To make progress of the internal investigations and gradual expansion of fuel debris retrieval etc. and to gain information and experiences as necessary towards the further expansion of the retrieval scale after the trial retrieval in the Unit 2 that started in September 2024
- TEPCO studies specific designs for further expansion of the retrieval scale in 1-2 years, based on the report by the Sub-Committee for the Evaluation of Fuel Debris Retrieval Methods

Progress Unit 1 Internal investigation

- PCV internal investigations were performed using drones for inside and outside the pedestal (dry area), and the effectiveness of drones was confirmed.
- As a result of the investigations, no major damage was observed on the outer and inner walls (dry area) of the pedestal.
- Inside the pedestal, it was found that control rod drive housings had fallen and lumpy objects were adhered to the upper section.



CRD housing inside the pedestal
(around the opening for CRD replacement)

(Source: Material of the Meeting of the Secretariat of the Team for Countermeasures for Decommissioning and contaminated water, March 28, 2024)

Fig. Results of the PCV internal investigation

3. Technological strategies toward decommissioning of the Fukushima Daiichi NPS 3.1 Fuel debris retrieval

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

Significance

Fuel debris retrieval is the first attempt at the Fukushima Daiichi NPS, and expanding the containment barriers to the outside of the PCV is a basic on-site configuration for planned retrieval operations.

Issues and technical strategies

The issue is to carry out fuel debris retrieval work steps in uncertain internal condition of the PCV.

- ✓ Rapid fuel debris sampling/analysis using telescopic-device
- ✓ Internal investigation with robot-arm and further sampling/analysis of fuel debris
- ✓ To make progress of the decommissioning safely and carefully based on the experience of problems during work

Work step for trial retrieval

01. Preparations (completed)
02. Install isolation chamber (completed)
03. Open the hatch of penetration X-6 (completed)
04. Remove deposits inside the penetration X-6 (completed)
05. Install penetration X-6 connection structure (complete)
06. Install telescopic device (complete)
- 07. Fuel debris sampling (trial retrieval) will be conducted**
08. Contain fuel debris
09. Accept/measure in glove box
10. Remove container/ store in canister and carry out
11. Off-site transport and off-site analysis

* Continued internal investigation and fuel debris retrieval using robot-arm

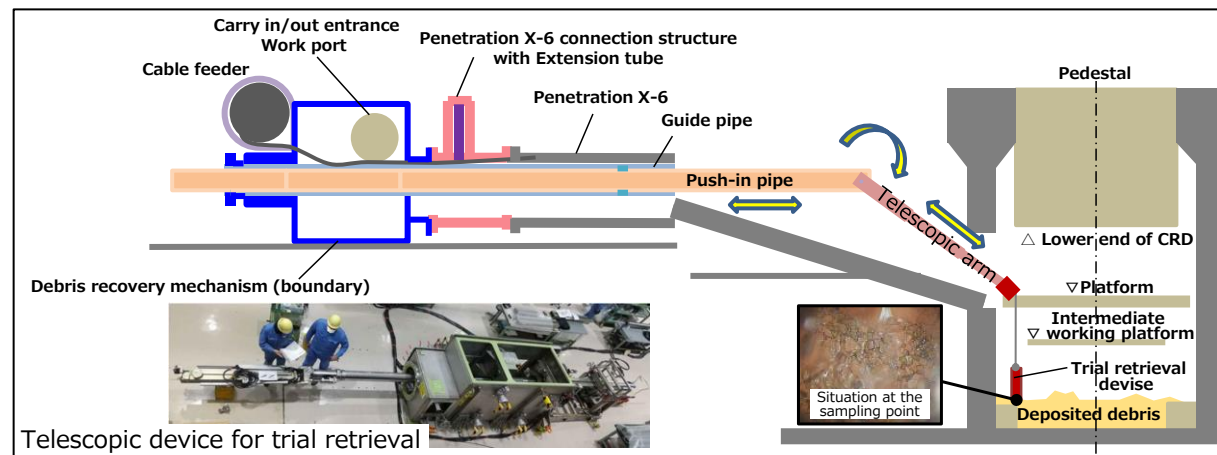


Fig. Debris sampling using telescopic device (Conceptual drawing)

Further expansion of the retrieval scale in Unit 3 (1)

Issues

Retrieval method selection and specific designs study need to be made, toward starting retrieval work in the 2030s.

▼

The Sub-Committee for the Evaluation of Fuel Debris Retrieval Methods was established and conducted specialized and focused studies, assessed the three retrieval methods proposed by the Sub-Committee, and summarized the recommendations for retrieval method selection

▼

Based on the recommendations by the Sub-Committee, TEPCO is proceeding with specific design studies, and plans to summarize the outcome by about the middle of FY2025 and then move onto the basic design phase

Recommendations for selecting retrieval methods

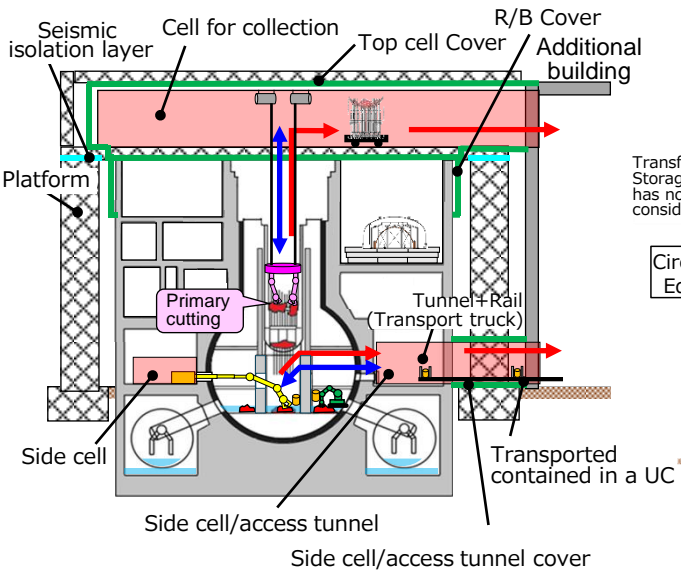
- ✓ Start design studies, research and development for a combination of the partial submersion method and the partial submersion with solidification/fill;
- ✓ proceed with small-scale internal investigations alongside, by accessing from the top; and
- ✓ concurrently study methods using water shielding function as well.

Further expansion of the retrieval scale in Unit 3 (2)

Outline of each retrieval method evaluated at the Sub-Committee

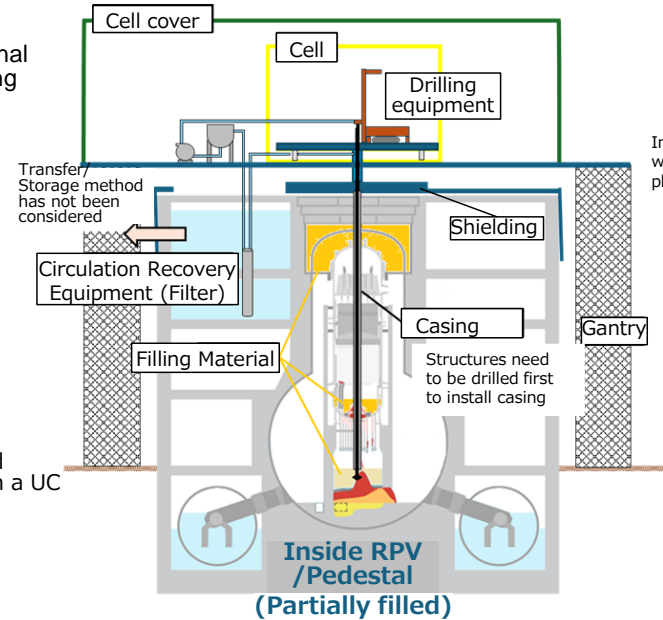
<Partial submersion method>

A method to retrieve fuel debris exposed to the air or immersed at a low water level



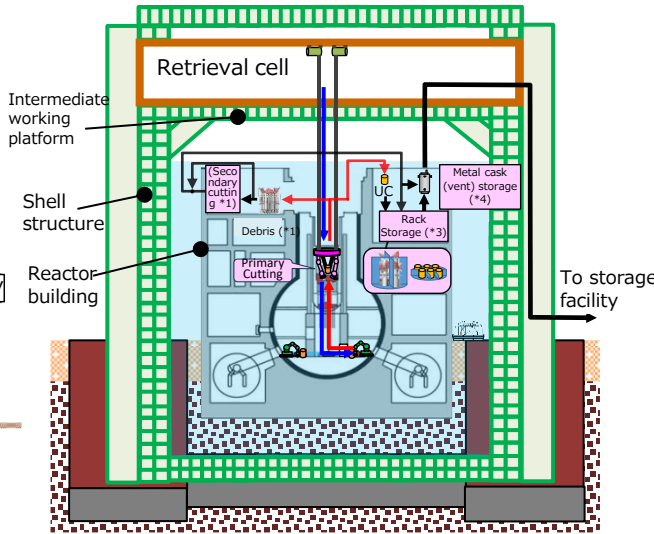
<Partial submersion with solidification/fill>

A method to solidify the pedestal bottom, the RPV, and the reactor well with fillers, and excavate and retrieve fuel debris together with the fillers.



<Submersion method>

A method to enclose the entire reactor building with a new structure, called a shell structure, and then flood the reactor building and retrieve fuel debris



[Legend in Figure]

- ➡ : Equipment/container carry-in/out route
- ➡ : Debris carry out route

Note: The outline of each method is an example and is not definitive.

Major targets for waste management

Major Targets

■ Appropriate measures should be studied as management approaches for overall solid waste to establish waste streams*.

* Individual waste streams, the flow of integrated measures from characterization to recycling and disposal of individual solid wastes, is evaluated, and the options that are recognized as safe and feasible are accumulated and integrated together.

■ Analysis plans are formulated and updated and the analysis necessary for each stage of the study from storage/management to disposal of waste is steadily conducted.

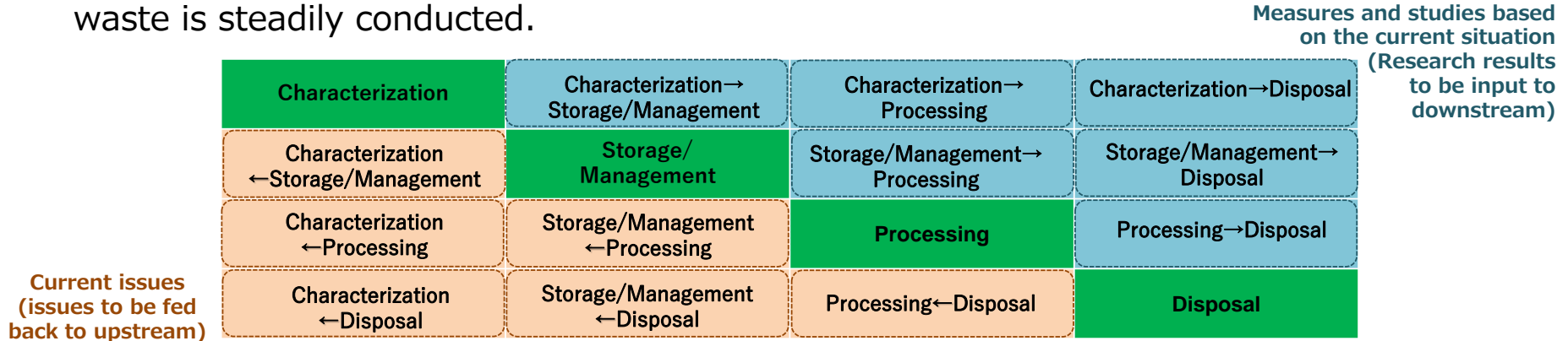
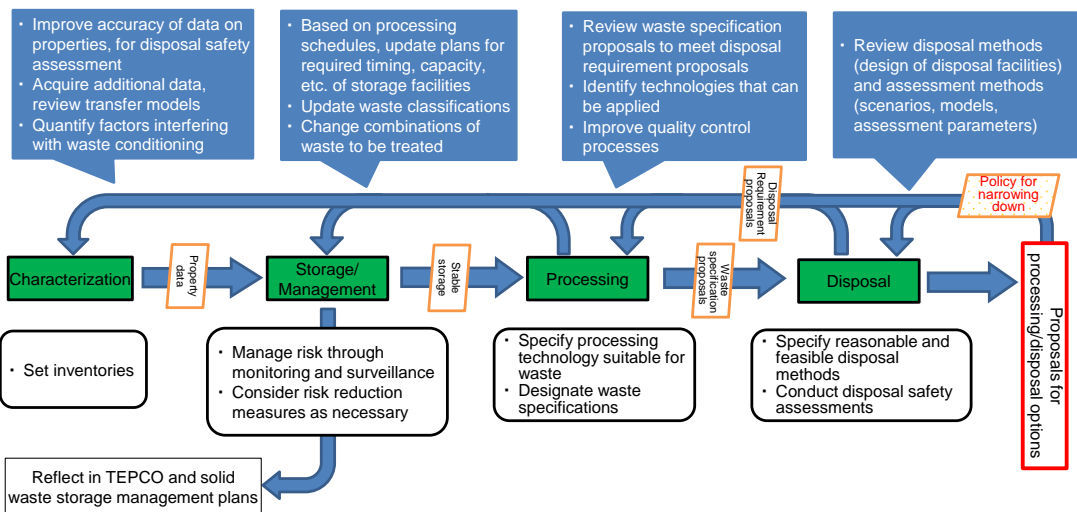


Fig. Procedure to reasonably select safe processing/disposal methods of solid waste

Key Issues and Technical Strategies Concerning Waste Management

Issues

Characterization

Waste management requires characterization of waste through analysis, and a medium-to long-term analysis strategy is required in which determining the priority, purpose, and quantitative target for various kinds of waste generated in large volume

Storage/management

More reasonable waste management is required, in order to safely and rationally proceed with storage/management of solid waste that will continue to be generated

Processing/disposal

Studies on appropriate handling methods in the management of solid waste in general need to be made in order to decide conditioning specifications and production method

Technical strategies

▶ For efficient analysis, consider an approach based on analysis planning methods using statistical techniques, etc.

▶ Shift from classification by surface radiation dose rate to management by radioactivity concentration that allows more appropriate storage/management, for more reasonable waste management

▶ Identify processing and disposal options through studies on technical issues and options of solid waste processing

↓
Compare and evaluate the options using waste property data obtained by analysis, and consider establishing a waste stream that is suitable for each type of solid waste

Major Targets and Technical Strategies Concerning Contaminated Water and Treated Water Management

Major targets

- Control the amount of contaminated water generated to about 50-70 m³/day by the end of FY2028

[The target to reduce it to about 100 m³/day or less by the end of 2025 was achieved about two years early]

- Give shape to ideal medium- to long-term contaminated water management, while maintaining coordination with other operations such as fuel debris retrieval
- Continue safe and reliable discharge of ALPS-treated water to secure the site and other resources necessary for promoting the decommissioning work

Technical strategies

Continue operation of land-side impermeable wall and sub-drain, take measures against rainwater including paving, and conduct local water sealing in buildings

Establish purification systems and in-building water sealing methods according to the fuel debris retrieval method, while giving consideration to interference among relevant operations

Continue disseminating the results of treated water analysis and marine monitoring in a prompt and transparent manner, while reliably operating treated water discharge facilities as planned

■ Results of ALPS-treated water discharge (8 times in total)

- Amount discharged: approx. 63,000 m³ [Total amount treated: approx. 1.3 million m³ (as of the start of discharge)]
- No abnormalities were observed in treated water transfer facilities, dilution and discharge facilities, etc., and their stable operation continues
- Prompt measurement of tritium concentration in the seawater near the outlet of treated water found that the concentrations are significantly lower than the index values (level to decide discharge suspension/level to trigger surveillance), verifying that treated water is being discharged safely as planned

Fiscal Year	Time of discharge	Period	Pre-dilution tritium concentration	Concentration of radionuclides other than tritium (Sum of ratios to regulatory concentrations)	Post-dilution tritium concentration	Amount of discharge	Total amount of tritium
FY 2023	First	Aug 24 to Sep 11 2023	140 thousand Bq/L	0.28	200 Bq/L	7,788m ³	Approx. 1,100 billion Bq
	Second	Oct 5 to Oct 23 2023	140 thousand Bq/L	0.25	189 Bq/L	7,710m ³	Approx. 1,100 billion Bq
	Third	Nov 2 to Nov 20 2023	130 thousand Bq/L	0.25	200 Bq/L	7,753m ³	Approx. 1,000 billion Bq
	Fourth	Feb 28 to Mar 17 2024	170 thousand Bq/L	0.34	254 Bq/L	7,794m ³	Approx. 1,300 billion Bq
FY 2024	First	Apr 19 to May 7 2024	190 thousand Bq/L	0.31	266 Bq/L	7,851m ³	Approx. 1,500 billion Bq
	Second	May 17 to June 4 2024	170 thousand Bq/L	0.17	234 Bq/L	7,892m ³	Approx. 1,300 billion Bq
	Third	Jun 28 to Jul 16 2024	170 thousand Bq/L	0.18	276 Bq/L	7,486m ³	Approx. 1,300 billion Bq
	Fourth	Aug 7 to Aug 25 2024	200 thousand Bq/L	0.12	267 Bq/L	7,897m ³	Approx. 1,600 billion Bq

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 by the end of 2031.

- Retrieval from Unit 1 started in FY 2027 to FY 2028
- Retrieval from Unit 2 started in FY 2024 to FY 2026

Issues and technical strategies

Unit 1

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

Unit 2

The issue 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.

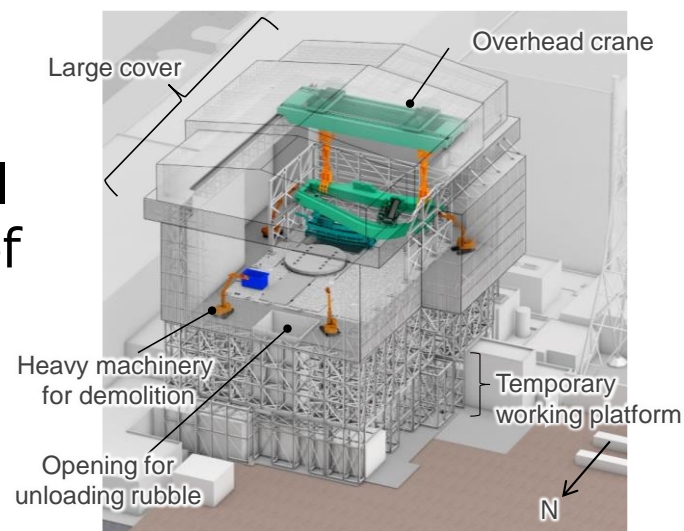


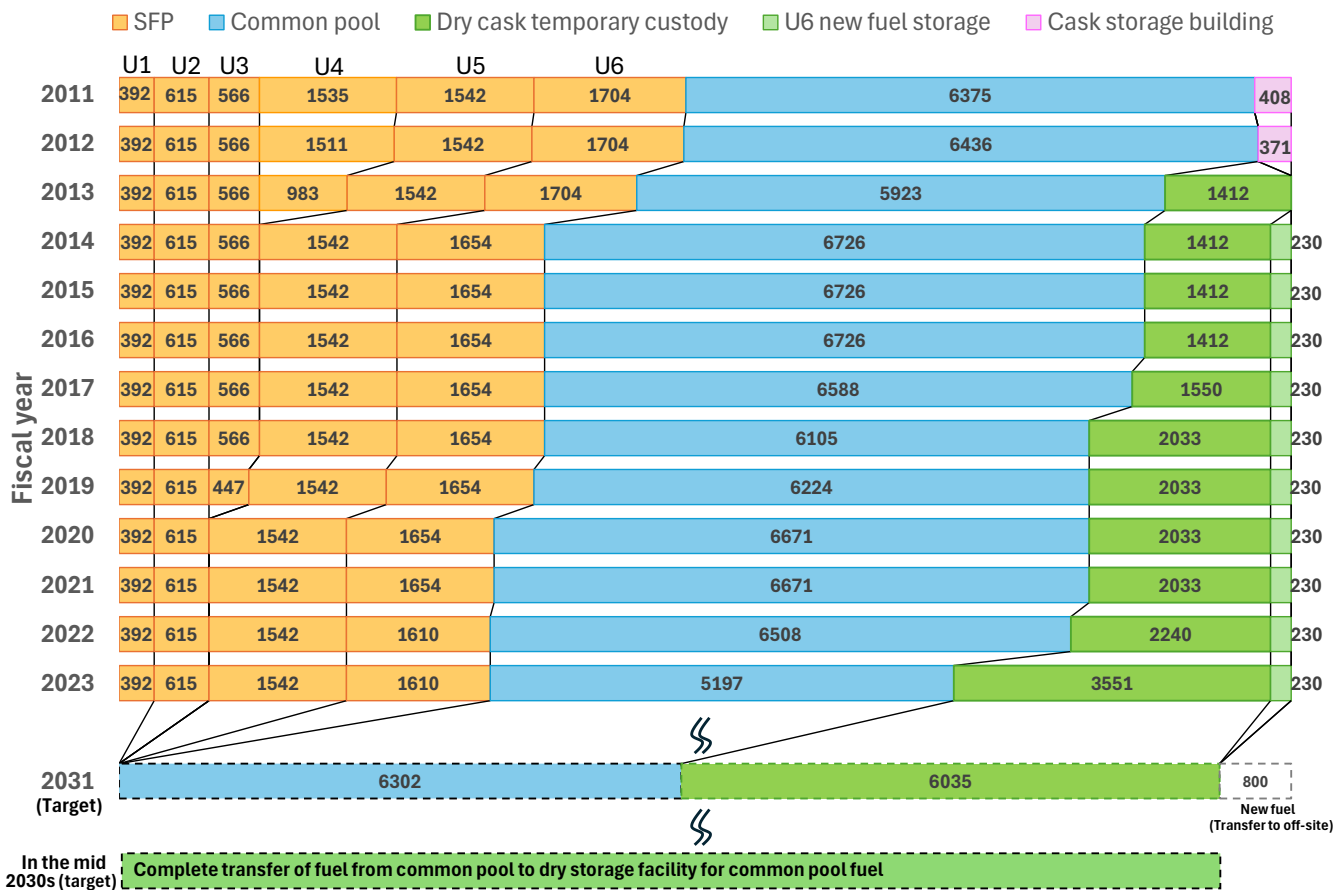
Fig. During rubble removal from Unit 1 (Conceptual drawing)

Promptly investigate it as soon as investigation becomes possible and incorporate into safety assessment and rubble removal plans.

To be sufficiently familiar with the operation and functionality of systems beforehand.

Transition of the fuel storage status

Spent fuel is steadily transferred to the safer common pool and stored appropriately.



* Dry cask at the temporary cask custody area : Started operation in 2013 Unit 4: Removal from spent fuel pool completed in 2014
 Unit 3: Removal from spent fuel pool completed in 2021
 Cask storage building (located beside the loading and unloading luggage port area before the accident): Stored dry casks were transferred to the Dry cask at the temporary cask custody area in FY 2013. New fuel as of 2031 (800 units) will be transported out of the site. 95 casks will be stored in the Dry cask at the temporary cask custody area.

Fig. Number of fuel in Fukushima Daiichi NPS at the end of each fiscal year

Purpose of the analysis and the analysis targets for Decommissioning

Purpose and significance

A wide range of analyses will be conducted on various samples to safely handle fuel debris and solid waste generated by the accident at the Fukushima Daiichi NPS, and to properly store and manage them.

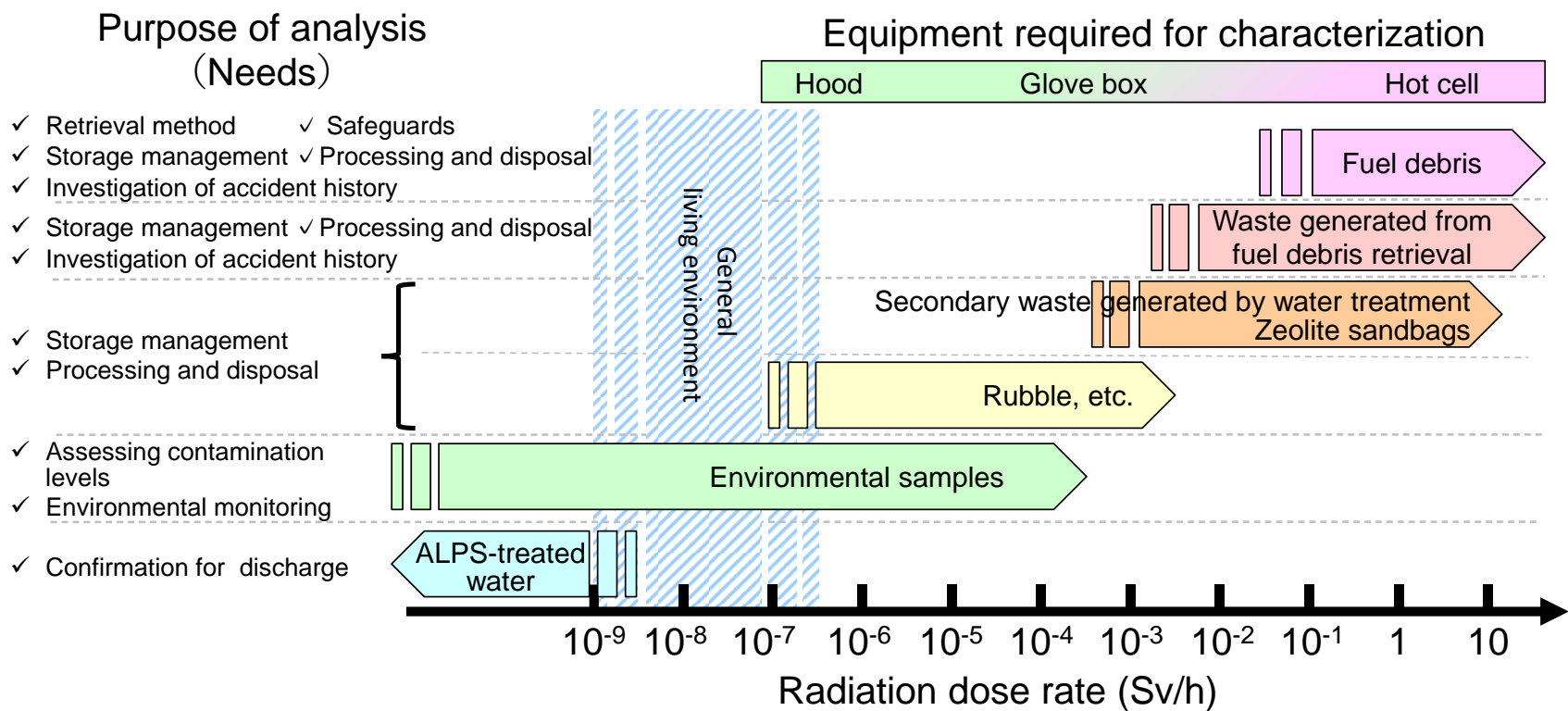


Fig. Relationship between the purpose of the analysis, equipment required for characterization, and radiation dose rates of the analysis targets

Issues and strategies

Strengthening analysis methods and structures

The issue is to analyze according to the plan, even when the volume of analysis increases in the future.



Formulate policies for characterization and analysis plans for waste with a high priority for analysis.

It is necessary to have a high level of ability to develop analysis plans that anticipate how the analysis results are utilized.



Organize "Characterization Plan Coordination Council" and "Analysis Support Team" to confirm analysis plans and provide advice on problem-solving, as well as develop human resources to formulate and update analysis plans.

Diversification of analytical techniques to increase sample size and volume

The issue with sample analysis is that each analysis takes a long time, and the amount analyzed is small.



It is important to study the application method of non-destructive measurement, which can measure large volume in a short time.

5. Efforts to facilitate research and development for decommissioning of the Fukushima Daiichi NPS

Significance

The steady promotion of decommissioning requires research and development to solve many challenging and technical issues.

Current status

- Recommendations for selecting retrieval methods were presented in March 2024, and full-scale engineering work by TEPCO has started.
- The implementation structure of the project has shifted from the IRID-led structure to a new one led by researching institutions and manufacturers on the basis of TEPCO's needs.

Strategies

- According to the recommendations by the Sub-Committee, while TEPCO proceeds with the engineering work, the relevant organizations (TEPCO, JAEA, NDF, etc.) study issues including basic/fundamental research and prioritize and accelerate the development in the Decommissioning Subsidized Project, the World Intelligence Project, and TEPCO's technological development
- Promote basic/fundamental research and human resource development initiatives that contribute to solving issues of the decommissioning, etc., through the World Intelligence Project, targeting universities and researching institutions
- Advance coordination between basic/fundamental research and applied/practical research, represented by practical research being underway for the use of a geopolymer developed through the World Intelligence Project as a candidate filling material for fuel debris retrieval in decommissioning subsidized project

Capabilities, organization, and personnel to proceed with decommissioning

Significance

To achieve goals in project-based operations such as the decommissioning of Fukushima Daiichi NPS, it is **essential to clarify the objectives, means, resources required, schedules, and risks and to manage project execution.**

Strategies

TEPCO's capabilities to be strengthened strategically

- ✓ Enhancement of engineering based on safety and operator's perspectives and investigation capabilities in the upstream side of the project

Building collaborative relationship with business partners

- ✓ It is important to build a supply chain in coordination with business partners for continuing with the decommissioning work that will run for a long period of time
- ✓ Reflecting on the series of incidents that occurred recently, TEPCO needs to carefully supervise and manage the entire decommissioning work with responsibility. For this reason, initiatives should be implemented to enhance education and management, such as improving the level of risk identification in operations and ensuring that operations are carried out under a defined work system, with the aim of ensuring safety and quality at the work site.

Initiatives to secure and foster human resources

- ✓ Activities to secure human resources necessary in a medium- to long-term and systematic development of leaders who will be responsible for the decommissioning are needed
- ✓ Implement initiatives for secondary and higher education stages, with a view to diverse areas of study, in the nuclear energy field and beyond

Strengthening international cooperation

Significance

- To learn lessons from precedent overseas cases, and **utilize the world's highest level of technology and human resources**
- **To share decommissioning experience in Fukushima Daiichi with the international community** is Japan's responsibility.
- **To gain international understanding and interest** in the decommissioning efforts of Fukushima Daiichi

Strategies

Integrating and giving back wisdom and knowledge from around the world

- ✓ Development of the robot-arm in cooperation with overseas companies and stationing of TEPCO employees to legacy sites
- ✓ Participation in various conferences including OECD/NEA and organization of the International Forum on the Decommissioning of the Fukushima Daiichi NPS

Maintaining and developing the international community's understanding, interest and cooperation in decommissioning

- ✓ Dialogue and exchange of opinions for experts in each country to enhance science-based and accurate understanding
- ✓ Clear and careful dissemination of information according to the interests of the recipients



The 8th International Forum on Decommissioning of the Fukushima Daiichi (August, 2024)

Stakeholder involvement

Significance

In achieving “Coexistence of reconstruction and decommissioning”, **revitalizing decommissioning-related industries is an important pillar of TEPCO’s contribution to the reconstruction of Fukushima.**

Current initiatives

- **Employment for Fukushima Daiichi NPS**
 - ✓ Approx. 3,500 to 4,700 workers engage in operations on weekdays (daily average for the last 2 years up to July 2024)
 - ✓ Among them, about 70% are hired from the local communities (as of July 2024)
- **A total of 1,183 matching sessions (e.g., exchange meetings) were held as of the end of August 2024 for decommissioning-related industries**

Strategies

Initiatives to facilitate participation of local companies in the decommissioning

- ✓ Relevant organizations including TEPCO and NDF listen to prime contractors, etc., for issues they found and opinions they have, and consider ideal support systems for local companies to participate in the decommissioning
- ✓ Continue explanatory sessions on the Medium- to Long-Term Outlook for Future Orders and matching assistance for local companies to keep participating in
- ✓ Consider initiatives that enable local companies to continue to foresee orders of a certain size