Mid-and-Long-Term Decommissioning Action Plan 2020

March 27, 2020

Tokyo Electric Power Company Holdings, Inc.

Mid-and-Long-Term Decommissioning Action Plan 2020

The “Mid-and-Long-Term Decommissioning Action Plan 2020” 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.

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 Plan 2020” corresponds with the following plans indicated in the Mid-and-Long-Term Road-map and the Technical Strategic Plan.
❿Specific 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.
❿A consistent long-term plan for decommissioning as a whole, from the present to the short-term, to the mid-term and to the long-term.

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)
Technical Strategic Plan: Technical Strategic Plan 2019 for decommissioning the Fukushima Daiichi Nuclear Power Station of the Tokyo Electric Power Company Holdings, Inc.
(Published by the Nuclear Damage Compensation and Decommissioning Facilitation Corporation on September 9, 2019)
NRA Risk Map: Mid-term risk reduction goal map for TEPCO’s Fukushima Daiichi Nuclear Power Station (March 2020 version)
(Finalized by the NRA on March 4, 2020)

Contaminated water management (1/5)

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

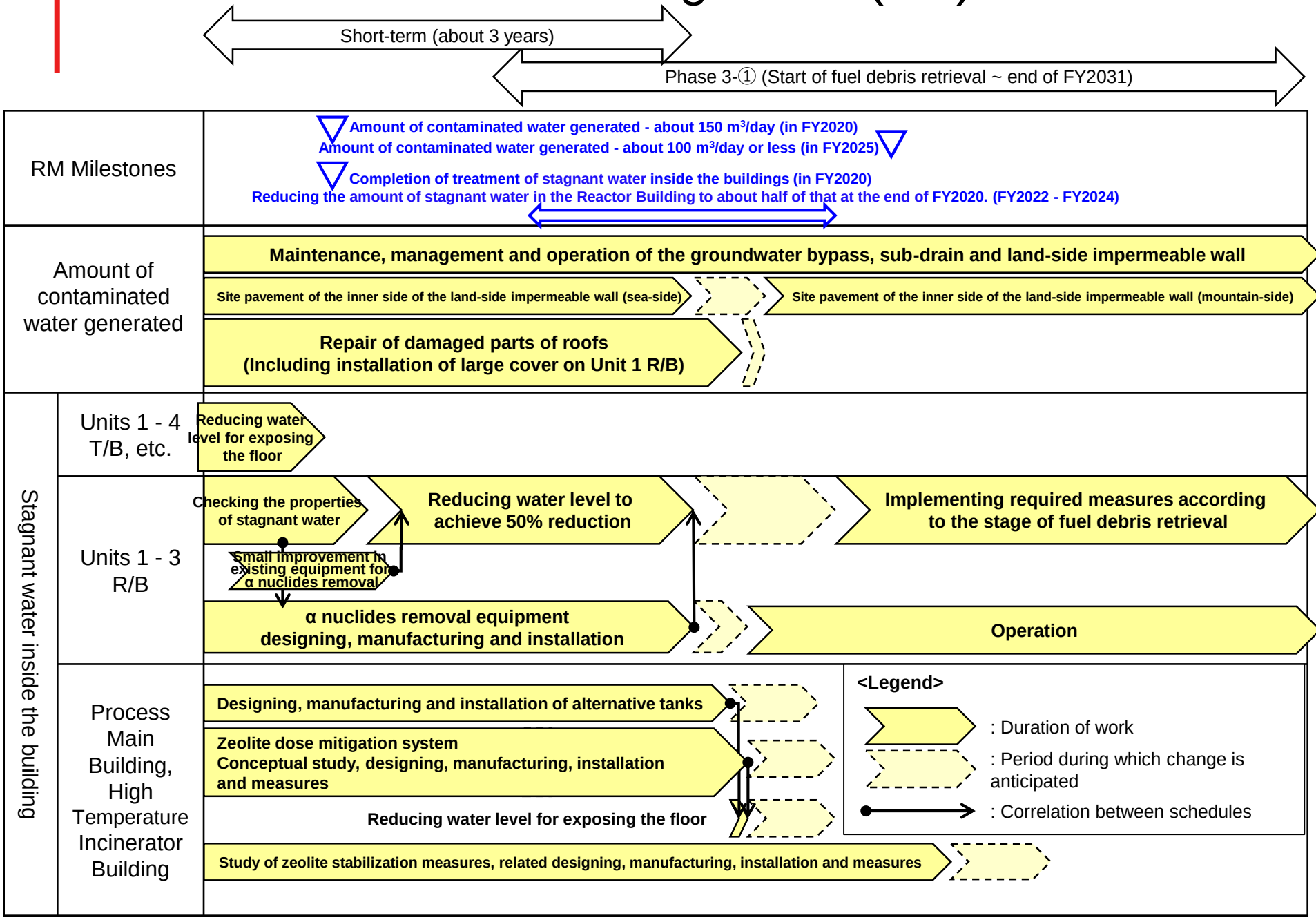
- **Reduce contaminated water generation to about 150 m^3/day (in FY2020)**
- **Reduce contaminated water generation to about 100 m^3/day or less (in FY2025)**
  - The maintenance, management and operation of the groundwater bypass, sub-drain and land-side impermeable wall will continue and the level 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.)
- **Complete stagnant water treatment in the buildings (in FY2020)**
  - Along with reducing the level of groundwater, the level of stagnant water inside buildings except the Reactor Buildings (R/B), Process Main Building (PM/B) and the High Temperature Incinerator Building (HTI) in Units 1 - 3, will be reduced so that floor is exposed.

  (Challenges)
  - Exposing the floor of the building basement, which is high radiation environment, and keeping it exposed.
- **Reduce the amount of stagnant water in the Reactor Building to about a half of that at the end of FY2020. (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.

Contaminated water management (2/5)



Contaminated water management (3/5)

○ Other work related to contaminated water countermeasures

- **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.
  - Since there are high radiation zeolite sandbags on the bottommost basement floor, the floor will be exposed after implementing dose mitigating measures.

  (Challenges)
  - Studying safety measures to be taken with regard to handling or implementing measures for high radiation zeolite sandbags

- **Natural disaster countermeasures**
  - Tsunami countermeasures such as installation of seawall, closing of openings in buildings, extraction of decontamination systems sludge of from PM/B, mega float grounding, etc. will be implemented.

  (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.

- **Countermeasures for puddle**
  - Puddle will be removed from the premises by blocking the backwash valve pit.
  - 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.

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Contaminated water management (4/5)

Short-term (about 3 years)

Phase 3-① (Start of fuel debris retrieval ~ end of FY2031)

Natural disaster countermeasures	Installation of seawall Closing the openings in buildings Study of equipment for transferring the decontamination systems sludge from PM/B, related designing, manufacturing, installation and transfer **Mega float grounding**
Countermeasures for puddle	Blocking the backwash valve pit **Dismantlement and removal of underground water storage tanks** **Conceptual study** → **Designing and removal**

Status of installation of sea wall

<Legend>

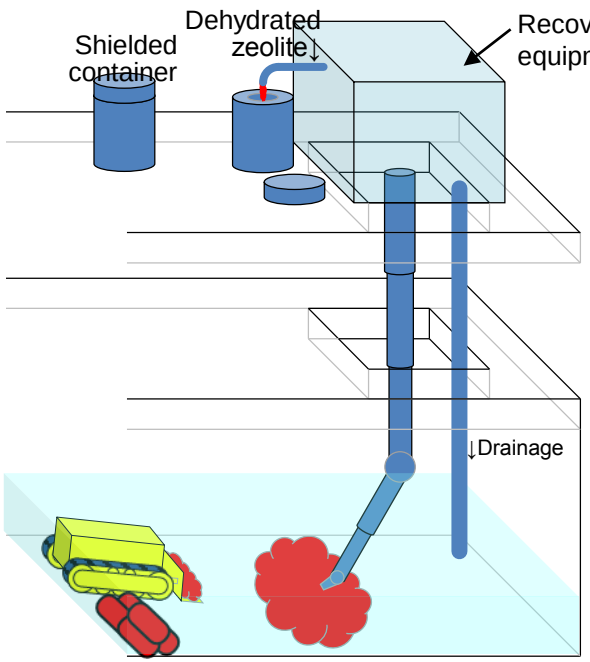
: Duration of work

: Period during which change is anticipated

: Correlation between schedules

Contaminated water management (5/5)

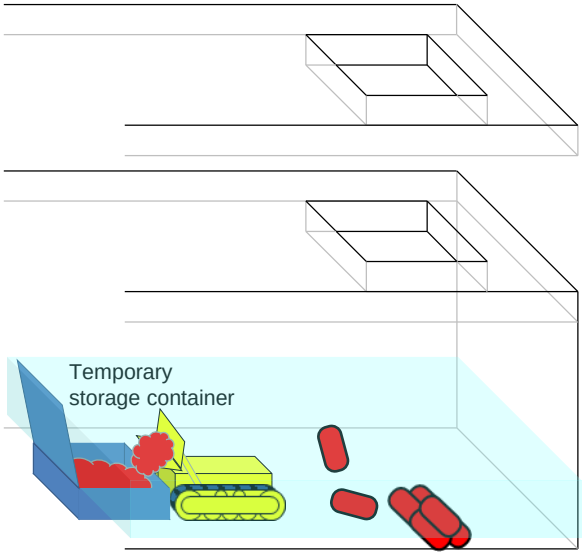
Will continue to be studied as the main policy



① Remote recovery

Merits
- There is no additional recovery work.

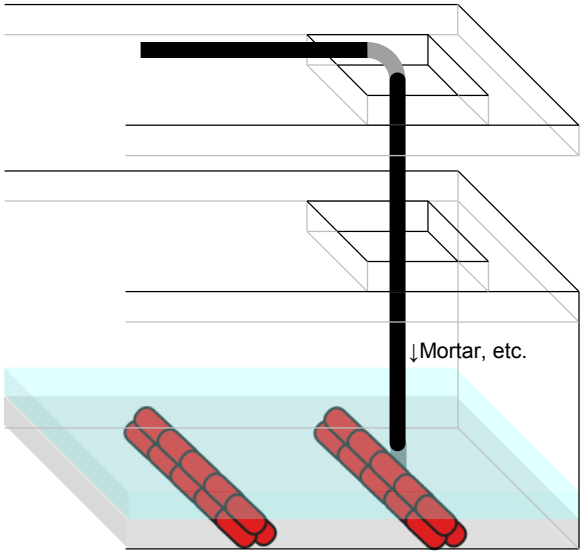
Demerits
- A location for storing the shielded container needs to be secured.
- The recovery equipment becomes highly radioactive.



② Remote accumulation on the spot

Merits
- Temporal storage location being can be secured.

Demerits
- Full-fledged recovery work will be required later.



③ Solidification

Merits
- Can be implemented early on.

Demerits
- Full-fledged recovery will be difficult later.
- It is widespread and difficult to fill.

Details of study on zeolite sandbags countermeasures

Spent Fuel Removal (1/3)

◯ **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.
- **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 without demolishing the building.
  - 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.

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Spent Fuel Removal (2/3)

- **Complete fuel removal from Units 1 - 6 (in FY2031)**
  - For Unit 3, fuel removal is aimed to be completed in FY2020. 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 higher grounds.
  - Additional temporary storage facilities will be installed after securing sites within the premises.

(Challenges)

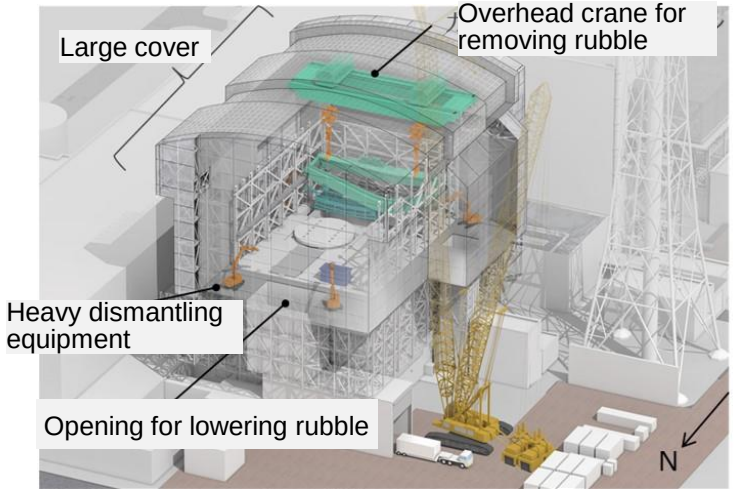
- Setting up additional temporary storage facilities for dry casks in accordance with the fuel removal plan including fuel removal from Units 5 & 6.

○ **Other spent fuel removal related work**

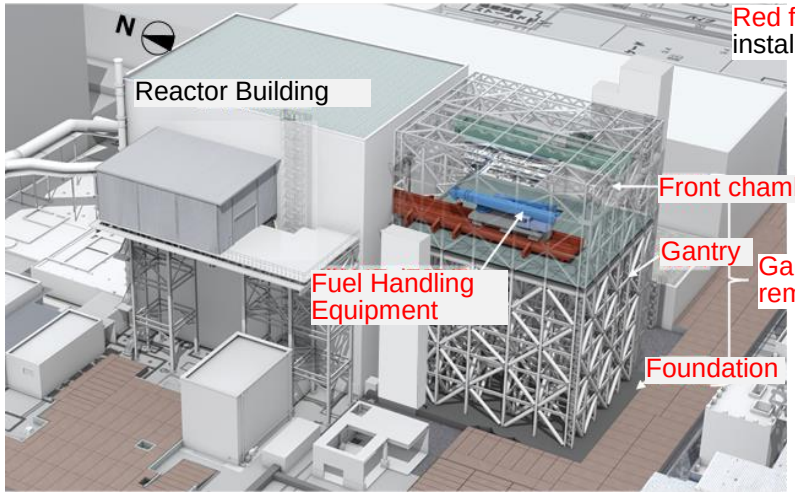
- After removing fuel from each unit, highly radioactive equipment such as spent control rods, etc. will be removed.

(Challenges)

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

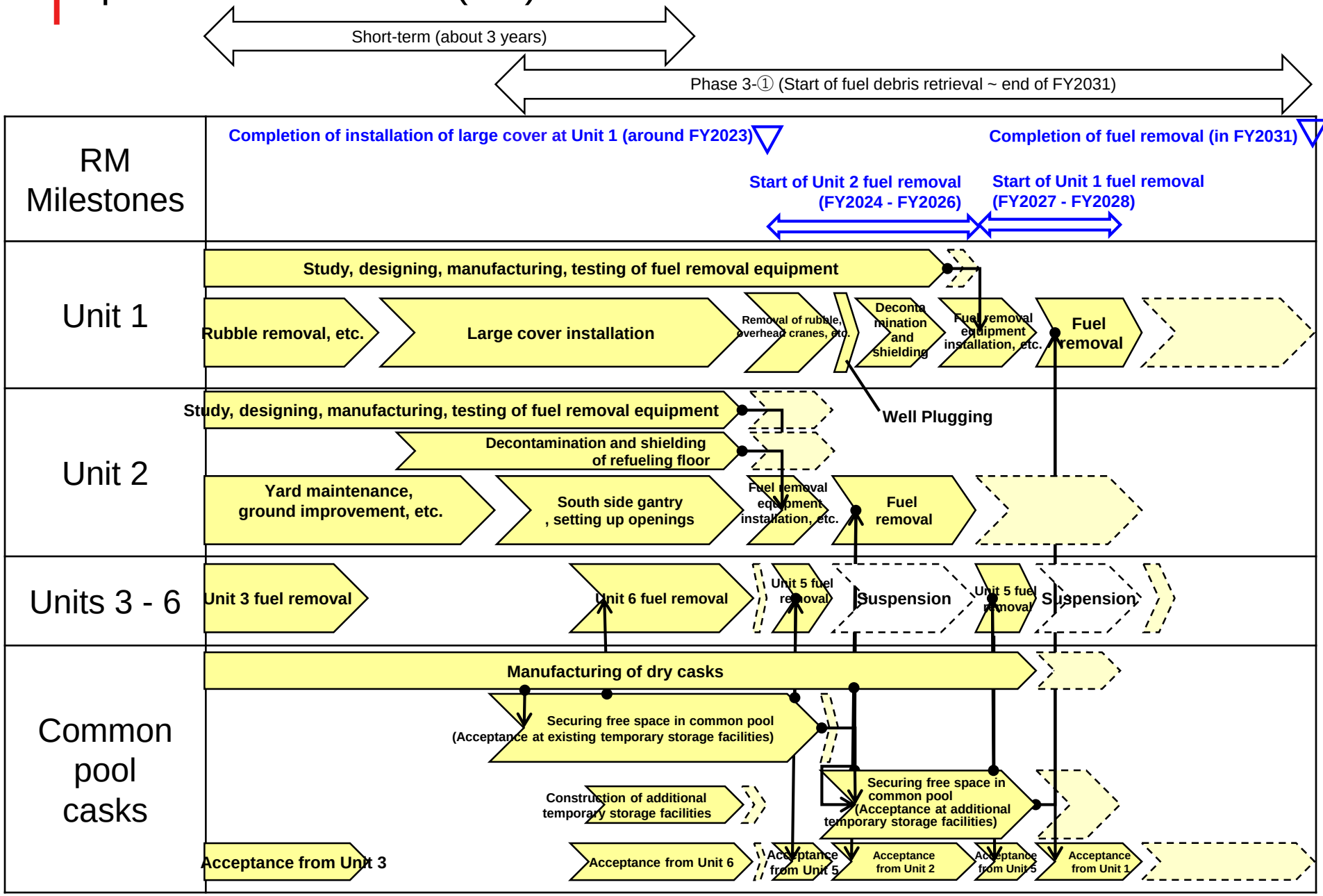


Unit 1 Large cover (Image)



Unit 2 gantry for fuel removal (Image)

Spent Fuel Removal (3/3)



Fuel debris retrieval (1/4)

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

- **Start fuel debris retrieval from the first implementing unit (in FY2021)**
  - 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.
  - For improving the environment inside the building, radioactive sources will be investigated and eliminated for reducing the radiation dose (about 5mSv/h) in the west-side area on the first floor of the Reactor Building, which will be the work site for the retrieval.
  - 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

Photograph:
Robot arm

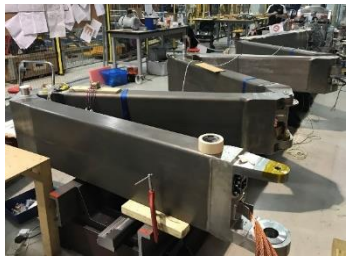
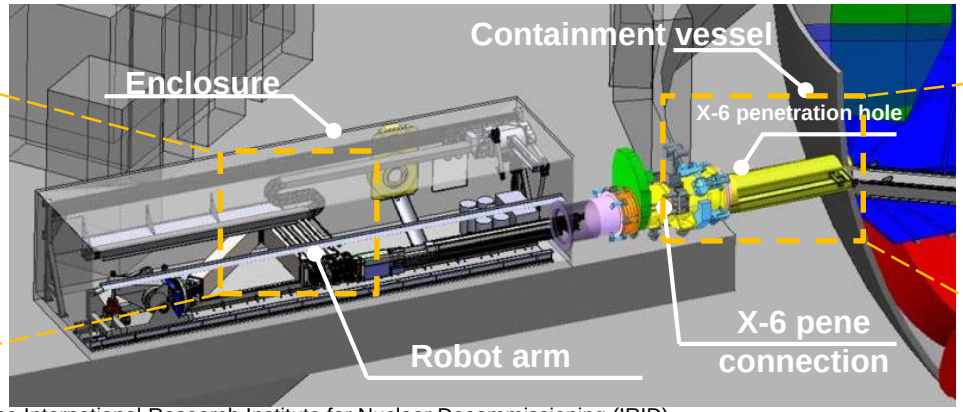


Image: Image of fuel debris retrieval device



Photograph:
Deposits in the X-6 penetration hole

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

Fuel debris retrieval (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.

– 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 (3/4)

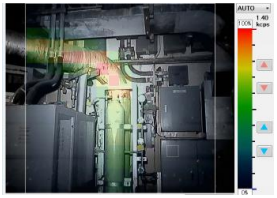
- In order to improve the environment inside the buildings, radioactive sources will be investigated and eliminated for reducing the radiation dose at the work site (in particular, highly contaminated pipes). In addition, equipment, etc. that could hinder future work will be removed. Moreover, the PCV 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)

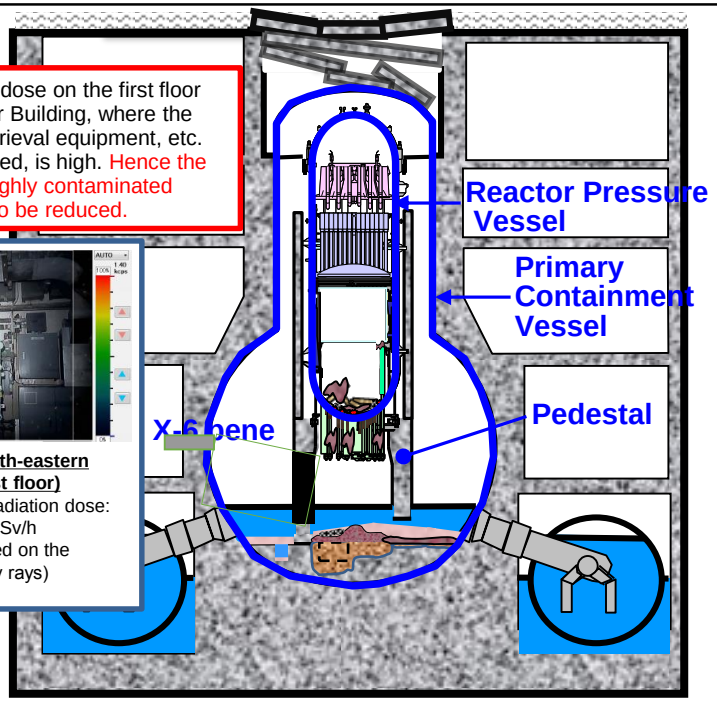
- Study on the method of reducing the dose of highly contaminated pipes by means of remote operations (removal or decontamination) and the method of installing equipment for retrieval and water intake, etc., since the dose at the work site in Units 1/3 is higher compared to that in Unit 2.

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.

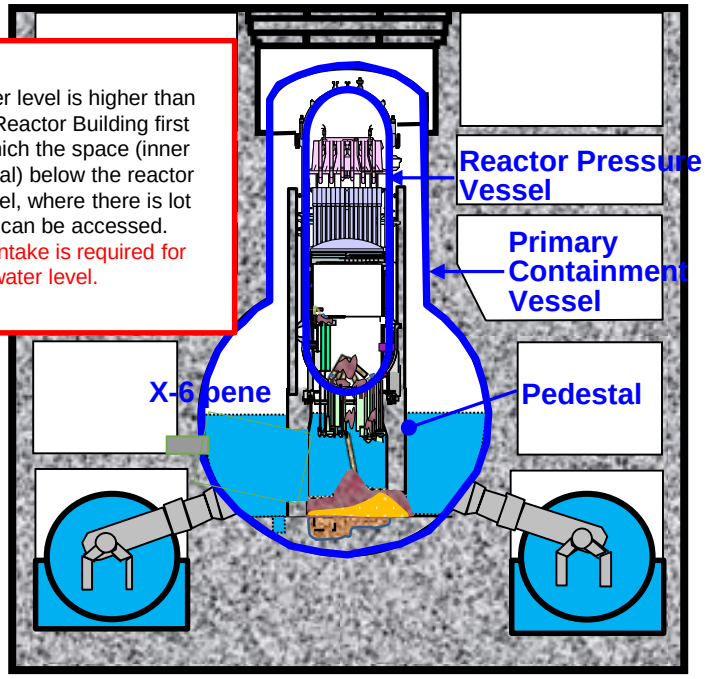


AC piping (south-eastern area on the first floor)
Surface 50cm radiation dose: Approx. 1000 mSv/h
(Estimated based on the intensity of the γ rays)



Unit 3

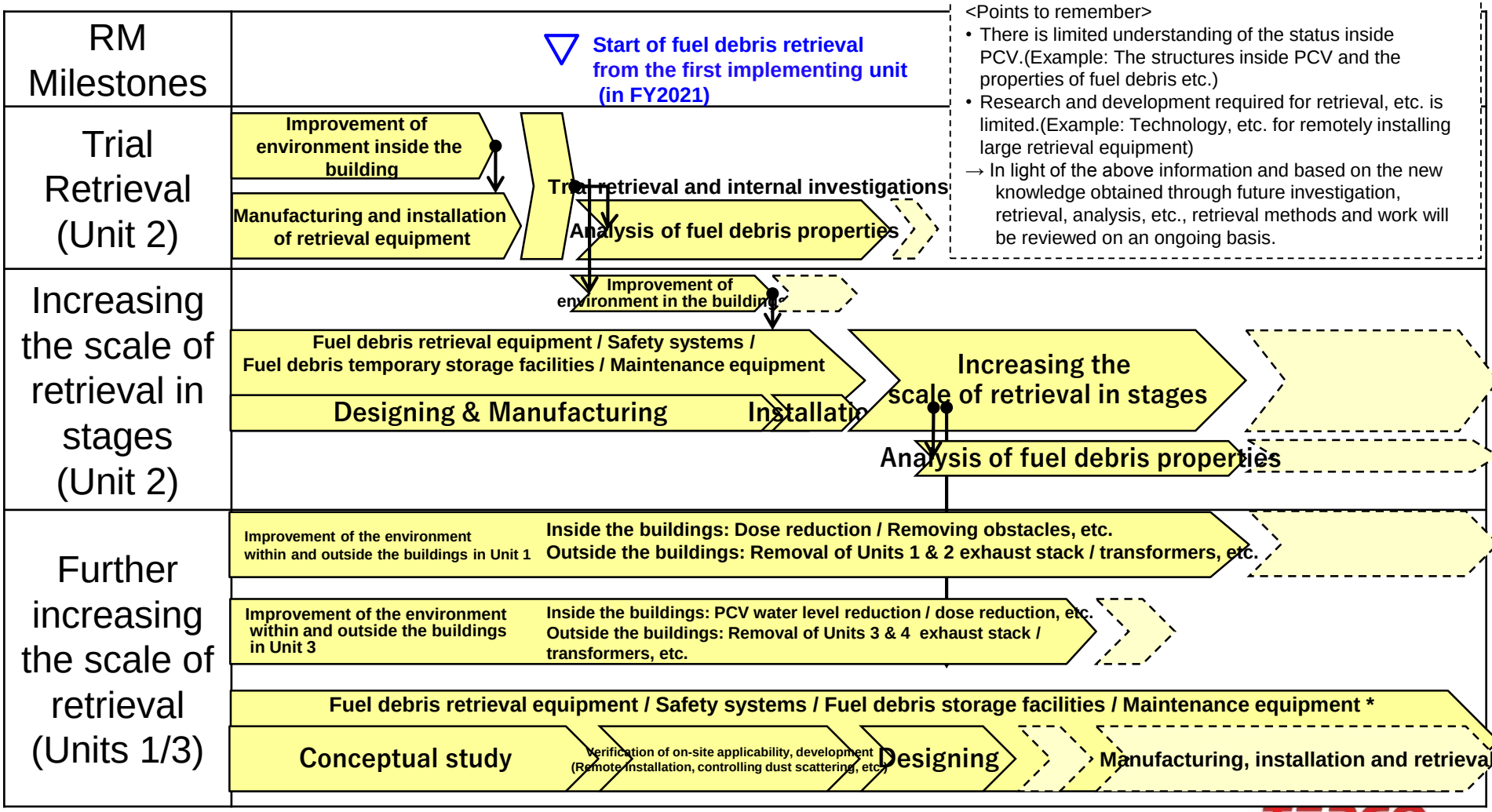
The PCV water level is higher than the opening (Reactor Building first floor), from which the space (inner side of pedestal) below the reactor pressure vessel, where there is lot of fuel debris, can be accessed. Hence water intake is required for reducing the water level.



Fuel Debris Retrieval (4/4)

Short-term (about 3 years)

Phase 3-① (Start of fuel debris retrieval ~ end of FY2031)



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

Waste management (1/3)

○ **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

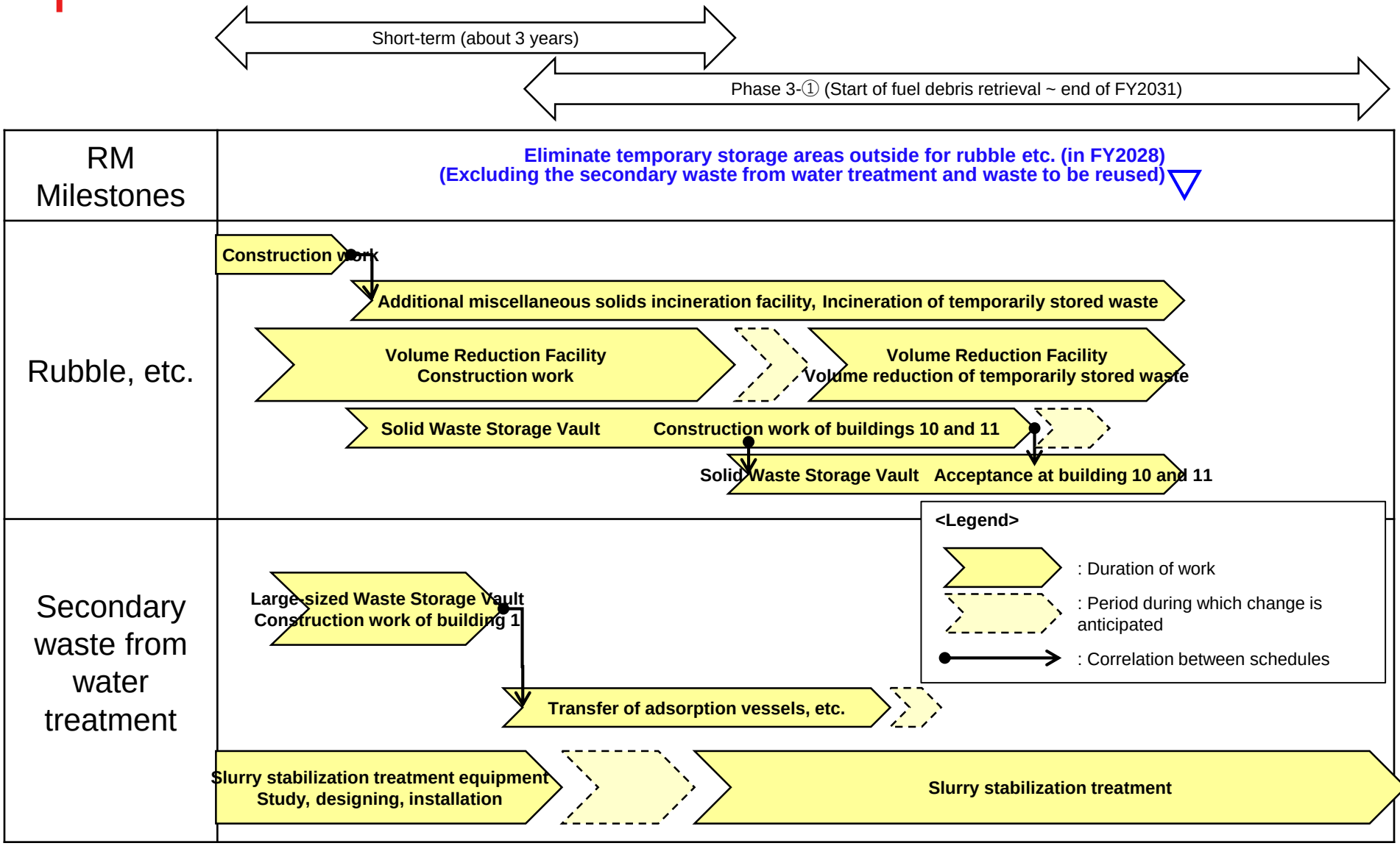
○ **Other work related to waste countermeasures**

- 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.

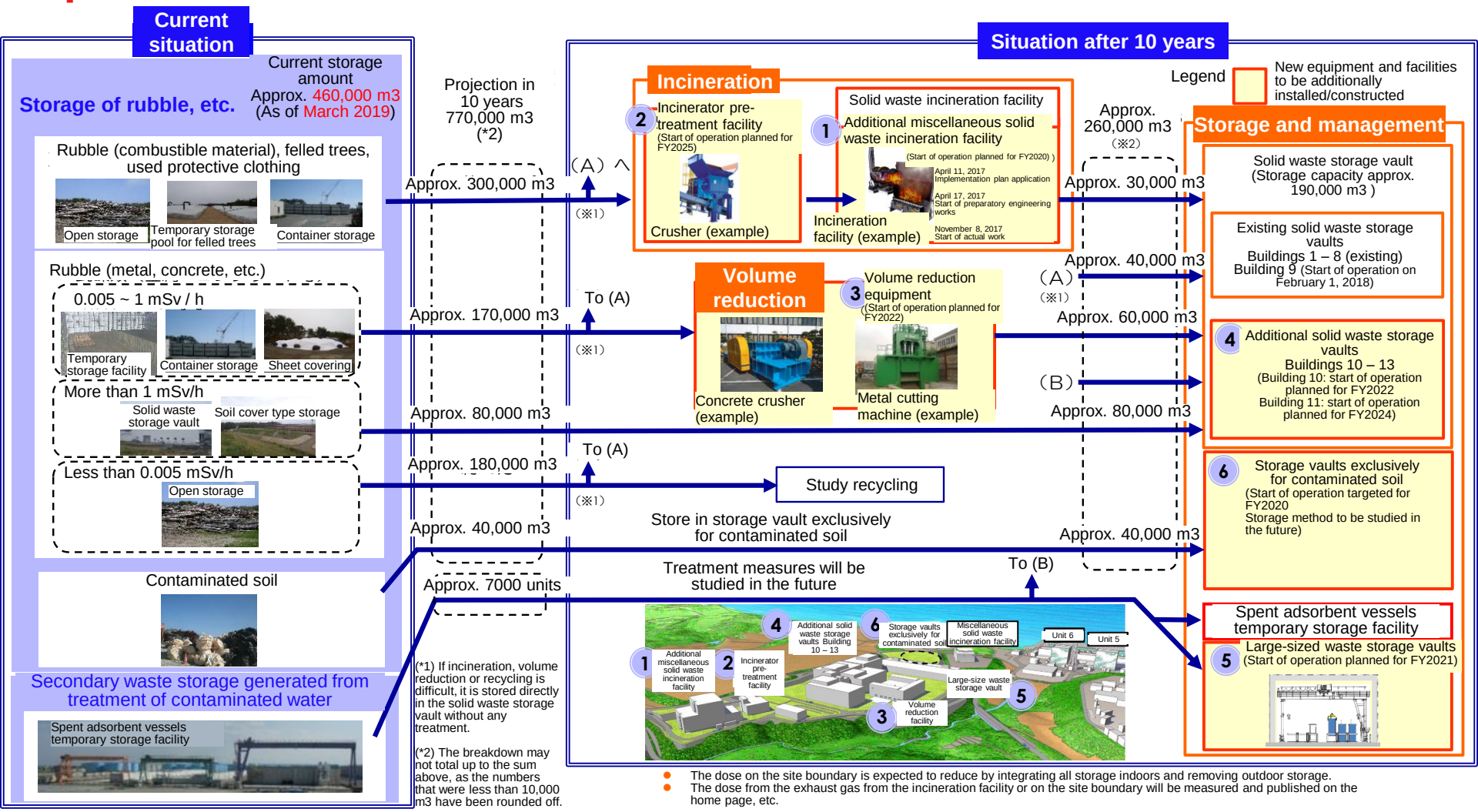
- **Secondary waste generated from contaminated water treatment**
  - Secondary waste generated from contaminated water treatment (adsorption vessels, etc.) will be moved to the large-sized waste storage vault.
  - Since the slurry, which is secondary waste generated from contaminated water treatment 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.

Waste management (2/3)



Waste management (3/3)



- 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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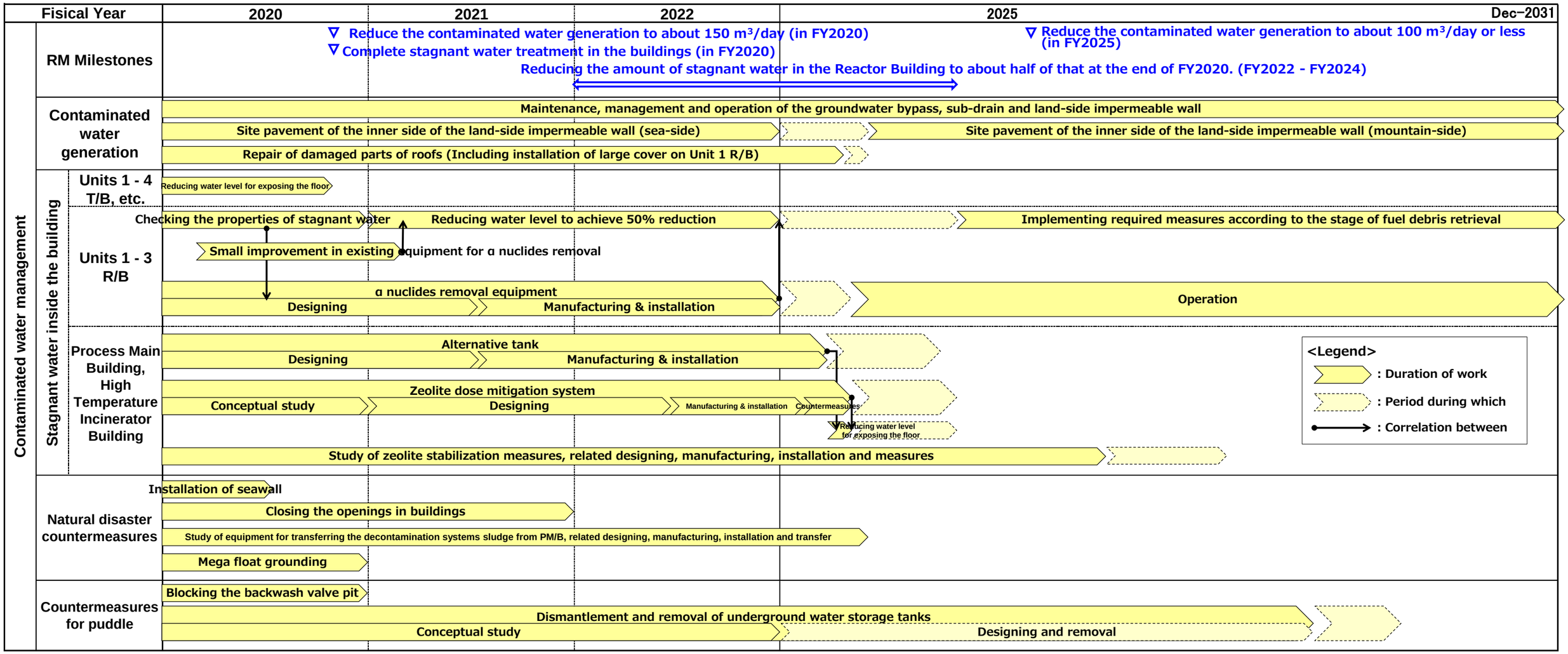

Note: The contents may change depending on future studies.

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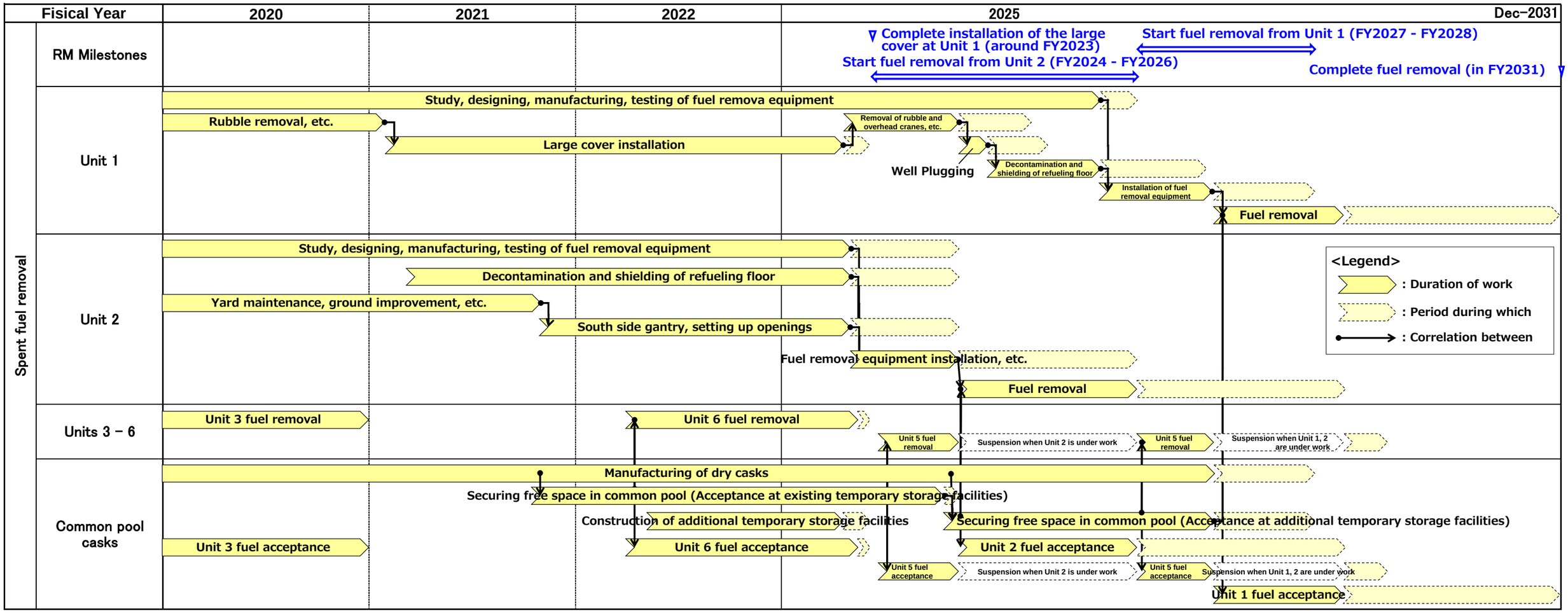

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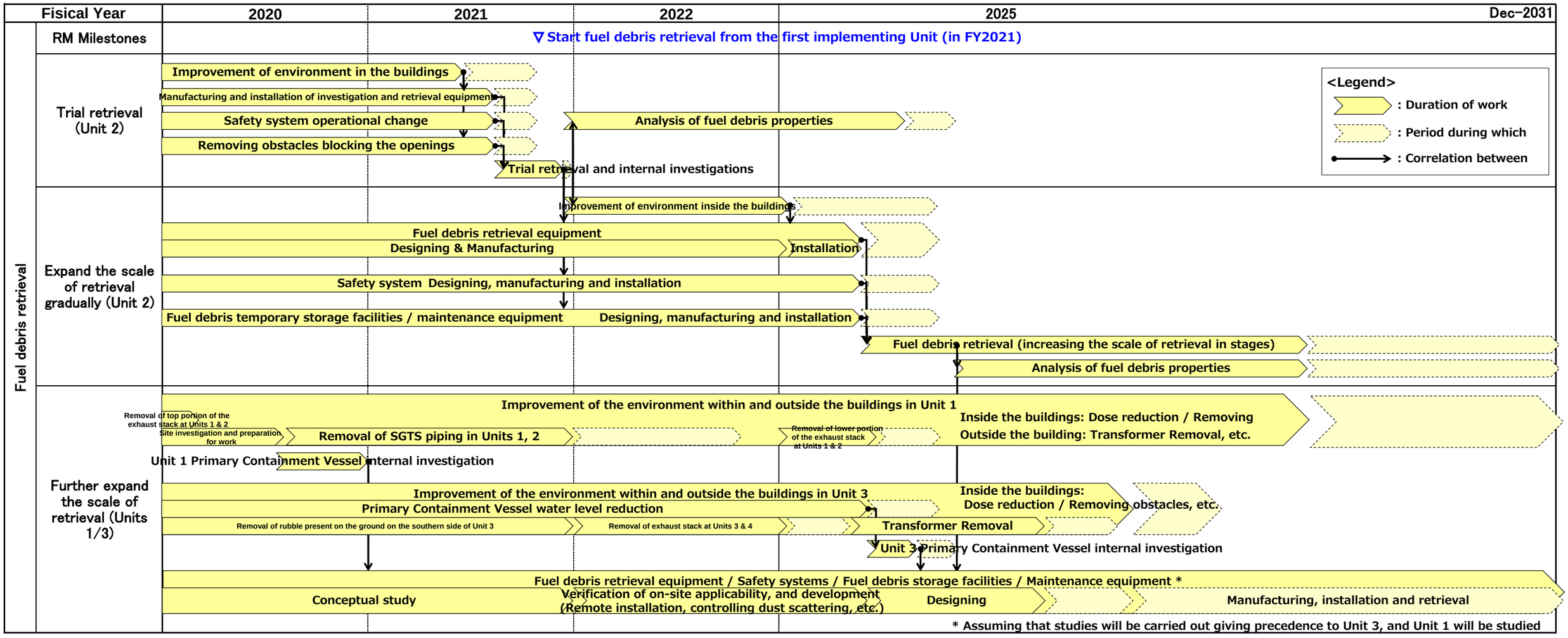

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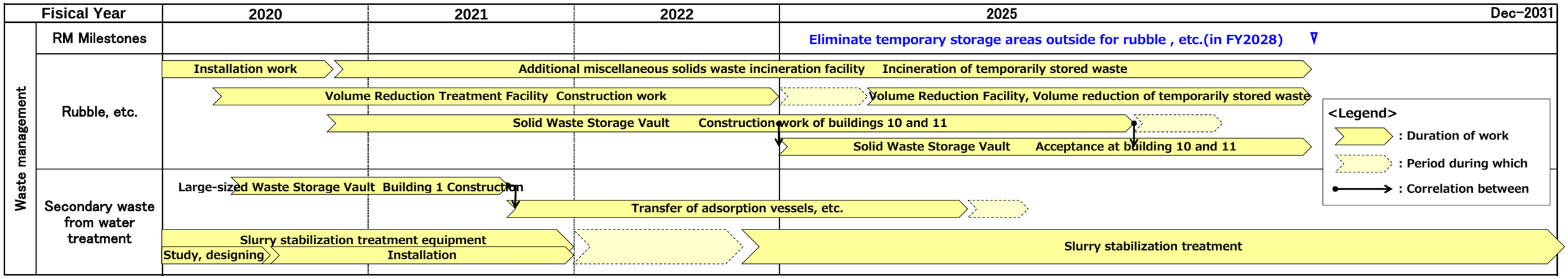

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