The Decommissioning Research and Development Plan for FY2024

Engineering by Operating Entities, Investigation of Next Measures

[A] Trial Retrieval and Retrieval Gradually Expanded Its Scale

[A1] Trial Retrieval in Unit 2

<no project>

[A2] Retrieval Gradually Expanded Its Scale in Unit 2

- **[A2]Technologies for Fuel Debris Retrieval Gradually Expanded Its Scale** (finished)

[B] Scaling Up Retrieval of Fuel Debris

[B1] Work Environmental Improvement Inside and Outside of Reactor Building

- **[B1] Technologies for Work Environmental Improvement in Reactor Building （～FY2025）** (partially new)

[B2] Investigation Technology of Inside of PCV/RPV, Fuel Debris Characterizatoin

- **[B2①] Development of Technologies for In-depth Investigation of PCV Inside** (under review)
- **[B2②] Investigation Technology of Inside of RPV (～FY2025)** (new)
- **[B2 ③] Analysis and Estimation Technology for Characterization of Fuel Debris （～FY2024）** (continued)

[B3] Retrieval System, Safety System, Maintenance System, Storage Equipment

- **[B3①] Fuel Debris Retrieval Method (～FY2024)** (continued)
- **[B3②] Safety System (～FY2025)** (partially new)
- **[B3④] Technologies for Containing, Transportation and Storage of Fuel Debris (～FY2024)** (continued)
- **[B3⑤] Assistive Technologies for Integration Management of Decommissioning of the Fukushima Daiichi Nuclear Power Station (～FY2025)** (continued)

[C] Waste Management

- **[C] Research and Development of Processing and Disposal of Solid Waste (～FY2025)** (new)

example

- **Research and Development Supported by METI**

B1：Development of Technologies for Work Environmental Improvement in Reactor Building

Purpose

Towards the scaling up retrieval of fuel debris and internal structure, technology development related to work environmental improvement shall be implemented as it is necessary for the safe and efficient work inside the R/B, where there still leaves the place where the damage status caused by the accident is unknown and the dose rate is still high.

Implementation Content

○Prior to fuel debris retrieval, environmental improvement is necessary for safe and efficient preparatory work for construction of access route in R/B, where there still leaves the place where the damage status caused by the accident is unknown and the dose rate is still high. Important technical element to improve the work environment is to recognize the work environment and the dose and the radioactive source distribution, to formulate an exposure dose reduction plan corresponding to changes of the work environment, technology for the safe and reliable removal of high dose PCV penetration pipes etc., which have a possibility to include contaminated fluid and hydrogen etc. inside. Regarding technology and devices related to it, taking into consideration the environmental improvement work which is required at any time during the fuel debris retrieval period, survey, investigation and elemental tests shall be implemented to enable on-site application.

○ This research and development shall reflect operators' point of view and the results of this research shall be used in the engineering conducted by the operating entity.

1. Development for Highly Performance of Exposure Reduction Technologies by Digitalization of Environment and Radioactive Source Distribution

In order to carry out the work in the R/B, including the preparation work to construct access routes for the fuel debris retrieval, it is necessary to reduce the exposure of workers as much as possible and to formulate a safe and efficient work plan. Therefore, it is necessary to properly recognize structures inside the R/B, the damage status of the equipment and the work environment including radiation dose etc. In particular, it is important to identify high-dose radioactive sources and plan the appropriate measures for the change of radiation dose etc. by removing equipment that may be the radioactive source and installing shielding.

Therefore, a system shall be developed to convert environmental data on the inside of the reactor building (location and shape of equipment and structures, radiation dose distribution, etc.) into a digital model, and to evaluate the distribution of radiation sources to be targeted for dose reduction through inverse estimation analysis. In addition, along with visualizing the distribution of radiation dose and radiation sources in cyberspace, it shall be formulated the accurate work plans in response to environmental changes caused by work in the R/B and it shall be developed the exposure dose estimation and evaluation system which is able to consider worker's moving routes, spent time and presence or absence of remote devise work.

So far, elemental technologies such as inverse estimation analysis technology and visualization technology have been developed, and a prototype system for environmental and source distribution has been developed that incorporates these technologies and effectiveness of these have been confirmed. For on-site application, there are issues of system functions for further improvement and streamlining.

Therefore, in particular, on-site applicability of the system shall be improved by streamlining the digital modeling process, rationalizing the inverse estimation analysis of radioactive sources and laborsaving the system operation etc. In addition, the development shall be conducted with considerations of maintaining and maintenance management of the system required during the environmental improvement works.

B1：Development of Technologies for Work Environmental Improvement in Reactor Building

2. Development of Systems for Remote Monitoring and Removal Operation for Removal of PCV Penetration Pipes etc.

Pipes etc. penetrating PCV have a high dose part where pipes, device and facilities are crowded in the narrow area, and it has a possibility to include contaminated fluid and hydrogen etc. inside. In order to conduct the safe and ensured removal operation for crowded pipes etc., it is required to stabilize posture of the remote device, and conduct operations by the position control with high accuracy, as well as coordinate appropriate operations with preventions of fluid leakage and the operation monitoring device. In addition, for the removal operation inside of R/B, it is necessary for preparation operation such as survey/measuring operation, locations of material and equipment and on-site curing, collecting operations of existing materials inside of the pipes, and post processing operation such as containing and transporting to the containers etc. Since the operators who engaged in monitoring and operations related these tend to have higher exposure dose, an operation system required minimum human interventions in the operating area by remote monitoring etc.is requested.

Therefore, in order to remove PCV penetration pipes etc. inside of R/B, remote it shall be developed removal operation system coordinated with autonomous remote monitoring of the operation situation. PCV penetration pipes etc. in each unit shall be surveyed, and the operating method and the system specification based on the contents of on-site operation corresponding to the series of the removal process from the preparation to the post processing shall be surveyed and investigated, and the necessary functions and elemental technologies for the remote monitoring and removal operation system shall be identified. For the next, based on the existing technologies, after setting the development issues, a prototype shall be manufactured, and elemental tests shall be conducted, as well as its on-site applicability shall be verified and investigated through combination tests corresponding to the series of process, using the simulants. Furthermore, specification and operating methods of remote monitoring and removal operation system shall be proposed for the actual operation corresponding to the issues identified by the evaluations.

(Notes)

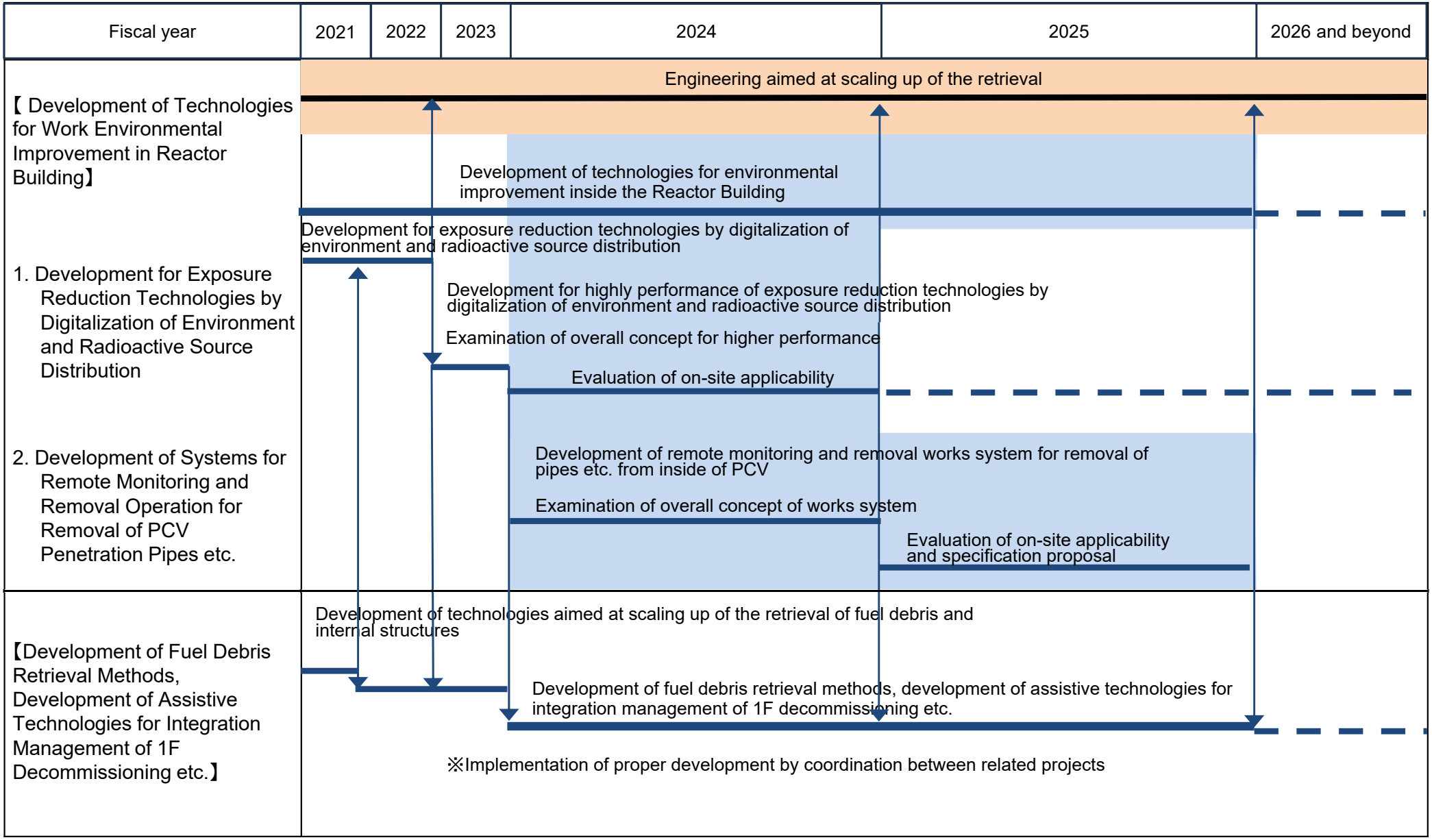
In this development under this project, the development shall be implemented considering the handling characteristics and maintenance method of the remote devices such as follows:

- In principle, devices should be maintained remotely because they should be installed in high radiation dose areas
- It should be necessary to consider the contamination and the decontamination necessary for the equipment
- The work areas for maintenance are limited
- It should be necessary to minimize the waste generated by maintenance works

Definition of criterion for judgment on objective achievement

- Evaluation of on-site applicability related to exposure reduction by improved functional digitalization of environment and radioactive source distribution (FY2024)
- Conceptual investigation of Systems for Remote Monitoring and Removal Operation for Removal of PCV Penetration Pipes etc.(FY2024), Evaluation of on-site applicability and proposal of specifications (FY2025)

(Implementation schedule)B1：Development of Technologies for Work Environmental Improvement in Reactor Building



B2②: Development of Investigation Technologies of Inside of RPV

Purpose

In order to contribute to consideration concerning fuel debris retrieval inside of the Reactor Pressure Vessel (RPV), the investigation technology for grasping the situation of fuel debris inside RPV etc. shall be developed

Implementation Content

- ○ In order to verify the situation inside RPV and the internal conditions such as radiation dose, ensuring confinement functions by remote operations under the environmental conditions such as high-dose radiation and highly radioactive contamination, the drilling device to construct an access route (new opening work etc.) and a device and system to carry the investigation equipment into the RPV shall be developed.
- ○ This research and development shall reflect operators' point of view and the results of this research shall be used in the engineering conducted by the operating entity.

1. Technology Development of the Access-from-Top/Side Investigation Method

As new access route inside the RPV, it is considered an Access-from-Top/Side Investigation Method which drills PCV head and RPV head from the side starting from the dryer separator (DS) pit. Since it is possible to access inside the RPV without providing an opening in the highly contaminated shield plugs, it has a possibility to investigate earlier than the Access-from-Top Investigation Method. In reference to the developments of Access-from-Top Investigation Method and Access-from-Side Investigation Method by FY2019, the development plan of necessary elemental technologies shall be formulated for on-site application of the Access-from-Top/Side Investigation Method starting from the dryer separator (DS) pit, and the entire conceptual design of the device shall be conducted based on the development plan. Furthermore, for technical issues such as drilling of DS slot plugs etc. and sealing of the penetration part of PCV head etc., elemental tests shall be conducted to verify possessions of necessary functions to be achieved.

In addition, based on the investigation of fuel debris retrieval method, if it is clarified new investigation issues of Access-from-Top Investigation Method to drill shield plugs, necessary developments for technical issues shall be conducted.

2. Technology Development of Access-from-Bottom Investigation Method

As Access-from-Bottom Investigation Method, by the end of FY2023, it had been developed the method to access the inside of the pedestal through X-2 penetration/CRD opening to investigate by a drone, and the method to access the inside of the pedestal through X-6 penetration/CRD opening by robot arm (assumed the arm for Fuel Debris Retrieval Gradually Expanded Its Scale) to investigate by a telescopic pipe. And then that on-site applicability has been verified. However, based on the previous results of the PCV internal investigation, due to many obstacles observed inside of the pedestal, it is necessary to develop an investigation device that is able to perform more flexible for the investigation of inside of the pedestal and the bottom of RPV.

(Continuation of 2.)

It shall be developed a device (arm etc.) to access inside of the pedestal from an existing penetration/CRD opening, and also an access and investigation device able to insert inside of the pedestal through the outside bottom of the RPV by the relocation of the investigation device upward inside of the pedestal with flexibility. If necessary, it shall be the devices which has the possession of obstacles removal. Conceptual design shall be conducted to verify the possessions of necessary required functions through manufacturing of prototype and in-factory tests.

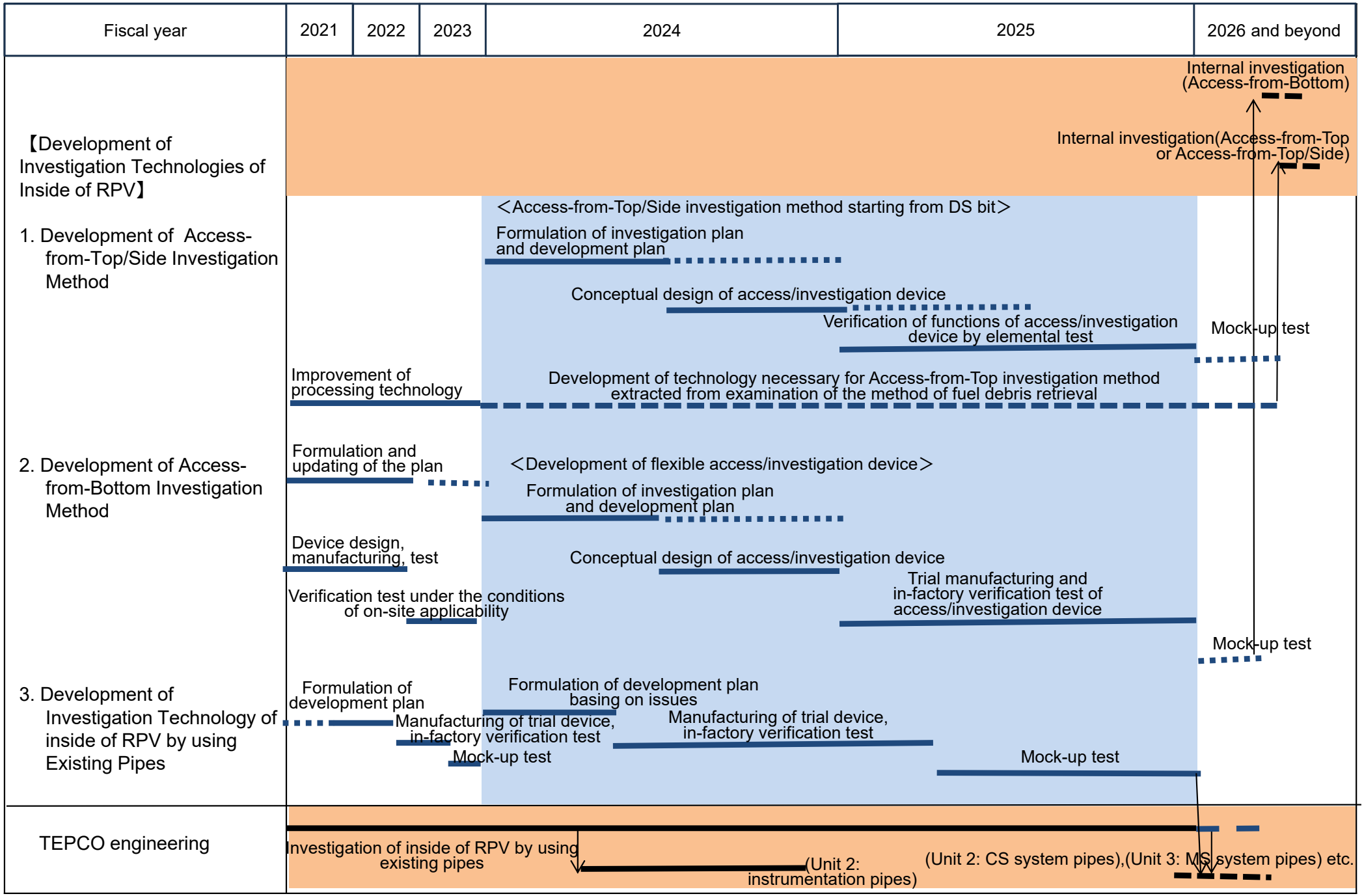
3. Development of Investigation Technology of Inside of RPV by using Existing Pipes

By the end of FY2023, as existing pipes which are able to be used for investigation inside of the RPV from the access route and on-site environment, core spray (CS) system, main steam (MS) system and primary loop recirculation (PLR) system have been selected, necessary functional requirements for constructing the route, moving inside pipes and confirming the conditions inside the reactor have been summarized. Additionally, the protype of device has been developed and on-site application has been confirmed through mock-up tests. In this project, for issues identified through the results of mock-up tests, review and improvement etc. of each the device shall be conducted, and reconfirmation of on-site application shall be conducted through mock-up tests.

Definition of criterion for judgment on objective achievement (FY2024,2025)

- ・Formulation of development plan (FY2024), conceptual design of device etc. (FY2024), function confirmation by elemental tests (FY2025) for Access-from-Top/Side Investigation Method starting from DS pit
- ・Conceptual design (FY2024), developing the prototype and function confirmation by in-factory tests (FY2025) for Access-from-Bottom Investigation Device
- ・Design improvement of device for internal investigation using existing pipes (FY2024), confirmation of on-site applicability by mock-up tests (FY2025)

(Implementation schedule)B2②：Development of Investigation Technologies of Inside of RPV



B2③: Development of Analysis and Estimation Technology for Characterization of Fuel Debris

Purpose

To develop technology necessary for quantitative analysis of components and estimation of characterization of fuel debris in order to contribute to the development of methods for retrieval of fuel debris and internal structures and technologies for containing, transportation and storage of fuel debris etc.

Implementation Content

- ○Fuel debris produced by the first core meltdown accident at BWRs in the world have uneven compositions affected by a reaction with concrete and the seawater injection, etc. and then include many poor solubility isobars and fission products. Therefore, it shall be implemented that development of analysis and estimation technology for characterization of fuel debris which include many uncertainties such as the formation process.
- ○The estimation technology for fuel debris characterization shall be developed by utilizing analysis and evaluation of on-site samples, then the methods for estimation on properties of fuel debris and display of PCV internal damaged condition shall be improved and also the analysis accuracy shall be improved.
- ○In order to realize safe and efficient retrieval and storage of fuel debris, the development of technologies for abbreviated analysis of the existence of fuel components and for grasping non-destructively fuel amount in fuel debris shall be implemented.
- ○The results of this research shall be used in the engineering conducted by the operating entity.

1. Development of Technology Necessary for Analysis and Estimation of Fuel Debris Characteristics

(1) In order to implement safety assessment such as criticality control and storage management etc. for fuel debris retrieval, it is necessary to grasp fuel debris properties. However, it has unprecedented fuel debris produced by BWR accident. It is difficult to analyze fuel debris properties because it includes insolubility and many isobars and fission product, in addition to the unknown of a reaction with concrete, the seawater injection and temperature history during the formation process. For the development of analysis technologies of fuel debris, fuel debris and deposits etc. obtained from inside PCV shall be analyzed at research institutes which have hot lab facilities. Furthermore, based on the analysis results of fuel debris and deposits etc. and the formation mechanism of fuel debris in each Unit, “estimation of fuel debris properties” shall be advanced and the information shall be provided for various processes related to fuel debris retrieval.

(2) Though internal investigations of the PCV have been implemented, it is unknown which visual confirmed parts contain the nuclear fuel because it has obtained mainly images and the air dose rate data. In order to lead to efficient fuel debris retrieval, in reference to the results of the deposits and adhesive materials analysis and on-site investigation obtained so far, it shall be implemented that melting and damaging tests among materials, accident progression analysis and evaluation for migration behavior of molten materials, then it shall be grasped the series of processes such as melting of the nuclear fuel, damaging of the RPV and downward flow of molten fuel into the pedestal etc. and also the distribution situation of fuel shall be estimated. Furthermore, main events occurred the damages of pedestal confirmed by internal investigations of PCV and such progression process and the analytical methods shall be studied. In order to present and understand the obtained results efficiently, it prepares the estimation figure of inside PCV by 3 dimensions CG shall be prepared.

(3) Fuel debris have uneven compositions and include insolubility and many isobars and fission products. In addition, due to the effect from pretreatment and device at each hot lab facility, etc. when the analysis, distribution degrees of analysis results tend to be large. Previously, investigation related to the improvement of the reliability of analysis result and analysis accuracy have been implemented by conducting analyses of chemical compositions and structure etc. for fuel debris simulants that have same chemical compositions. However, there were no progress in the investigations for fuel debris properties affected by the fuel after fission such as the content ratio of fission products, isotopic compositions of fuel etc. Using the fuel debris formed in Three Mile Nuclear Power Plant Unit 2 (TMI-2) accident as a sample, at each hot lab facility, it shall be confirmed the effectiveness for fuel debris of the analysis processes and pretreatment methods cultivated through analysis of fuel debris simulant so far, and then it shall be reflected into the efficiency of the analysis processes.

B2③: Development of Analysis and Estimation Technology for Characterization of Fuel Debris

Furthermore, the comparison data with TMI-2 sample and the fuel debris that will be obtained in the future at 1F on-site shall be obtained, while referring to common and different points of those fuel debris, it shall be reflected into the estimation for the formation process of fuel debris and accident progression, and investigation of safety measures and storage management. By attending global round robin tests for analysis of fuel debris, it shall be confirmed that Japan has sufficient capability of analysis abilities for fuel debris and acquired the findings of analysis evaluation by overseas research institutes.

- The considerations of above (1)~(3) shall be progressed with the discussion among experts in Japan and abroad and obtained finding by such discussion.

2. Development of abbreviated analysis and non-destructive technology of fuel debris

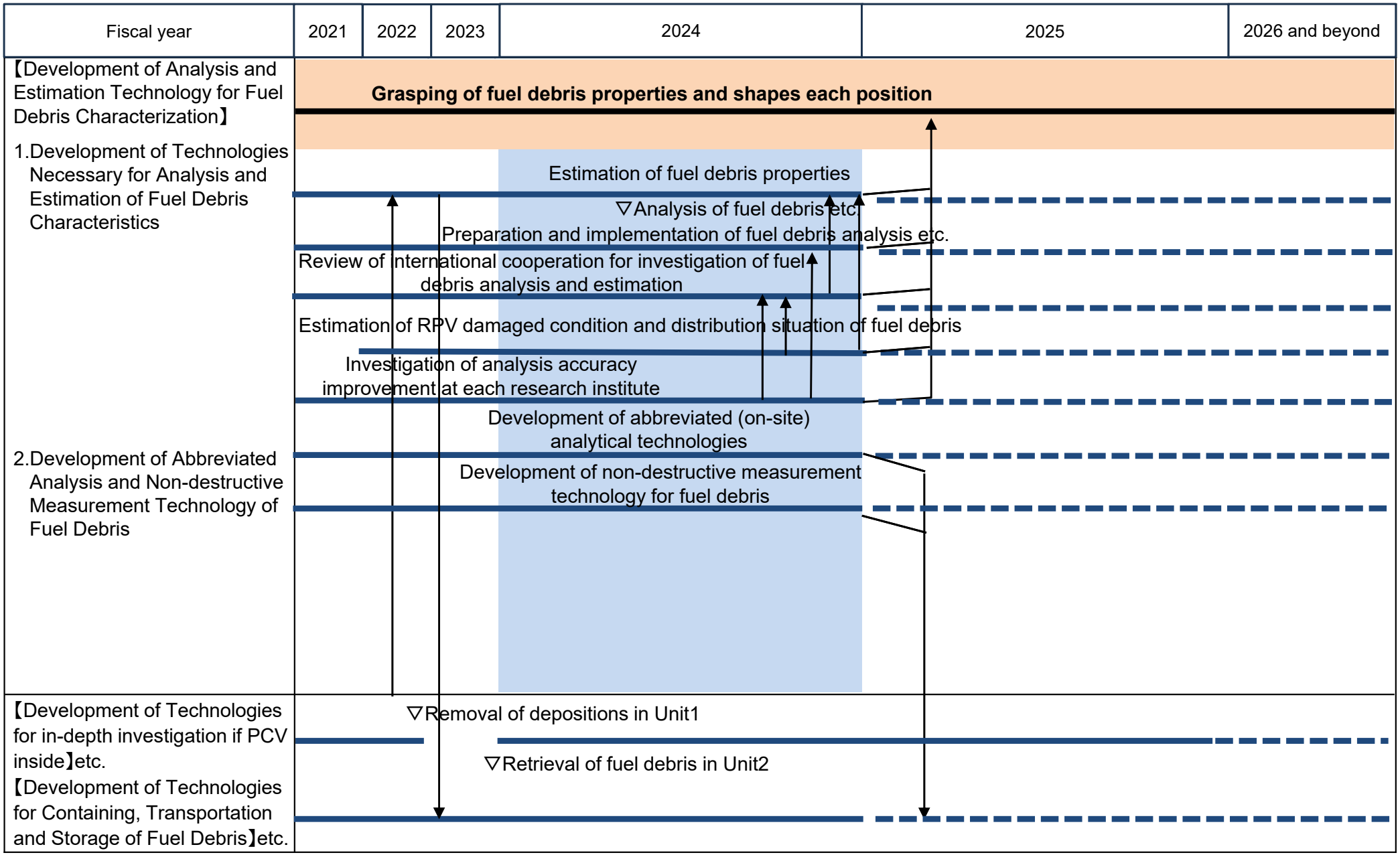
(1) Due to the results of previous internal investigation, adhesion of molten materials have been identified in the structural materials inside PCV. In order to identify the existence of fuel components in the molten materials during fuel debris retrieval works it is necessary to transport to hot lab facilities each time to analyze them. Time and resource will be necessary for the transportation of fuel debris to hot lab facilities and it may interfere prompt fuel debris retrieval works. In order to reduce the transportation burdens to hot lab facilities, abbreviated (on-site) analysis technologies to identify promptly the existence of fuel components adhered and invaded in the structural materials inside PCV shall be developed. Specifically, by utilized spent fuel etc., it shall be accumulated results and findings of the analysis against high level radiation samples and then advancements for fuel components detection such as improvement of detection efficiency and contamination counter measurement when measuring shall be conducted. In addition, the devices for long time stable operations under the on-site environment affected by humidity, dust etc. shall be sophisticated.

(2) Fuel debris contains neutron absorbers when melting. Therefore, it has possibility not to generate sufficient nuclear fission reactions because incident neutrons are absorbed by neutron absorbers if it use the method to measure the radiation released by inducing nuclear fission reaction due to incident neutrons from outside. Furthermore, it is difficult to apply the methods which estimate the fuel burn-up based on the gamma-ray from cesium because highly volatile cesium was released during melting. Due to this individual characteristics of fuel debris, it has concerns to apply originally non-destructive measurement methods used at nuclear fuel reprocessing facilities etc. Accordingly, in order to obtain the data contributed to criticality control and storage management of fuel debris and then conduct the prompt sorting depending on the fuel amounts of materials removed from PCV, research and development shall be conducted for aiming at on-site application of non-destructive measurable technology for fuel mass. Specifically, it shall be investigated the evaluation methods and conceptual structures of the sorting scenario and measuring system for the case to apply the non-destructive measurement technology to the fuel debris. Furthermore, calculation models for reproduction of fuel debris measurement simulation shall be prepared and then, in order to confirm the applicability to the fuel debris, the measurement tests for fuel debris simulant which has the factors which interfere with the existing or small equipment and measurement shall be conducted.

Definition of criterion for judgment on objective achievement

- Preparation for fuel debris analysis and analytical evaluation (FY2024)
- Advancement of “estimation of PCV inside damaged condition” and “estimation of fuel debris properties” based on the latest information (FY2024)
- Analytical evaluation of fuel debris in TMI-2 (FY2024)
- Evaluation for feasibility and expansion of measurement results by abbreviated analytical methods (FY2024)
- Summary of simulation results of technology development of non-destructive measurement, results of measurement tests and results of conceptual study of measurement devices (FY2024)

(Implementation schedule) B2③：Development of Analysis and Estimation Technology for Characterization of Fuel Debris



B3①： Development of Fuel Debris Retrieval Method

Purpose

Towards scaling up retrieval of fuel debris and internal structures, development and test shall be conducted for elemental technology required for feasibility of works regarding retrieval method, and on-site applicability shall be evaluated.

Implementation Content

○In the partial submersion method in order to verify important technological elemental issues for work continuity of long-term fuel debris retrieval on the premise that fuel debris retrieval will be remotely operated under high radiation dose, high contamination and environmental conditions including uncertainties, equipment for upper part of operation floor like large transportation devices, filling stabilization technology, technology for protection from falling during processing and other technologies shall be developed.

○In the examination of fuel debris retrieval methods, regarding other methods including submersion method (shell method), issues shall be considered and resolution of necessary technical issues shall be conducted.

○This research and development shall reflect operators' point of view and the results of this research shall be used in the engineering conducted by the operating entity.

1. Development of Top-Access Partial Submersion Retrieval Method

(1) Large Transportation Device

For transportation of large internal structures from inside of the reactor it is necessary to shield and transport heavy structures with high radiation dose and high contamination to prevent the spread of contamination. So far, research and study of previous transportation technologies, choice of the method of transportation, devices structural examination etc. were conducted. From now on, regarding large transport mechanism focused on confinement, connecting passage gate which will act as isolation boundary etc. conceptual study, verification by trial manufacturing and evaluation of on-site applicability will be conducted.

(2) Filling Stabilization Technology

Method to improve safety and efficiency during dismantling works by filling stabilization of damaged internal structures shall be examined. So far, characteristics of filling material and others were evaluated by basic tests. From now on, regarding damage condition, effective method of filling stabilization of the opening in the bottom part of reactor, device configuration, filling procedure etc. conceptual study shall be conducted, element test using simulants shall be conducted and on-site applicability shall be evaluated.

(3) Technology for Fall Prevention Measures

Because of the possibility of falling to pedestal bottom of fragments during fuel debris processing and/or heavy objects due to vibration etc., it is necessary to take fall prevention measures in order to prevent re-criticality situation due to falling, suppress dust dispersion, prevent equipment damage etc. The concept of fall prevention measures shall be examined, the feasibility shall be verified by the elemental test and on-site applicability shall be evaluated.

(notes)

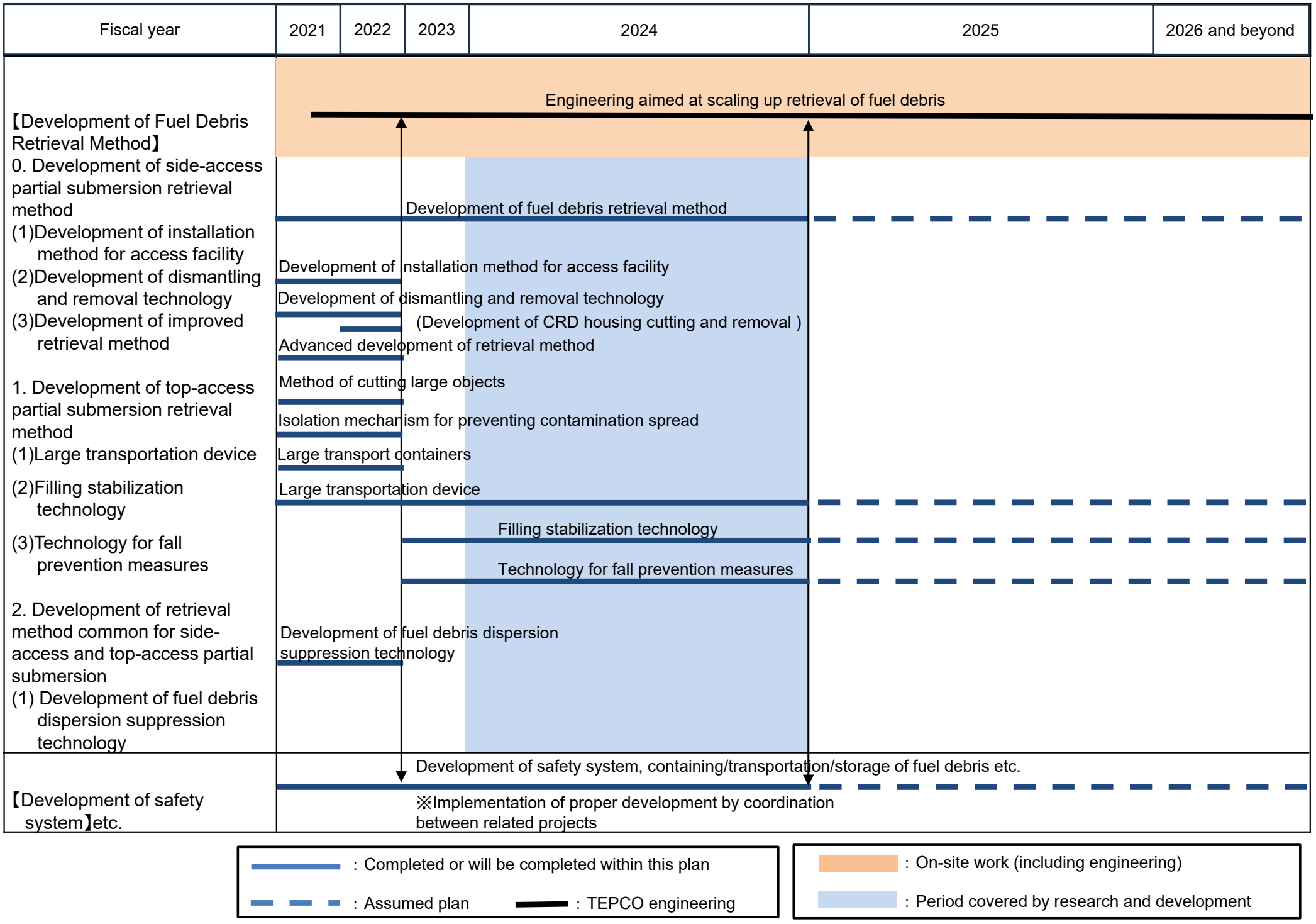
In the partial submersion method development shall be conducted focusing on handleability and maintenance method regarding the following matters.

- As the installation will be made in high radiation area, remote maintenance is the rule.
- It is necessary to consider device contamination and necessary decontamination.
- Work area for maintenance is limited.
- It is necessary to curb waste generated by maintenance works as much as possible.
- It is necessary to consider setting up and handling of criticality monitor.

Definition of criterion for judgment on objective achievement

- Verification by test manufacturing and on-site applicability evaluation for large transportation device (FY2024)
- Verification by test execution and on-site applicability evaluation for filling stabilization technology (FY2024)
- Verification by test execution and on-site applicability evaluation for fall prevention measures (FY2024)

(Implementation schedule)B3①：Development of Fuel Debris Retrieval Method



B3②： Safety System (1/2)

Purpose

For the scaling up retrieval of fuel debris and internal structures, it shall be implemented the development and tests of essential technologies which will be necessary for ensuring the safety during on-site works.

Implementation Content

○Fuel debris retrieval works have uncertain elements of environmental conditions in addition to the conditions under high radiation and high contamination. For the scaling up retrieval of fuel debris, it shall be implemented the acquisition of data necessary for safety system, safety monitoring and assessment and the technology development of analytical methods.

○This research and development shall reflect operators' point of view and the results of this research shall be used in the engineering conducted by the operating entity.

1. Development of Liquid Processing System

⑴ Development of α-nuclides Removal Technology

With regard to removal technologies of soluble α-nuclides assumed to be leached from fuel debris to the circulating cooling water, elemental tests using simulated liquid have been conducted and then the applicability to actual facilities have been evaluated so far. From now on, for the development of further rational processing method, it shall be compared and evaluated multiple processing systems (for example, batch processing by absorption tank and water quality adjustment etc.) to be able to remove α-nuclides in the colloidal state, which are thought to exist in circulation cooling water and be difficult to remove due to the complicated behavior in addition to the soluble α-nuclides, and then various elemental tests to be necessary for the evaluation shall be conducted.

For the technology development, rationality of the entire system, such as suppressing the amount of secondary waste, shall be considered.

In addition, in order to reduce risks related to the applicability of the liquid processing system to on-site, preparation of tests (investigation of adjustment method etc. for testing liquid, elemental tests) using liquid sample of the Fukushima Daiichi NPS (water retained in the reactor building) shall be conducted.

⑵ Development of Secondary Waste Processing Technology

Based on the assumed properties and countermeasures of secondary wastes (sludge etc.) generated from the liquid processing systems, in cooperation with "the project of containing, transportation and storage of fuel debris" and "the project of processing and disposal of solid waste", pretreatment methods considering actual management and storage canisters have been investigated. From now on, summarizing assumed properties of secondary waste generated in the liquid processing system, it shall be conducted elemental tests of necessary technologies of secondary waste processing until the wastes are formed storage forms, and then the technology development of further rational processing method considered optimization and efficiency of storage forms shall be conducted to be able to process the secondary wastes generated from the liquid processing system.

⑶ Development of Technologies for Improvement of Analysis Acceleration and Efficiency for Nuclear Fuel Materials and Elements etc. with Difficulty to Analyze

Due to the contact of fuel debris, nuclear fuel materials and radioactive elements are dissolved into the circulating cooling water in the liquid processing system. Additionally, gaseous radioactive materials are also precipitated as fine particles due to decay or chemical changes. Since these nuclear fuel materials and radioactive elements are adhered or mixed, the contaminations are distributed over a wide area in the building. Under these contamination levels, although the concentrations of these nuclear fuel materials and radioactive elements are lower compared with fuel debris, large number of samples need to be collected for the monitoring. Due to differences of oxidation valences and chemical characteristics, it is necessary for complicated pretreatments by each element such as precipitation and separation etc. In addition, with regard to samples have low-radioactive concentration, there have the cases of difficult analyses due to the small contained amount of radioisotope or the large amounts of isobars etc. In the future, along with the progress of the decommissioning process, it will increase numbers and kinds of samples need to be analyzed. Therefore, in the entire analytical processes including pretreatments, it needs technology development for acceleration, efficiency, automation and laborsaving, improvement of work efficiency related the analyses and acceleration of the monitoring in the reactor building. Specifically, simultaneous quantitative analytical technologies for multiple elements need to develop to separate and detect target nuclear fuel materials and radioisotopes in the samples with high efficiency. For the developments of these technologies, it is necessary to assure the quality of analysis and accuracy control for isotope ratio. Therefore, it shall be conducted advancement of technologies to calculate isotope ratio.

B3②： Safety System (2/2)

2. Acquisition of Dust Dispersion Rate Data

For the works of fuel debris retrieval, in order to develop safety assessment technologies related to dust dispersion rate data during fuel debris cutting, the dust dispersion rate data under drying conditions by several cutting methods have been acquired so far. Based on the results of the data acquisition, further acquisition and organization of data focused on dust generation and transfer under the assumed environment during fuel debris cutting shall be implemented, and then the findings of those behaviors shall be expanded.

In order to contribute to the safety assessment at the normal and accidental conditions, tests for the acquisition of dust dispersion rate data which is applicable to expected environment (moisture condition etc.) by several cutting methods shall be conducted and the behaviors of dust dispersion shall be grasped. The tests are implemented by adding the assessment conditions and using test specimen simulating fuel debris (cold materials* or MCCI debris simulant including uranium). The obtained data shall be organized systematically for the technical basis of safety assessment during fuel debris cutting in the future.

*Cold materials: test specimen not including uranium. The materials which have similar physical properties to those of fuel debris have been selected and they are used to implement the test under the various ranges of cutting conditions.

3. Technology Development of Analytical Method for Exposure Dose Evaluation

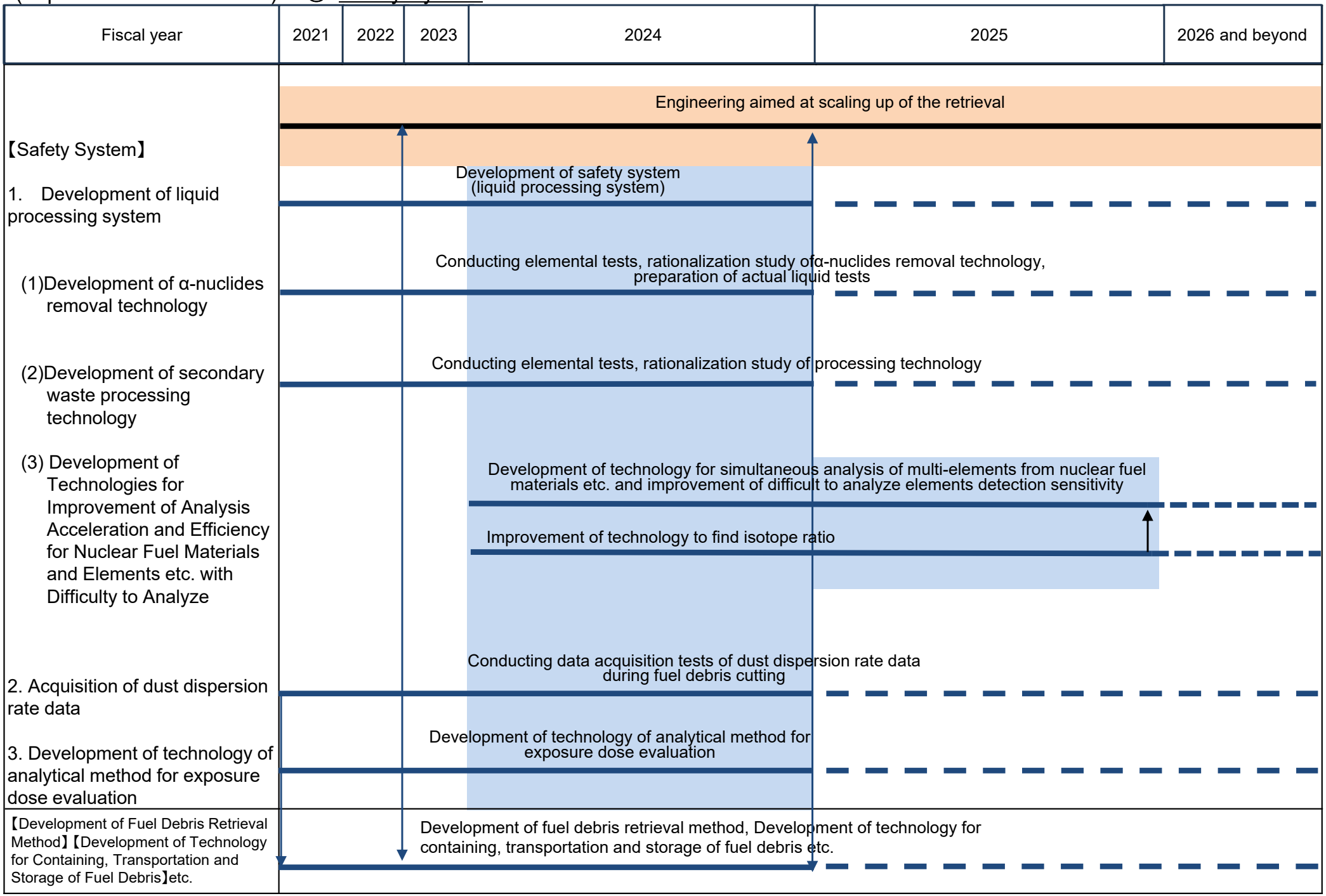
In order to the necessity of monitoring of various nuclides of many operators at the decommissioning works, as the accurate and prompt method for internal exposure dose evaluation, the conceptual study of the program for internal exposure dose evaluation and the technology development such as speed-up of bioassay and accuracy improvement of paper filter samples measurement have been proceeded so far.

Preparing for the radiation risk of intaking α・β nuclides during decommissioning woks such as fuel debris retrieval, both the development of program for internal exposure dose evaluation by the organization and standard development of comprehensive evaluation system for internal exposure dose using bioassay or in vitro measurement (lungs monitoring etc.) and the continuous technology development related to internal exposure dose measurement and evaluation shall be proceeded.

Definition of criterion for judgment on objective achievement

- Conducting elemental tests etc. and evaluating actual applicability for rationalization of α-nuclides including colloidal state removal technology, and preparing the tests using the actual liquid (FY2024)
- Conducting tests and studies such as elemental tests and evaluating actual applicability for rationalization of secondary waste (sludge, etc.) processing system (FY2024)
- Evaluating improvement methods for simultaneous quantitative analysis for multiple elements such as nuclear fuel materials and detection sensitivities of elements with difficulty to analyze (FY2025)
- Conducting the test for acquisition of dust dispersion data including the moisture conditions during fuel debris cutting and developing the evaluation technology (FY2024)
- Developing the program for internal exposure dose evaluation considering the decommissioning process. (FY2024)

(Implementation schedule)B3②：Safety System



B3④：Development of Technology for Containing, Transportation and Storage of Fuel Debris

Purpose

In order to establish a scenario for the process from fuel debris retrieval to its storage, system shall be developed for safe, reliable and rational containing, transportation and storage of retrieved fuel debris.

Implementation Content

○Technology shall be developed for construction of the system which can handle various forms of collection (from lump to powdery, slurry/sludge state) of fuel debris with heterogeneous composition and make possible long-term storage after safe, reliable and rational containing and transportation, considering the hydrogen that may be generated by radiolysis and the criticality of nuclear fuel materials. Furthermore, the development shall be conducted in coordination with related projects.

○This research and development shall reflect operators' point of view and the results of this research shall be used in the engineering conducted by the operating entity.

1. Development of Technology for Handling of Powdery and Slurry/Sludge State Fuel Debris

(1) Improvement of the hydrogen gas generation prediction method

- Verification test shall be executed for verification of the influence evaluation results of the factors affecting hydrogen generation from powdery and slurry/sludge-like fuel debris (hereinafter referred to as "powdery fuel debris"), and for verification of the method to predict the hydrogen gas generation speed, which were obtained from desk study executed in FY2022. Based on these results, the prediction method of hydrogen gas generation shall be improved.
- Regarding the results of FY2022 desk study concerning generation behavior of hydrogen gas accumulation and its release characteristics such as effects at the time of release, verification experiment shall be conducted based also on the effects of various mixtures in fuel debris.

(2) Evaluation of the storage canister filter life span

- Based on the selection results of failure scenarios that may affect filter performance and investigation of test methods necessary for assessment which were conducted in FY 2020/2021, and investigation of powdery debris amount accumulated in the storage canister filter conducted in FY 0222, detailed assessment shall be conducted regarding the possibility of storage canister filter deterioration in the process before the storage and during the storage and possibility of its failure scenario and impact on safety function. In addition, test simulating cases of filters' deterioration and failure shall be conducted, and together with validation of the impact of filter deterioration and failure on the safety functions (for example, hydrogen release and confinement function etc.), methods to mitigate/avoid deterioration and failure shall be investigated.

(3) Reevaluation of storage method and storage container

- Based on the results of mentioned above (1),(2) the investigation results of storage method and storage container for powdery fuel debris, which was conducted in 2021, shall be reevaluated.

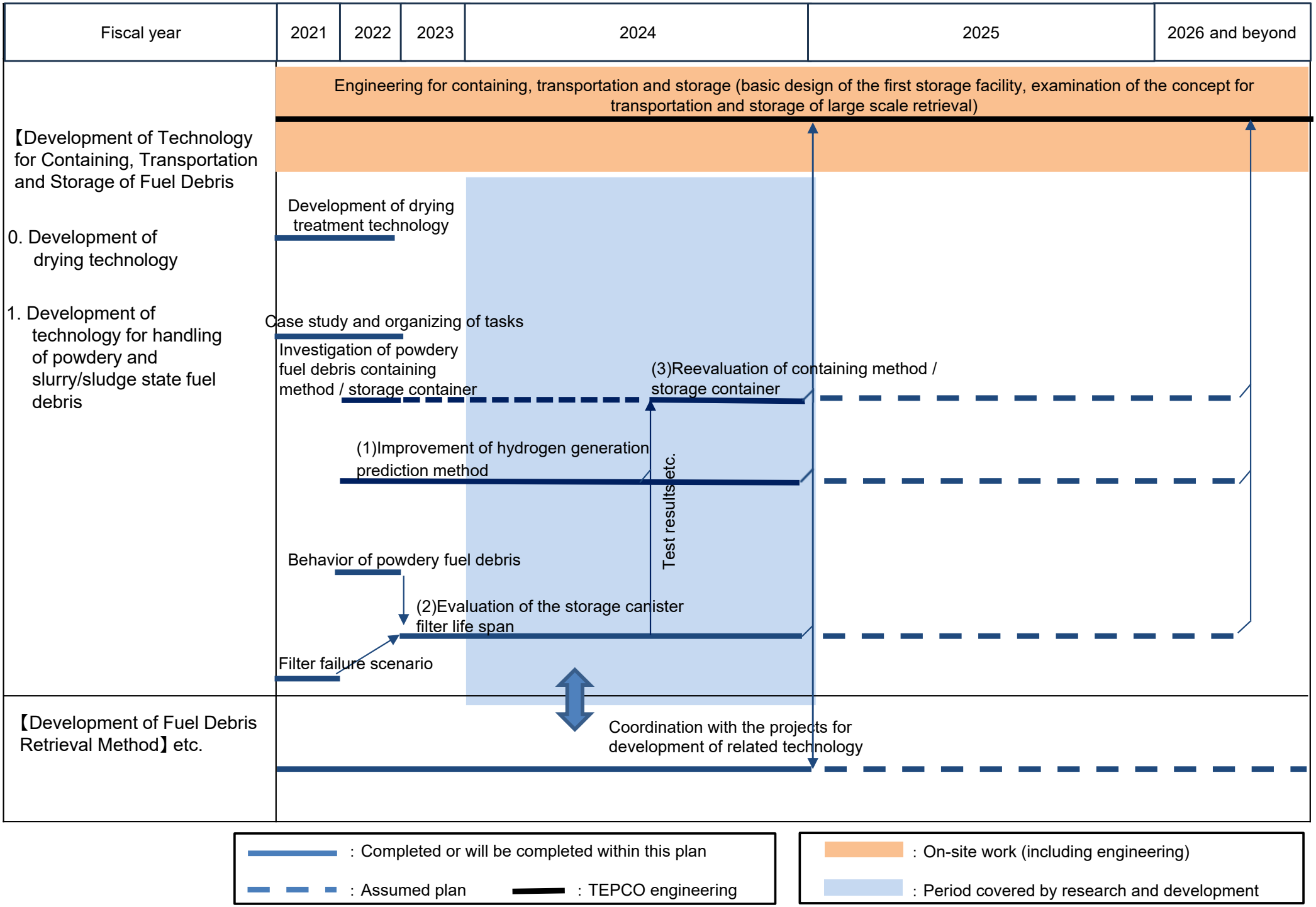
※Projects for development of related technology

"Development of Analysis and Estimation Technology for Characterization of Fuel Debris", "Development of Technologies for Retrieving Fuel Debris and Internal Structures" and "Research and Development of Processing and Disposal of Solid Waste".

Definition of criterion for judgment on objective achievement

- Implementation of the test regarding hydrogen gas generation prediction method and hydrogen gas generation behavior which was planned and prepared in the previous year, and improvement of the prediction method based on it (FY2024)
- Implementation of verification test regarding deterioration and failure of storage canister filter and its impact which was planned and prepared in the previous year, evaluation of the impact of deterioration and failure due to test results and examination of the methods to mitigate/avoid it (FY2024)
- Reevaluation of storage method / storage container based on above results (FY2024)

(Implementation schedule)B3④: Development of Technology for Containing, Transportation and Storage of Fuel Debris



B3⑤：Development of Assistive Technologies for Integration Management of Decommissioning of the Fukushima Daiichi Nuclear Power Station

Purpose

Technologies related to the assistive system necessary for smooth integration management of decommissioning of the Fukushima Daiichi NPS shall be developed, including scaling up retrieval of fuel debris and internal structures.

Implementation Content

○It is necessary to implement safely and smoothly decommissioning of Fukushima Daiichi NPS including scaling up retrieval of fuel debris and internal structures by remote operation under conditions of high-dose radiation, high contamination and uncertainties. For this reason, regarding information management system which enables accurate and quick on-site response by long-term and continuous monitoring of environmental changes during the fuel debris retrieval, and also by integrating and sharing the monitored data and operation data including trouble information, the technology development using digital technologies would be useful. Based on the results of “Development of Technologies for Scaling up Retrieval of Fuel Debris and Internal Structures”, technology for integration management using digital technologies shall be developed as an elemental technology to support safe, efficient and sustainable integrated management for long-term Fukushima Daiichi NPS decommissioning.

○This research and development shall reflect operators’ point of view and the results of this research shall be used in the engineering conducted by the operating entity.

1. Examination of overall concept of assistive system for integration management

It is important to proceed with fuel debris retrieval putting safety first under unified understanding and sharing various information obtained at each stage of retrieval as “Trial retrieval, investigation inside PCV”, “Retrieval gradually expanded its scale” and “Scaling up retrieval of fuel debris”. For that purpose, it is necessary to maintain the system which will integrate the information in an easy-to-recognize way and support data management and operation. In proceeding with efficient decommissioning of the Fukushima Daiichi NPS, it is considered effective to introduce digital technology which will integrate and share information at every stage of design, development, installation, operation and others in addition to monitoring information.

Regarding data management and utilization method corresponding to the stages of fuel debris retrieval from preparation to operation, along with organizing the requirements for the system for monitoring and control of the entire operation and considering of the overall concept of integrated management assistive system, issues for its implementation shall be organized.

2. Development of technology for integrated management using digital technology

- Development of operation database for fuel debris retrieval which will handle digital technology

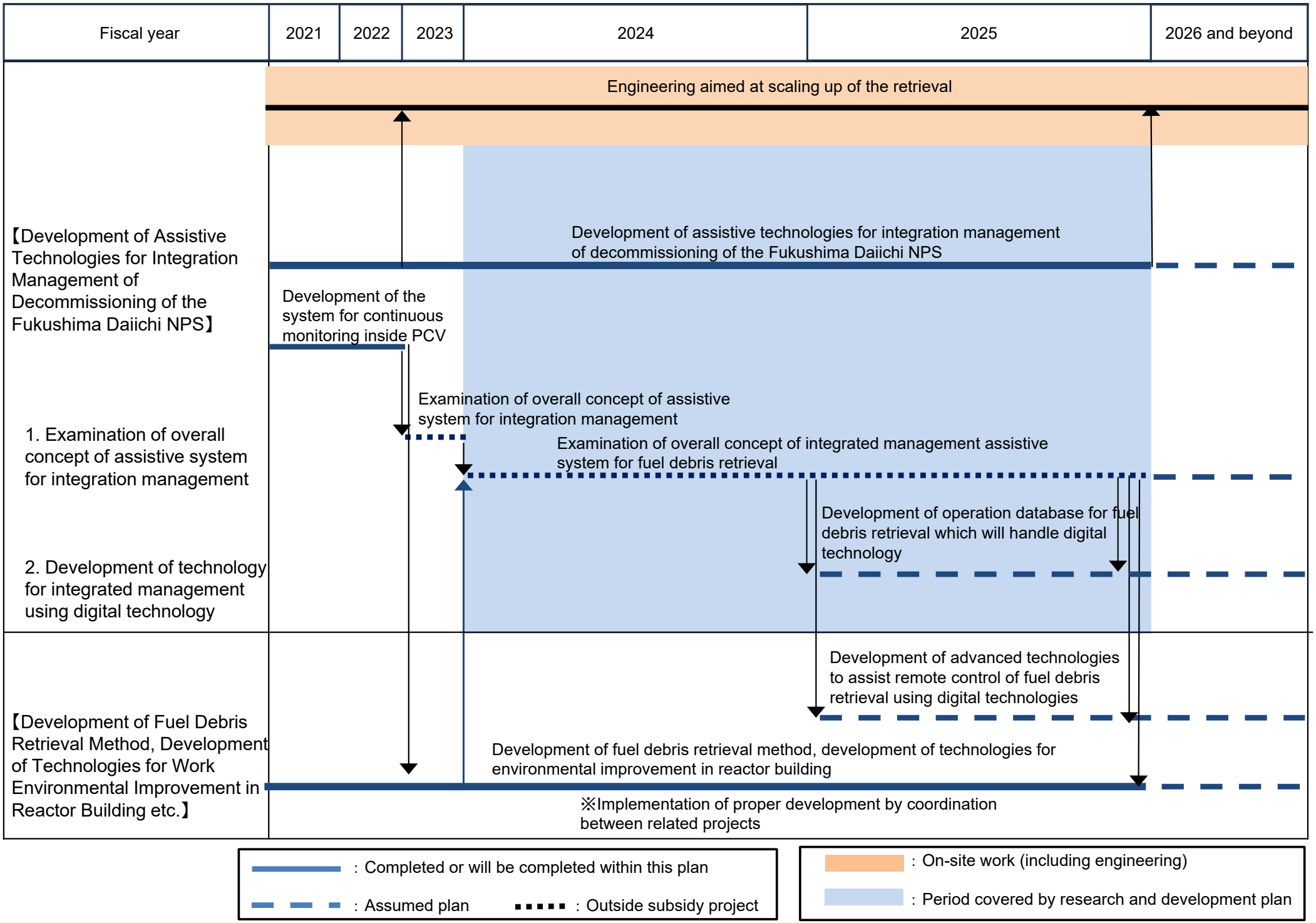
In assistive system for integrated management, assistive subsystems responding to different issues necessary for 1F decommissioning such as works plan, remote operation, status monitoring, equipment maintenance etc., and platform integrating these subsystems are necessary. In order to process, convert, and use efficiently and effectively huge amount of information/data collected by various assistive subsystems, it is important to develop database including data platform which will enable integration and sharing of quick information using digital technology.

Examination and investigation shall be conducted regarding database concept including configuration of data platform for database operation, data management according to its usage, data sharing for its rational classification and usage and ensuring security and others, and also issues to provide necessary functions and practical use shall be extracted and development plan shall be formulated.

Definition of criterion for judgment on objective achievement

・Concept and plan of development of operation database for fuel debris retrieval which will handle digital technology (FY2025)

(Implementation schedule)B3⑤：Development of Assistive Technologies for Integration Management of Decommissioning of the Fukushima Daiichi Nuclear Power Station



C： Research and Development of Processing and Disposal of Solid Waste（1/2）

Purpose

Considering the prospects of processing/disposal method and technology related to its safety, as provided in FY2021, in order to construct waste streams suitable for the characteristics of solid wastes[*1], proceeding the progress of waste characterization, it shall be conducted to develop, compare, and evaluate processing/disposal options and planned to investigate towards presenting the overall appropriate measures for the practical solid waste management.

Implementation Content（Overview）

1. In order to reflect in overall solid waste management, acquisition and management of analysis data shall be conducted and activities for enhancement of efficiency of waste characterization shall be proceeded.
2. For safe and reasonable storage and management, the technology for reduction and recycling in order to reduce the amount of waste shall be developed.
3. Technology development related to processing and disposal shall be conducted to obtain necessary technical knowledge for establishment of waste stream. With respect to processing technology, an investigation shall be conducted on issues related to the applicability of low-temperature processing, the stability of the solidified waste manufactured by various processing technologies, the interim processing technology contributing to expanding the range of application of the low-temperature processing technology, and flexible and reasonable processing technology. With respect to disposal technology, the proposal of disposal concept options shall be established and presented, as well as critical scenarios affecting safety functions of a disposal site are identified to assess its safety, and technologies to assess its safety corresponding to the scenarios are developed.
   This research and development shall be used in the engineering conducted by the operating entity

1. Wasete Characterization

(1) Acquisition and Management of Analysis Data, etc.

Considering waste analysis plan by TEPCO for fulfillment of storage/management etc., nuclides to be analyzed and the necessary analytical accuracy required for the purpose shall be investigated according to the waste classification, and the annual analysis plan shall be formulated. According to the annual analysis plan, analysis data shall be obtained, evaluated and managed etc.

With regard to the analyses of C-14, I-129 etc. which is difficult to measure and important for safety assessment of disposal, the analysis data shall be obtained after the investigation of pretreatment method etc. based on the chemical form. With regard to the adsorbents collected from the actual cesium adsorption vessels, pretreatment and analytical methods shall be investigated, and the analysis data shall be obtained. For a non-destructive measurement system based on γ-ray measuring for waste generated during fuel debris retrieval, a concept of the measurement system shall be organized.

(2) Enhancement of Efficiency on Waste Characterization

In order to contribute to the proposal of the analysis plan, it shall be proceeded the trial of the analysis planning method that combines Data Quality Objectives (DQO) process[*2] with Bayesian statistic, and it shall be accumulated the applied cases of the analysis planning method. A collection of case studies of the analytical planning method based on those results shall be formulated and updated appropriately. The statistical inventory estimation method proceeded the development so far shall be investigated to apply major stored wastes and target facilities of dismantling in the future etc. Calculated results shall be provided for technology developments of processing and disposal etc.

2. Storage and Management

In order to improve the calculation accuracy of radioactivity inventory for contaminated metals (target metals of melting processing due to the contamination by radioactive materials), the contamination calculation model etc. shall be improved. In addition, obtaining the radioactive concentration data from actual wastes, the validation of assessment results by the contamination calculation model, etc. shall be confirmed.

Migration rates data of the nuclides that could be important nuclides shall be expanded through melting tests, and reliabilities of migration rates data of the nuclides shall be improved. Furthermore, evaluation method for the migration behaviors of the nuclides shall be investigated through thermodynamic equilibrium calculations. Reflecting the investigation results etc. from the melting tests and thermodynamic equilibrium calculations, nuclide migration rates during melting processing shall be evaluated. It shall be investigated selecting methods for the nuclides that could be important nuclides during clearance inspection, and those nuclides shall be selected. In addition, the evidence led to its selection shall be summarized.

The proposals for determination methods based on the radiation measurement of the selected nuclides that could be important nuclides shall be investigated. In addition, it shall be investigated an analysis plan (proposal) using an analytical planning method that combines the DQO process and Bayesian statistics. It shall be developed reasonable and accelerated analytical methods that can be used for clearance inspection.

*1 Solid waste: Include rubbles and water treatment secondary waste after the accident and radioactive solid waste stored at Fukushima Daiichi Nuclear Power Plant before the accident.

*2 A method to plan analytical samples for decision makings developed by U.S. Environmental Protection Agency.

C： Research and Development of Processing and Disposal of Solid Waste（2/2）

3. Processing/Disposal

(1) Processing Technology

In order to identify the range of chemical compositions, etc. that can be solidified by low-temperature processing technologies (cement solidification, AAM solidification), it shall be evaluated the impacts of major components assumed to affect the physical properties of solidified wastes especially for ALPS slurries, etc. In addition, the impact shall be investigated in case several affecting components are contained. With regard to screening methods to determine the possibility of solidification using low-temperature processing technology, in order to improve the processing abilities, investigation shall be conducted for automation of series of evaluation.

In order to identify the physical property values of the solidified wastes necessary for disposal safety assessment, characteristics of solidified waste shall be evaluated by low-temperature processing. For the long-term evaluation of stability of solidified waste, it shall be conducted the interrogations related to the survey of the long-term alteration behavior by acceleration tests and the change of the amorphous phase in the solidified wastes. In addition, with regard to the stability of carbonate slurry, it shall be investigated the changes of chemical compositions due to the changes of heating, pressurization and phosphorylated etc. With regard to carbonate slurry, it shall be evaluated the applicability of full-scale processing (200L scale) of low-temperature processing.

For interim processing, with regard to the assumed issues for practical use of pyrolysis processing, evaluation and measures of the impacts shall be investigated. The wastes whose effectiveness of application for pyrolysis processing are not high, that alternative measures shall be investigated. With regard to the following technologies investigated the possibility as flexible and reasonable processing technology, applicability of full-scale processing shall be evaluated based on the results obtained so far; bulk solidification technologies for rubbles difficult to segregate and glass melting processing technologies for the dehydrated slurry together with a container for the dehydrated materials.

(2) Disposal Technology

①Presentation of the proposal of disposal concept options

Utilizing the survey results by FY2023 of information and knowledge necessary to present disposal concept, it shall be selected the wastes based on the priority of investigation of waste stream in all targeted wastes, and that disposal concept options shall be proposed. In doing so, the necessary information and knowledge shall be organized to satisfy the proposal requirements of disposal concept.

②Improvement of reliability of safety assessment technology for solid waste disposal

Utilizing survey results and storyboard etc. by FY2023 of disposal concept and safety assessment in Japan and overseas, in order to evaluate the safety of disposal concept options presented in ①, important scenario affected safety functions of the disposal site shall be extracted, and it shall be developed the technology which is able to evaluate the safety corresponding to the scenario.

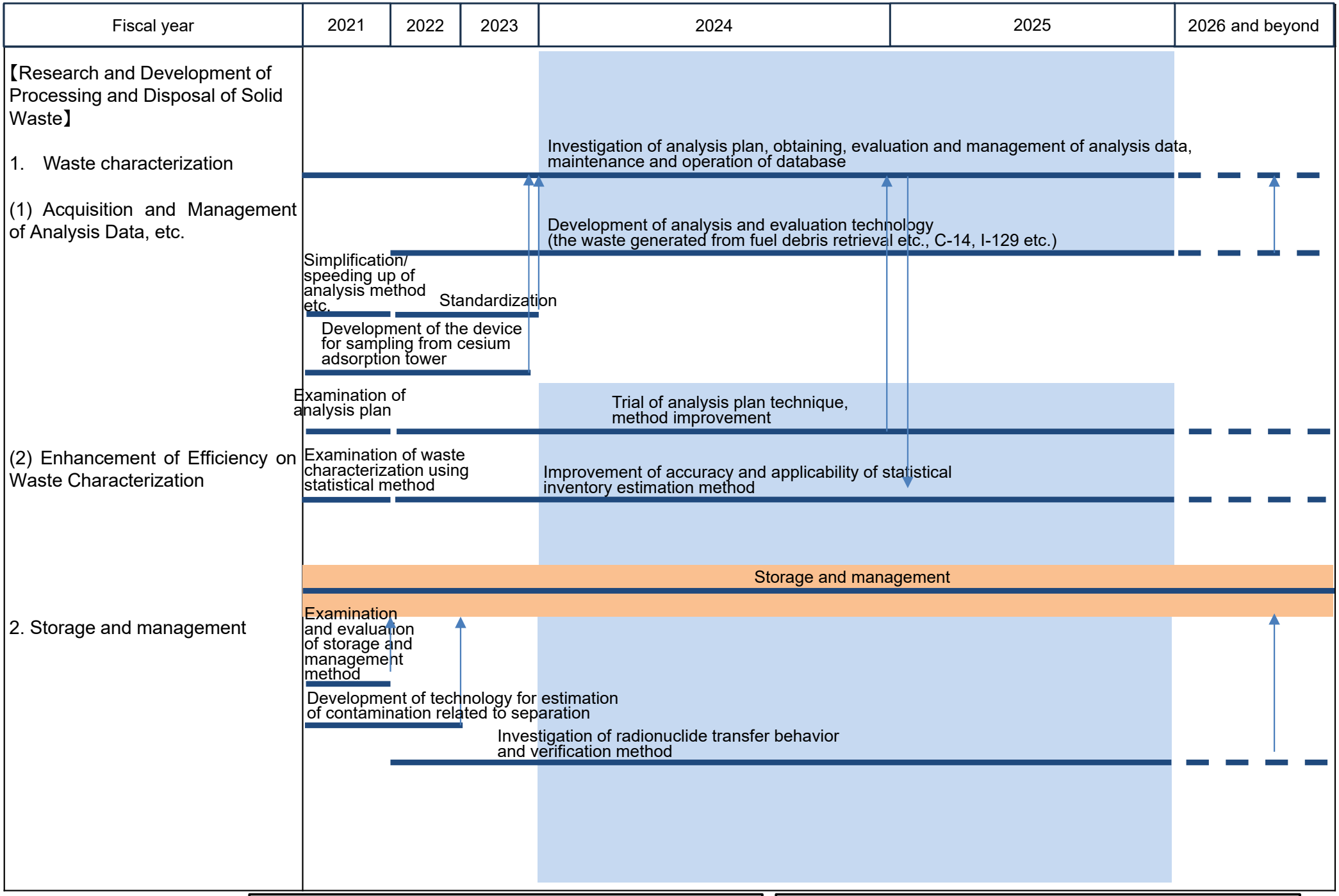
Definition of criterion for judgment on objective achievement

1. Waste Characterization
- Formulation of annual analysis plan and accumulation of obtained analysis data and sample information in the database (FY2025)
- Concept of the non-destructive measurement system based on γ-ray measuring for waste generated during fuel debris retrieval and presenting the analysis results of the nuclides difficult to measure (C-14, I-129) (FY2025)
- Presenting the investigation results of pretreatment and analytical methods for the adsorbents collected from the actual cesium adsorption vessels (FY2025)
- Organizing typical cases of investigations of analysis plan using the analysis planning method that combines DQO process with Bayesian statistic, and formulating (FY2024) and updating (FY2025) a collection of the case studies
- Presenting the results of inventory calculation related to the being storage wastes (FY2025)

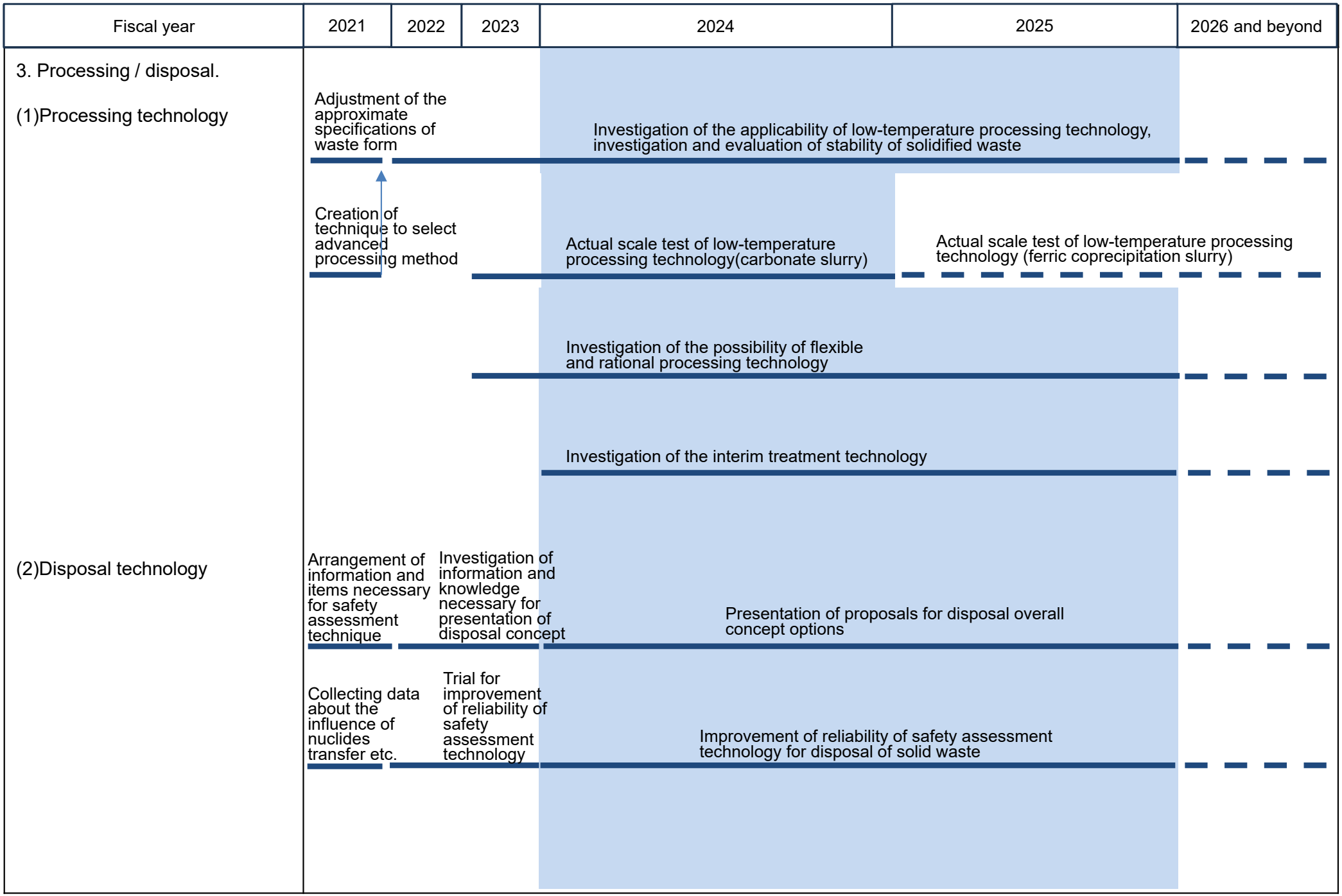
2. Storage and Management
- Improvement of analytical inventory calculation method for contaminated metals (FY2025)
- Assessment results of migration rates data during melting based on the investigation results of Melting tests and thermodynamic equilibrium calculations (FY2025)
- The selection results of the nuclides that could be important nuclides during clearance inspection, the summary of the evidence led to its selection results, and the development result of analytical methods that can be used for clearance inspection (FY2025)

3. Processing/Disposal
- The impact evaluation results related to assumed materials which affect the physical properties of solidified wastes in low-temperature processing (FY2025)
- Investigation results related to the automation of evaluation in screening methods to determine the possibility of solidification using low temperature processing technology (FY2025)
- Obtained results of the characteristics values of the solidified wastes by low-temperature processing (FY2025)
- Investigation results of the long-term stability of solidified wastes by low-temperature processing (FY2025)
- Evaluation results of the applicability of full-scale processing of low-temperature processing for the carbonate slurry (FY2024)
- The investigation result of measures of the assumed issues for practical use of pyrolysis processing, and the investigation result of alternative measures for the wastes whose effectiveness of application for pyrolysis processing are not high (FY2025)
- Testing results of bulk glass melting solidification tests for rubbles etc. (FY2025)
- Results of glass melting processing tests for the dehydrated carbonate slurry together with a container (FY2025)
- Presentation of the proposal of disposal concept options for the selected wastes (FY2025)
- Approaches summarized important scenarios corresponding to the proposal of disposal concept options, developed the model that can be installed the important scenarios, and set the evaluation parameters (FY2025)

(Implementation schedule) C：Research and Development of Processing and Disposal of Solid Waste（1/2）



(Implementation schedule)C：Research and Development of Processing and Disposal of Solid Waste（2/2）



R&D Mid-and-Long-term Plan

- Major Processes and Approach to Major R&D Activities for Decommissioning [Fuel Debris Retrieval] of the Fukushima Daiichi NPS of TEPCO -

Reference 1

FY: 2022 | 2023 | 2024 | 2025 | 2028 | 2033～

Key Milestones

Phase 2 | Phase 3-(1) | (Next phase)

- **Start of debris retrieval at the first implementing unit**
- **Gradual expansion of retrieval scale**
- **Further expansion of fuel debris retrieval scale**

[A] Trial retrieval/ Gradual expansion of fuel debris retrieval (Unit 2)

［1］Trial retrieval at Unit 2

Improvement of the environment inside the buildings

Trial retrieval (internal investigations and fuel debris sampling), Characterization of fuel debris

Manufacturing, testing*1 and installation of retrieval devices
Operational change of the safety systems, Removal of obstacles in openings, etc.

Development of technology for detailed PCV internal investigations

*1: Performed at Naraha Center for Remote Control Technology Development

Legends :
- Main Processes — Described based on TEPCO DAP 2023
- Practical application development and Applied research
- Basic/fundamental research — Major studies on debris retrieval
- Key Technical issues ( )
- → : Where R&D results are applied
- → : Linkage between main processes

［2］Gradual expansion of retrieval scale at Unit 2

Improvement of the environment inside the buildings

Fuel debris retrieval facility/Safety system/Fuel debris temporary storage facility/Maintenance facility

Design, manufacturing and testing (Performed at the Naraha Remote Technology Development Center) → Installation → Fuel debris retrieval (Gradual expansion of scale)
Operation of temporary storage facility for fuel debris
Operation of maintenance equipment → To fuel debris characterization

Technological development for gradual expansion of retrieval scale

Technical issues for gradual expansion of fuel debris retrieval
① Providing retrieval system (improving device durability, verifying passing with transport truck)
② Manufacturing equipment for gradual expansion of fuel debris retrieval
③ Preparing storage facilities for fuel debris/waste

[B] Further expansion of fuel debris retrieval (Units 1/3)

［1］Environmental improvement

Environmental improvement inside and outside the Unit 1 buildings — Inside the buildings: Radiation dose reduction/Removal of obstacles, etc.
Outside the buildings: Removal of SGTS piping/lower part of exhaust stacks at Units 1/2, and transformers, etc. => Securing space *2

Environmental improvement inside and outside the Unit 3 buildings — Inside the buildings: PCV water level lowering/Radiation dose reduction, etc.
Outside the buildings: Removal of exhaust stacks and transformers at Units 3/4, Improvement of the basement floor, etc. => Securing space *2

*2: Added buildings, maintenance buildings, storage buildings

Development of technology for environmental improvement inside/outside reactor buildings — Achieved lowering the PCV water level

Research to visualize the distribution of radioactive materials and contribute to the reduction of radiation exposure
Research on the relationship between radiation and corrosion and material degradation
→ Target : - Improvement of a system for work planning to reduce radiation exposure
- Establishment of measures and evaluation methods considering the effects of corrosion on long-term integrity

［2］PCV/RPV internal investigations, Characterization of fuel debris

Development of technology for detailed PCV internal investigations at Unit 1 → PCV internal investigations at Unit 3 → To fuel debris characterization

Development of RPV internal investigation technology /Advancement of RPV internal investigation → To RPV internal investigation design

RPV internal investigations

Development of technology for RPVquick internal investigation

Characterization of fuel debris

Development of analytical technology for fuel debris characterization

Demonstration of analytical technology (Radioactive material analysis/Utilization of research facilities)

Research on analytical evaluation methods for retrieved fuel debris, including non-destructive measurement
Research on the advancement of analytical techniques for radioactive material and nuclear fuel material
→ Target : - Establishment of analytical evaluation method including non-destructive measurement, and methods for radioactive waste sorting and inventory evaluation
- Establishment of remote/in-situ/rapid analysis technique

Advanced estimation of the situation in the PCV

Estimation of in-core conditions and research on accident events by analyzing and evaluating fuel debris
→ Target : - Grasping of in-core situation and refinement of understanding of FP behavior in the PCV based on on-site knowledge and actual debris data

Extraction of required technology[1)]

1) Extracted from the process of preparation/envionmental improvement to fuel debris retrieval

Sharing issues for strengthening collaboration in 1F decommissioning R&D
1. Clarifying the necessity and priority of technology development

Prioritized technological development items
Ⓐ Examining isolation and removal technologies of piping: Development of remote piping isolation and removal technologies for HCU and RHR piping
Ⓑ Examining investigation technologies inside RPV and D/W: Development of technology for investigation of unknown areas such as inside RPV and D/W, etc.

Prioritized technological development items

［3］Retrieval equipment, safety systems, maintenance equipment, and storage facility *3

*3: Main processes for proceeding with the study on Unit 3 as a preceding case

Reflecting the results of Trial retrieval (Internal investigation / fuel debris sampling)

Reflecting findings obtained after the start of a gradual scale expansion

Conceptual study → Study of safety systems/maintenance

Design of retrieval installations → Design of safety system / maintenance installations

Manufacturing, installation and testing of retrieval equipment/training facility and fuel debris retrieval [cutting/recovery] [sorting/storing] [transfer/custody]

Manufacturing, installation and testing of safety systems/ maintenance installations

R & D themes
Ⓐ Sorting criteria: Evaluation of sorting scenarios (advantages and disadvantages)
Examining fuel debris management streams as a basis for sorting
Ⓑ Examining maintenance during storage: Detection of filter plugging (remote hydrogen concentration measurement technology) and maintennance technology, etc.

Set hold points[2)]

Sharing issues for strengthening collaboration in 1F decommissioning R&D
2. Analyzing/sharing of medium to long term issues and its specific considerations

2) Set from each process of fuel debris retrieval

Specifying issues and R&D themes

Development of technologies toward further expansion of fuel debris and in-core structure retrieval
Partial submersion side-access method: Examination and enhancement of elemental technologies,

Partial submersion top access method: Conceptual study, examination and enhancement of elemental technologies

Development of Submersion (Shell) method

Research on safety assurance during fuel debris retrieval and storage
Research to visualize the distribution of radioactive materials and contribute to the reduction of radiation exposure
→ Target : - Eestablishment of effective evaluation methods for ensuring safety during long-term in-core residency and after retrieval
- Improvement of a system for work planning to reduce radiation exposure

Technical issues toward further expansion of fuel debris retrieval
① Development of fuel debris retrieval method (partial submersion method of side-access/top-access/common, submersion (shell) method)
Development of access facility installation method, technology for realizing a large structure removal concept, crashing and collection technology, and shell structure construction technology, etc.
② Development of safety systems (liquid-phase system/gas-phase system and criticality control)
Strengthening of function to remove radioactive material, development of boric acid management technology such as boric acid recovery, evaluation/collection of dust behavior, and development of operavility of critical control technology, etc,
③ Development of safety assessment technology Data acquisition of debris dispersion rate and analytical method for evaluating radiation exposure, etc.
④ Development of technologies for maintaining remote equipment Development of decontamination and maintenance technology for contaminated remote equipment

R&D Mid-and-Long-term Plan

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Reference 1

FY	2022	2023	2024	2025	2028	2033～
Key Milestones	Phase 2	Phase 3-(1)				(Next phase)
		Start of debris retrieval at the first implementing unit			**Gradual expansion of retrieval scale**	**Further expansion of fuel debris retrieval scale**
[B] Further expansion of fuel debris retrieval		Design of fuel debris storage facilities		Construction/installation of facility		Trial operation, Start of operation
	Development of technology for collection, transfer and storage of fuel debris					
	Resarch onsafety assurance during fuel debris retrievaland storage					Target : - Establish safety and risk assessment for fuel debris storage
	Development of support technology for 1F decommissioning integrated management					
[C] Waste Management	**［1］Characterization**					
	Characterization					
	Acquisition and maagement of analysis data, etc.					
	Improvement of efficiency in characterization					
	Technical issues for characterization ① Preparatin of analytical plan and acquisition/evaluation/control of analytical data ② Refinement and operation of analytical and material database ③ Development of analytical techniques for important nuclides for disposal ④ Development of analytical technology of absorbent sampled from the actual Cs absorption tower ⑤ Development of non-destructive measurement technology, etc. The rerated issues and needs are taken up in the processing/disposal fields of tghe over all map of basic and fundamental research, and implemented as basic fundamental research.					
	［2］Storage					
	Storage					
	Development of alpha surface contamination measurement technology					
	Research on waste reduction through reuse					
	［3］Processing/disposal					
	Development of processing technology Development of disposal technology Study on waste stream					
	Technical issues for processing/disposal ① Development of low-temperature processing technology ② Evaluation of stability of solidified products ③ Development of intermediate processing technology ④ Show the concept of diposal option ⑤ Trial to improve reliability of safety assessment technology for solid waste disposal, etc. The rerated issues and needs are taken up in the processing/disposal fields of tghe over all map of basic and fundamental research, and implemented as basic fundamental research.					

In reviewing the R&D Mid-and-Long-term plan, TEPCO, MEXT, METI and NDF have discussed the required results, timing needed and implementing structures through the R&D planning meetings. The plan is being prepared by incorporating basic/fundamental research into practical application development and applied research, such as the Project of Decommissioning and Contaminated water/Treated water, as an integral part.