Mid-and-Long-Term Decommissioning Action Plan 2021

March 25, 2021

Tokyo Electric Power Company Holdings, Inc.

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Mid-and-Long-Term Decommissioning Action Plan 2021

The “Mid-and-Long-Term Decommissioning Action Plan 2021” was created by TEPCO for indicating the main work processes involved in decommissioning as a whole, in order to achieve the goals laid out in the Mid-and-Long-Term Road-map and the NRA Risk Map.

This is our “Mid-and-Long-Term Decommissioning Action Plan 2021,” a revised version based on the achievements made during FY2021.

Under the basic principle of “coexistence of reconstruction and decommissioning”, TEPCO aspires to carefully communicate about the future prospects of decommissioning in an easy-to-understand manner, so as to proceed with decommissioning while obtaining the understanding of the region and the people.

Moreover, the initiatives undertaken during the work of decommissioning the Fukushima Daiichi Nuclear Power Station are unprecedented in the world, and hence, we will revise this plan regularly in accordance with the progress made and the challenges faced, as we systematically proceed with safe and stable decommissioning.

(Note) The “Mid-and-Long-Term Decommissioning Action Plan 2021” corresponds with the following plan indicated in the Mid-and-Long-Term Road-map.
⑩Specific plan for achieving the main target processes, etc. specified in the Mid-and-Long-Term Road-map and the goals laid out in the NRA Risk Map.

Mid-and-Long-Term Road-map: Mid-and-Long-term Road-map for decommissioning the Fukushima Daiichi Nuclear Power Station of Tokyo Electric Power Company Holdings, Inc.
(Finalized by the Inter - Ministerial Council for Contaminated Water and Decommissioning Issues on December 27, 2019)
NRA Risk Map: Mid-term risk reduction goal map for TEPCO’s Fukushima Daiichi Nuclear Power Station
(Finalized by the NRA on March 3, 2021)

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Revisions in the Mid-and-Long Term Decommissioning Action Plan 2021

- Clearly show progress made in decommissioning work in FY2020
- Add responses to newly identified challenges and plans that can be created in more detail
- Revisions of schedule to address the newly identified challenges

	New plans	Major revisions of schedule
Contaminated water management	• Collection of sludge on the floor after the turbine building (T/B) floor has been exposed	• Collection of zeolite sandbags in the Processing Main Building (PM/B) and the High Temperature Incinerator Building (HTI) and revision of the stagnant water treatment plan
Spent fuel	• Removal of high dose equipment and drainage of the pool after fuel removal • Fuel removal from the common pool after spent fuel has been removed from Units 1-6	• Reflection of the progress made in preparation for Units 1 and 2 spent fuel removal
Fuel debris	• Development of training facilities etc. to further expand the scale of removal	• Change in starting date of the removal on a trial basis due to COVID-19
Waste management	–	• Changes in the operation starting date of the additional miscellaneous solid waste incineration facility as a result of malfunctions in the rotary kiln
Others	• Installation of the Japan Trench Tsunami seawall • Installation of a drainage channel in preparation for large-scale rainfall • Deriberation on long-term integrity of buildings • Installation of analysis facilities necessary for decommissioning work	–

Processes completed in FY2020
-List of processes completed

○Contaminated water management

- **Reduced contaminated water generation to about 150 m^3/day**
  - **The amount of contaminated water generated per day was about 140 m^3 in 2020 (achieved the target in the Roadmap)**
- **Completed stagnant water removal and treatment in the building***
  - **Removal and treatment was completed in December 2020 (achieved the target in the Roadmap/Risk map)**

  *Except for the Unit 1~3 Reactor Buildings (R/B), Process Main Building (PM/B), High Temperature Incinerator Building (HTI)

○Spent fuel removal

- **Fuel removal from the Unit 3 spent fuel pool**
  - **Fuel removal was completed in February 2021 (achieved the target in the Risk map)**

○Other measures (natural disaster prevention measures)

- **Dismantling of the top part of the Units 1 & 2 exhaust stack**
  - **Dismantling was completed in April 2020* (Achieved the target in the Risk Map) *The work processes completed in May 2020**
- **Installation of the Chishima-Kamchatka Trench Tsunami seawall**
  - **Installation was completed in September 2020 (achieved the target in the Risk Map)**
- **Mega float countermeasures**
  - **The mega float was grounded in August 2020 (achieved the target in the Risk Map)**

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Contaminated water management
-Progress made in FY2020

○Progress made in FY2020 in processes that are ongoing

●Reduce the amount of contaminated water generated

– Countermeasures to prevent rainwater penetration through roofs such as closure of damaged parts of the building roofs are being implemented to reduce the amount of contaminated water generated. The countermeasures for the Unit 3 turbine building has been completed.

Status of the roof on the Unit 3 turbine building
[Before start of construction]
[Shot taken from the west side]

Status of the roof on the Unit 3 turbine building
[Completed installing the discharge prevention weir/rainwater cover (south side)]
[Shot taken from the west side]

Contaminated water management
-Major work processes going forward (1/4)

○ **Schedule for achieving the milestones of the Mid-and-Long-Term RM**

- **Reduce contaminated water generation to about 100 m^3/day or less (in 2025)**
  - The maintenance, management and operation of the groundwater bypass, sub-drain and land-side impermeable wall will continue and the level of the groundwater around the buildings will be kept low in a stable manner.
  - As measures to prevent rainwater seepage, site pavement will be carried out on the inner side (sea-side and mountain-side) of the land-side impermeable wall and the damaged parts of building roofs will be repaired.

  (Challenges)
  - The constraints in carrying out site pavement (radiation environment of the work area, removing existing equipment, etc.)
  - The constraints in carrying out rainwater measures for buildings (removing existing equipment, method of closing contaminated piping, etc.)
- **Reduce the amount of stagnant water in the Reactor Building to about a half of that at the end of 2020 (FY2022 - FY2024)**
  - The water level will be reduced after checking the properties of stagnant water in the R/B.
  - Nuclide removal equipment will be designed and installed after ascertaining the properties of the α nuclides present in the stagnant water in the R/B.

  (Challenges)
  - Specific methods for separating and removing α nuclides present in stagnant water in the R/B will be studied.

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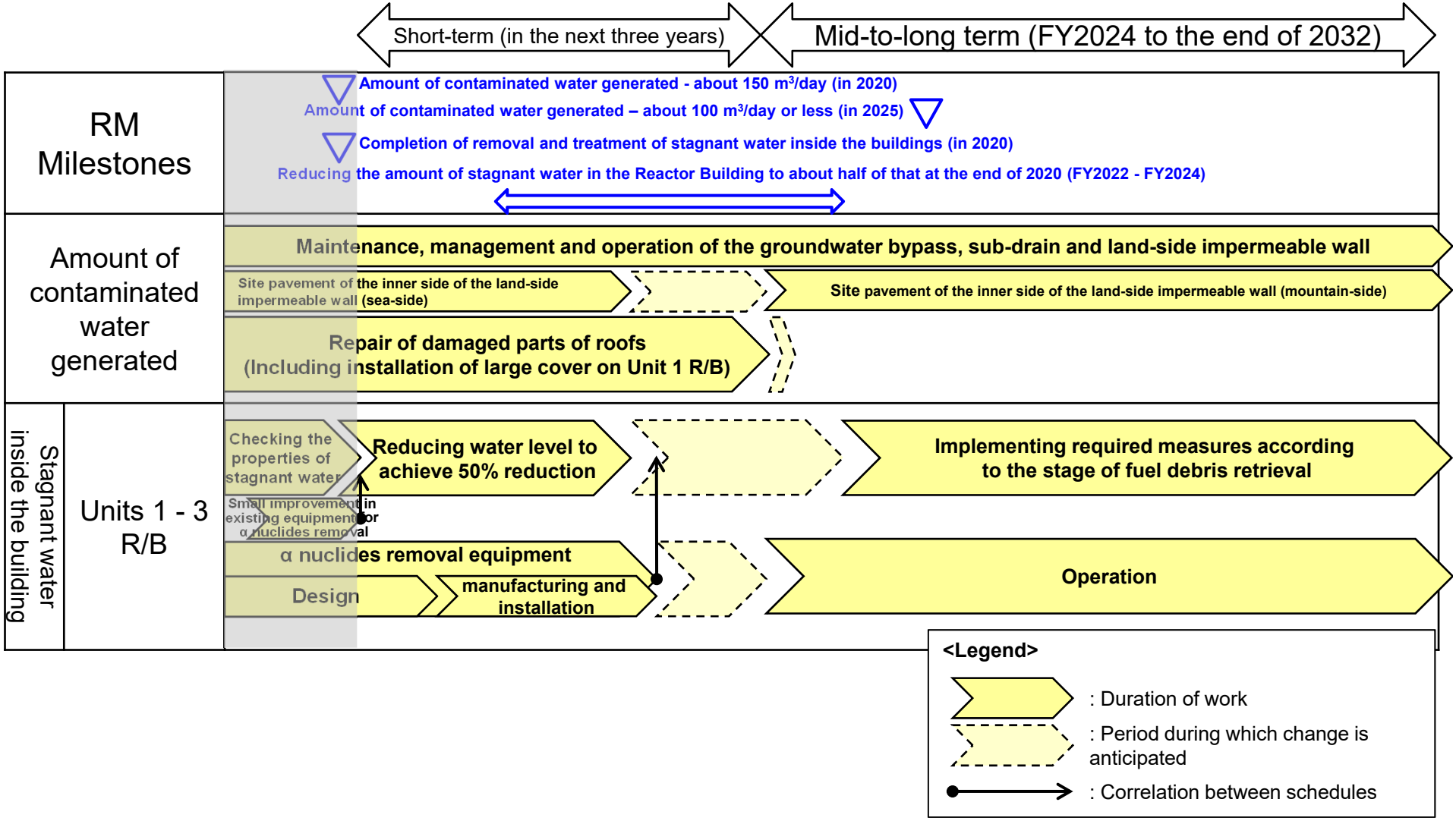
Contaminated water management

-Major work processes going forward (2/4)



Contaminated water management
-Major work processes going forward (3/4)

○ Other work related to contaminated water countermeasures

- **Countermeasures after removing stagnant water in the reactor buildings of Units 1-4 T/B. etc.**

– Study recovery methods and manufacture/install recovery equipment to handle sludge etc. that exists at the bottom of the tanks.

- **Removal and treatment of stagnant water in Process Main Building (PM/B) and High Temperature Incinerator Building (HTI)**

– Since the basement of these buildings are being used for storing water before it is treated using cesium adsorption apparatus (KURION / SARRY / SARRY-II), additional tanks will be installed as alternative tanks.

– The floor will be exposed after removing high radiation zeolite sandbags etc. on the lowermost subfloor.

(Challenges)

• Studying safety measures to be taken with regard to handling or implementing measures for high radiation zeolite sandbags etc.

- **Countermeasures for puddle**

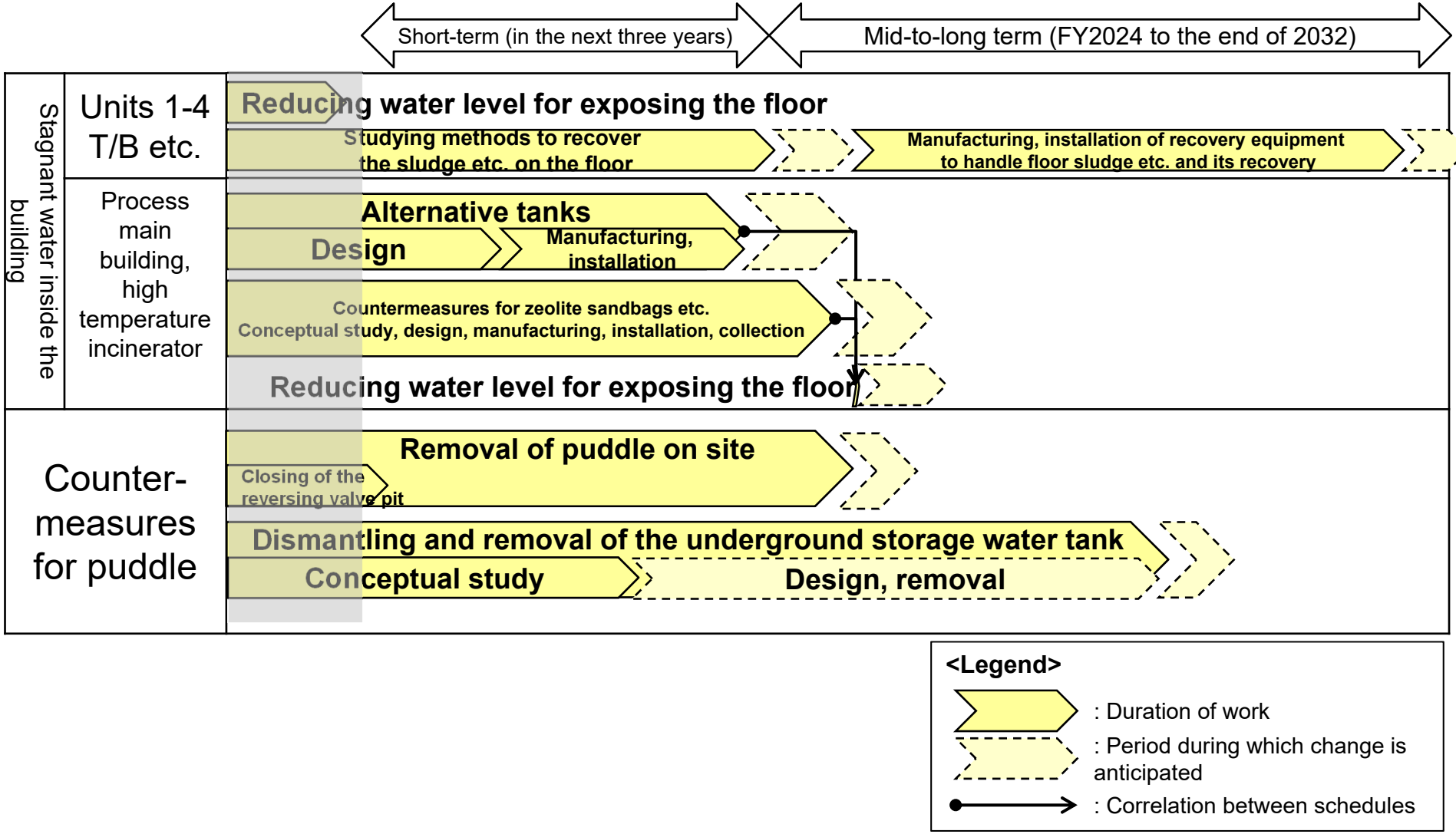
– Puddle will be removed from the premises.

– The underground water storage tanks will be removed after studying the method of dismantling them while ensuring that dust is not scattered.

(Challenges)

• Measures for volume reduction and storage of contaminated waste generated when the underground water storage tanks that store stagnant water are dismantled.

Contaminated water management
-Major work processes (4/4)



Spent fuel removal
-Progress made in FY2020

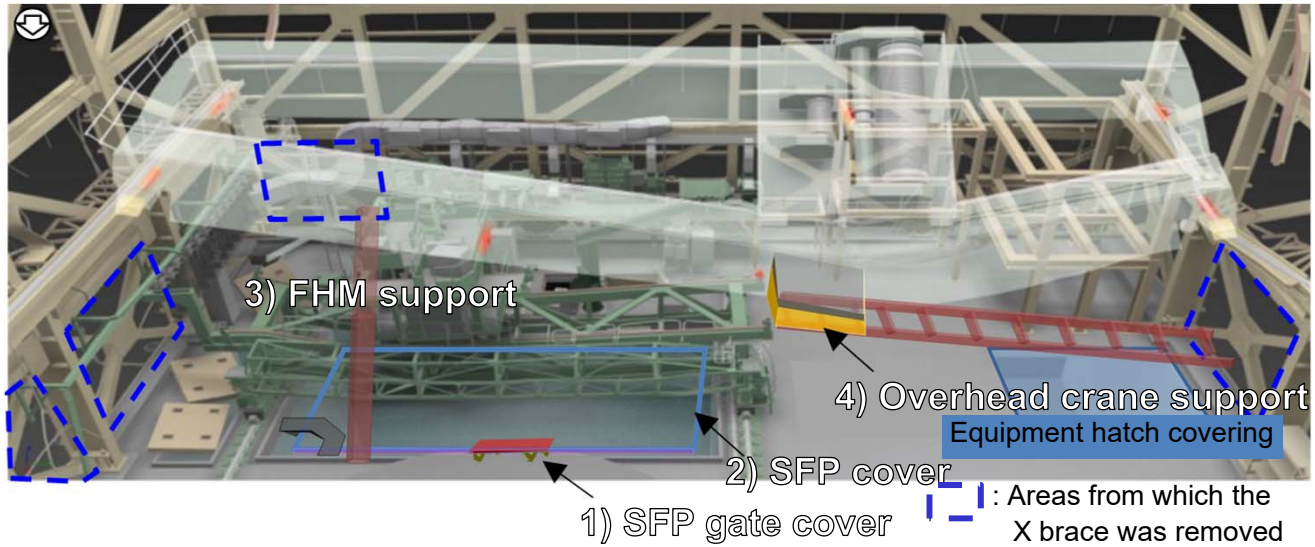
○Progress made in FY2020 in processes that are ongoing

●Unit 1

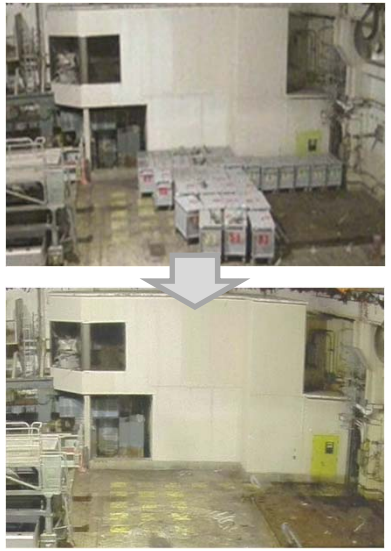
- Rubble falling prevention/mitigation measures were implemented to minimize the risk of roof steel structures and rubble falling into the spent fuel pool during the removal of the fallen roof etc. on the south side.
- Dismantling of the interfering building cover (residual parts) was started to install a large cover on the Unit 1 reactor building.

●Unit 2

- The first Unit 2 spent fuel pool investigation was conducted since the Accident.
  No particular deficiencies were identified during the investigation, such as damage to the fuel racks and fuel handles that may obstruct fuel removal.
- Residual items on the refueling floor of the Unit 2 reactor building that may interfere with the installation of the fuel removal equipment were removed.



Unit 1 rubble falling prevention/mitigation measures



Before and after removing the residual items on the Unit 2 refueling floor

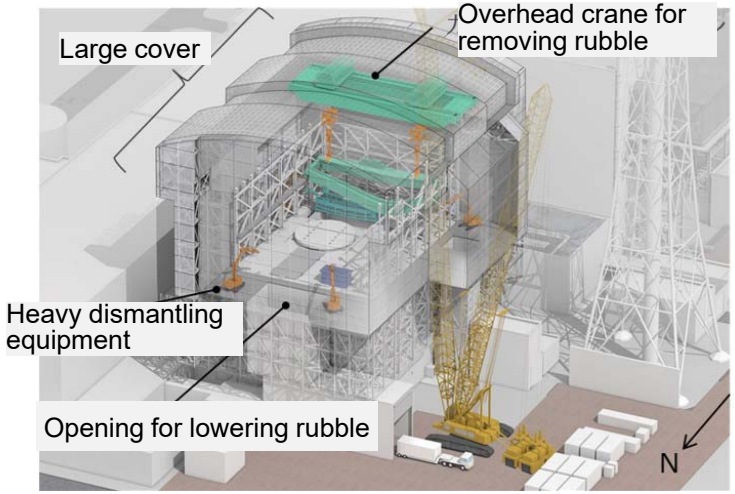
Spent Fuel Removal
-Major work processes going forward (1/5)

○ **Schedule for achieving the milestones of the Mid-and-Long-Term RM**

- **Complete installation of the large cover at Unit 1 (around FY2023)**
  - A large cover will be installed to control scattering of dust while removing rubble.
- **Start fuel removal from Unit 1 (FY2027 – FY2028)**
  - Fuel handling system required for fuel removal will be fabricated.
  - The fuel handling system will be installed after removing rubble, collapsed overhead crane, etc., handling the well plug (shielding concrete installed on top of the reactor containment vessel) that has gotten out of alignment due to the accident, and reducing the dose by means of decontamination and shielding, etc.
  - Fuel removal will be started after conducting training on fuel handling.

(Challenges)

- Studying and implementing plans for removing rubble for which dust scattering can be reliably controlled.
- Studying and implementing plans for effective decontamination and shielding in order to reduce the dose on the refueling floor.
- Studying and implementing plans for handling damaged fuel stored from before the earthquake disaster.



Unit 1 Large cover (Image)

Spent Fuel Removal

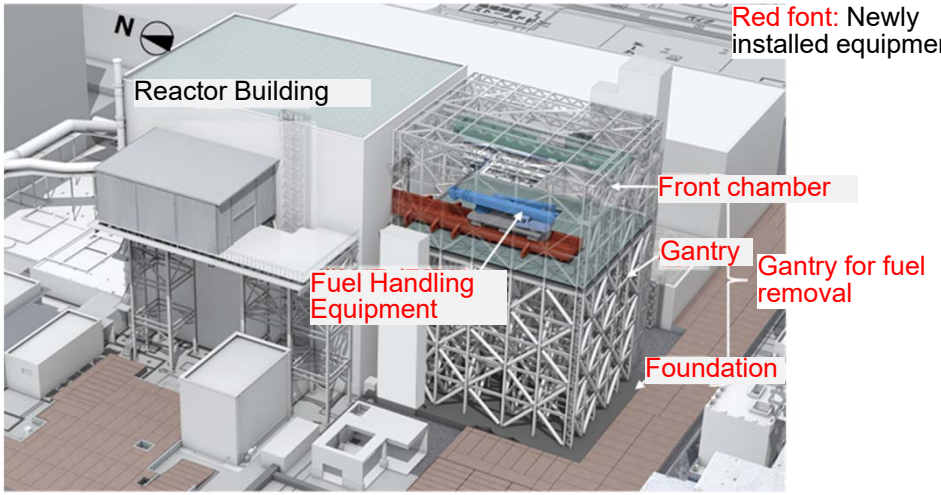
-Major work processes going forward (2/5)

○Schedule for achieving the milestones of the Mid-and-Long Term RM

- **Start fuel removal from Unit 2 (FY2024 - FY2026)**
  - Fuel handling system required for fuel removal will be fabricated.
  - A gantry will be installed on the southern side of the Reactor Building for removing fuel from openings of R/B walls.
  - Fuel handling system will be installed after reducing the dose on the refueling floor by means of decontamination and shielding.
  - Fuel removal will be started after conducting training on fuel handling.

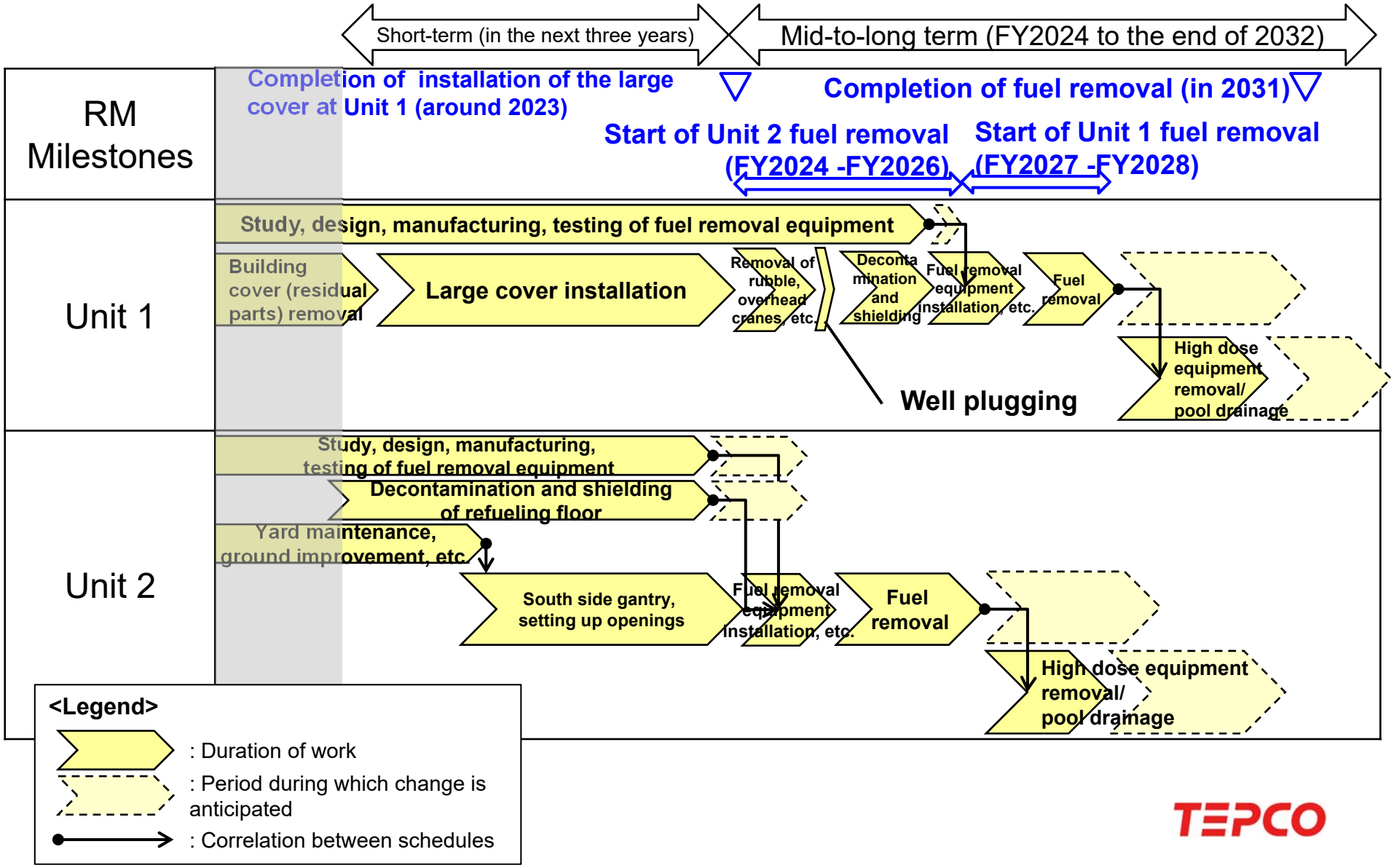
(Challenges)

- Studying and implementing plans for effective decontamination and shielding in order to reduce the dose on the refueling floor.



Unit 2 gantry for fuel removal (Image)

Spent fuel removal
-Major work processes going forward (3/5)



Spent Fuel Removal

-Major work processes going forward (4/5)

○ Schedule for achieving the milestones of the Mid-and-Long-Term RM

- **Complete fuel removal from Units 1 - 6 (in 2031)**
  - Fuel will be removed from Units 5 & 6 in a way that does not interfere with work at Units 1 & 2.
  - Since the common pool receives spent fuel from each unit, the spent fuel from the common pool will be stowed in dry storage containers (casks) in advance and stored on high grounds.
  - Additional temporary storage facilities will be installed after securing sites within the premises.

(Challenges)

- Setting up additional temporary storage facilities for dry casks in accordance with the fuel removal plan including fuel removal from Units 5 & 6.

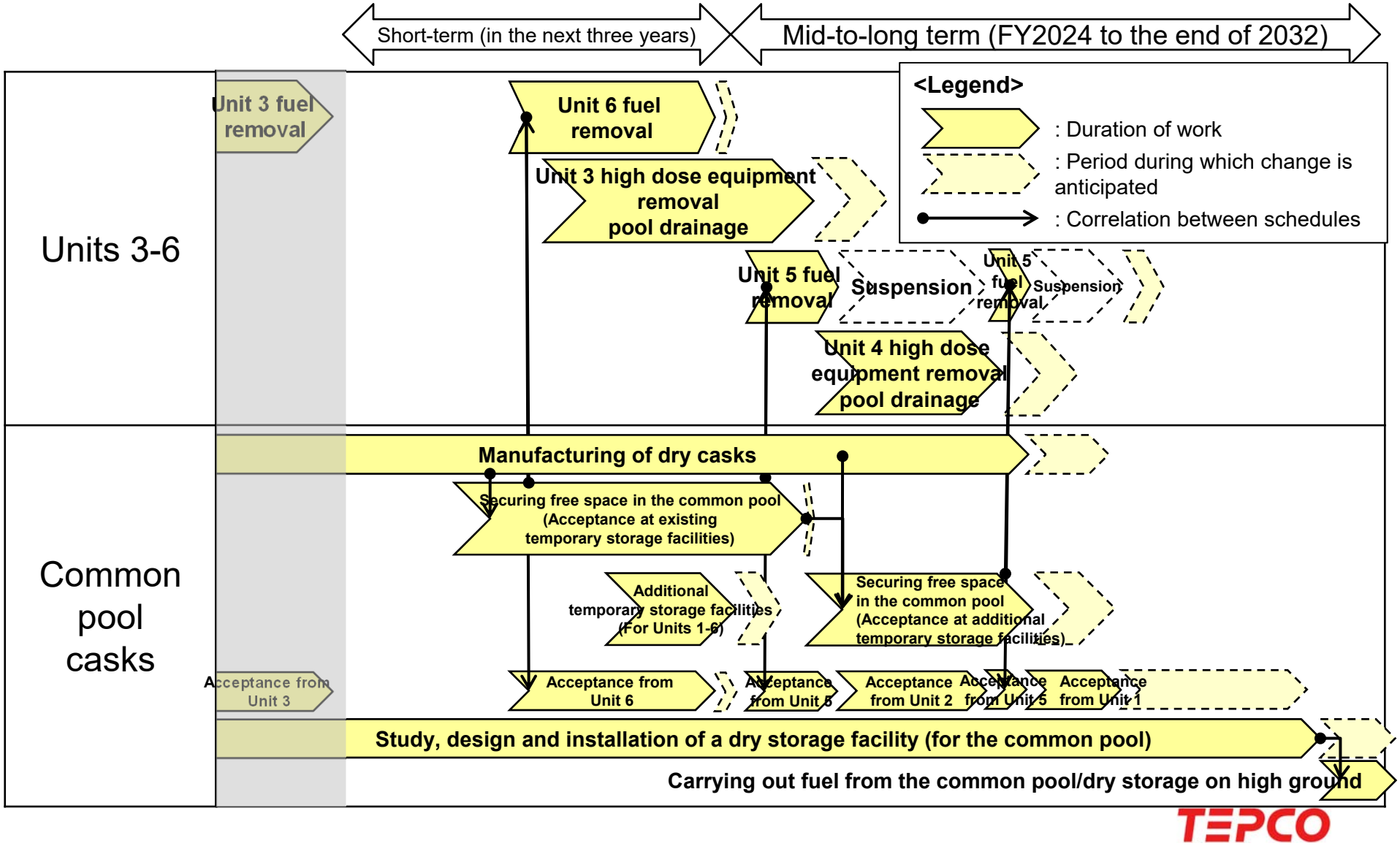
○ Other spent fuel removal related work

- After removing fuel from each unit, highly radioactive equipment such as spent control rods, etc. will be removed.
- Study, design and install a dry storage facility on high ground in preparation for the storage of fuel currently being stored in the common pool.

(Challenges)

- Study of specific method for removing diverse equipment with varying sizes and shapes. (remote operation, transfer and storage)

Spent fuel removal
-Major work processes going forward (5/5)



Fuel debris retrieval
-Progress made in FY2020

○Progress made in FY2020 in processes that are ongoing

- **Preparation for the Unit 1 Primary Containment Vessel (PCV) internal investigation**
  - Holes were opened at three locations on the inner door to build an access route in preparation for the Unit 1 Primary Containment Vessel (PCV) internal investigation. Afterward, the handrails and gratings which are inside the PCV and interfere with the investigation, were severed.
- **Preparations for trial retrieval (Unit 2)**
  - In the Unit 1 PCV internal investigation and trial removal of fuel debris, the plan is to insert an arm-type device from the containment vessel penetration hole (X-6 penetration hole) into the PCV.
    There are deposits inside of the X-6 penetration hole that are scheduled to be removed as they interfere with future work. A deposit contact investigation was conducted in October 2020 to study the procedures for the removal work.
    A 3D scan investigation of the X-6 penetration hole was conducted in October and information regarding the distribution of the deposits was obtained.

Fuel debris retrieval
-Major work processes going forward (1/4)

○ **Schedule for achieving the milestones of the Mid-and-Long-Term RM**

● **Start fuel debris retrieval from the first implementing unit**

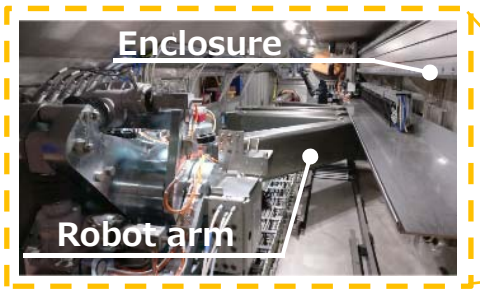
– Towards the trial retrieval in Unit 2, research and development will be undertaken, engineering work will be carried out to apply the results of R&D on site, and fuel debris retrieval equipment (access equipment, recovery equipment, etc.) will be manufactured and installed. Primary Containment Vessel (PCV) internal investigation will be implemented in accordance with retrieval.
Since the development of equipment in the UK has been delayed due to the COVID-19 pandemic, performance confirmation tests, etc. will be conducted in Japan to minimize the delay to approximately one year.

– The operation of the existing gas management system will be changed for enhancing the function of monitoring radioactive substances and for preventing dust from scattering to outside the PCV

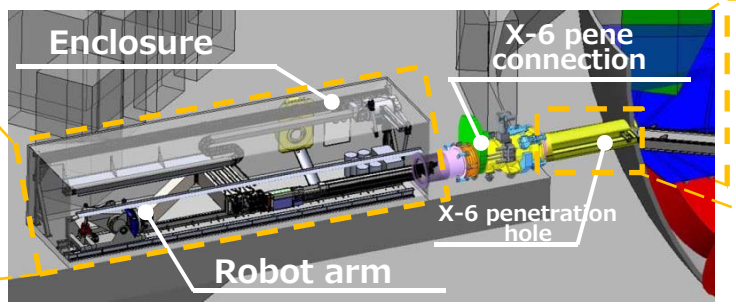
– The deposits or obstacles in the existing opening (X-6 penetration hole) that leads to the inside of the PCV will be removed.

(Challenges)

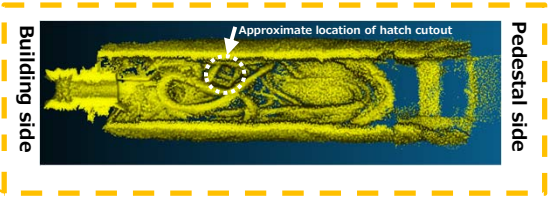
• Study on measures to control scattering of dust while removing the deposits or obstacles from the access route, and developing relevant devices



Enclosure and robot arm



Overview of equipment for trial retrieval



3D scan from above the X-6 penetration

* This document leverages the results of the International Research Institute for Nuclear Decommissioning (IRID).

Fuel debris retrieval
-Major work processes going forward (2/4)

○ Other fuel debris retrieval related work

Expand the scale of retrieval gradually (Unit 2)

– In order to increase the scale of retrieval in stages, research and development will be undertaken. Also, engineering work will be carried out to apply the results of R&D on site, and based on the knowledge, etc. obtained through trial retrieval, designing, manufacturing and installation of fuel debris retrieval equipment, safety systems (containment, maintaining cooling, criticality control, etc.), fuel debris temporary storage facilities and equipment for the maintenance of the retrieval equipment will be carried out.

– For improving the environment inside the building, the radiation dose in the west-side area on the first floor of the Reactor Building will be further reduced.

– Internal investigation of the reactor pressure vessel (RPV) in Unit 2 will be studied.

(Challenges)

• Study on measures to control scattering of dust while crushing fuel debris or removing structures from inside the PCV.

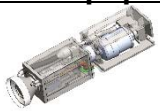
Efforts for determining methods for processing and disposal of fuel debris

– After starting fuel debris retrieval, analysis, etc. of fuel debris properties will be performed.

Further expand the scale of retrieval (Units 1/3)

– In order to further increase the scale of retrieval, research and development will be undertaken. Also, engineering work will be carried out to apply the results of R&D on site, and based on the knowledge, etc. obtained through retrieval in Unit 2, the retrieval method will be determined, and designing, manufacturing and installation of fuel debris retrieval equipment, etc. will be carried out. We will also move forward with the construction of a training facility for acquiring required skills.

– In addition to the internal investigation of the PCV, that is planned to be implemented at present, further investigations such as internal investigation of PCV, internal investigation of RPV, etc. in Unit 3, will be studied.

Trial retrieval (Unit 2)		Increasing the scale of retrieval in stages (Unit 2)	
Access equipment	Fuel debris retrieval equipment	Access equipment	Fuel debris retrieval equipment
	 Proposed metal brush  Proposed vacuum container		 Proposed gripper tool  Proposed digging recovery tool

* This document leverages the results of the International Research Institute for Nuclear Decommissioning (IRID).

Fuel debris retrieval
-Major work processes going forward (3/4)

– In order to improve the environment inside the buildings, radioactive sources will be investigated and eliminated for reducing the radiation dose at the work site (in particular, highly contaminated pipes). In addition, equipment, etc. that could hinder future work will be removed. Moreover, the PCV water level will be reduced by developing equipment that draws water from the Unit 3 PCV.
– For improving the environment outside the building, facilities that pose an impediment (Units 1 & 2 exhaust stack, Unit 3 & 4 exhaust stack etc.) will be removed, thereby securing space for fuel debris retrieval equipment, etc.

(Challenges)

– Study on the method of reducing the dose of highly contaminated pipes by means of remote operations (removal or decontamination) and the method of installing equipment for retrieval and water intake, etc., since the dose at the work site in Units 1/3 is higher compared to that in Unit 2.

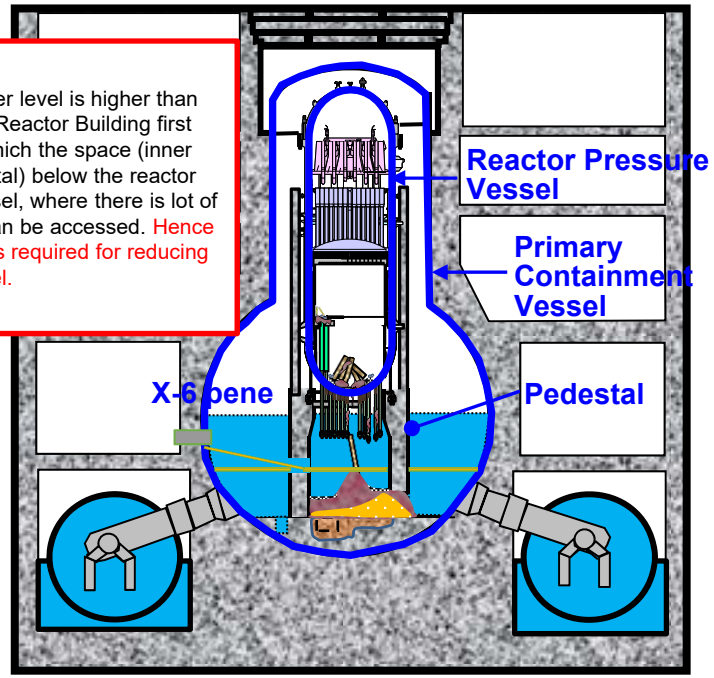
Unit 1

The radiation dose on the first floor of the Reactor Building, where the fuel debris retrieval equipment, etc. is to be installed, is high. Hence the dose of the highly contaminated pipes needs to be reduced.

AC piping (south-eastern area on the first floor)
Surface 50cm radiation dose: Approx. 1,000 mSv/h
(Estimated based on the intensity of the γ rays)

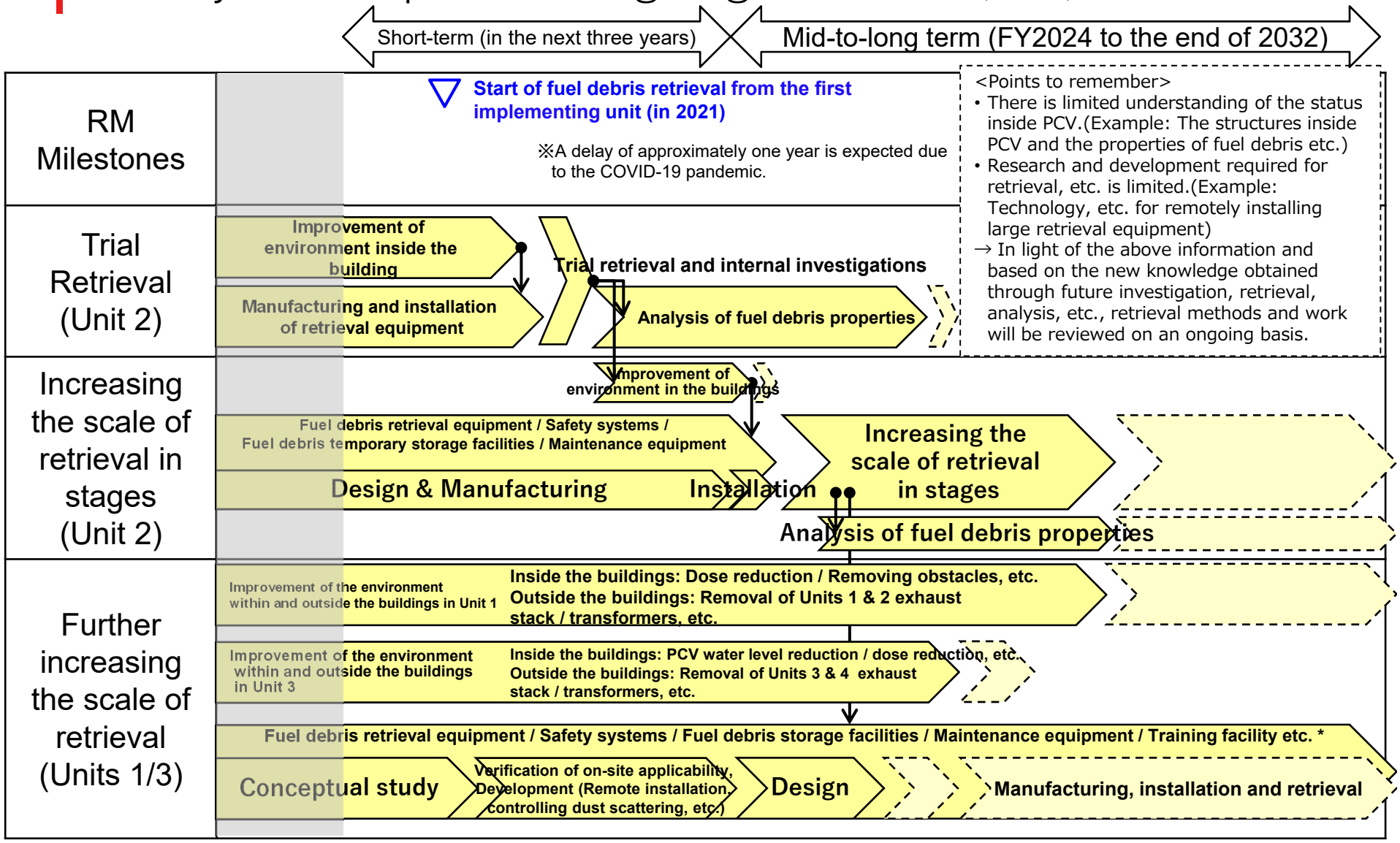
Unit 3

The PCV water level is higher than the opening (Reactor Building first floor), from which the space (inner side of pedestal) below the reactor pressure vessel, where there is lot of fuel debris, can be accessed. Hence water intake is required for reducing the water level.



Fuel debris retrieval

-Major work processes going forward (4/4)



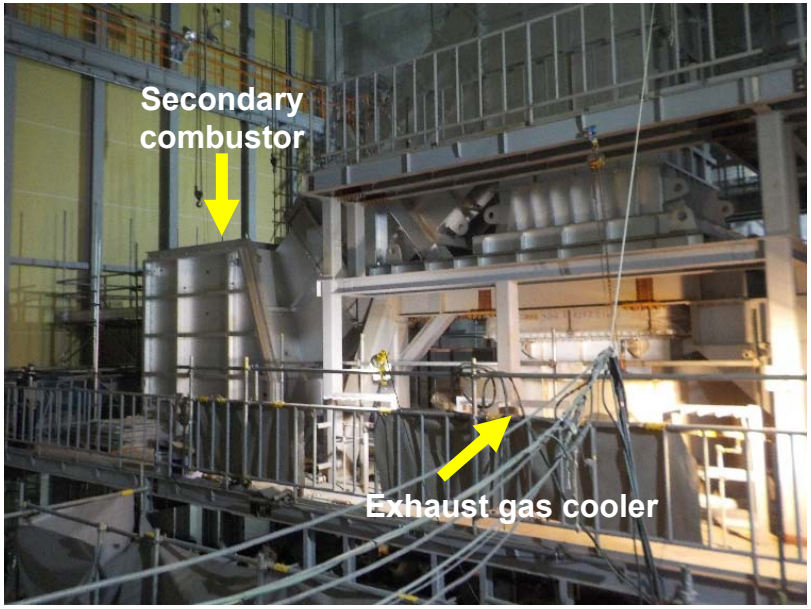
* Assuming that studies will be carried out giving precedence to Unit 3, and Unit 1 will be studied thereafter.

Waste management
-Progress made in FY2020

○Progress made in FY2020 in processes that are ongoing

- **Efforts to eliminate temporary storage areas outside for rubble etc.**
  - Additional miscellaneous solid waste incineration facility installation work is being conducted to incinerate felled trees and combustible rubble (wood, cushioning material, paper, etc.)

Overview of the additional miscellaneous solid waste incineration facility building



Major equipment

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Waste management
-Major work processes going forward (1/4)

○ **Work processes for achieving the milestones of the Mid-and-Long-Term RM**

- **Technical prospects concerning the processing/disposal policies and their safety (around FY2021)**
  - As NDF noted in its Technical Strategic Plan that the prospects of a processing/disposal method and technology related to its safety should be made clear by around FY2021, the policy for ensuring safety during storage and management and the measurement data useful for characterization will be shown early on by TEPCO.
- **Eliminate temporary storage areas outside for rubble and other waste (in FY2028)**
  - Additional miscellaneous solid waste incineration facilities for reducing the volume of combustible materials or volume reduction facilities, etc., for reducing the volume of incombustible materials (metal, concrete) will be installed and their operation will be started.
  - Incineration and volume reduction of waste that is temporarily stored outdoors, will be carried out and it will be stored in the solid waste storage facility.
  - If the projection of the amount of solid waste that will be generated in the future, fluctuates and storage facilities are inadequate as a result, additional storage facilities will be built after securing space within the premises.

(Challenges)

- Reflection of fluctuation in the projection of the amount of waste that will be generated in the future, into the storage management plan

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Waste management

-Major work processes going forward (2/4)

○ **Other work related to waste countermeasures**

– Based on the status of progress of future decommissioning work, characterization required for studying treatment and disposal of solid waste will be carried out utilizing the radioactive substances analysis and research facility that is currently under construction.

● **Secondary waste generated from contaminated water treatment**

– Secondary waste generated from contaminated water treatment (adsorption vessels, etc.) will be moved to the large-sized waste storage vault.

– Since the slurry, which is secondary waste generated from contaminated water treatment carried out using multi-nuclide removal equipment, has lots of water content, dehydration and stabilization treatment will be carried out for the slurry.

(Challenges)

• Designing the slurry stabilization treatment equipment and study on the specific method for its operation.

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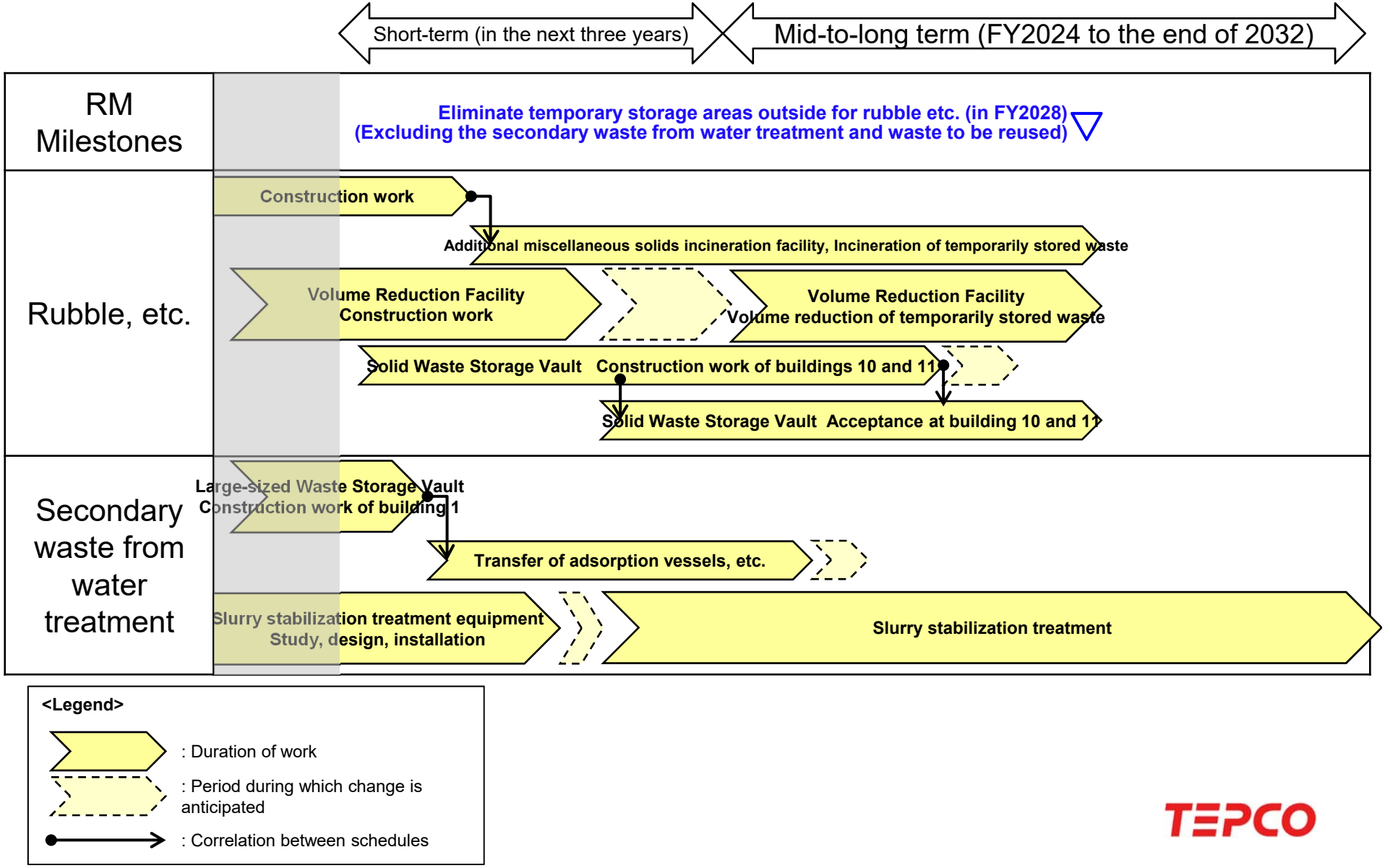
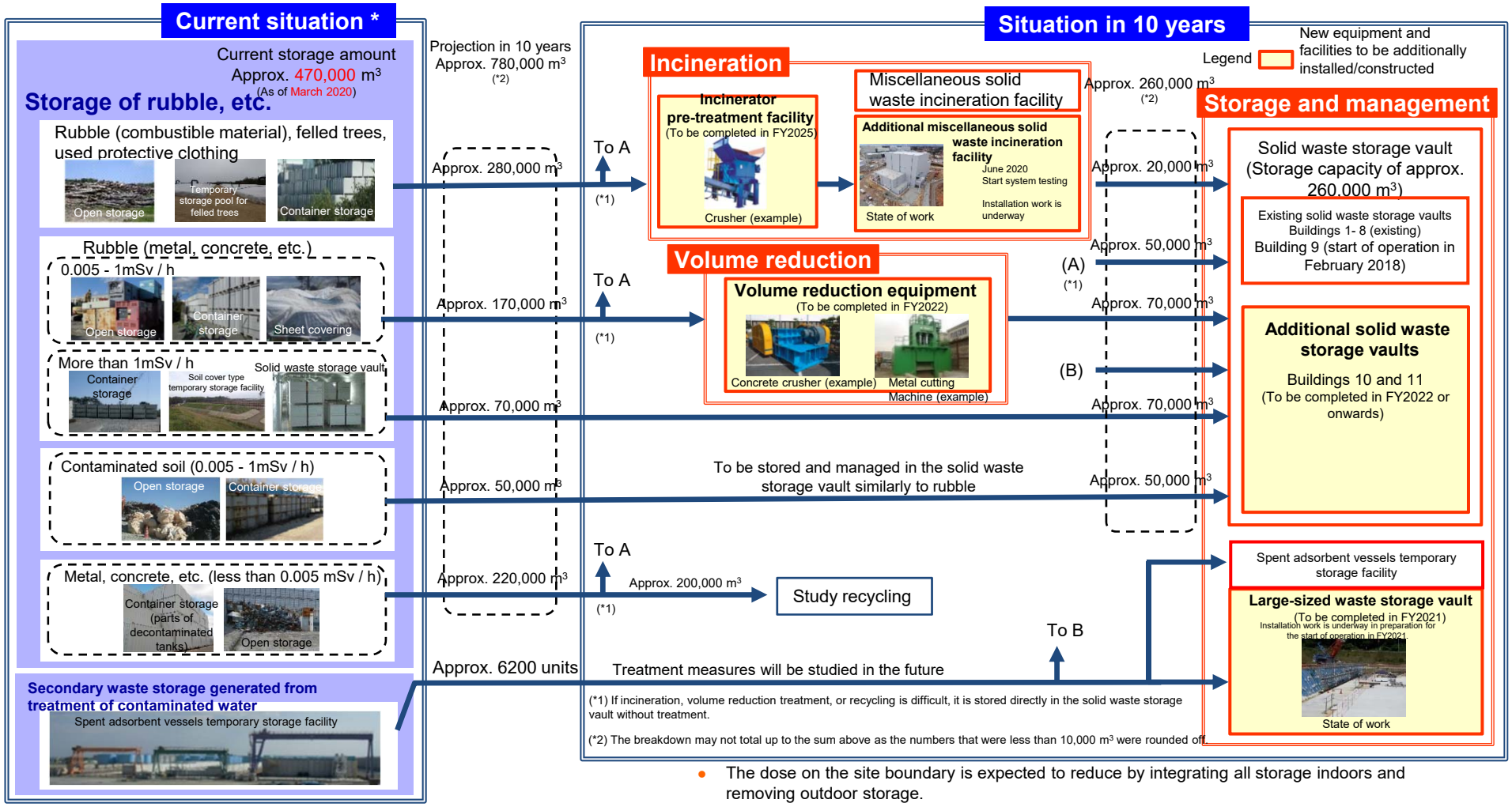
Waste management

-Major work processes going forward (3/4)



Waste management
-Major work processes (4/4)



Note) Used protective gear that is not yet incinerated and is determined at this point in time to be processed/reused and concrete waste at the BG level are not included.

- The dose on the site boundary is expected to reduce by integrating all storage indoors and removing outdoor storage.
- The dose from the exhaust gas from the incineration facility or on the site boundary will be measured and published on the home page, etc.

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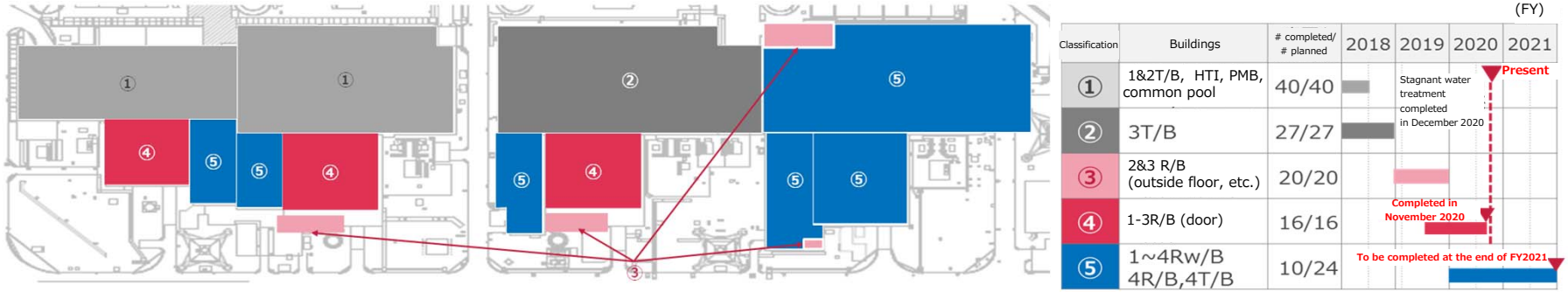
Other measures
-Progress made in FY2020

○Progress made in FY2020 in processes that are ongoing

●Natural disaster prevention measures

– Building openings are being closed as a tsunami countermeasure and the openings of the reactor buildings of Units 1-3 have been closed.



Building opening closing classification

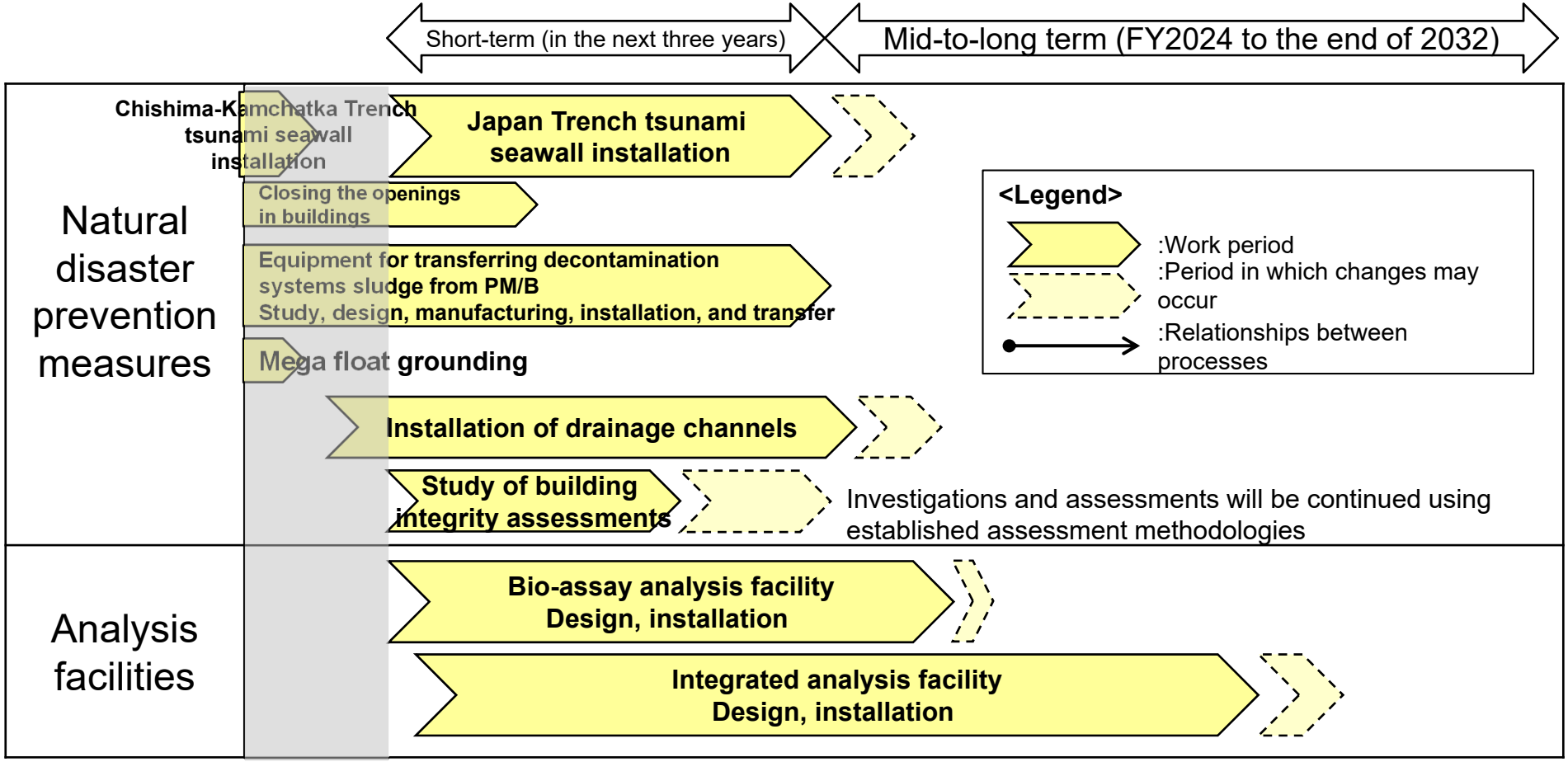
Other measures
-Major work processes going forward (1/3)

○Other related work

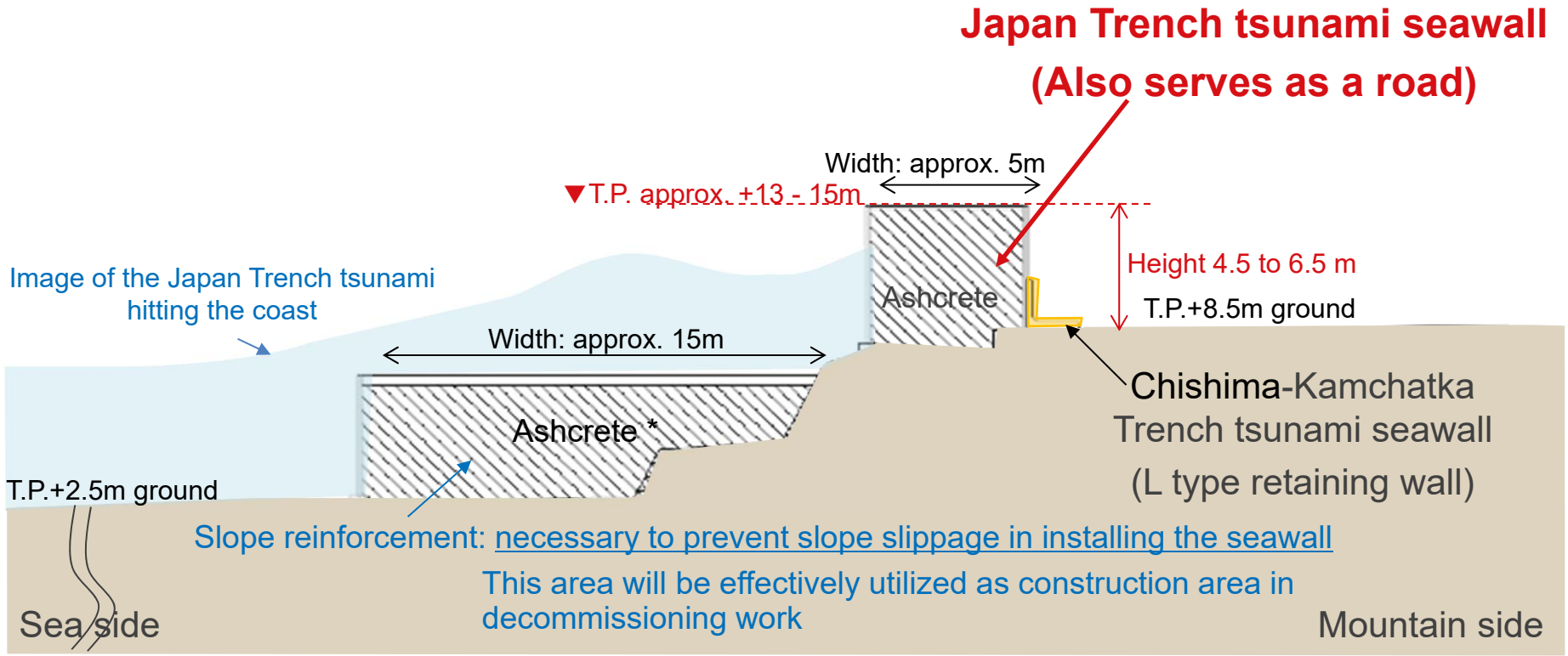
- **Natural disaster prevention measures**
  - Countermeasures for possible tsunami such as installation of Japan Trench tsunami seawall, closing of openings in buildings, extraction of decontamination systems sludge from PM/B, etc. will be implemented.
  - A drainage channel will be installed in preparation for large-scale rainfall.
  - The integrity of the reactor building of Units 1-3 that needs to be ensured in the long-term before debris retrieval completion will be assessed by trend analysis through investigations of the inside of the building and seismometers.

  (Challenges)
  - Measures other than sea wall as tsunami countermeasures (protecting the freezing brine transfer pipes, moving the sub-drain tank to an elevated location, etc.)
  - Studying safety measures to be taken with regard to handling and evaluating remote recovery and dewaterability of decontamination systems high radiation sludge from PM/B.
  - Study of methods to investigate integrity inside high dose buildings
- **Analysis facilities**
  - Install facilities that has the analysis capability to be required as decommissioning progresses

Other measures
-Major work processes going forward (2/3)



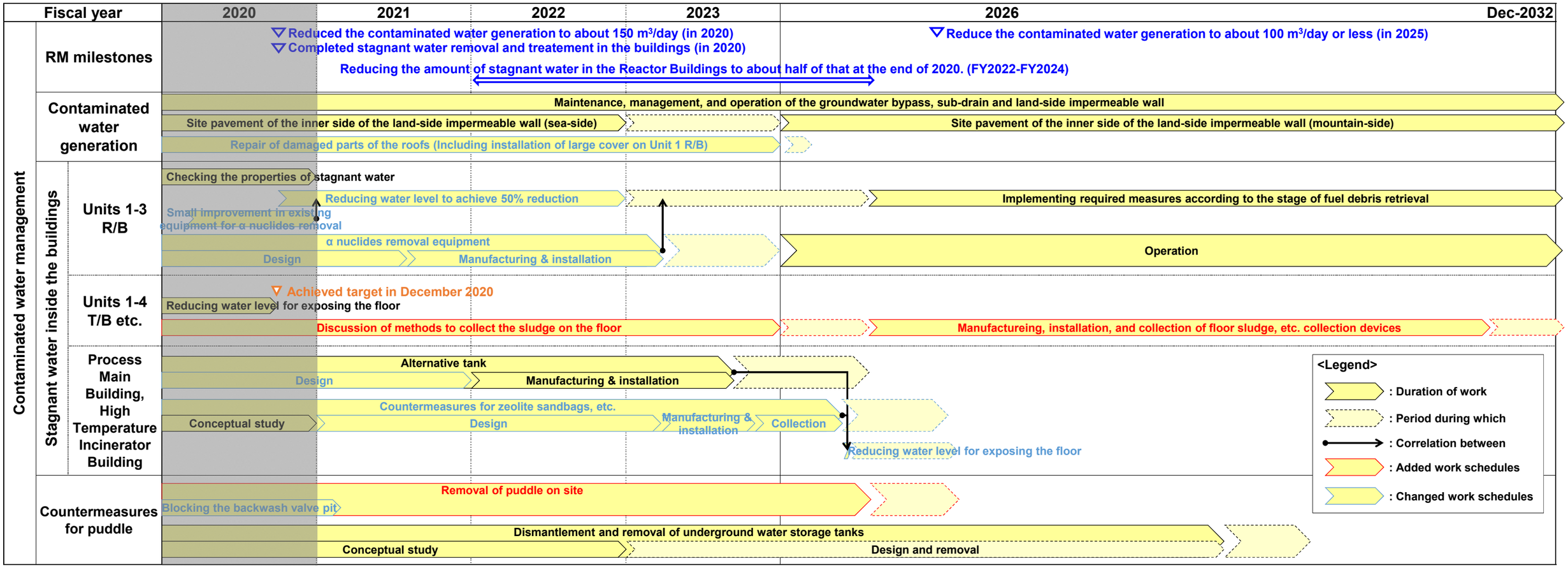
Other measures
-Major work processes going forward (3/3)



*Ashcrete: Artificial ground material that is a mixture of fly ash (from the JERA Hirono Thermal Power Plant) and cement

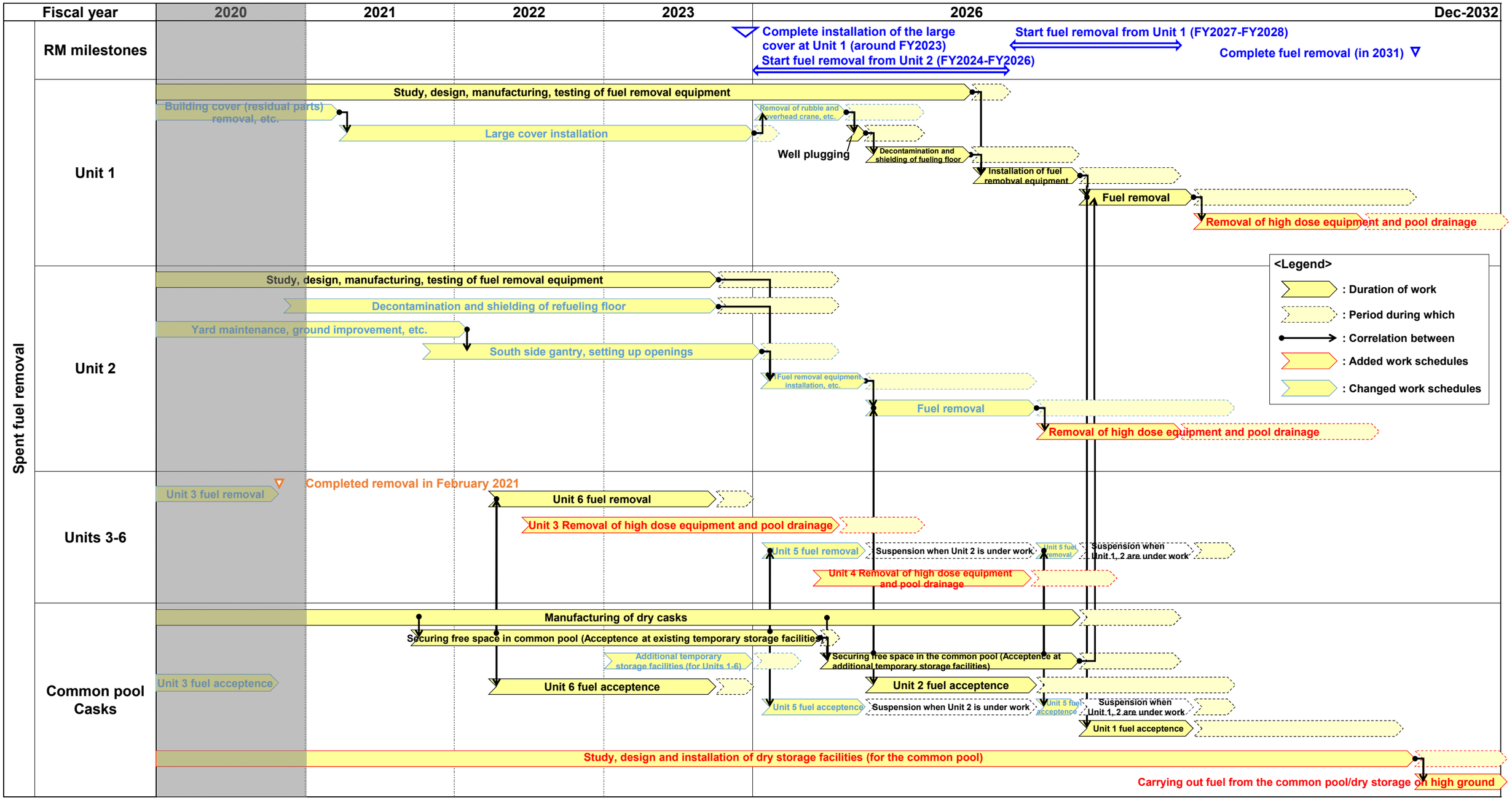
Basic concept proposal for the Japan Trench tsunami seawall

Mid-and-Long-Term Decommissioning Action Plan 2021



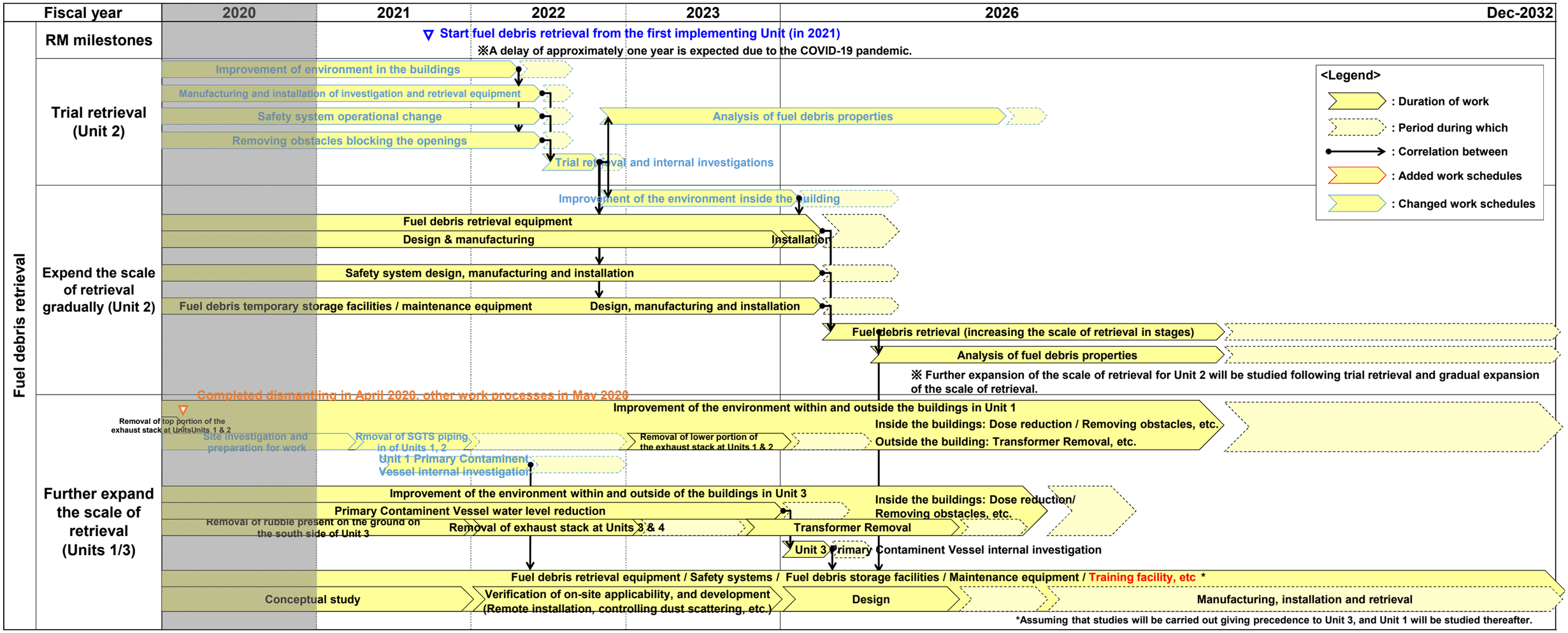
Note: The contents may change depending on future studies.

Mid-and-Long-Term Decommissioning Action Plan 2021



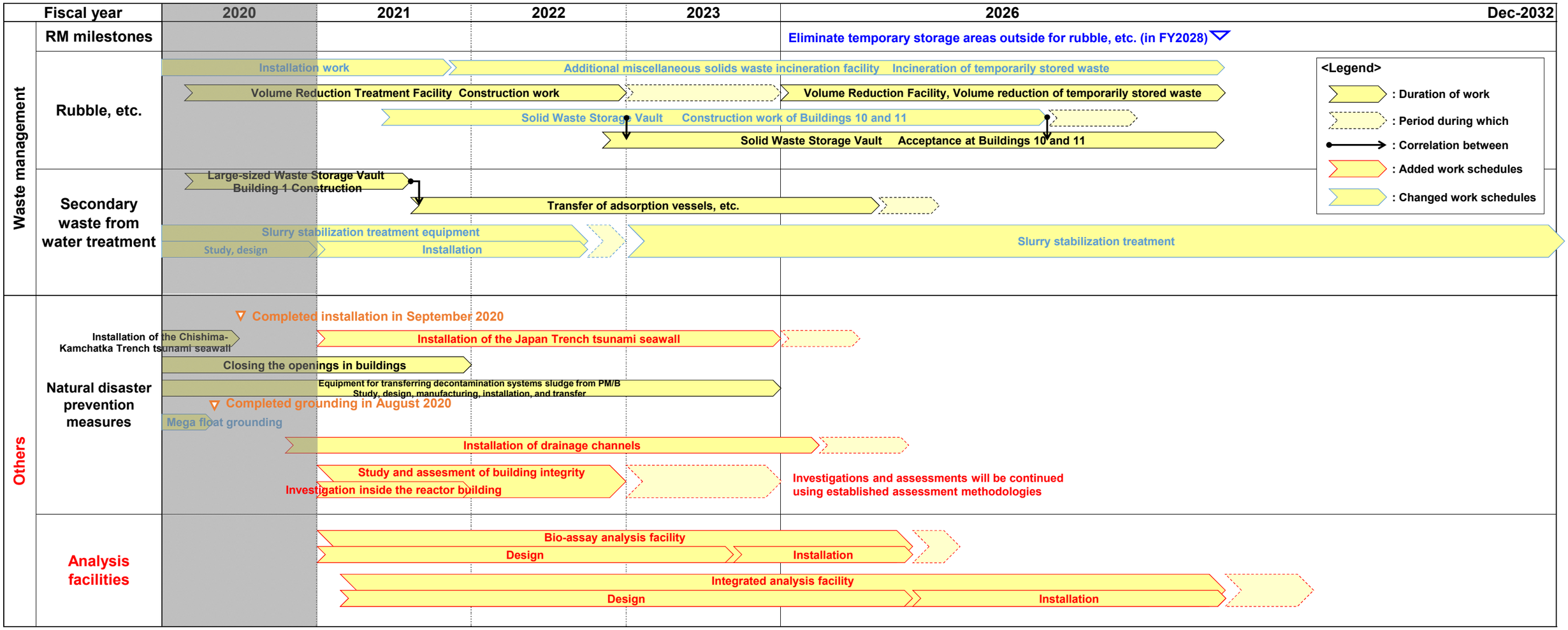
Note: The contents may change depending on future studies.

Mid-and-Long-Term Decommissioning Action Plan 2021



Note: The contents may change depending on future studies.

Mid-and-Long-Term Decommissioning Action Plan 2021



Note: The contents may change depending on future studies.