Phase: **Preparation**

Decommissioning Process **"Transport/Storing/Storage (including Wastes containing Alpha Nuclides originating from Fuels)"**
Investigation Subject **"Characterization1"**
Issue **"Characterization"**

Needs

1. Understanding the properties of water treatment secondary waste

Characterization for rational waste management：【Short】

Desired state and reasons for it

- The secondary waste generated from contaminated water treatment has not been treated so much in the past. It is desirable to understand its properties, amount generated, dose, and quality, with a view to transport, storing and storage.
- At this time, it should be noted that water treatment secondary wastes that contain moisture and are stored outdoors under ventilated conditions may be subject to microbial growth, which may make analysis and subsequent solidification process difficult. Therefore, it is desirable to evaluate the effects of microorganisms, etc. under high radiation doses and to develop a countermeasure technology as necessary.
- Slurries with high water content may be dehydrated and stabilized. It is desirable to have a detailed understanding of the changes in properties and volume before and after dewatering, with an anticipation of storage, management, and even treatment and disposal.
- It is desirable to develop a medium- to long-term analysis strategy that defines target wastes, priorities, quantitative targets for analysis, etc. and to proceed with analysis and evaluation based on the strategy.

Current state against ideal

- It is the stage of collecting and analyzing samples that are important in waste measures, following the stage of analyzing samples that are easy to collect.
- In addition to existing analysis facilities such as the analysis facility at the JAEA Ibaraki site, construction of the Radioactive Material Analysis and Research Facility Laborator-1 (Okuma Analysis and Research Center) was completed in June 2022. Analytical work using radioactive materials began in October of the same year. Demonstration of the simplified and expedited analytical technology that has been completed in FY2023, with full-scale operations beginning in FY2024. In addition, a new analysis facility built by TEPCO is scheduled to begin operation in the late 2020s.
- In order to obtain analytical data on high-dose wastes, adsorbent from the cesium adsorption towers (KURION and SARRY) collected at the Fukushima Daiichi Nuclear Power Plant site has been transported to the JAEA Ibaraki analysis facility, and analytical methods are being investigated.

Issues to be resolved

- The secondary waste generated from contaminated water treatment are stored in adsorption towers, etc. and it is not easy to sample the contents due to the high dose, so it is necessary to understand and evaluate the properties.

- Storage may be continued for a certain period of time until processing and disposal. Therefore, especially it is necessary to evaluate the long-term integrity of the storage containers, considering the influence of component, which may affect on long term integrity, even its amount is trace. In addition, it is necessary to evaluate not only the degradation caused by radiation but also the aging properties of the waste materials themselves. Then, it is important to identify the issues that may occur and investigate a countermeasure as necessary.
- The secondary waste generated from contaminated water treatment is likely to be stored in the adsorption tower while it contains water. It is necessary to determine the chemical effects of water-containing wastes.
- It is important to formulate a medium- to long-term analysis strategy that defines the target wastes and their priority, analysis objectives and quantitative targets, etc., and to analyze and evaluate them based on the strategy.
- Since the target nuclides, analytical items, precision, the number of analytical samples, etc. required differ depending on the target waste, it is necessary to establish a system based on the appropriate division of roles according to the characteristics of the facility and the purpose of analysis.

2. Analyzing SF

Characterization for rational waste management：【Short】

Desired state and reasons for it

- It is desirable to analyze the fuel (wholesome fuel and failed fuel) in the SFP, with a view to transport, storing and storage.
- It is desirable to understand the impact of seawater and rubbles received during the accident with a view to future treatment and storage methods for the fuel in the pool.
- It is desirable to assess the status of the removed fuel so that necessary information can be obtained to evaluate the long-term integrity of the fuel and to determine the future treatment and storage methods.

Current state against ideal

- An assessment of the impact of seawater and debris on the fuel removed from Unit 4 has been conducted, and these impacts are expected to be small.

Issues to be resolved

- For fuel retrieved from the SFP, it is necessary to efficiently and reliably confirm the presence of and the extent of damage to it.

3. Evaluating the long-term integrity of SF

Characterization for rational waste management：【Mid】

Desired state and reasons for it

- Fuels in the SFP were in contact with seawater at the beginning of the accident, and some of the fuels are considered to have been damaged by explosions or falling rubbles, etc. It is desirable to evaluate whether or not such spent fuels will stay wholesome in the long term.
- With an eye toward future treatment and storage methods, investigations are required to evaluate the long-term integrity of the removed fuel and to treat it.

Current state against ideal

- An assessment of the impact of seawater and debris on the fuel removed from Unit 4 has been conducted, and these impacts are expected to be small.

Issues to be resolved

- It is necessary to clarify the factors that affect the long-term storing, understand the properties of the fuel retrieved from the SFP, and evaluate whether or not the long-term integrity can be ensured.
- The plan is to transfer the fuel in the pools of all units to the common pool by the end of 2031. After that, in consideration of tsunami risk, studies are underway for dry storage on higher ground, including existing fuel in the common pool. In addition to the existing metal casks as dry storage facilities, TEPCO is preparing with a view to introducing concrete casks using canisters which have been proven overseas. Regardless of which dry storage facility is selected, it is necessary to consider reasonable storage measures in consideration of the integrity of the damaged fuel.

4. Simplifying the management of waste generated from dismantling of the PCV/RPV/building

Characterization for rational waste management：【Long 1】

Desired state and reasons for it

- Considering the transport／storing／storage of waste, it is desirable to understand the properties of equipment in PCV／RPV／building and investigate an implementing method of dismantling work.
- For this purpose, it is desirable that the requirements, needs and points to be noted are presented from the transport／storing／storage side to the dismantling side of the PCV／RPV／building.

Current state against ideal

- At the bottom of the torus room in the reactor building, there is stagnant water containing α-nuclides derived from fuel debris in particulate form (α-sludge) and ionic form, and relatively high total α concentrations have been detected.
- The situation of α contamination in the Unit 3 reactor building and the presence of α sludge associated with the treatment of residual water at the bottom of the tank are becoming clear.

Issues to be resolved

- The characteristics of the wastes generated from dismantling of the PCV／RPV／building are very large in volume and wide in range from high to low contamination, and may contain alpha-nuclides and so on. Taking these factors into consideration, it is necessary to have technologies for understanding the properties of the waste more quickly, easily, reliably, and at a lower cost.
- The above technologies include one that can conduct on-site characterization of the wastes before dismantling. If on-site characterization becomes possible, it will be possible to feed back the results for the dismantling method and waste classification.
- In addition, it is necessary to assume the quantity and properties of waste that is expected to be generated before dismantling.

5. Evaluating the solid waste inventory

Desired state and reasons for it

- In order to contribute to the investigation on the transport, storing and storage of the waste, it is necessary to evaluate the amount of radioactivity (inventory) contained in the waste.
- Since the collection of waste samples is limited, it is necessary to estimate and evaluate the inventory using analytical methods, etc.
- In estimating the inventory, it is desirable to take into account the overall picture of the migration and behavior of radioactive elements.
- In estimating the inventory, it is desirable to include not only major nuclides but also nuclides with low concentrations.
- It is desirable to develop and advance analytical models for inventory estimation and evaluation in order to obtain more detailed results more quickly.
- With regard to low-dose waste, although the analytical work itself is not highly difficult, the amount of material is enormous, and therefore, the implementation of the total measurement requires an enormous amount of time. Efficient analysis and analysis planning methods are needed as well as volume reduction.
- For high-dose waste, sampling and analysis themselves are difficult, and the number of analytical data to be obtained is limited, so statistical inventory estimation based on a migration model is important.
- It is desirable to determine the radioactivity concentration by analyzing each waste with a view to promoting its reuse on the premises.

Current state against ideal

- Investigation is underway to establish a methodology for developing a medium- to long-term analytical strategy to determine the solid wastes to be targeted, their priority, and quantitative targets for analysis.
- A demonstration has been initiated and full-scale operation has been underway since FY2024 to use the outcomes of the analytical methods established so far for simple and rapid data acquisition as standard analytical methods in the Radioactive Material Analysis and Research Facility Laboratory-1(completed in June 2022).
- Efforts are underway to establish an efficient analytical planning method that combines the DQO process (a method developed by the U.S. Environmental Protection Agency to plan sampling of analytical samples for decision-making purposes) and statistical methods, based on the characteristics of both low-dose and high-dose wastes.
- In the storage and management of waste to date, management has been based on classification using surface dose rate as an indicator, since debris, etc. generated in large quantities were contaminated due to fallout. In the future, in order to ensure more appropriate storage and management, the radioactivity concentration of each waste material is to be determined by analysis, with a view to promoting its reuse on the premises.

Issues to be resolved

- There are many different types of wastes, and even if they are of the same type (e.g., rubble), their individual inventories vary. Even for a single type of waste, the inventory varies depending on the location (surface vs. interior) and shape (pores vs. smooth areas). Under these circumstances, it is not practical to measure the inventory of all wastes, so it is necessary to

conduct sampling measurements and then evaluate the overall inventory. Therefore, it is required to have a technology that enables quick, easy, reliable, low-cost, and highly accurate evaluation.

- In order to realize an approach that efficiently ensures the necessary accuracy, which is important for low-dose wastes, it is required to proceed with efficient analysis through simplification and expediting, and establish an efficient analytical planning method incorporating the DQO process (a method developed by the U.S. Environmental Protection Agency to plan sampling of analytical samples for decision making) with statistical methods.
- As for high-dose wastes, it is required to continue efforts to collect and analyze samples from cesium adsorption vessels, which are currently being conducted, and to efficiently obtain data on actual samples using an analytical planning methods that combine the DQO process and statistical methods, as well as to investigate the priority of data to be collected for improving the accuracy of the migration model.

Relevant Issues

- SFP-301 "SF removal"
- FDR-301 "Fuel debris retrieval inside PCV"
- FDR-302 "Fuel debris retrieval inside RPV"
- DRB-301 "Removing in-core structures and dismantling buildings"
- TSR-201 "Technology development to assess and manage storage container integrity"
- TSR-202 "Understanding hydrogen generation behavior"
- TSR-204 "Design of canister specifications"
- TSR-205 "Criticality control"
- BST-003 "Measurement and analysis technology"