Technical Strategic Plan 2021 for Decommissioning of the Fukushima Daiichi Nuclear Power Station of Tokyo Electric Power Company Holdings, Inc.

(Explanatory Material)

October 29, 2021

Nuclear Damage Compensation and Decommissioning Facilitation Corporation

NDF

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Four key aspects in Technical Strategic Plan 2021

- The Technical Strategic Plan 2021 presents mid-to-long-term technical strategy by focusing on the following four key aspects of this year.

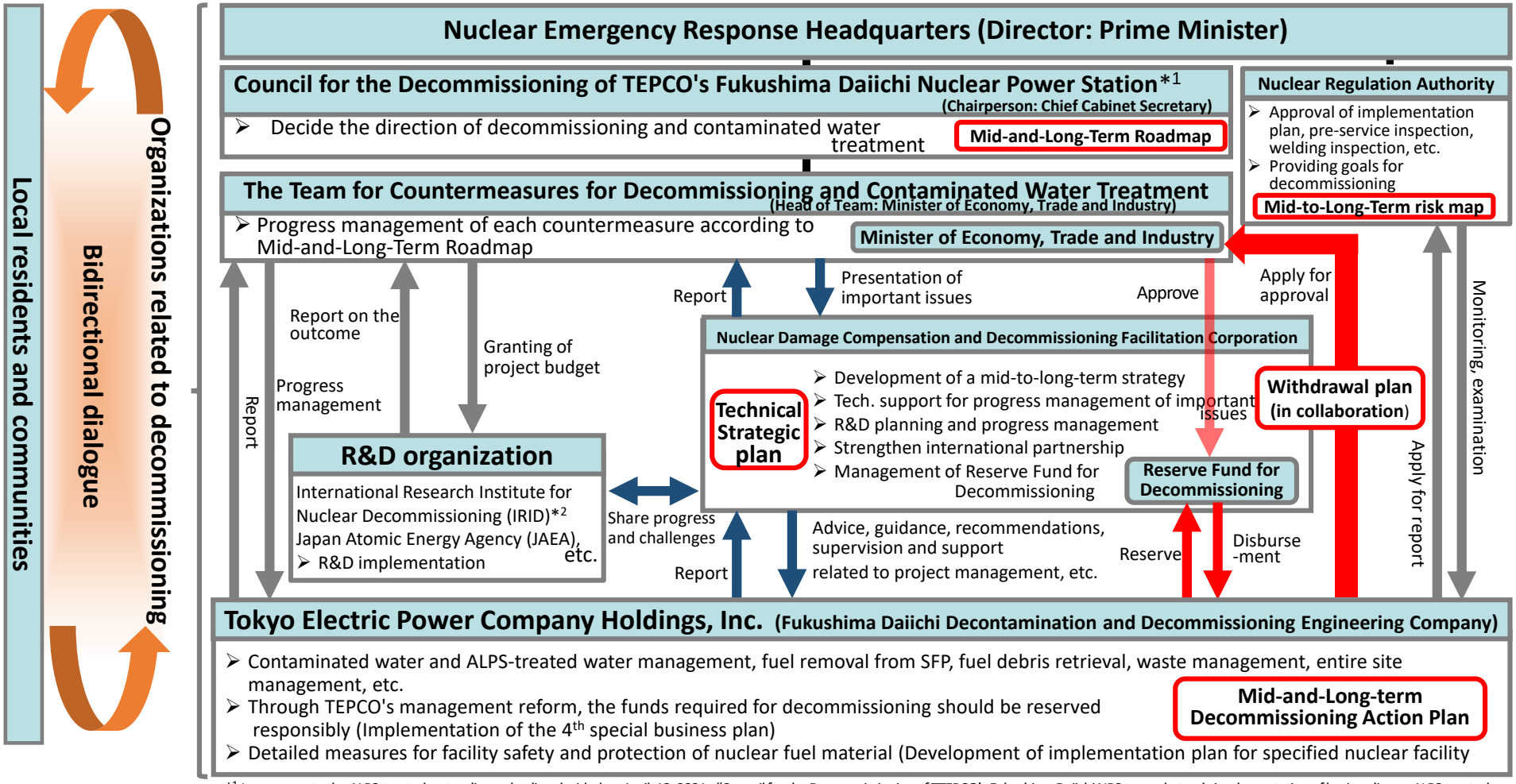
First Proposed Prospects of a processing/disposal method and technology related to its safety

Second Issues to be addressed for the trial retrieval to minimize the impact of the COVID-19 infection

Third Summary of issues to be discussed for the selection of methods for further expansion of fuel debris retrieval

Fourth Efforts for the ALPS-treated water

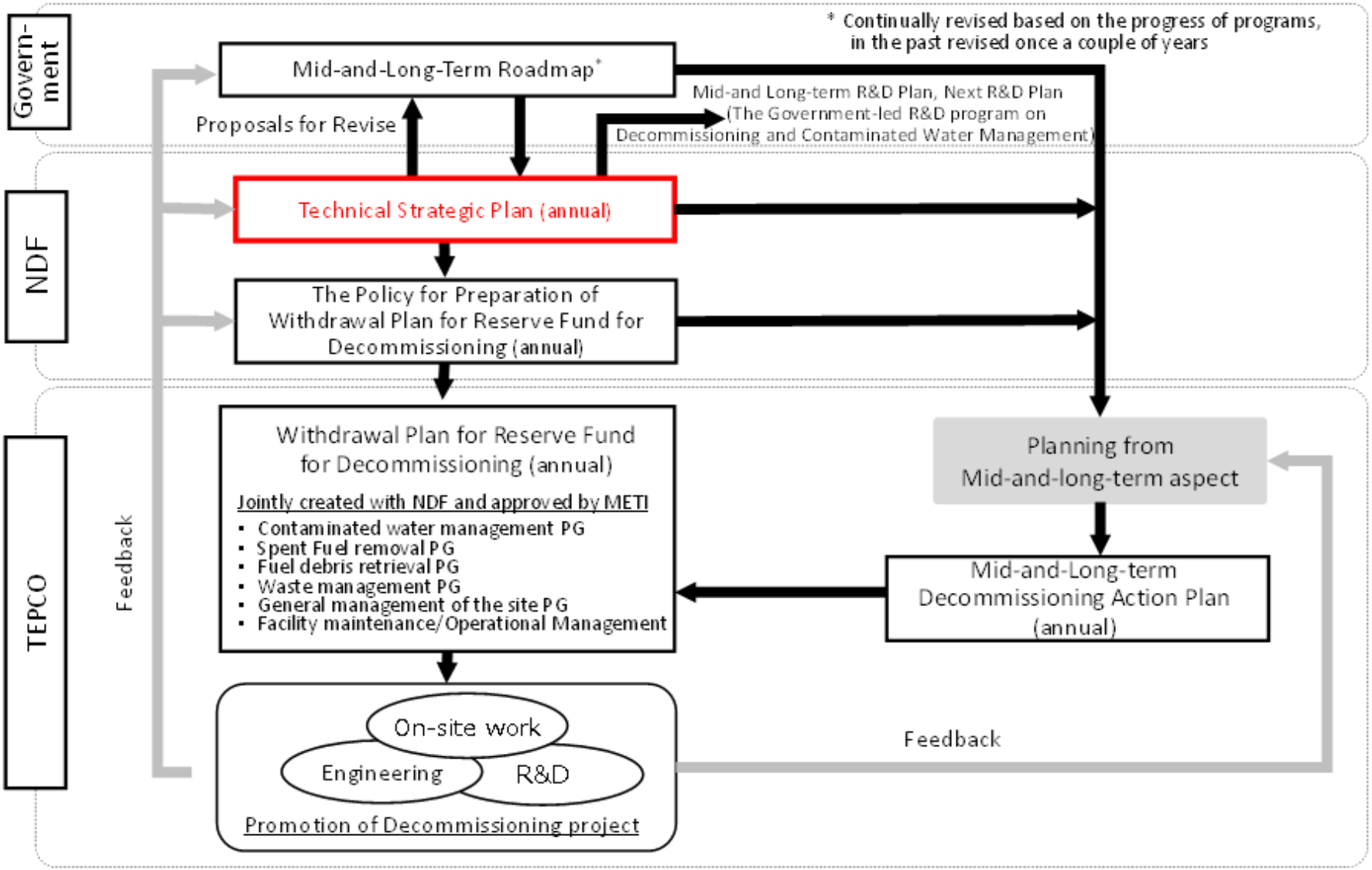
Division of roles of related organizations responsible for decommissioning of the Fukushima Daiichi NPS



*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

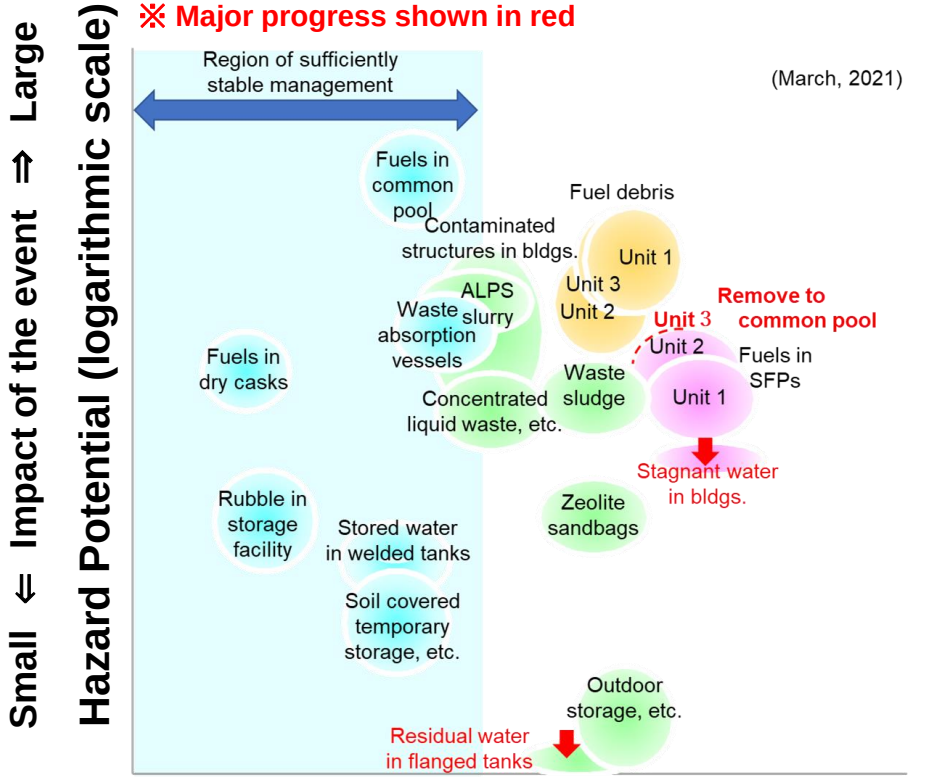


Concept on risk reduction

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

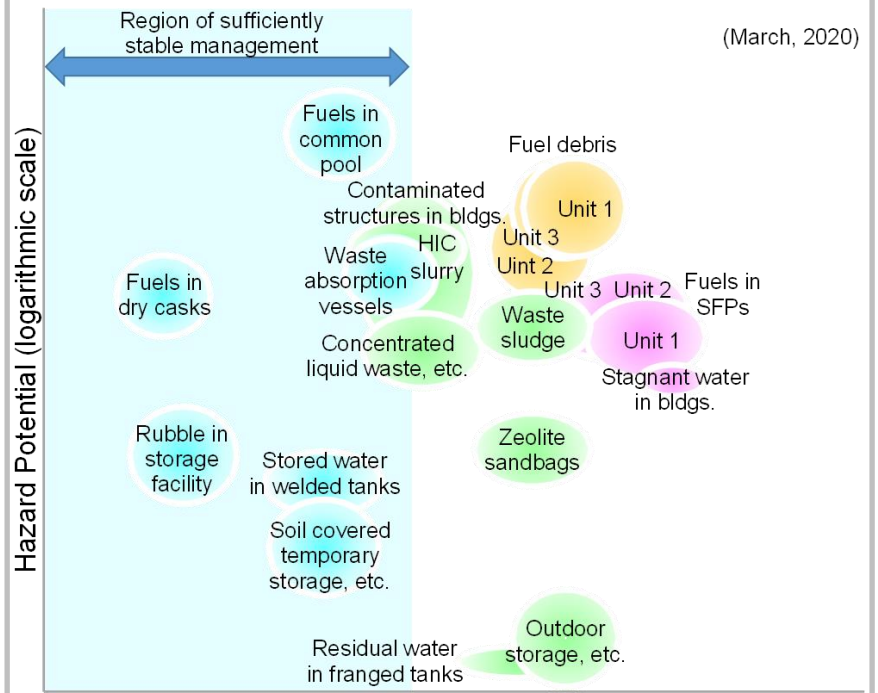
Technical Strategic Plan 2021

※ Major progress shown in red



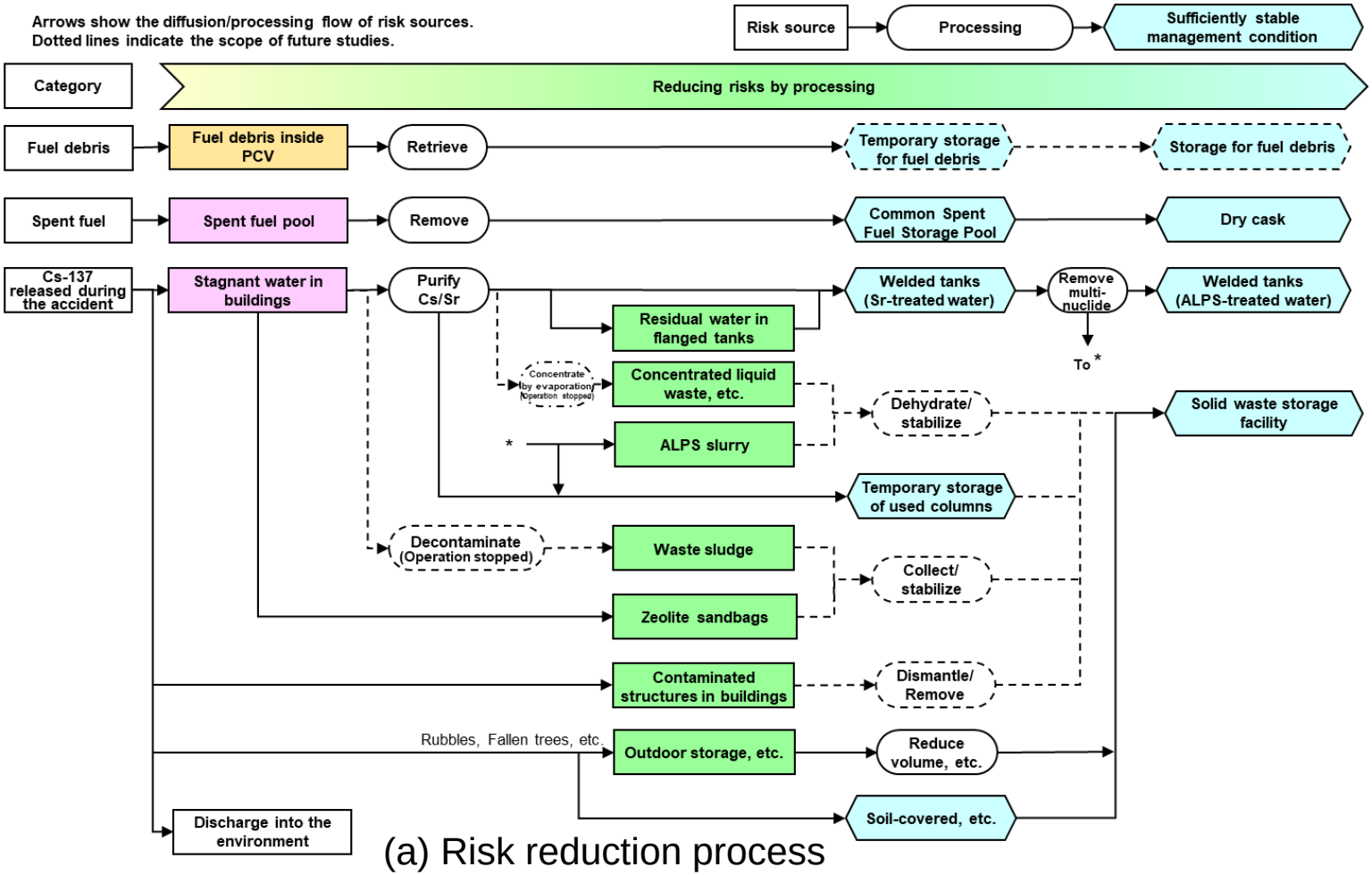
Example of risk levels at the Fukushima Daiichi NPS

Technical Strategic Plan 2020



Risk reduction process for major risk sources and its progress

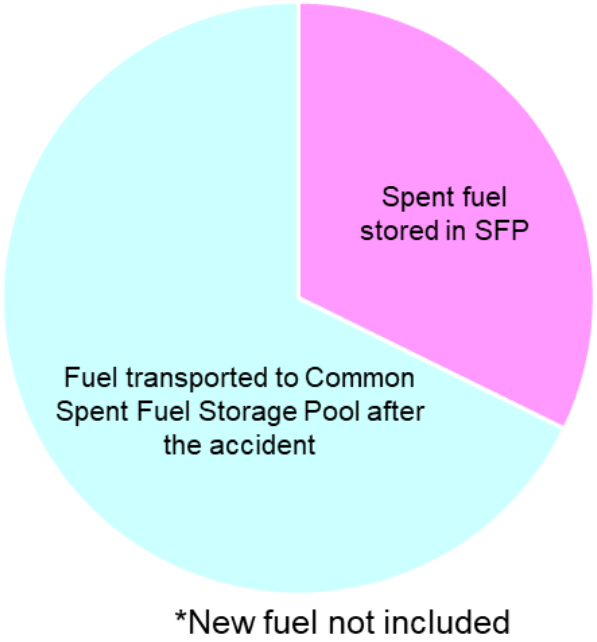
- Risk reduction process for major risk sources and an example of representing the decommissioning work progress
  (Visualized transition process of the risk sources from the time of the accident)



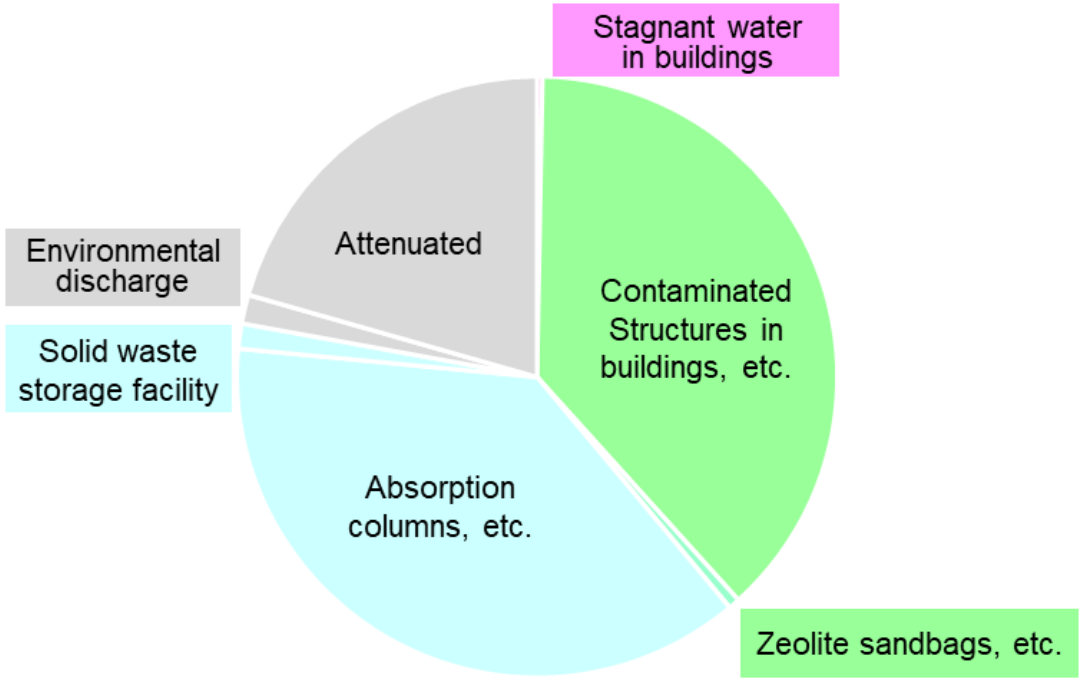
(a) Risk reduction process

Risk reduction process for major risk sources and its progress

- Status of transition (in what proportion) to the “Sufficiently stable management” region for each risk source compared to the beginning of the accident



(b) Number of fuel assemblies of spent fuel (units 1 to 4)



(c) Radioactivity of Cs-137 released at the accident (units 1 to 3)

Fig. Risk reduction process for major risk sources and its progress
(example as of March 2021)

Approach to ensuring safety during decommissioning

Basic policy

- 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.

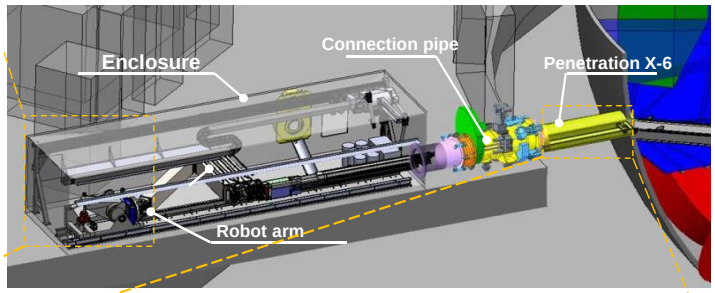
Major targets and progress for fuel debris retrieval

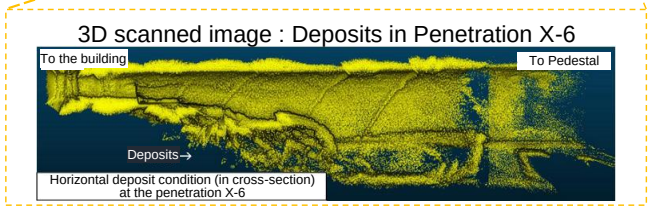
Major targets

- As for trial retrieval in unit 2, which is stated in Mid-and-long-term Roadmap as to be conducted in 2021, the process has been delayed due to the COVID-19 infection. In order to limit the delay to about one year, preparations will be made for starting retrieval.
- With regard to further expansion of fuel debris retrieval, consideration will be given to the methods including those for containing, transferring, and storing of fuel debris, by assessing internal investigations, research and development.

Progress

- The arm-type access equipment has arrived in Japan and started testing.
- Deposit contact investigation and 3D scanning investigation in the penetration X-6 was conducted.





Photographed in October 2020

(TEPCO material edited by NDF)

Fig. Investigation result of 3D scanning

Strategies for trial retrieval

Strategy Trial retrieval

- Although small in scale, the operation in which an opening will be newly provided to extend the containment barrier outside the PCV, is a fundamental form of site construction for future retrieval work, since the conventional containment barrier was located in the closed flange part (convex edge) of the penetration X-6. This presents an approach that enters a new stage.

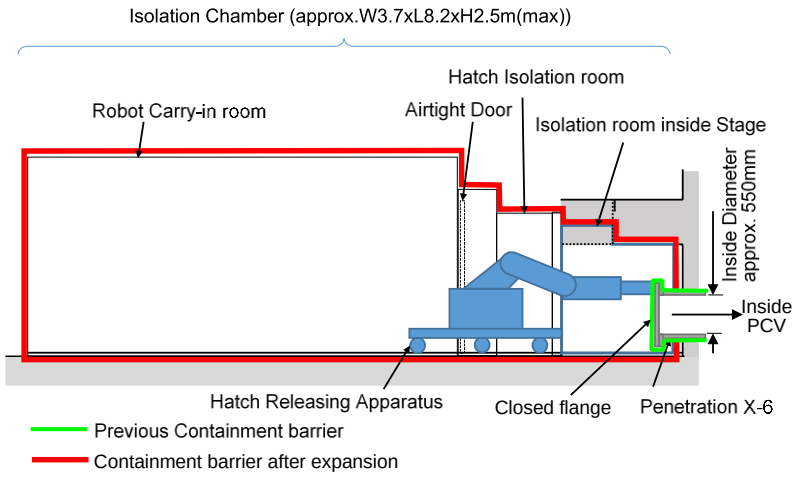


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Fig. Schematic drawing of isolation chamber to be installed at penetration X-6

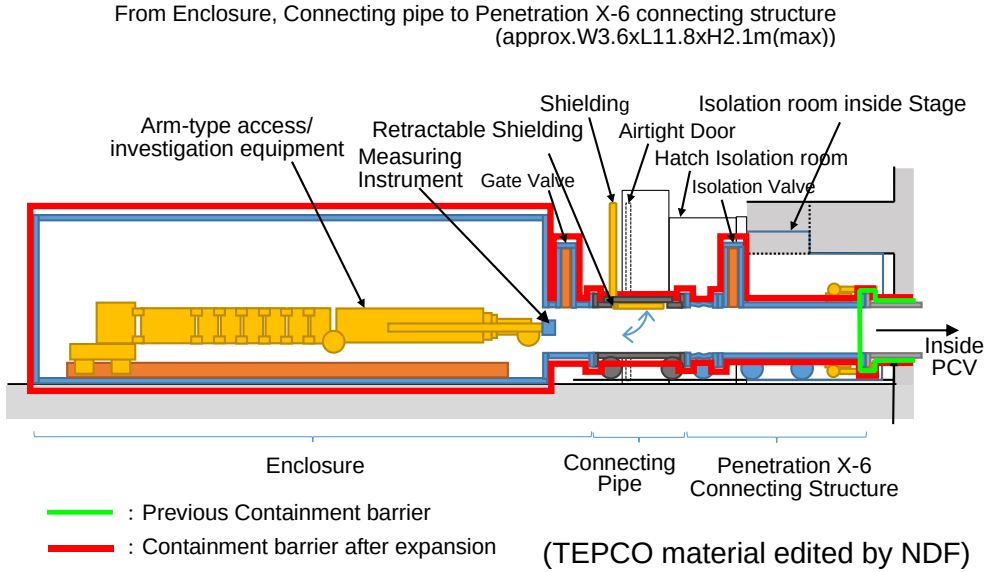

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Fig. Schematic drawing of enclosure to penetration X-6

Strategies for trial retrieval

- While minimizing delays caused by the COVID-19 infection, mockup testing that takes full account of uncertainties on site is important in terms of actual site applicability and ensuring safety.
- It is necessary to maintain the backup system on the UK side, while sharing information and communicating smoothly with the UK engineers who fabricated the equipment.

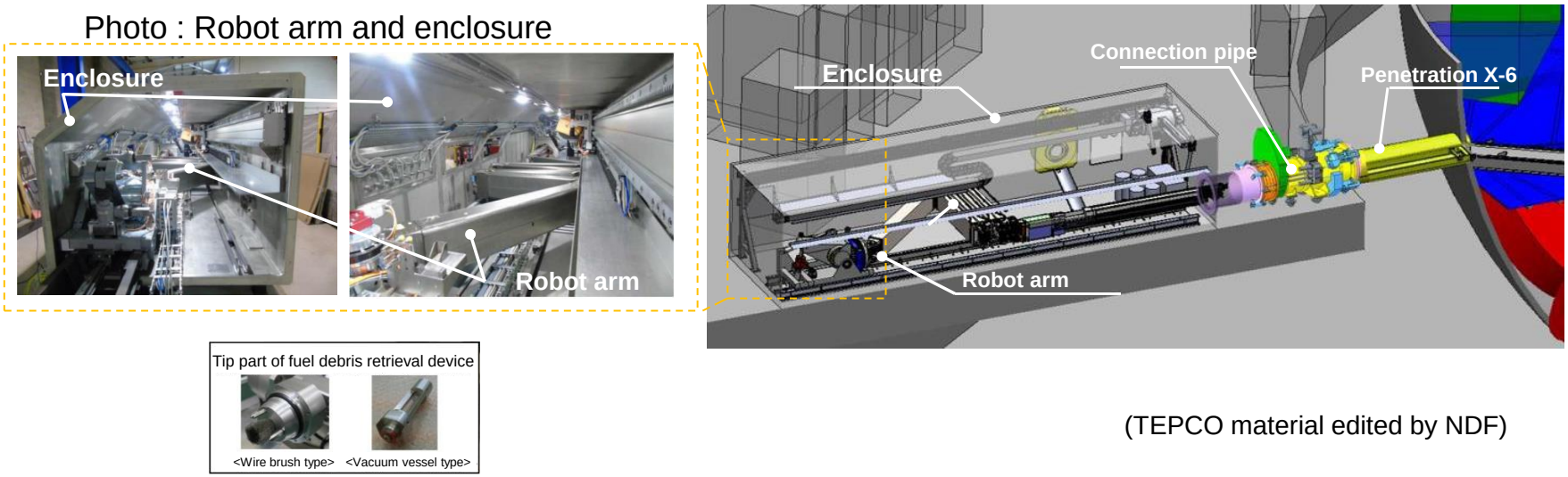

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Fig. Conceptual image of fuel debris retrieval system

Strategies for further expansion of fuel debris retrieval

Strategy **Further expansion of the retrieval scale**

① How to select retrieval methods

- In selecting the method, it is necessary to use evaluation items such as schedule and resources as indexes for selection while satisfying the target of safety level.
- In the process of selecting the method, it is most important to quantify each of these evaluation items, to use what evaluation items as indexes for selection, and how to set the weighting of these indexes.
- In a situation with many uncertainties, it is necessary to proceed with examination based on the currently available information and then to feed back the results gained from the investigation.

② Development of retrieval scenarios

- Several scenarios of fuel debris retrieval by each unit should be examined and clarified several paths. Then, it is important to narrow down the pathways thereafter to take according to the information obtained afterward.

Strategies for further expansion of fuel debris retrieval

③ Clarification of requirements

- Followings are important because operations, devices and equipment, and facilities will be larger, and the scope of construction will be wider.
  - ✓ Consideration in overviewing the entire Fukushima Daiichi NPS
  - ✓ Specification and optimization of the requirements (containment, criticality, operability, maintainability, throughput ※, etc.) for operations and devices

④ Process for narrowing down promising retrieval methods

- Diverse ideas are expected to be derived, but it is important to conduct objective evaluation and to narrow down the methods by the gradual process.

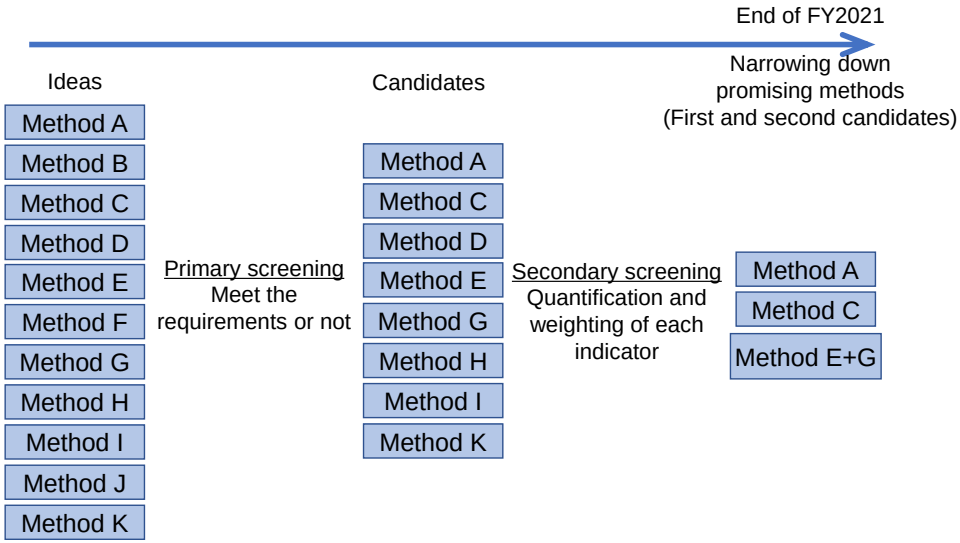


Fig. Image diagram of the process for narrowing down retrieval methods

※ Fuel debris retrieval capacity that indicates the processing time and operational efficiency

Major targets and progress for solid waste

Major targets

- As an effort towards implementing processing/disposal, prospects of a processing/disposal method and technology related to its safety should be made clear by around FY 2021.

Progress

Providing prospects of a processing/disposal method and technology related to its safety

a. **Present measures toward reducing the volume** of solid waste

b. **Develop analytical/evaluation method** for efficient characterization

c. **Develop methods to reasonably select** safe **processing/disposal methods** at the time when the necessary information such as solid wastes' properties are proven

Prospects of a processing/disposal method and technology related to its safety

■ Present measures toward reducing the volume

➢ The priorities for measures to be taken as waste management are ① prevention of waste generation, ② minimization of waste volume, ③ reuse, ④ recycling. In waste management, it is important to consider ⑤ disposal as the last option for volume reduction of waste.

①: Consider in the design and construction plan to reduce the volume of materials to be used. Not to bring in substances that affect processing/disposal as much as possible

②: Strict segregation

③: Reuse should be promoted after contamination checks, decontamination, repair and parts replacement

④: Consider the contamination condition, separate and process recyclable materials, and use them as new materials and products

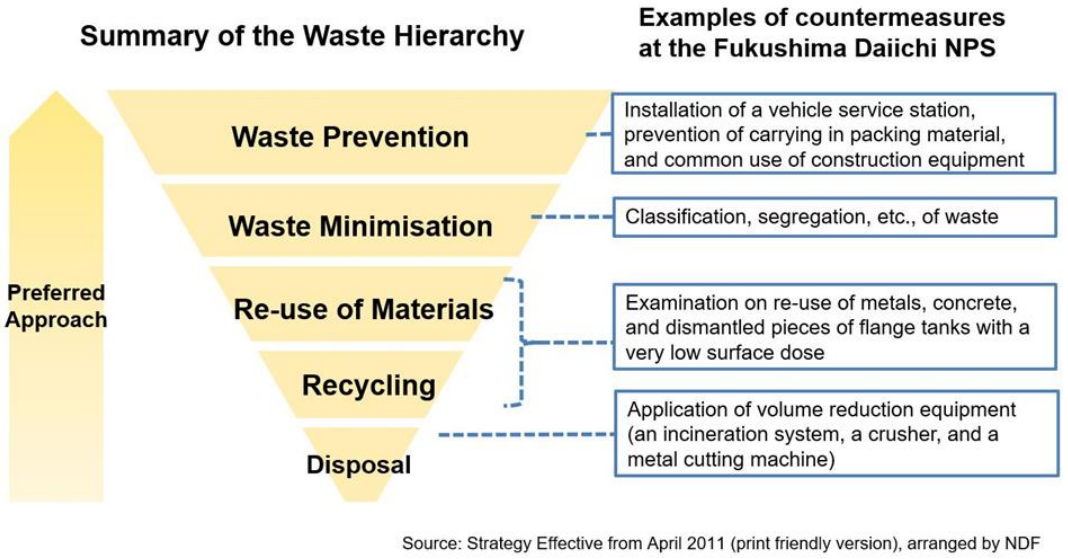


Fig. Summary of waste hierarchy at the NDA, UK, and countermeasures at the Fukushima Daiichi NPS

Prospects of a processing/disposal method and technology related to its safety

■ Develop analytical/evaluation method

- ➢ Automation of pretreatment and simplified analytical methods compared to the conventional radioactivity measuring method, etc.
- ➢ Establishing the method in which statistical methods have been applied to identify variable distribution and the width (quantify uncertainties in evaluated values).

■ Develop methods to reasonably select processing/disposal methods

- ➢ For the waste for which properties have been identified to some extent, repeating examination steps from ① to ③, and an appropriate combination of processing (waste form) and disposal※ methods would be examined,

① Establish several feasible disposal methods suitable for waste characteristics.

② Establish several processing methods suitable for waste characteristics to be considered and set the specifications of waste package after applying each processing method.

③ Evaluate the safety of several selected disposal methods based on the specifications of waste form after processing to verify whether risk to the public and environment can be sufficiently low, and to consider more effective processing/disposal methods based on the evaluation results.

※ The location and scale of the facility are not specified.

Prospects of a processing/disposal method and technology related to its safety

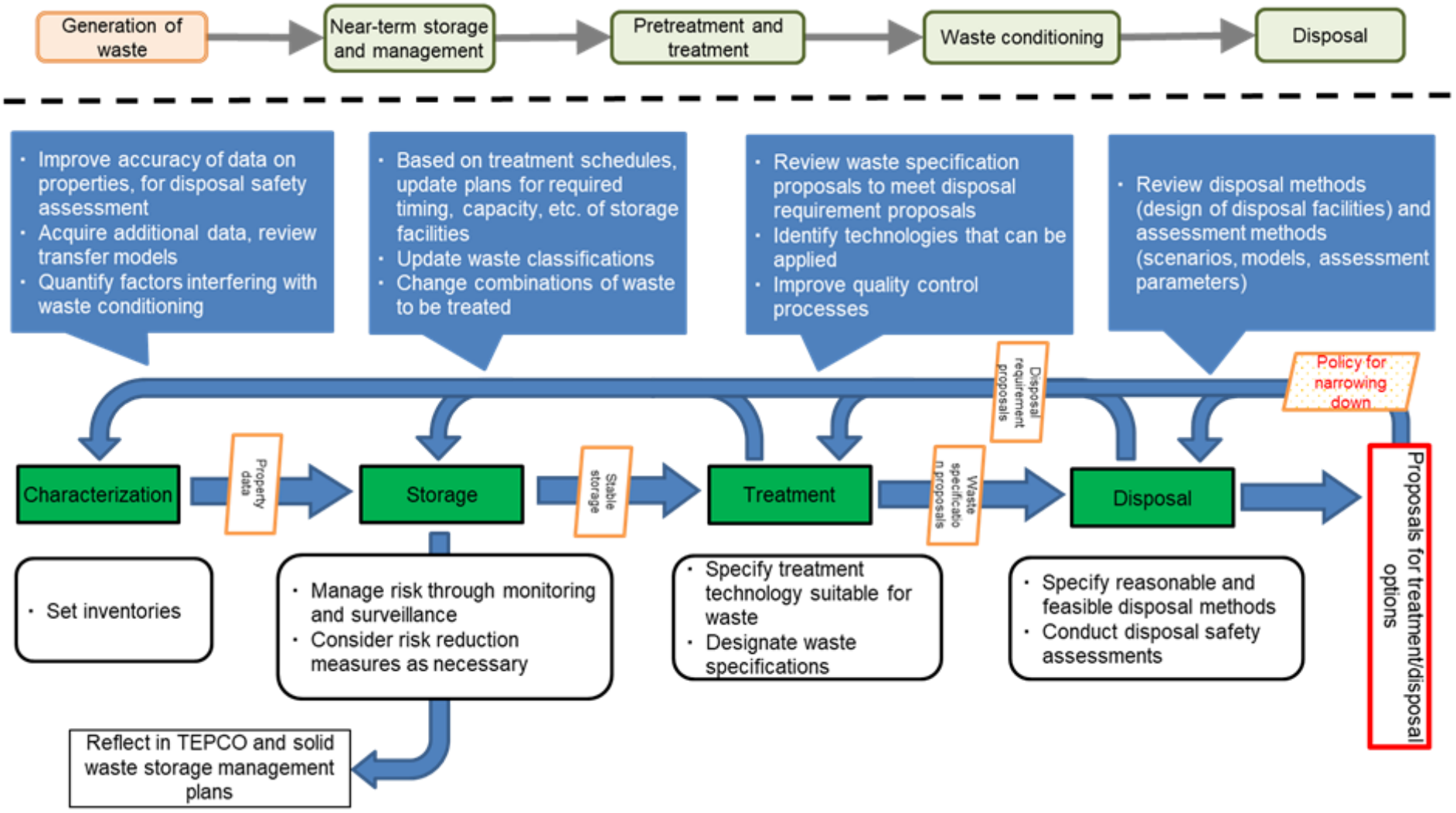


Fig. Develop methods to reasonably select safe processing/disposal methods

Technical strategy by sector related to waste management

Strategy

Characterization

- It is important to develop a medium-to-long-term analysis strategy that defines the solid waste to be analyzed, its priority, and quantitative targets for analysis, etc., and to proceed with analysis/evaluation accordingly.

Storage

- It is important to reconsider measurement items and timing, etc., while acquiring necessary information through continuous monitoring and surveillance of the storage status commensurate with the risks involved.

Processing/disposal

- In order to establish safe and reasonable processing/disposal methods, and to widely obtain knowledge for optimizing each individual stream※, it is necessary to continue development/research of processing/disposal technologies required for the series of studies.

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

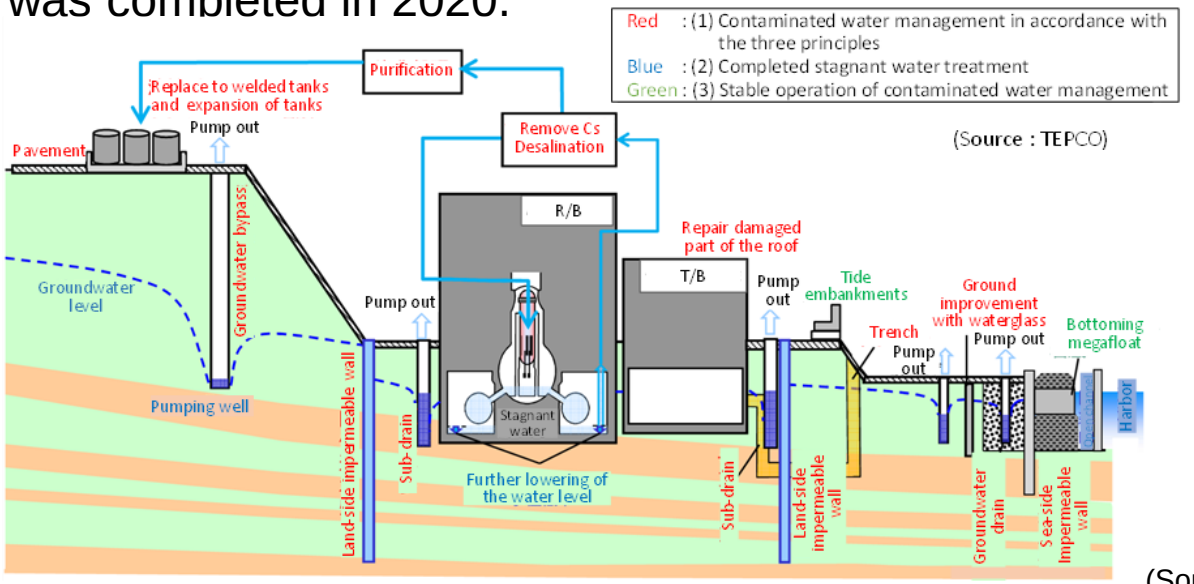
Major targets and progress for contaminated water management

Major targets

- 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 controlling the generation amount of the contaminated water to 100 m^3/day or less in 2025

Progress

- Excluding the reactor buildings of units 1 to 3, the process main building and high-temperature incinerator building, the treatment of stagnant water in buildings was completed in 2020.



(Source : TEPCO)

Fig. Outline of contaminated water management

Reducing stagnant water in reactor buildings

Strategy **Reduction of the stagnant water in the reactor buildings**

- In considering the removal methods for preventing the spread of α-nuclides, it is necessary to collect samples from as many places as possible and to understand the variation in their properties.

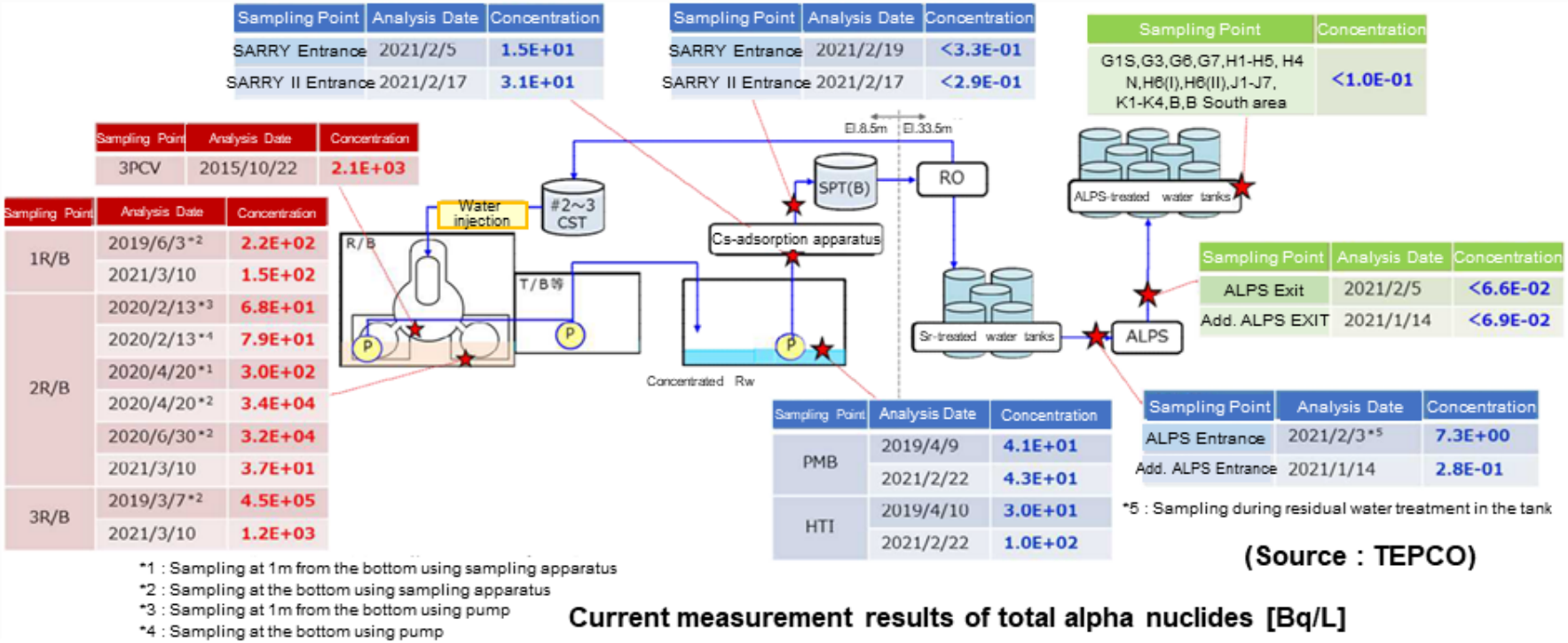


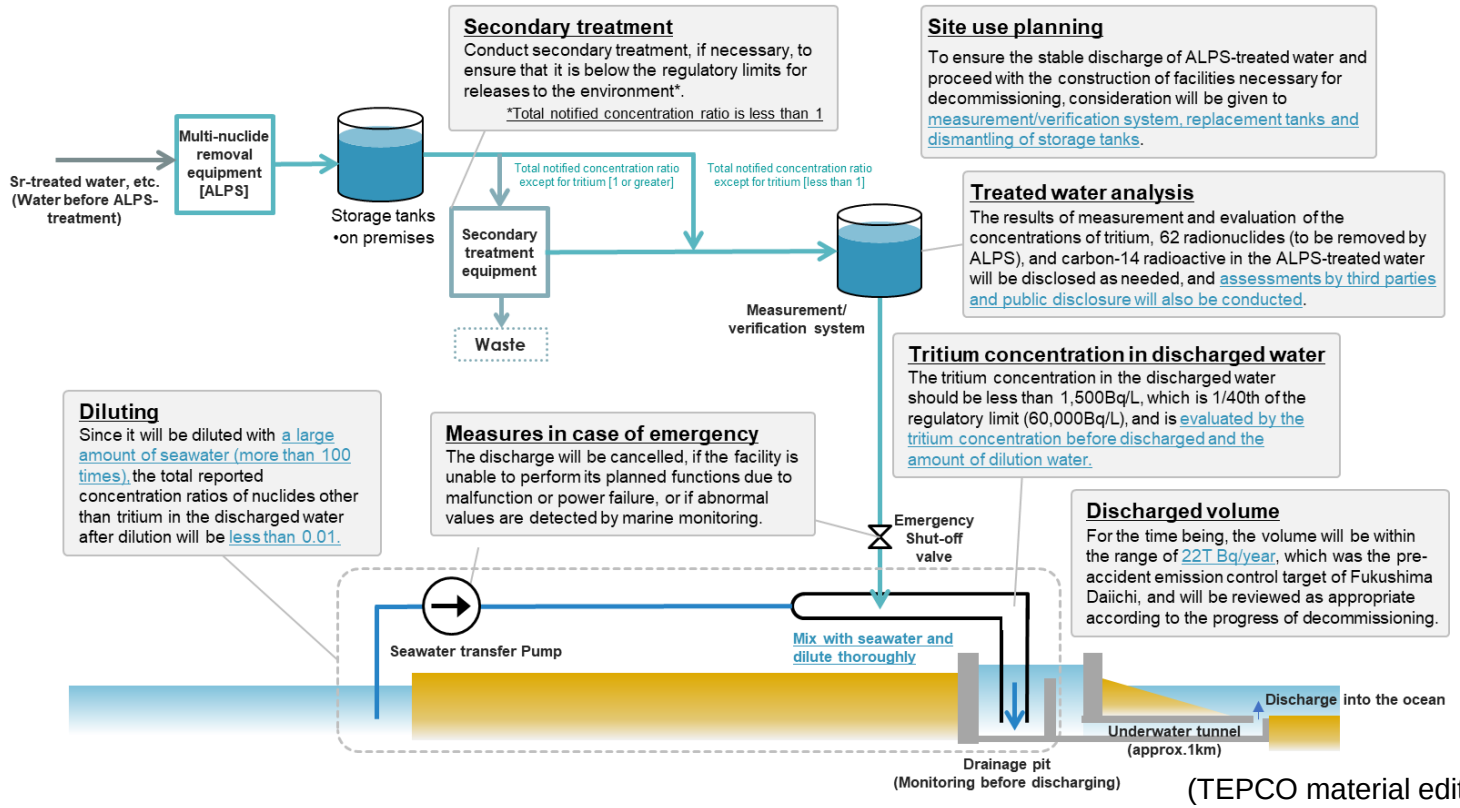
Fig. Water treatment systems for stagnant water in buildings and measurement results of total α-nuclides

Strategies for ALPS-treated water

Major targets

- ALPS-treated water currently being stored in tanks will be handled in accordance with the government's basic policy decided in April 2021.

[Conceptual diagram of the discharging system]



(TEPCO material edited by NDF)

Fig. Conceptual diagram of ALPS-treated water discharge system planned by TEPCO

Efforts for releasing ALPS-treated water into the sea

■ Issues for discharging ALPS-treated water into the ocean

- The government's decision on the policy is in line with international guidelines. It is an important decision from the perspective of ensuring the sustainability of decommissioning work.
- The discharge system is based on existing domestic and international experience, and safe discharge can be achieved through thoroughly maintaining manuals and strictly following the plan.
- In order to ensure the reliable operation of the implementation plan, it will be necessary to increase the transparency of the plan execution status, including confirmation and monitoring by third parties such as the IAEA.

Major targets and progress for fuel removal from spent fuel pools

Major targets

- Fuel removal from SFPs will start in FY 2027 to FY 2028 for Unit 1 and FY 2024 to FY 2026 for Unit 2. (For Unit 3, completed in February 2021)

Progress

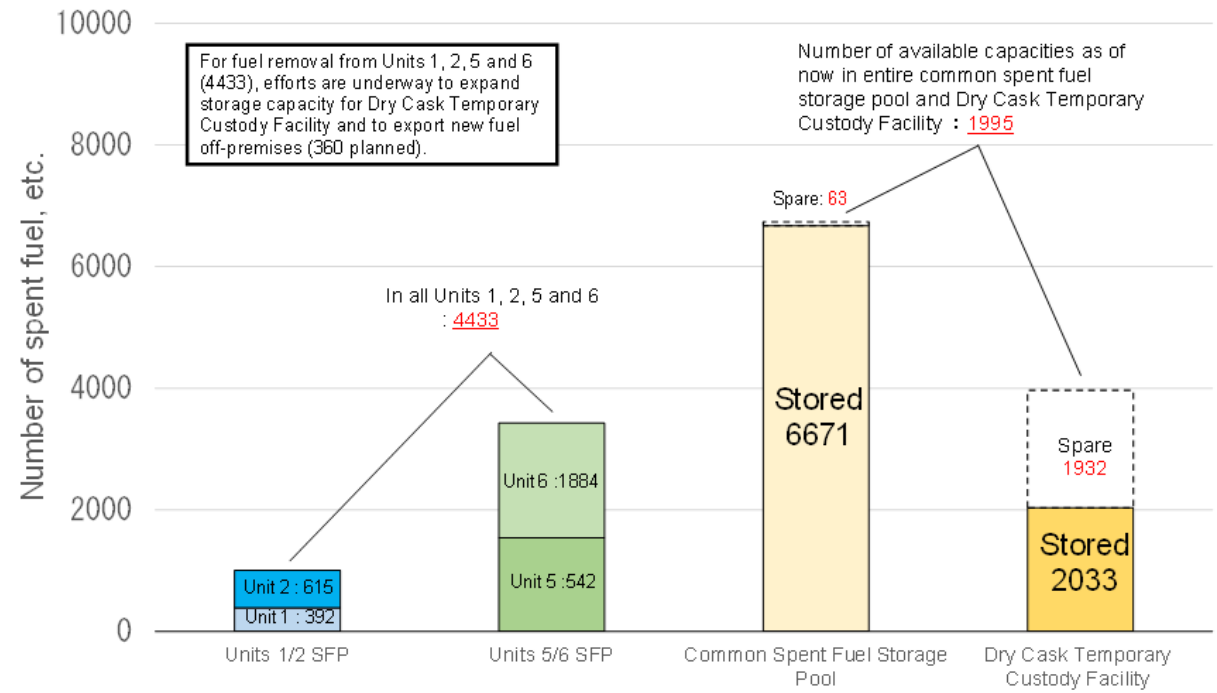


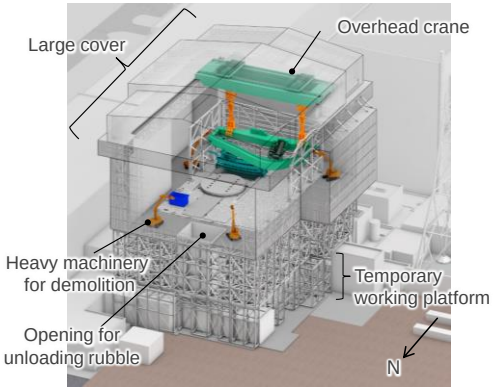
Fig. Storage status of spent fuel (As of March 2021)

Strategies for fuel removal from spent fuel pools

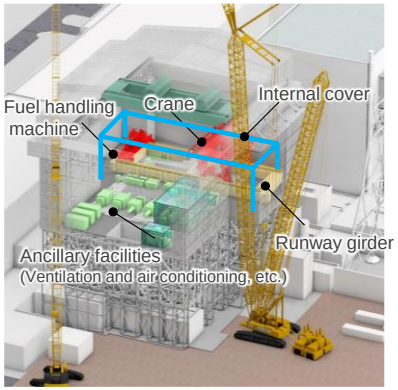
Strategy

Unit 1

- It is important to comprehensively consider removal of overhead crane and how to handle well-plugs, taking into account the impact on the other operations by performing thorough safety assessments.



During rubble removal (Conceptual drawing)



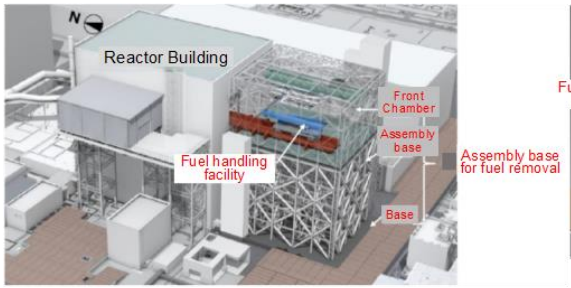
During fuel removal (Conceptual drawing)

(TEPCO material edited by NDF)

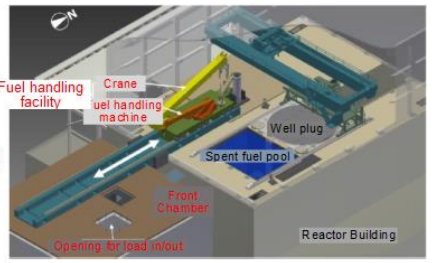
Fig. Fuel removal method from SFP (Unit 1)

Unit 2

- For a fuel handling machine to be introduced as a new system, it is important to perform mockup tests and to be sufficiently familiar with remote operation.
- For further dose reduction of the operating floor, it is important to incorporate new survey results in decontamination and shielding installation methods .



Fuel removal method (conceptual drawing)



Fuel handling facility (conceptual drawing)

(TEPCO material edited by NDF)

Fig. Fuel removal method from SFP (Unit 2)

4. Analysis strategy for promoting decommissioning

- Analysis is one of the important factors in considering solid waste and fuel debris with significant uncertainty.
- To obtain good analysis results, it is effective to properly maintain (i) the methods and systems for analysis, (ii) the quality of the analysis results, and (iii) the size and quantity of sample.
  - ✓ It is necessary to organize division of roles according to the characteristics of the of facilities for analysis including the Ibaraki area.
  - ✓ Securing of analytical engineers and developing human resource are needed.
  - ✓ It is important to comprehensively review/evaluate at what stage of the accident, what elements were mainly contained, and what properties they have.
  - ✓ It is effective to diversify and expand the analysis methods and to perform comprehensive evaluation.

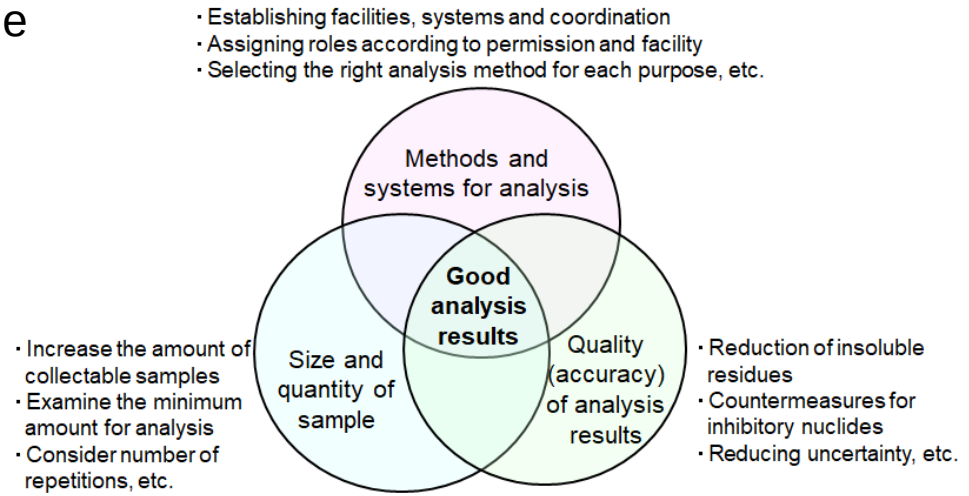


Fig. Three elements of the fuel debris analysis strategy

5. Efforts to facilitate research and development

- Updating the R&D medium-and-long term plan for fuel debris retrieval and others
- Strengthening of the functions of project planning and management in the Project of Decommissioning and Contaminated Water Management. (NDF has been participating in the secretariat)
- TEPCO's own R&D activities, and strengthen their structure. (Establishment of Decommissioning Technology Development Center)
- Strengthening and accelerating the perspective of the needs in the Nuclear Energy Science & Technology and Human Resource Development Project (TEPCO joined as the screening member for selection.)

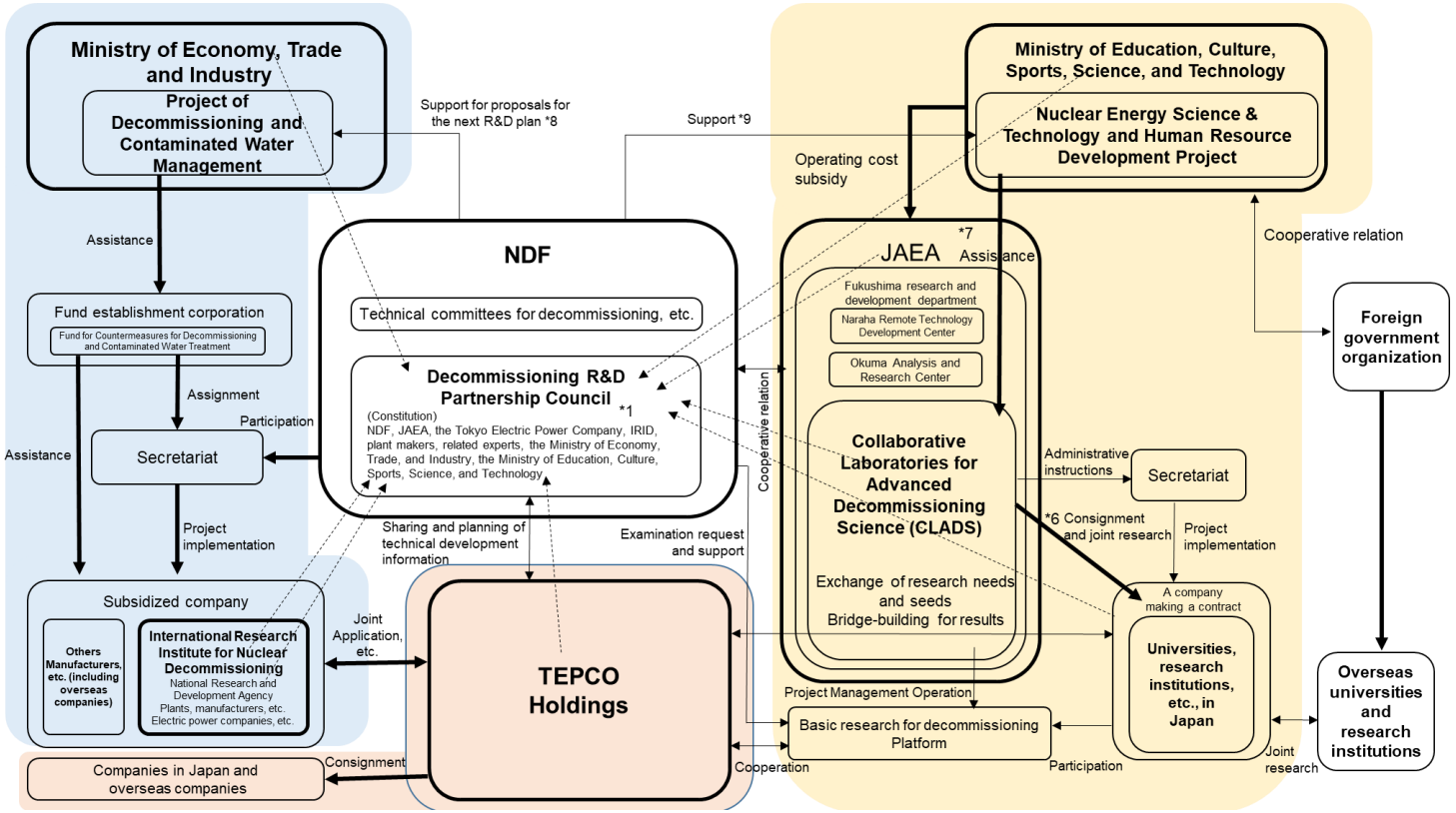


Fig. Overview of the R&D structure of the decommissioning of Fukushima Daiichi NPS

Project management approach

■ Significance and current status of project management

- For smooth promotion of the decommissioning project, it is necessary to establish and enhance a management system in which the organizations work together to achieve the goals.
- TEPCO has been working to build and strengthen its project management system, and the general framework was established, it is important to rooted in the on-site operations.

■ Key issues and strategies to be strengthened in the future

- Every employee needs educational materials and opportunities to learn about safety in a systematic way for establishing safety as an organizational culture.
- TEPCO needs to improve the owner's engineering capability
  - ✓ Ability to assess and manage process risks
  - ✓ Improving acquisition management capability (Acquiring the final outcome (product or deliverables) by "making things up", in considering everything from development to manufacturing and operation and maintenance)
  - ✓ Promotion of internalization to develop the ability to plan/design, maintain/operate themselves.
- Securing and developing human resources for the smooth implementation of decommissioning projects
  - ✓ Development of the Medium-to-long term human resources development plan and its systematic implementation

Strengthening international cooperation

■ Significance of international cooperation

- ➢ It is important to learn lessons from precedent overseas decommissioning activities, and to utilize the world's highest level of technology and human resources.
- ➢ It is important to secure the confidence of the international community by disseminating accurate information on the decommissioning, and to promote decommissioning in a mutually beneficial manner by actively returning to the international community the knowledge, etc., gained through the accident.

■ Key issues and strategies

- ➢ It is necessary to continue this mutually beneficial relationship while also working to return the results to the interna community.
- ➢ It is important to continue to build and strengthen relationships by utilizing online systems and other means so that international cooperation will not be diluted.
- ➢ For the steady implementation of decommissioning, it is necessary to disseminate accurate information that meets the interests of the recipients through various opportunities.

Fig. Annual meeting of NDF with foreign organizations concerned (held online in April 2021)

Local community engagement

Current status of initiatives for regional industrial and economic infrastructure

- The fundamental principle for the decommissioning of the Fukushima Daiichi NPS is "coexistence of reconstruction and decommissioning". Revitalization of decommissioning-related industries is an important pillar of TEPCO's contribution to the reconstruction of Fukushima.
- Efforts for the accumulation of decommissioning industries based on TEPCO's "Commitment" published at the end of March, 2020.
  - ① *Increased participation of local enterprises*
  - ② *Support for local enterprises to step up*

  Matching support with prime contractors

  Survey of the needs regarding human resource development
  - ③ *Creation of new local industries* → **Building an integrated decommissioning project implementation system in the Hamadori region※**

Key issues and strategies

- With the understanding of prime contractors, it is necessary to implement ordering and contracting methods that will make it easier for local companies to receive orders on a trial basis.
- Further strengthening of cooperation and collaboration with local governments, and local related organizations, including the Fukushima Innovation Coast Framework and the Fukushima Soso Recovery Promotion Organization, which are operating a joint consultation service and co-hosting matching business meetings.

※ TEPCO, " The recruitment of factory operation partners and Cask license partners for the establishment of a factory for decommissioning-related products in Hamadori Region of Fukushima Prefecture", announced on July 9, 2021