Technical Strategic Plan 2020 for Decommissioning of the Fukushima Daiichi Nuclear Power Station of Tokyo Electric Power Company Holdings, Inc.

(Explanatory Material)

October, 2020

Nuclear Damage Compensation and Decommissioning Facilitation Corporation

NDF

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1. Introduction (1/2)

Four key aspects in Strategic Plan 2020

The Strategic Plan 2020 presents mid-to-long-term technical strategy by focusing on the following four **key aspects of this year**.

First key aspect

- **In March, Tokyo Electric Power Company (TEPCO) announced its Mid-and-Long-term Decommissioning Action Plan**, describing the specific work schedule to accomplish the Mid-and-Long-term Roadmap. See pages 3 and 22.

Second key aspect

- With the trial retrieval of fuel debris approaching very soon, NDF once again reviewed the safety-prioritized operations and **established a new recommendation, "Approach to Ensuring Safety" section**. See page 7.

Third key aspect

- In **further expanding fuel debris retrieval**, on the premise of safety as the project executor, **the needs of setting requirements (boundary conditions)** in consideration of time, exposure dose and cost with realistic constraints are specified in the section "Fuel Debris Retrieval". See page 14.

Fourth key aspect

- **The administrative structure in R&D is enhanced**, since the **importance of R&D**, particularly that of the Government-led R&D Program on Decommissioning and Contaminated Water Management, **is growing**, in response to unprecedented difficulties of fuel debris retrieval in the future. See Page 21.

1. Introduction (2/2)

Purpose of TEPCO's announcement of its Mid- and Long-term Decommissioning Action Plan

- As one of major deliverables in 'Plan Review including Medium-to-long-term perspectives', TEPCO **newly provided its "Mid-and- Long-term Decommissioning Action Plan"**.

  ↑ **This year's first key aspect**

- **Based on the Mid-and-Long-term Decommissioning Action Plan** updated every year, **NDF and TEPCO jointly formulate the Withdrawal Plan** to promote the project.
- TEPCO's more active engagement became clear in the project by announcing the Action Plan.

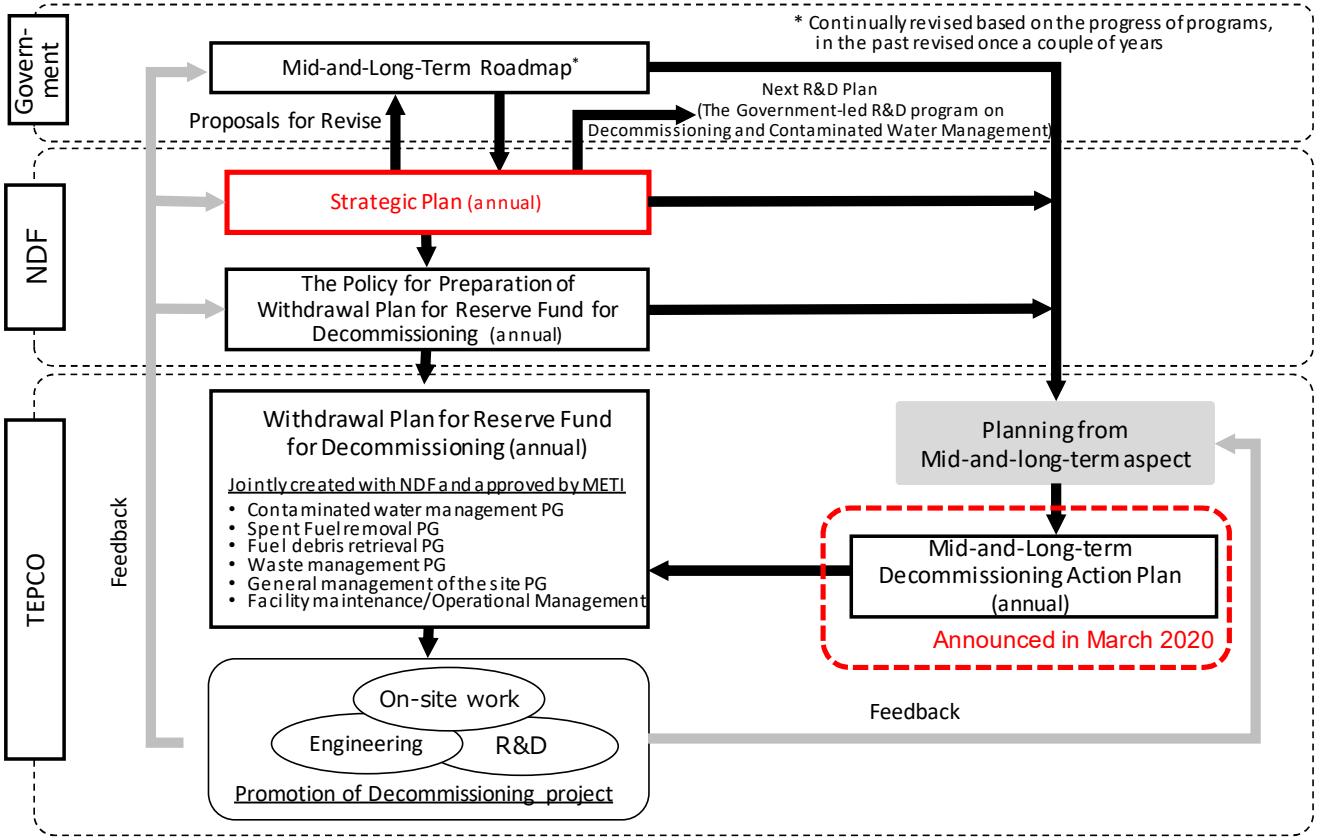
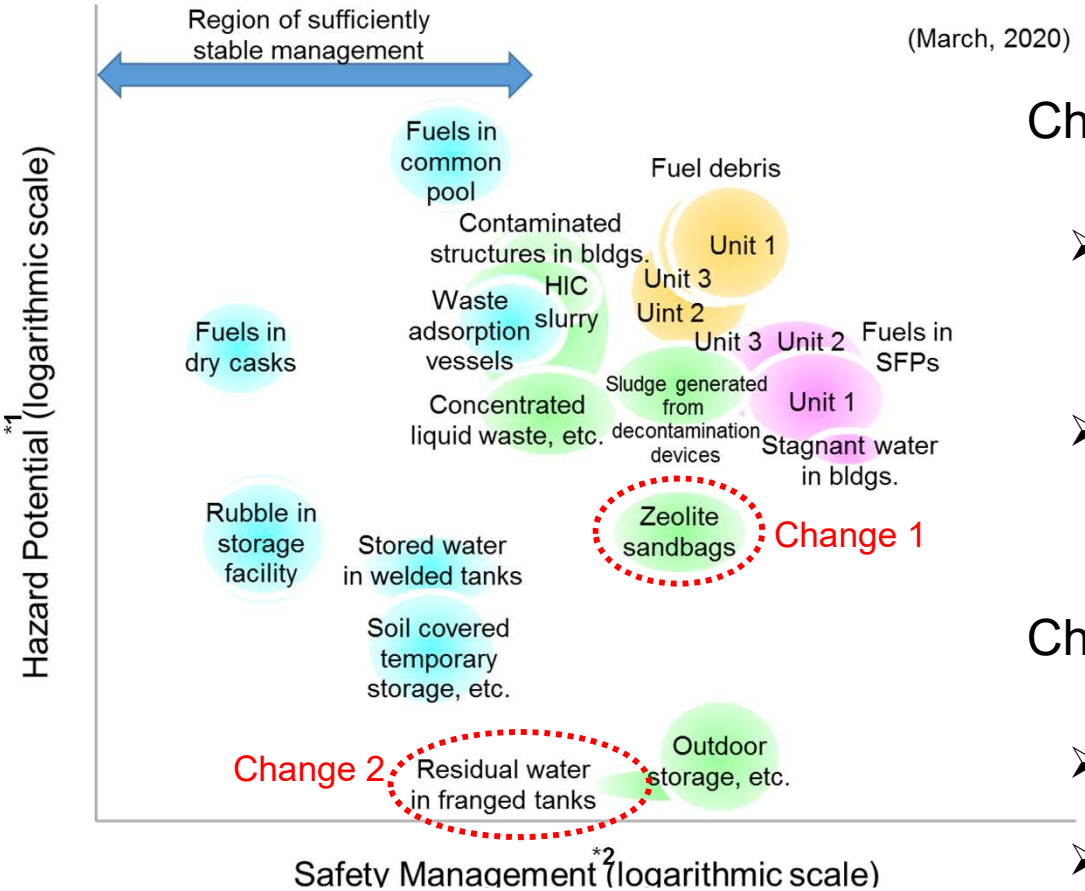


Figure: Positioning of strategic plan

2. Concept on risk reducing and safety assurance for decommissioning of the Fukushima Daiichi Nuclear Power Station (1/5)

Concept on risk reduction (1/3)

- The interim goal of the risk reduction strategy is **to bring risk items into the "Region of sufficiently stable management (pale blue area)**.



Examples of risk levels of Major risk sources at the Fukushima Daiichi PS

Major changes from last year

Change 1 : **Zeolite sandbags** are newly added into the major risk sources

- Zeolite sandbags were installed on the basement floors of the process main building and the high temperature incinerator building as contaminated water management activities .
- They were identified as miscellaneous risk sources in the Strategic Plan 2019, and were added into the major risk sources in the Strategic Plan 2020.

Change 2 : **Treatment of residual water** in the flanged tanks has **made progress**.

- Treatment of strontium-treated water remained at the bottom of the flanged tanks made progress.
- At present, 500m^3 of the residual concentrated salt water is stored only. (As of the end of August 2020)

*1: An index to show the severity of an event, depending on inventory (amount of radioactive materials), forms of risk source (such as gas, liquid, and solid), and time allowance to the exposure of risks after loss of safety function

*2: An index to show the likelihood of occurrence, depending on the health of facilities and containment and monitoring conditions of risk sources

2. Concept on risk reducing and safety assurance for decommissioning of the Fukushima Daiichi Nuclear Power Station (2/5)

Concept on risk reduction (2/3)

- There was still significant uncertainty, however, to eliminate uncertainties, many resources including long time are required. In order to realize prompt risk reduction it is necessary to make **integrated decisions through a flexible and prompt approach**, based on the directions determined with previously obtained experiences, **placing safety as the top priority**, even though a certain extent of uncertainties remain.
- As the **viewpoint** to make these comprehensive decisions, NDF summarizes the following five guiding principles:

(Five guiding principles)

- Safe: Reduction of risks posed by radioactive materials and ensuring of work safety
  (Issues such as containment of radioactive materials [environmental impact], and radiation exposure to workers, and assessment of risk reduction effects)
- Proven: Highly reliable and flexible technologies
  (Issues such as conformity to requirements, effectiveness and flexibility against uncertainty)
- Efficient: Effective and rational use of resources, including people, things, money, space, etc.
  (Issues such as reduction of waste generation, cost, improvement in efficiency, and securing necessary work area and site)
- Timely: Time consciousness
  (Issues such as early start of fuel debris retrieval and estimation of time required for fuel debris retrieval)
- Field-oriented: Comprehensive three-reality policy by checking actual site, actual goods, and actual situation
  (Issues such as workability including environment-friendliness, accessibility, and operability, and maintainability including ease in maintenance and troubleshooting)

2. Concept on risk reducing and safety assurance for decommissioning of the Fukushima Daiichi Nuclear Power Station (3/5)

Concept on risk reduction (3/3)

- It is important to **proceed with the decommissioning operation** after **greatly emphasizing on safety assurance** for the purpose of **protecting human beings and environment** from **radioactive materials** associated with the operations, **thoroughly conducting radiological consequence evaluation**, and **taking appropriate radioprotective measures**. (“Safe”)
- While controlling this risk as low as **reasonably** achievable (“Efficient”) as **promptly** as possible (“Timely”) in light of **the situation at the site**, proceeding with the decommissioning **in a reliable manner** (“Proven”) by **feasible ways** in the harshest condition on-site (“Field-oriented”) will lead to ensuring safety in **medium-to-long-term**.
- As for the result judged based on these guiding principles, it is also important to work to **disseminate information carefully** so that the results of this judgment will be **widely accepted by society**.

2. Concept on risk reducing and safety assurance for decommissioning of the Fukushima Daiichi Nuclear Power Station (4/5)

Concept on safety assurance (1/2) <= This year's second key aspect

■ Basic policy for **ensuring safety based on the characteristics of Fukushima Daiichi NPS**

✓ **"The safety perspective"** should be reflected in the decommissioning work review.

- The Fukushima Daiichi NPS containing the reactor involved in the accident is different from that of **a normal reactor** in that a great **uncertainty** exists about the status of radioactive materials and confinement barriers, and **on-site access** and **installation of instrumentation devices** to reduce the uncertainty **are** also **restricted**. Under such circumstances, a large amount of **atypical** and **unsealed** radioactive materials will be handled in an **incomplete containment** condition. Therefore, **the starting point** for all **reviews** needs to be **confirmation of the feasibility of ensuring safety** with a wide range of possibilities assumed.
- It is important **not to prolong** the work period, while paying attention to risk reduction over the entire work period. It is necessary to **avoid exceedingly few or excessive safety measures** by **performing thorough safety evaluations** and to **take optimum safety measures** (ALARP).

✓ Ensuring safety by incorporating **"the operator's perspective"**

- To ensure that safety measures are effective, **"the operator's perspective" (perspectives and judgements from the standpoint of those who are familiar with the site and perform operations and tasks on site)** is important.
- "The operator's perspective" is also important from the viewpoints such as **enhancement of safety in total through operations in addition to design** and **utilization of the information obtained through on-site operations into designing safety measures**.

✓ It is essential to **reflect "the safety perspective" and "the operator's perspective"** to address the characteristics of decommissioning of the Fukushima Daiichi NPS.

- In reviewing decommissioning work, **TEPCO**, as the project executor, should define the **"requirements"** for the work **in advance**, and should design specific safety measures to achieve them, **taking "the safety perspective" and "the operator's perspective" into account**.

2. Concept on risk reducing and safety assurance for decommissioning of the Fukushima Daiichi Nuclear Power Station (5/5)

Concept on safety assurance (2/2)

■ Preliminary implementation and utilization of the obtained information in the latter stages

- ✓ Considering current environment with already high radiation level and further deterioration of containment barrier, it is **necessary** to **improve such risk state** and **reduce uncertainties** as **quickly** as possible.
- ✓ The operation proceeds **with** its **safety ensured** through monitoring the condition inside reactor and restricting operational actions at each stage of the process. **Utilizing** the acquired information in the design **of subsequent stages** allows to **reduce uncertainties** as well as to improve the reliability of safety assurance and **rationalize** design.
- ✓ TEPCO is required to **quickly introduce** approach like this into actual **engineering** and **project management**. It is important to **accumulate experiences** acquired in this approach.

■ Approach to address a temporary increase in risk level associated with decommissioning operations

- ✓ While the decommissioning work is striving for prompt risk reduction, careful deliberation is required over the possibilities that the **performance of decommissioning work may temporarily change the risk levels** and **may increase the radiation exposure of workers.**
- ✓ The possibility of a temporary increase in the risk level must be addressed by **taking measures to prevent and restrict** them. It is necessary to operate with **thorough preparations, i**n particular, **the radiation safety of workers** should be ensured in accordance with **the concept of ALARA** (to suppress radiation exposure to As Low As Reasonably Achievable).

3. Technological strategies toward decommissioning of the Fukushima Daiichi Nuclear Power Station (1/12)

① Fuel debris retrieval (1/7)

Targets

(1) **Retrieve fuel debris safely after thorough and careful preparations**, including safety measures, and bring them **to the state of stable storage under full management**.

(2) **Beginning with trial retrieval of fuel debris from Unit 2,** the first implementing unit **within 2021, then start the gradual expansion of fuel debris retrieval and a series of operations timely.** Through this process, acquire knowledge and experience necessary for the further expansion of fuel debris retrieval in the future.

(3) To further expand the retrieval scale, thoroughly examine the result and progress of the fuel debris retrieval from the first implementing unit, through **internal investigation, R&D (the government-led program on decommissioning and contaminated water management and TEPCO's voluntary project),** on-site environmental conditions. Through this process, study the best methods of contain, transfer, and store.

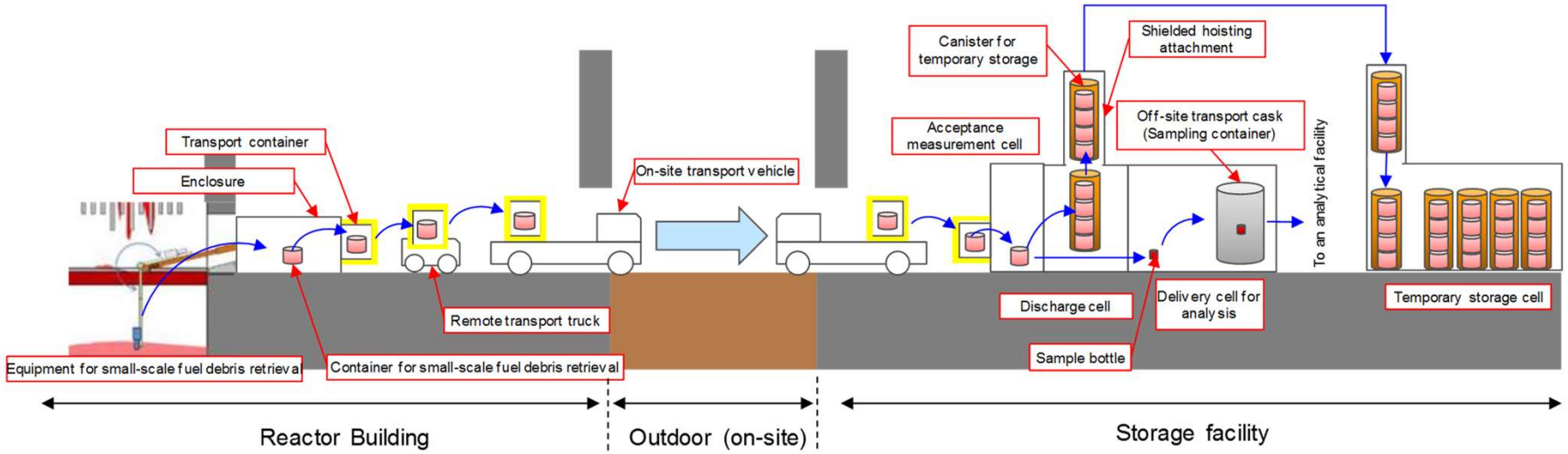


Figure : Image from retrieval to temporary storage of fuel debris (Gradual expansion of retrieval scale)*

* Edited by NDF based on TEPCO materials

3. Technological strategies toward decommissioning of the Fukushima Daiichi Nuclear Power Station (2/12)

① Fuel debris retrieval (2/7) Technical strategy

■ Trial retrieval, internal investigations of PCV and gradual expansion of fuel debris retrieval

✓ Although small in scale, this is a fundamental form of site construction for future work, in which **an opening** will be newly provided to **extend the containment barrier** outside the PCV. It is an approach that enters **a new stage**.

- Containment barrier will be extended from blank flange part of the penetration X-6 to **an isolation chamber** and **an enclosure**.

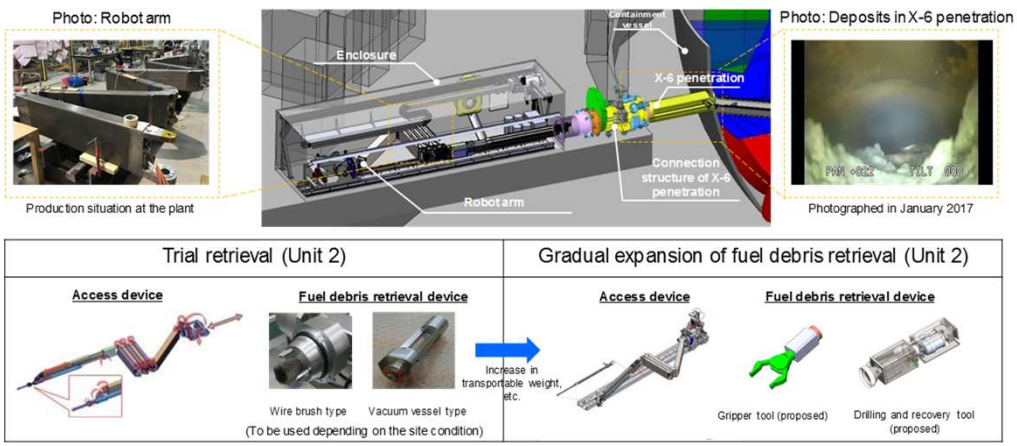


Figure 1 : Image of fuel debris retrieval system (Trial retrieval and subsequent gradual expansion)*

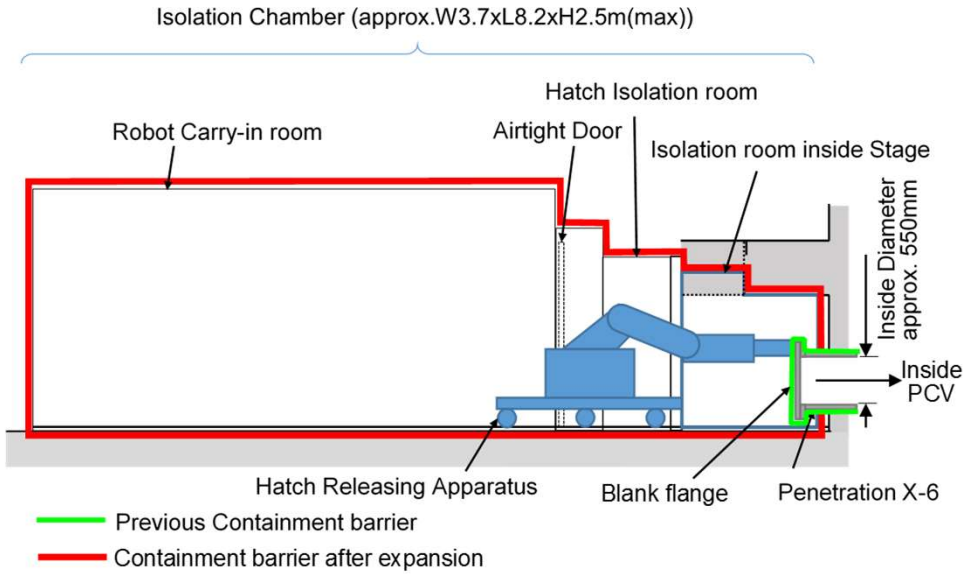


Figure 2 Schematic drawing of Isolation Chamber to be installed at Penetration X-6 *

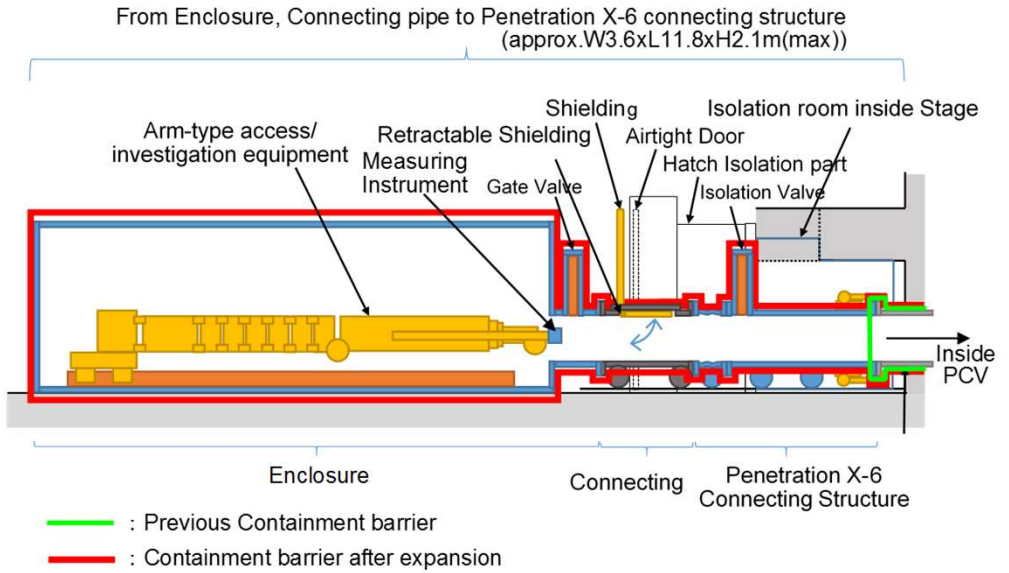


Figure 3 Schematic drawing of enclosure to be installed at Penetration X-6 *

* TEPCO material edited by NDF

3. Technological strategies toward decommissioning of the Fukushima Daiichi Nuclear Power Station (3/12)

① Fuel debris retrieval (3/7) Technical strategy

■ Trial retrieval, internal investigations of PCV and gradual expansion of fuel debris retrieval

- ✓ With regard to the trial retrieval, it is important to conduct **a mock-up test simulating the harsh site environment** from **the operator's perspective**, while adequately confirming **safety** and **the actual site applicability** to **steadily** proceed.
- ✓ It is also important for TEPCO **to take the initiative** in promoting engineering based on the **considerations** related to **acquisition and utilization of information during fuel debris retrieval**.
  - Due to the restricted attendance of engineers under the influence of the coronavirus, it is **assumed that the planned work would be more difficult** than before, and therefore, **more deliberate and careful attention should be paid to ensuring safety.**
- ✓ Removal of obstacles, a trial retrieval, and internal investigations of PCV that are performed after opening the penetration X-6 shall be deemed as **integrated work**.
  - According to the state of obstacles in the PCV and the internal conditions actually obtained , **the sequence and method** of removing obstacles, a trial retrieval, and internal investigations of PCV may vary depending on the observation results obtained at that time.

3. Technological strategies toward decommissioning of the Fukushima Daiichi Nuclear Power Station (4/12)

① Fuel debris retrieval (4/7) Technical strategy

■ Further expansion of fuel debris retrieval

✓ **Study flow of the retrieval methods**

- **Operations, devices and equipment, and facilities will be larger in scale and the scope of construction will be wider** than in the case of retrieving fuel debris from the first implementing unit (Unit 2), much more attention should be paid in **overviewing the entire Fukushima Daiichi NPS**, including other works.
- Because of the high dose on site and the limited understanding of the situation inside the PCVs, **the scope of operations will be enlarged**. Therefore, it is important **to specify the requirements** required for operations and devices **more clearly** and to proceed with the **study of the systematic retrieval method**.
- NDF will evaluate **the actual site applicability** and **feasibility** based on the results of TEPCO's conceptual study.

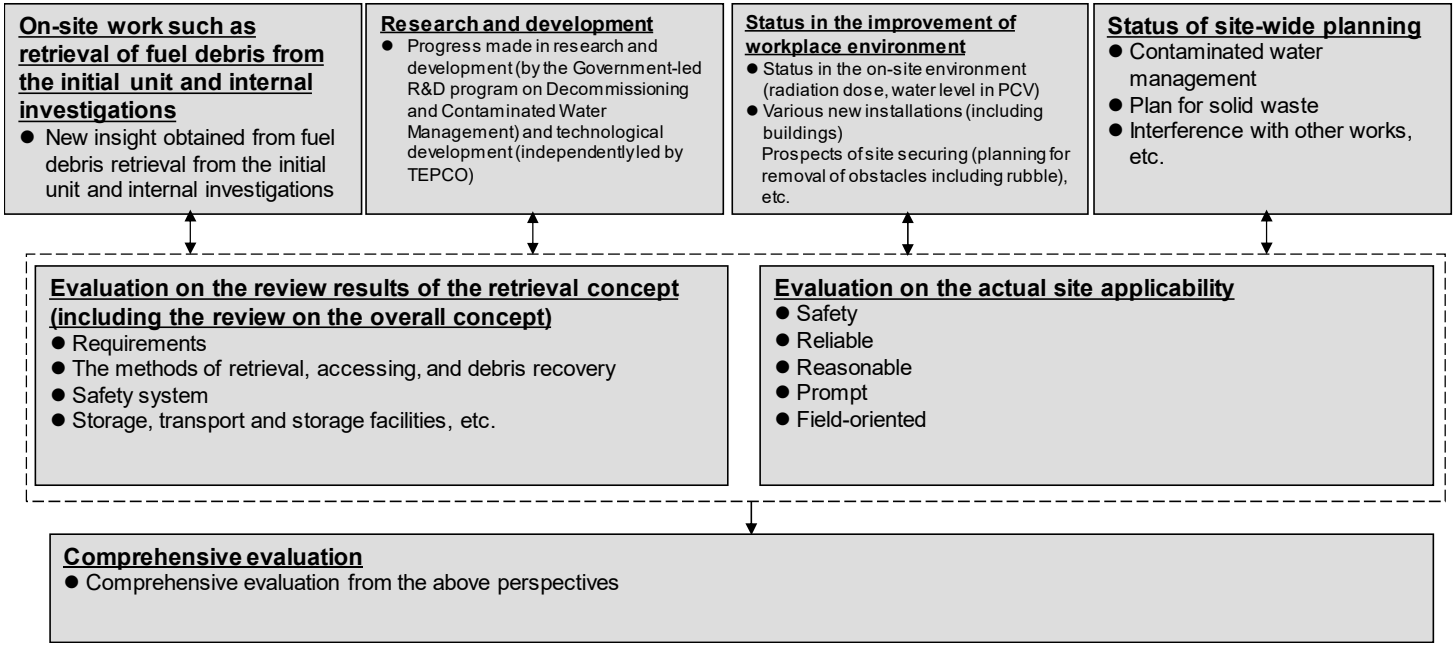


Figure: Study flow of the retrieval methods (Conceptual diagram)

3. Technological strategies toward decommissioning of the Fukushima Daiichi Nuclear Power Station (5/12)

① Fuel debris retrieval (5/7) Technical strategy

■ Further expansion of fuel debris retrieval

✓ **It is deemed appropriate to consider Unit 3 as a pioneer unit.**

- While a trial retrieval will be implemented at Unit 2, it is **Unit 1 or Unit 3** that enables **easy access to a large amount of fuel debris**, because **fuel debris remains in bulk at the bottom of the pedestal** of these Units.
- In view of the sufficiency of information and the site conditions, Unit 3 will be able to commence debris retrieval and **obtain information earlier**, as it will enable advancement of engineering including study of retrieval method
- By setting a certain unit as a representative one, it will **enable earlier obtainment** of technical points and items to be further studied. **Utilizing the results in other units** will lead to **reducing the overall risk of fuel debris in Units 1 to 3**.
- While taking a pioneering approach at Unit 3, status of other units and their review results should be **reconfirmed**, **and the unit under review as a pioneer unit** may need to be **reconsidered**, depending on the outcome.
- Even if the first implementing unit (Unit 2) is **in the process** of retrieving fuel debris, the method of proceeding shall be **flexibly** considered in light of **optimizing the overall work**, for example, by **starting retrieval from another unit** that is in preparation for retrieval.

3. Technological strategies toward decommissioning of the Fukushima Daiichi Nuclear Power Station (6/12)

① Fuel debris retrieval (6/7) Technical strategy

■ Further expansion of retrieval scale

↓ This year's third key aspect

✓ Concept of **important requirements (Boundary conditions)** for the retrieval method

- When proceeding with the study on retrieval methods, TEPCO is required **to clearly define the important requirements (boundary conditions) as the project executor**.
- The important requirements (boundary conditions) shall be **stipulated based on the safety perspective and the operator's perspective**, regarding which requirements to be defined as important (that is, the boundary conditions) and which level of performance is required.

(For example, total exposure dose of workers, criticality, dust (containment), reduction of waste generation, and recovery rate)

- In addition to **the requirements illustrated** above, **TEPCO** should more **independently** determine various important requirements (boundary conditions) to steadily proceed with study on retrieval method.

■ **A flexible approach** in studying the retrieval method

- It is required to take a flexible approach including **partial improvement of the retrieval method**, according to the assessment of the actual site applicability.
- While **establishing preconditions including assumptions** and advancing its study, **a repetitive and iteration-based approach** will be required by incorporating newly obtained information to verify the appropriateness of the preconditions to be established based on **the safety perspective** and **the operator's perspective**, and by reviewing it if necessary.

3. Technological strategies toward decommissioning of the Fukushima Daiichi Nuclear Power Station (7/12)

① Fuel debris retrieval (5/5) Technical strategy

■ Key Technical issues and future plans

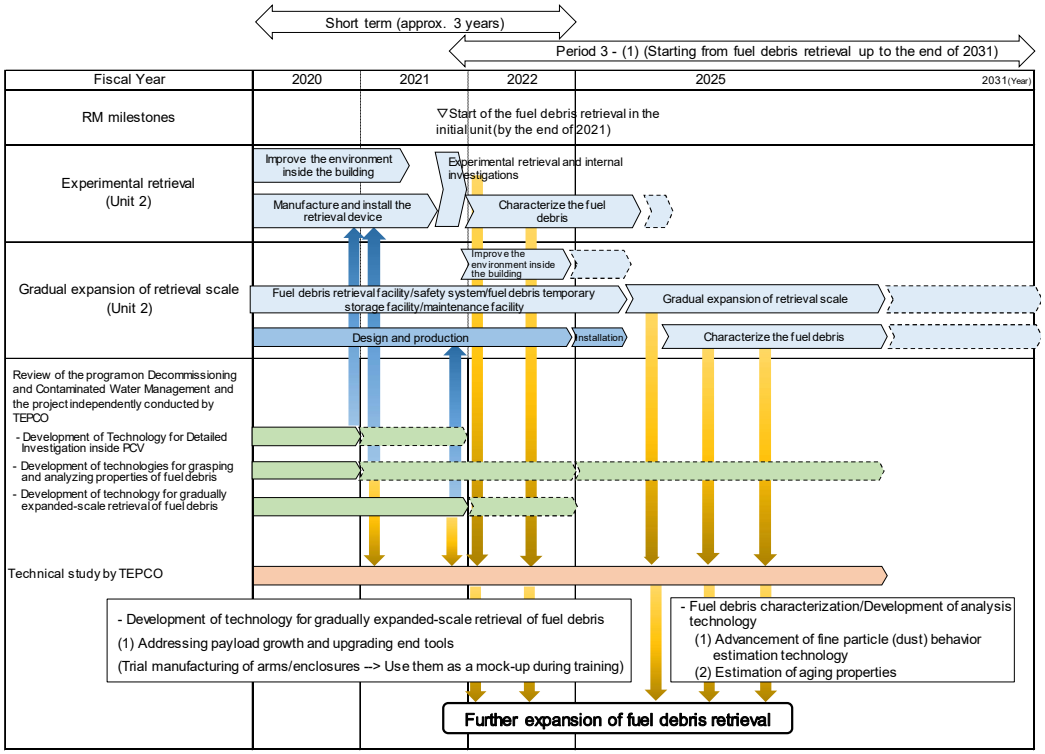


Fig. 1 Trial retrieval and gradual expansion of fuel debris retrieval

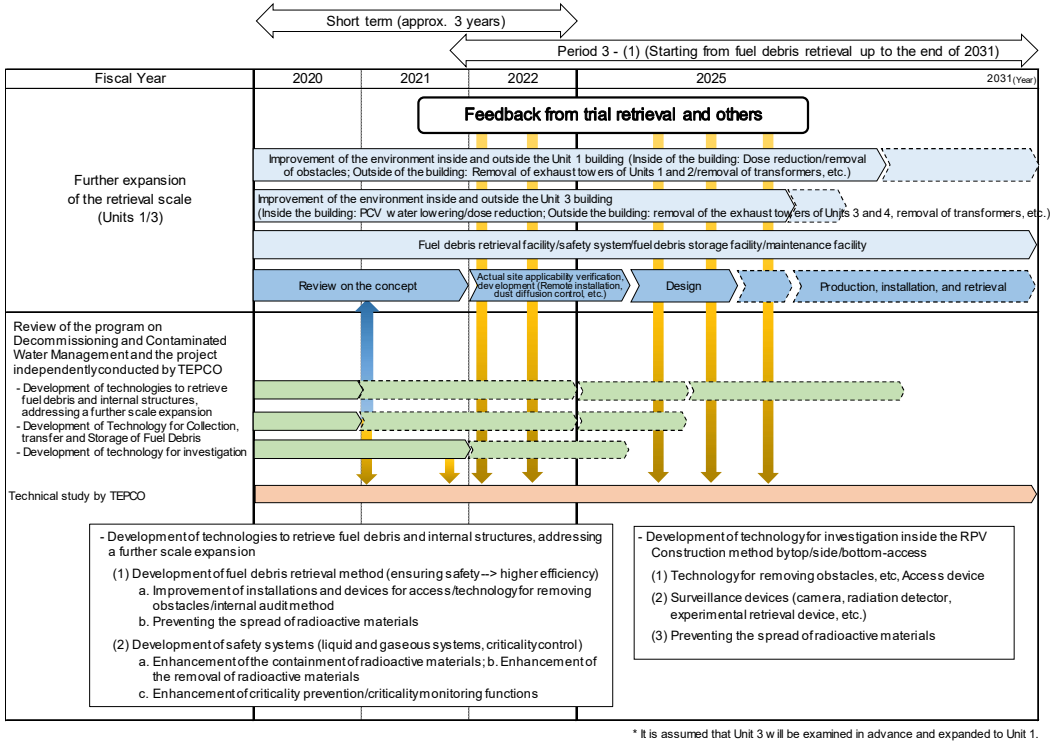


Fig. 2 Further expansion of fuel debris retrieval

3. Technological strategies toward decommissioning of the Fukushima Daiichi Nuclear Power Station (8/12)

② Waste management

Targets

(1) As the approaches to solid waste storage, **the Solid Waste Storage Management Plan ("Storage Management Plan") is appropriately developed, revised and implemented**, including waste prevention, volume reduction and monitoring, while updating the estimated amount of solid waste to be generated in the next 10 years periodically.

(2) As an approach to processing/disposal, countermeasures integrated from characterization to processing/disposal of solid waste are studied from expert point of view, and. **the prospects of a processing/disposal method and technology related to its safety should be made clear by around FY 2021**

Technical strategy

■ Promotion of characterization and enhancement of analysis system and technical capabilities

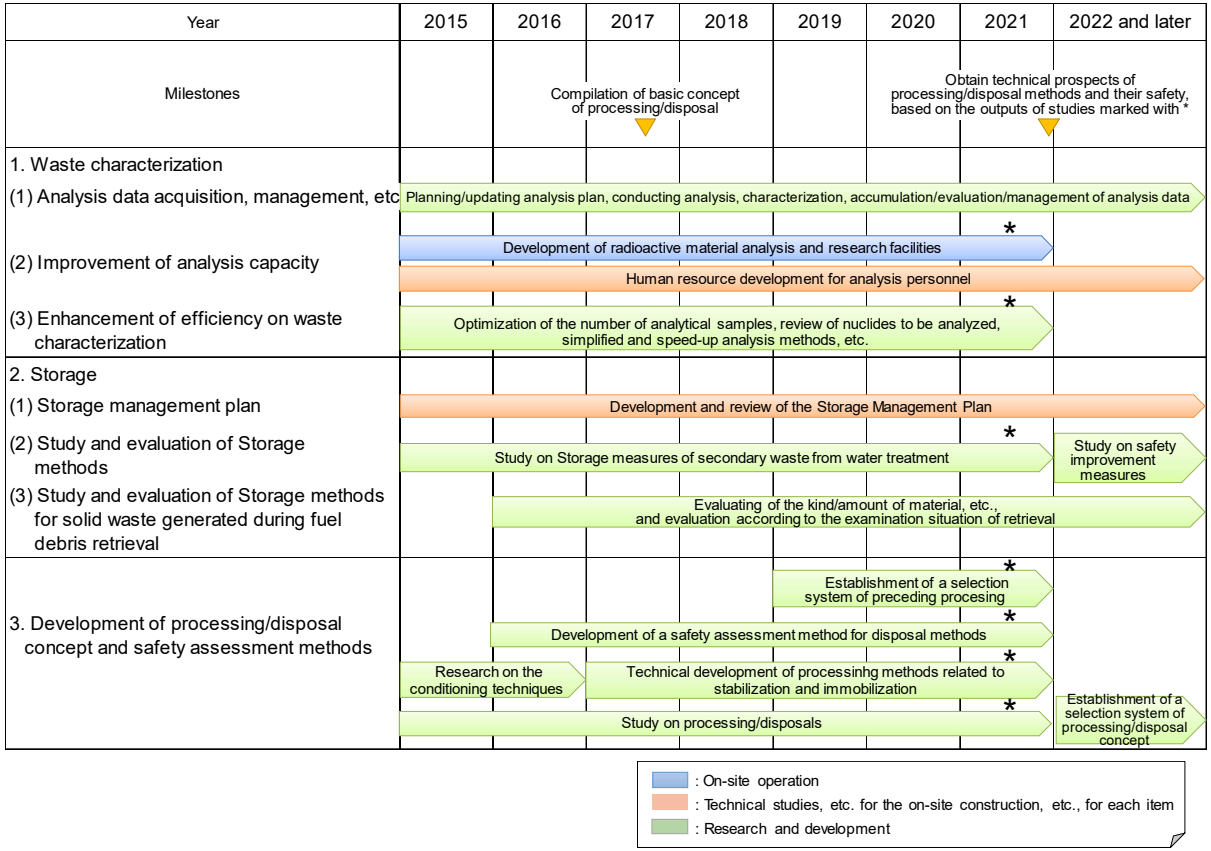
✓ It is important to proceed with **human resource development** for analysis in the organized manner as well as to **arrange the Radioactive Material Analysis and Research Facility** and to **reflect achievement of simplified and speed-up analysis methods**.

■ Development of processing/disposal concept and safety assessment method

✓ To **select candidate technology** for preceding processing method, it is necessary to **identify** reasonable and feasible **processing technology** and **develop safety assessment technique** for disposal corresponding to such technology.

■ The prospects of a proceeding/disposal method and technology related to its safety

✓ Outlook will be **presented by around FY2021** based on the results of R&D as well as TEPCO'S engineering achievement.



3. Technological strategies toward decommissioning of the Fukushima Daiichi Nuclear Power Station (9/12)

③ Contaminated water management

Targets

(1) Under three principles for the contaminated water problem (“Removing” contamination sources, “Redirecting” fresh water from contamination sources, and “Retaining” contaminated water from leakage), **to reduce the stagnant water in the reactor buildings in FY 2022 to FY 2024 to about the half of the amount of the end of 2020** while continuing the operation of the constructed water-level management system and **controlling the generation amount of the contaminated water to 100 m³/day or less in 2025**.

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

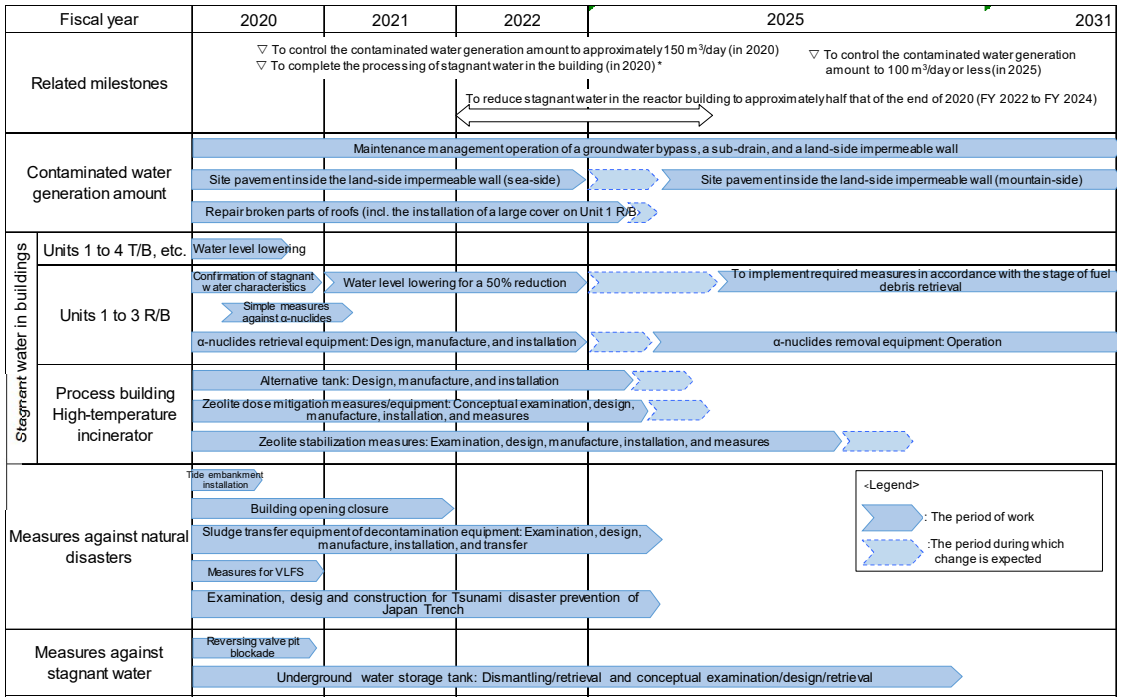
Technical strategy

■ Issues in future treatment of stagnant water in buildings

- ✓ It is required **to strengthen the monitoring of α-nuclides concentration** in each building and water treatment systems as well as **property analysis**, while continue R&D **to establish a measure to remove sludge-like sedimentation containing α-nuclides**.
- ✓ **A method to remotely collect and accumulate zeolite** existing in a high radiation dose **are being studied**. It is required to select an appropriate method by **comprehensively evaluating radiation exposure dose during work.**

■ Issues of contaminated water management **considering the decommissioning process such as debris retrieval**

- ✓ It is necessary **to take measures such as enhancement of monitoring of water treatment systems**, **installation of α-particle collection equipment, and criticality monitoring**.
- ✓ To further expand the fuel debris retrieval, it is required to study **downsizing of equipment** considering the installation space, **operation and maintenance under high radiation dose**, **and utilization of existing purification facilities.**



*Except Units 1 to 3 reactor buildings, process buildings and high-temperature incinerator building.

3. Technological strategies toward decommissioning of the Fukushima Daiichi Nuclear Power Station (10/12)

(4) Fuel removal from spent fuel pools (1/2)

Targets

(1) While the return of residents and reconstruction in the surrounding area is gradually advanced, **to carry out a risk assessment and ensuring safety certainly** including preventing dispersion of radioactive materials and **to start the removal of fuel in SFPs (spent fuel pools) in FY 2027 to FY 2028 for Unit 1 and FY 2024 to FY 2026 for Unit 2**. **To complete the removal of fuel in SFPs in FY 2020 for Unit 3**.

(2) The fuel in Units 1 to 4 that were affected by the accident are taken out of the SFPs and **transferred to the Common Spent Fuel Storage Pool, etc., where they are appropriately stored so that they are in a stable management state**. In order to secure the Common Spent Fuel Storage Pool capacity, the fuel stored in the Common Spent Fuel Storage Pool is transferred to and stored in the Dry Cask Temporary Custody Facility.

(3) To carry out **the evaluation of long-term integrity and the examination for treatment for the removed fuel and to decide the future treatment and storage method.**

Technical strategy

■ For Units 1 and 2, it is required to advance the work steadily to realize the determined new removal method.

✓ Unit 1:

- From the viewpoint of further reduction of radioactive dust dispersion risk, the whole operating floor was covered with a large cover. The removal method was changed to one in which rubble removal and the removal of fuel in SFP are carried out inside the cover.
- **The existing collapsed overhead crane must be removed, which remains in an unstable state**. To do so, selection of engineering method and its implementation should proceed **after the thorough safety assessment**. Toward its realization, it is essential to **formulate a work plan for identifying risk items**.

✓ Unit 2:

- New method that the upper part of the operating floor will not be dismantled and access from the south side of the reactor building was adopted from the viewpoint of further reduction of radioactive dust dispersion risk similar to Unit 1. Preparations are being advanced at present.
- **Boom-crane-type fuel handling machine** is new to us. So, **fully preparation for its operation and functions in advance** are crucial, before **remotely operating** it to remove fuel.

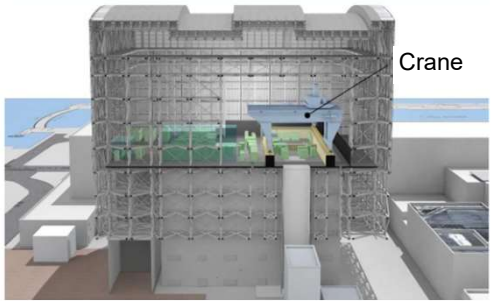


Figure 1 : Image of removal method for Unit 1

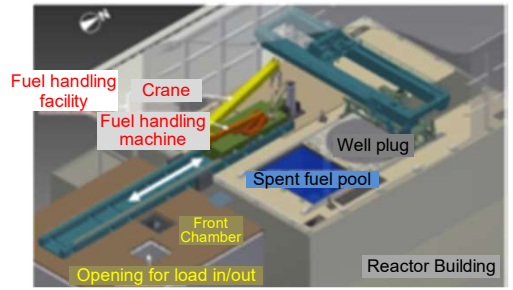


Figure 2 : Image of removal method for Unit 2

3. Technical strategy toward the decommissioning of the Fukushima Daiichi Nuclear Power Station (11/12)

④ Fuel removal from spent fuel pools (2/2)

■ As for removal of fuel assemblies with deformed handle, it is important to load them reliably into transport cask by lifting safely from fuel rack.

- ✓ 16 fuel assemblies with deformed handle were confirmed for Unit 3. (Fig.1)
- ✓ Manufacturing of a tool for removing rubbles is now systematically being prepared.
- ✓ It is important to reliably execute the preparations including verifying in advance, giving these feedback and examining multiple responses.

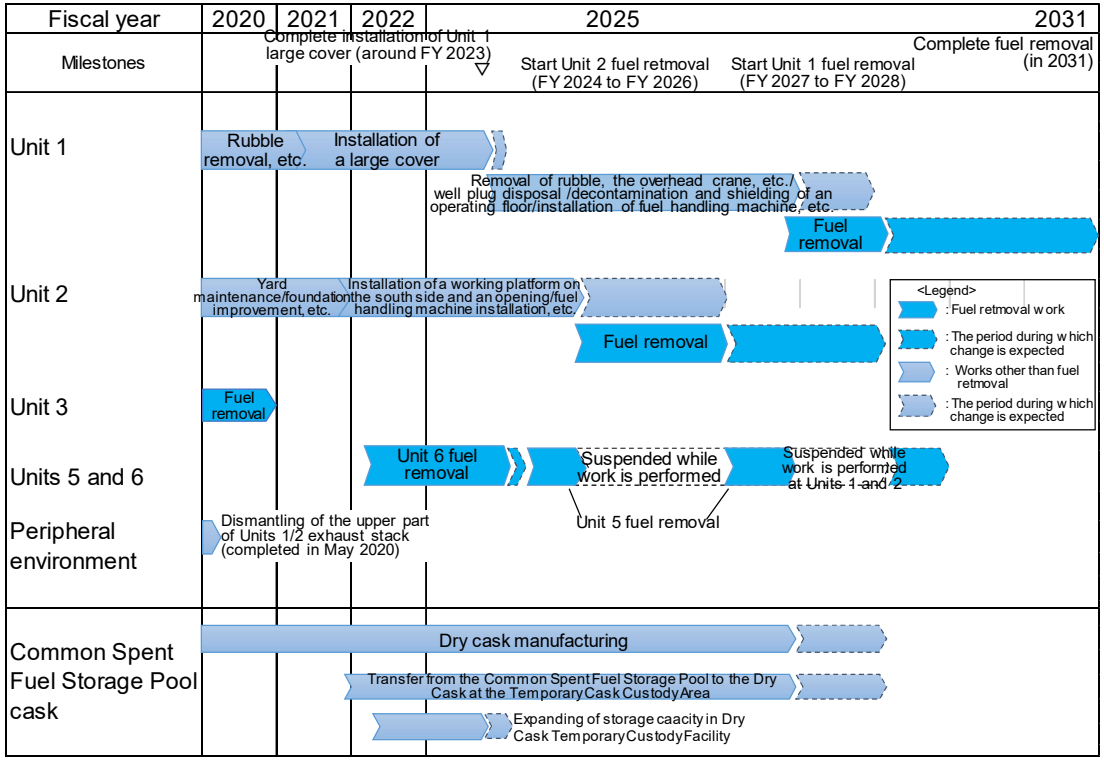


Figure 2 Major technical issues and future plans

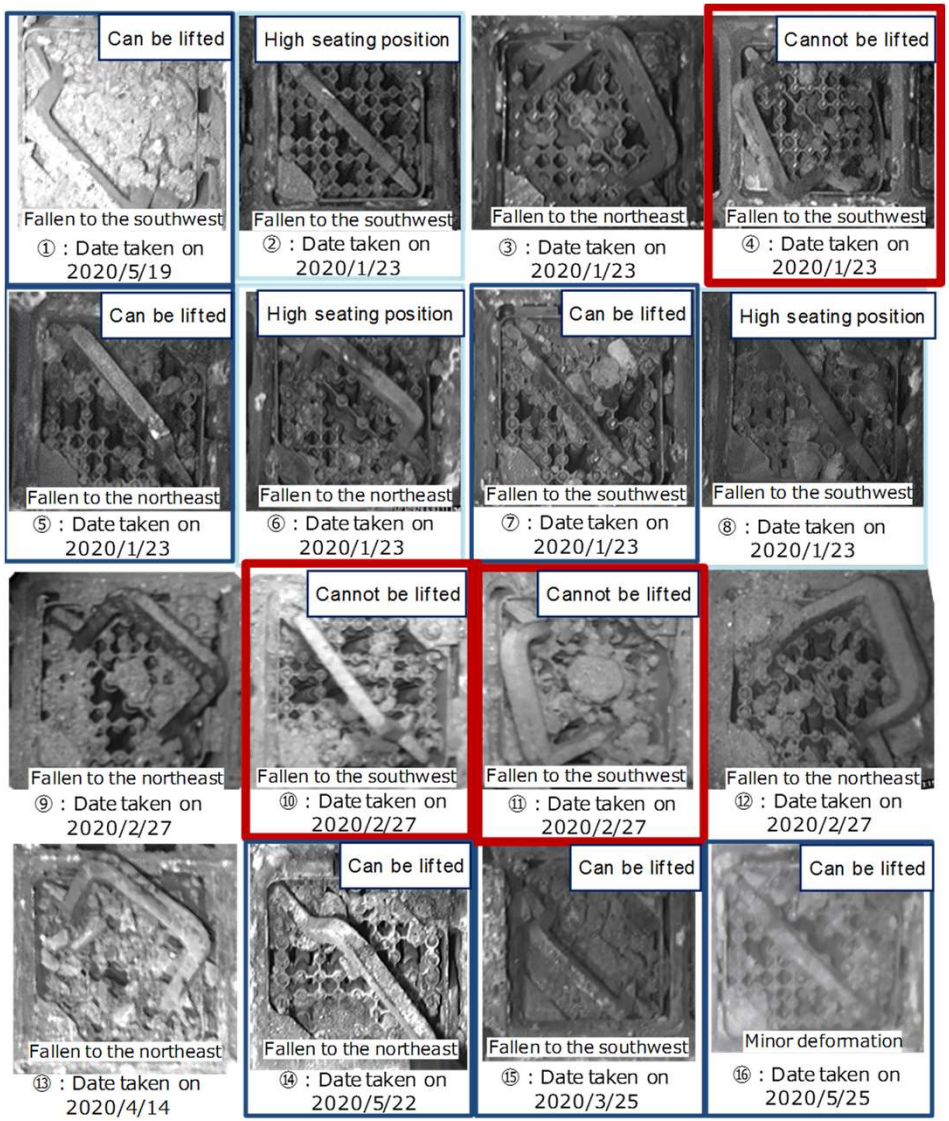


Figure 1 Status of 16 fuel assemblies with deformed handle

* Source by TEPCO

3. Technological strategies toward decommissioning of the Fukushima Daiichi Nuclear Power Station (12/12)

⑤Utilization of Analysis Results for Smooth Promotion of Decommissioning

Significance and Current Status

- It is necessary to **establish and develop analysis facilities and functions and to build a system** required for handling of waste or fuel debris.
- TEPCO is planning to **establish an analytical facility necessary** for smooth performance of **routine analyses** in the future.
  - As operation proceeds, **risk of α contamination intake** is supposed to be gradually increased, **a bioassay function** is planned to be established.
  - **The Radioactive Materials Analysis and Research Facility (Facilities Management Building, Building 1, and Building 2)** is being developed by JAEA, to contribute to **facilitation of smooth decommissioning**, **reliable processing/disposal measures**.
- Analysis results are "an important piece" **to reduce the range of uncertainties** for the smooth decommissioning.
  - Important basic information for the study on processing/disposal measures for various kinds of waste generated by the accident.
  - Analyses are reflected in a number of areas, including retrieval methods, storage, processing/disposal, and enhancement of nuclear safety.

Issues and Strategies

- Analysis shall **be positioned at a higher level** in the decommissioning project.
  - Analytical data plays an important role in the study on the method to mitigate excessive safety design while ensuring safety.
- Consideration should be given to **securing and retaining of the analytical engineers**.
- It is important **to pursue a reasonable analysis plan** by comprehensively **utilizing analysis results and on-site information**.
  - An important stance is that the **decommissioning work shall be implemented on schedule** by conducting **analyses without delay.**
  - Taking note of the fact that analysis results have **functions to benchmark** the estimation results of internal conditions given by instrumentation monitoring, visual observation, in-situ measurement, and evaluation of calculations (simulation).
- TEPCO should establish a system where **TEPCO itself will actively commit control and leadership of the whole of activities related to the analysis.**
  - TEPCO is required to start examining the overall strategy and a plan for the analysis of decommissioning work as early as possible.

4. Efforts to facilitate research and development

■ Strengthening the research and development management organization in the Government-led R&D program on Decommissioning and Contaminated Water Management <= This year's fourth key aspect

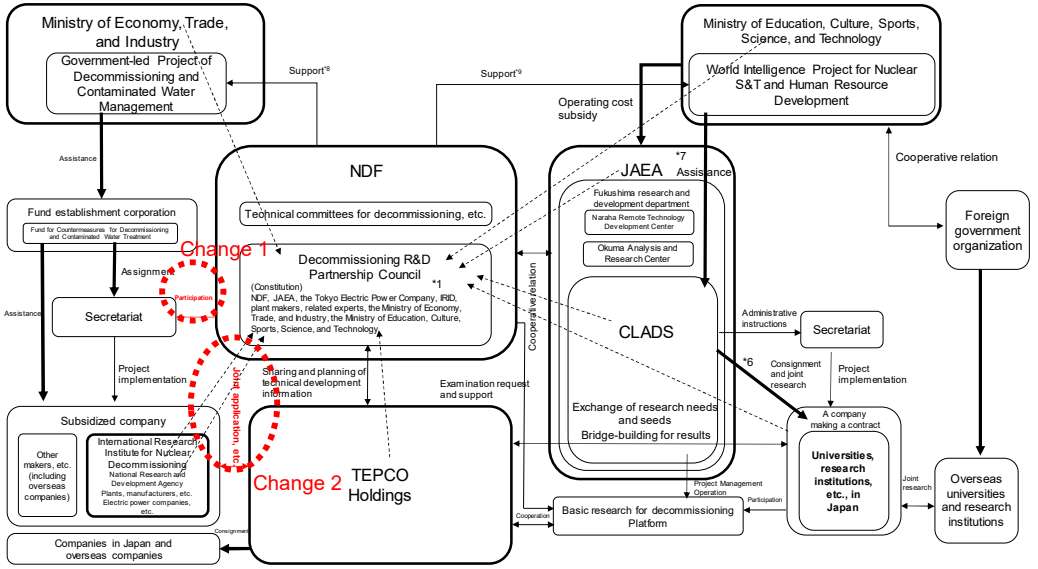
- ✓ Trial retrieval in 2021 is approaching. Soon thereafter, for expanding the retrieval scale, **the organization was strengthened** as we recognized **the need to accelerate R&D**.
- ✓ Changes due to the organization strengthening
  - Change 1: NDF **participated in the secretariat of the Government-led R&D program on Decommissioning and Contaminated Water Management.**
  - Change 2: TEPCO **jointly applies for subsidy with R&D implementation entities.**

■ Formulating the R&D medium-to-long-term plan

- ✓ Formulation of the Next-term R&D plan based on new R&D medium-to-long-term plan **will clarify how and where each development corresponds to the decommissioning process.** The plan will be **updated and expanded every year**.

■ Matching of needs and seeds of decommissioning work sites and universities/research institutions

- ✓ Up to date, good results have been obtained from the World Intelligence Projects of MEXT and JAEA/CLADS and it is important **to accelerate to reflect directly in the decommissioning site.**
- ✓ Based on those results, new **joint research between four universities and TEPCO has started** last year. Continuous enhancement of collaboration with related institutions is needed.



*1 The Decommissioning R&D Partnership Council is established in the NDF based on the determination by Team for Countermeasures for Decommissioning and Contaminated Water Treatment.
*2 The arrow drawn in a thick solid line indicates expenditures such as research expenses and operating expenses (excluding facilities expenses), the arrow drawn in a thin solid line indicates a cooperative relation, etc., and the arrow drawn in a dotted line indicates the participation in the Decommissioning R&D Partnership Council.
*3 Some organizations such as JAEA are located at two or more places.
*4 Each organization has cooperative relations with foreign organizations based on MOU, etc., respectively.
*5 Research and development uniquely conducted by the Central Research Institute of Electric Power Industry, etc., are omitted in this figure.
*6 Although among the World Intelligence Project for Nuclear S&T and Human Resource Development the part adopted up to FY 2017 is the consignment from the Ministry of Education, Culture, Sports, Science, and Technology to a company making a contract, it is omitted in this figure.
*7 Although the subsidy for the World Intelligence Project for Nuclear S&T and Human Resource Development is delivered to JAEA, it is expressed as what is delivered to CLADS, to make it easier to understand.
*8 With regard to the Government-led Project of Decommissioning and Contaminated Water Management, based on the policy in the Mid-and-Long-term Roadmap or Strategic Plan and the progress situation of research and development, the NDF formulates a draft plan of the next research and development, and the Ministry of Economy, Trade, and Industry determines it.
*9 The NDF participates as a member in a steering committee of the World Intelligence Project for Nuclear S&T and Human Resource Development.

Figure: Overview of the R&D structure of the decommissioning of Fukushima Daiichi Nuclear Power Station (FY2020)

5. Activities to support our technical strategies (1/5)

Enhanced project management (1/3)

■ Formulation and announcement of the Mid-and-Long-term Decommissioning Action Plan <= This year's first key aspect

- ✓ TEPCO announced it to make the **decommissioning project transparent to local community and society** and to **tackle decommissioning independently**, while **materializing the complicated work prospect over a long period**.
- ✓ The meaning of announcing the Mid-and-Long-term Decommissioning Action Plan was significant, because it would enable medium-to long-term planning in **R&D, HR, and procurement**. In the future, it is also important to make **constant review based on new knowledge and on-site conditions**.

■ Further strengthening of project management

- ✓ In **April 2020**, TEPCO **converted** the decommissioning project into a project management type by changing **the organization of Fukushima Daiichi D&D Engineering Company**.
- ✓ While further strengthening the project management system as well as **integrally managing engineering and R&D,** it is necessary to implement appropriate and efficient project operation.

■ Reinforcement of "safety and operator's perspectives" in project activities

- ✓ To realize the results, it is indispensable to fully reflect **safety and operators' perspectives** in the construction method and equipment.
- ✓ A business process to **incorporate safety and operator's perspectives in the upstream of project activities** needs to be established at an early stage.

■ Promulgating the "Safety First" principle that safety perspective comes first

- ✓ It is important that all who work in the processes (projects) leading up to the realization of methods and installations on the site, **keep the safety perspective first in mind as they engage in their work (safety first).**
- ✓ Leaders of nuclear operations at TEPCO have worked hard to raise awareness on the issue of nuclear safety. In order to thoroughly **promulgate the "safety first" principle to all persons who work on projects including on-site**, it is important to have the attitude **to reiterates the special nature of nuclear safety** and **how it must be approached with an accordingly special kind of awareness**.

5. Activities to support our technical strategies (2/5)

Enhanced project management (2/3)

■ Improving the owner's engineering capabilities

✓ Importance of **"safety and operator's perspectives"** in Owner's Engineering

- Performance requirements need to be carried out by **iteration** to some extent, it is strongly required that TEPCO "makes a judgment on engineering and is responsible for the results". It is required to **improve** the engineering capability **(owner's engineering capability)** implemented **independently** by TEPCO as an owner.
- The most important thing in Owner's Engineering is to **incorporate "safety and operator's perspectives" as upstream** as possible in engineering.

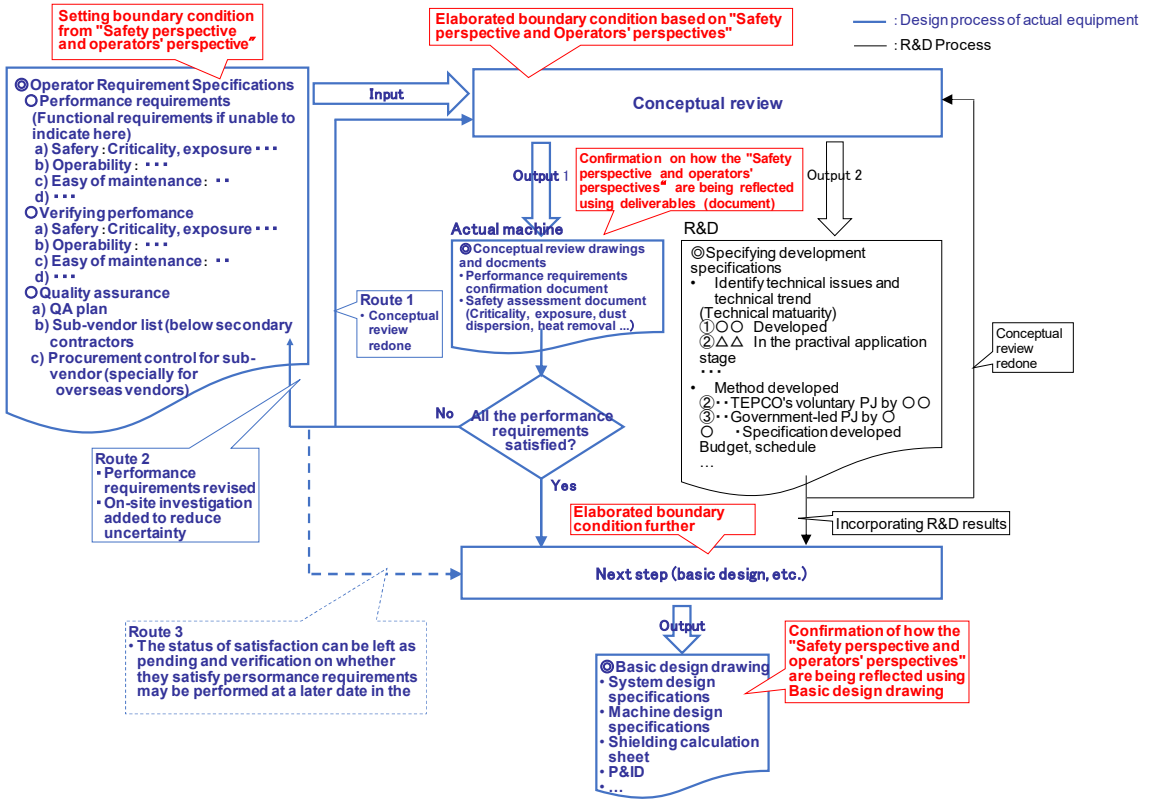


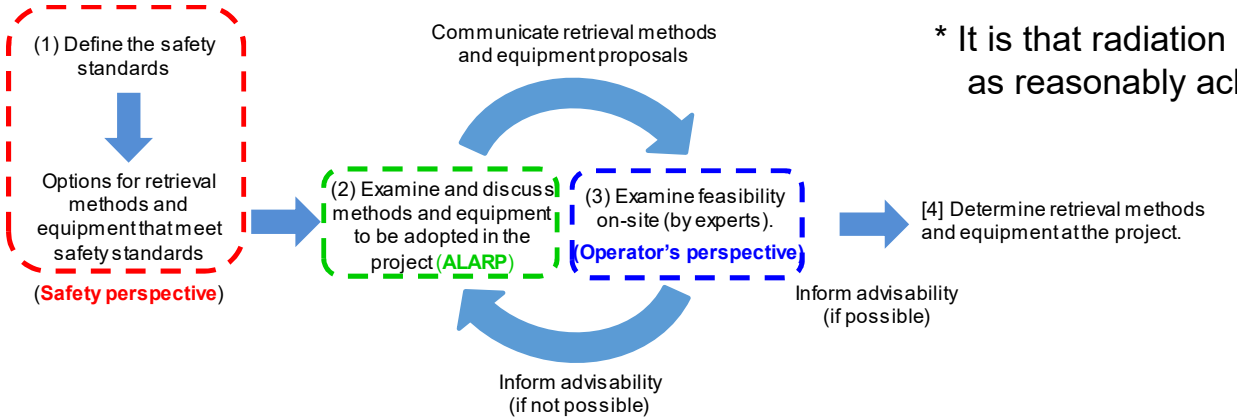
Figure. Design flow of fuel debris retrieval (Image)

5. Activities to support our technical strategies (3/5)

Enhanced project management (3/3)

■ ALARP judgment based on safety

- ✓ For safety, there is **a range of choices** at levels above the level that meets a **minimum level**, construction methods and equipment to be adopted will be determined **based on the judgment of ALARP***.
- ✓ In determining them, it is important to decide through the cycle of **"define the safety standards (safety perspective)"**, **"indicate the feasibility on site (operators' perspective)"**, and **"examine and discuss at project (project management)"**
- ✓ **The operator's perspective** is necessary to actually incorporate the safety perspective into the site, and **the judgment based on the safety perspective** is needed to utilize the operator's perspective.



* It is that radiation impact must be as low as reasonably achievable.

Fig. 26 ALARP judgement that reflect the viewpoint in the field (image)

Figure. ALARP centered on safety (Image)

■ Development based on the Mid-and-Long-term Decommissioning Action Plan

- ✓ It is important to assume **occupational categories and the number of engineers** **and the time to be required in the future** in light of **the Mid-and-Long-term Decommissioning Action Plan**, to summarize them as the medium-to-long term human resources development plan, and to promote **human resources development and staff securing** systematically.

5. Activities to support our technical strategies (4/5)

Strengthening international cooperation

■ Significance and the current status of international cooperation

- ✓ To **promote** the decommissioning of Fukushima Daiichi Nuclear Power Station **in an internationally open manner**, NDF is making efforts to **provide information on the decommissioning** by giving speeches at international conferences.

■ Dissemination of information to the international community and efforts to integrate wisdom and knowledge from around the world

- ✓ While engineering is put into practice, it is necessary to make efforts for **continuous communication** with the private sectors, and **form an environment in which required technology is accessible when required** while **sharing information** on the progress of decommissioning work.

Figure Presenting at a side event of the IAEA General Conference (September 2019)

5. Activities to support our technical strategies (5/5)

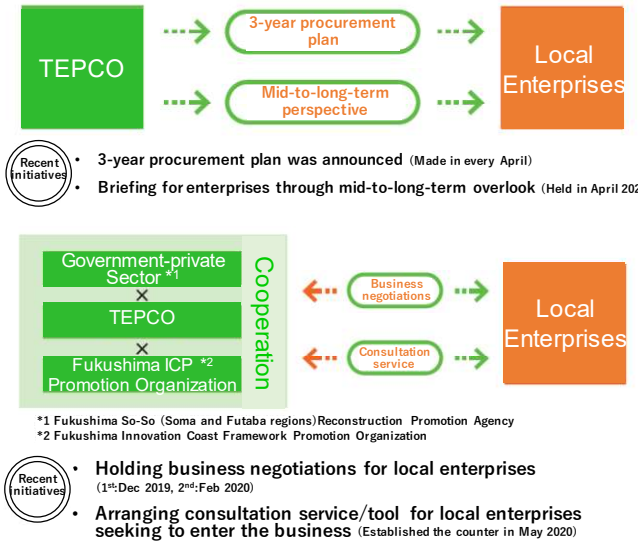
Local community engagement

■ Basic approach

- ✓ The confidence from the communities is indispensable and various efforts are made under **the fundamental principle of "coexistence of reconstruction and decommissioning**.

■ Specific measures under the current situation

- ✓ While obtaining the Fukushima Innovation Coast Framework Promotion Organization's cooperation, TEPCO held a decommissioning project matching event for local businesses.
- ✓ At the end of March 2020, **TEPCO formulated the "commitment to Fukushima residents for the coexistence of reconstruction and decommissioning (Commitment)** summarizing the efforts, such as the participation of local businesses in decommissioning project, the attraction of companies outside the area, human resources development.
- ✓ To strengthen the organization, TEPCO established **Promotion of Partnership with local communities Group** under the Fukushima Daiichi D&D Engineering Company in April 2020, as well as **Hama-dori Decommissioning Industry Project Office under the direct control of the president** in October 2020.



Figure：Example of commitment to Fukushima residents for the coexistence of reconstruction and decommissioning

(TEPCO materials edited by NDF)

■ TEPCO must not end "Commitment" just as a shape, but secure effectiveness.

- ✓ After **subdividing** the Medium-to-long-term outlook in the decommissioning project as well as **the detail, timing and scale** of the project orders to be placed **as much as possible**, TEPCO formulated **"Medium-to-long-term outlook in the decommissioning"** that specifically states **equipment or technology required for each project.**
- ✓ TEPCO will positively provide **coordination with the local communities by carefully explaining it** via the local governments or the association of commerce and industry, through dedicated **joint consultation centers** and **business fairs** for local companies.
- ✓ By **promoting the participation of the local companies** including **technical guidance**, TEPCO makes efforts to **build a foundation** for the local economy and to **foster local businesses and human resources** through the decommissioning project.
- ✓ It is required to develop the necessary **environment and support** so that **external human resources can fit into the regional society and play an active role**. As for the environmental improvement, in particular, it is necessary to consider **a wide range of living functions** so that **their whole family can stay with peace in mind**.