The 9th International Forum on the Decommissioning of the Fukushima Daiichi Nuclear Power Station, Aug. 4, 2025

Key Approaches to Decommissioning for Fuel Debris Retrieval

Tokyo Electric Power Company Holdings, Inc.

Agenda

1. Overview of Decommissioning at Fukushima Daiichi Nuclear Power Station
2. Concept of full-scale fuel debris retrieval
3. Key points for full-scale retrieval
4. Summary

1. **Overview of Decommissioning at Fukushima Daiichi Nuclear Power Station**

2. Concept of full-scale fuel debris retrieval

3. Key points for full-scale retrieval

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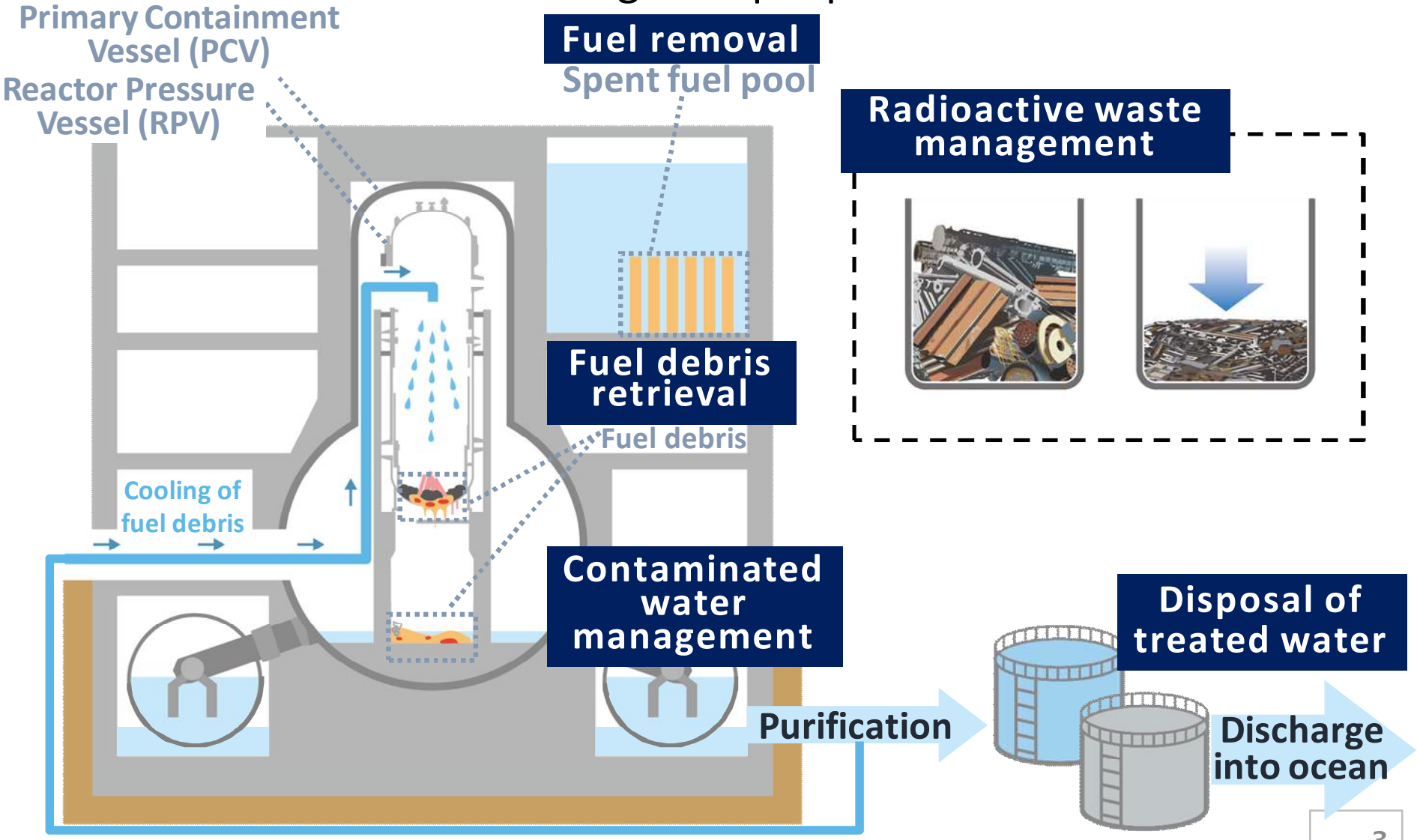
1. Overview of Decommissioning at Fukushima Daiichi Nuclear Power Station

TEPCO

- Decommissioning work is being carried out to reduce the risk of radioactive materials affecting local people and the environment.

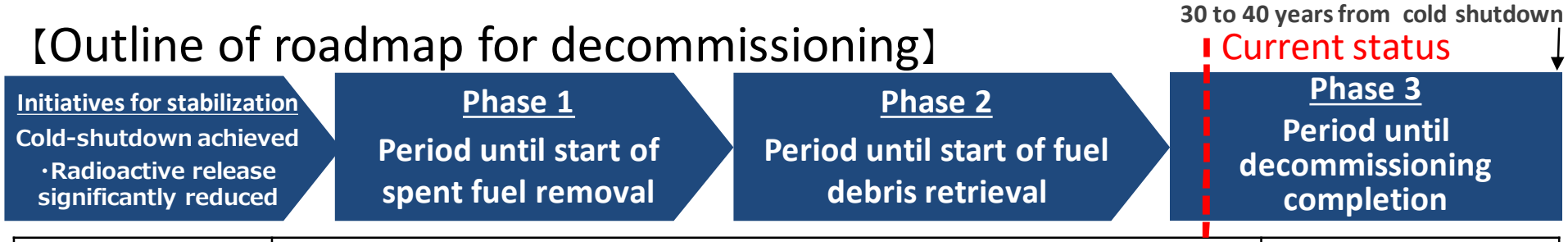


1.Mid-and-Long-Term Roadmap for Decommissioning

- Upon the initiation of the first trial retrieval in 2024, the roadmap transitioned to phase 3.

⇒TEPCO is currently deliberating measures to carry out full-scale fuel debris retrieval.

【Outline of roadmap for decommissioning】



Area	Target		Time
Contaminated water management	Reduce generation to about 150㎥/day		Within 2020 : Achieved
	Reduce generation to about 100㎥/day		Within 2025 : Achieved※1
	Completion of stagnant water removal/treatment	Complete stagnant water removal/treatment in buildings	Within 2020 : Achieved
		Reduce the amount of stagnant water in reactor buildings to about a half of that at the end of 2020	FY2022 to 2024 : Achieved
Fuel removal from spent fuel pools	Complete fuel removal from Units 1 to 6		Target: within 2031
	Complete installation of large cover at Unit1		Target: around FY2023 ※2
	Start fuel removal from Unit 1		Target: FY2027 to 2028
	Start fuel removal from Unit 2		Target: FY2024 to 2026
Fuel debris retrieval	Start of fuel debris retrieval at Unit 2 reactor building, preceding other 2 reactor buildings		Within 2021: Achieved ※2
Radioactive waste management	Technical prospects concerning processing/disposal policies and safety		Around FY2021: Achieved
	Eliminate temporary storage areas outside for rubble and other waste		Target: within FY2028

※1: Achieved 2 years ahead of schedule at the end of FY2023 ※2: Target timelines have been revised to enhance safety and certainty of site operations

Reference: TEPCO HP https://www.tepco.co.jp/en/hd/decommission/project/roadmap/index-e.html

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2. Concept of full-scale fuel debris retrieval

TEPCO

- "NDF's Sub-Committee for the Evaluation of Fuel Debris Retrieval Methods" is conducting comprehensive study and assessment for full-scale retrieval.

<Policies created by TEPCO in response to NDF's proposal >

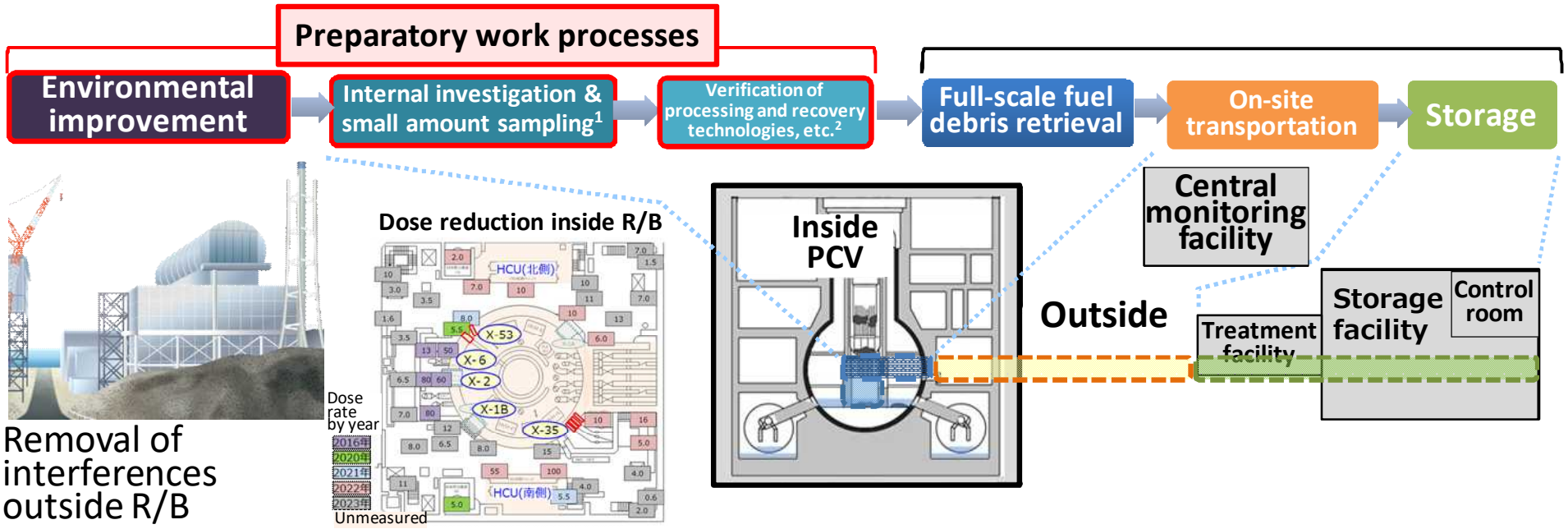
① Access through small opening

② Unification & simplification of fuel debris handling

③ Combination of side entry & top entry method

Reduce on-site exposure as low as possible and proceed steadily with **Step by Step** approach

【Main Work processes for fuel debris retrieval】



1: Collect small amount of fuel debris and analyze its components and properties etc.
2: Countermeasures against dust dispersion and fluctuation in water quality during processing and recovery etc., and data expansion regarding storage etc.

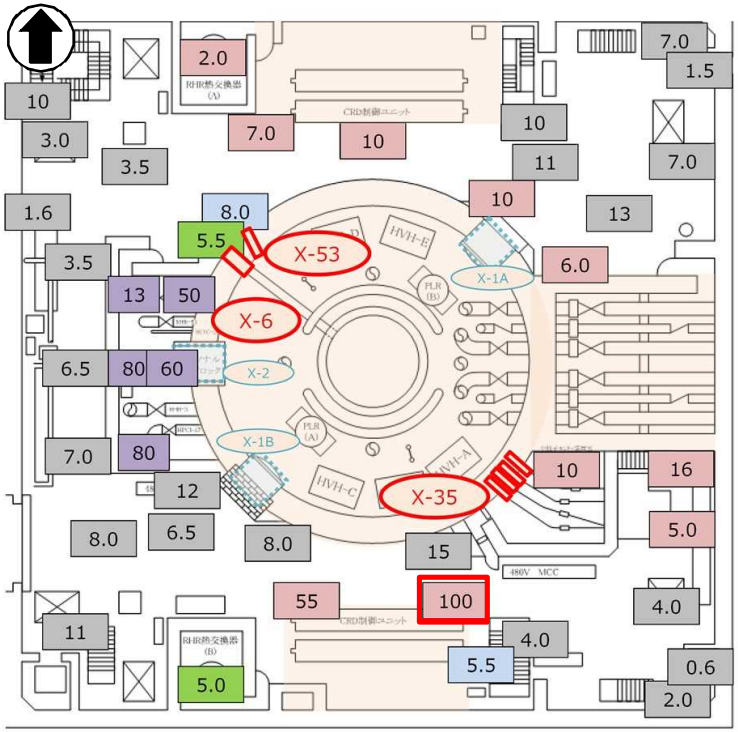
2. Initiative for full-scale retrieval 〈Environmental improvement〉

TEPCO

- For full-scale retrieval, environmental improvement is essential in addition to internal investigation.

【Radiation dose in Unit3 reactor building】

Even on the first floor, areas with tens of mSv/h to 100mSv/h have been identified.



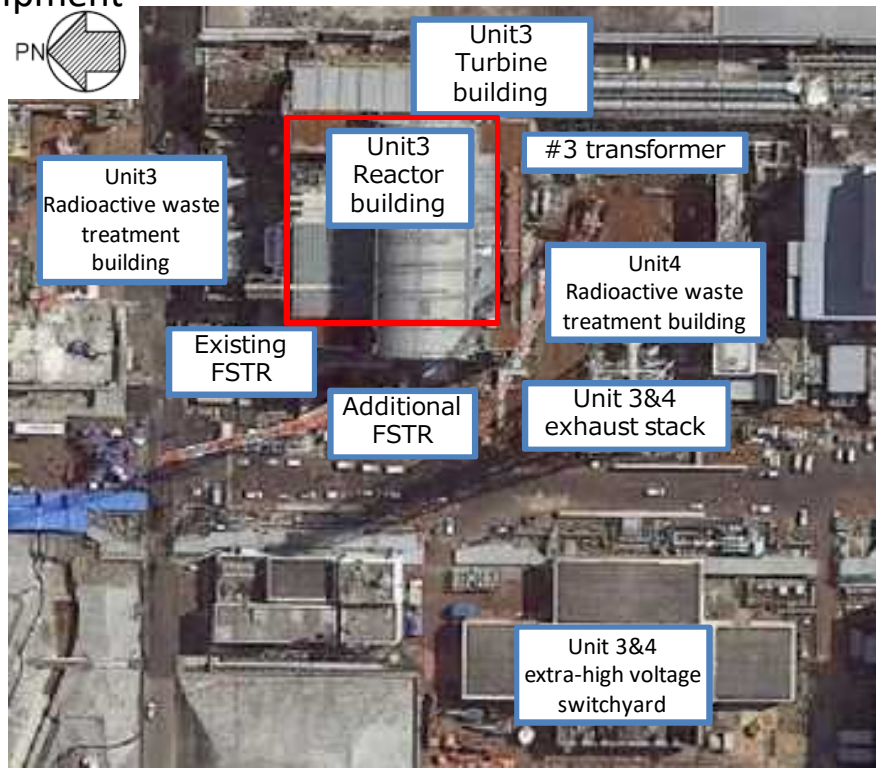
First floor in Unit 3 Reactor building

2016 2020 2021
2022 2023 Not measured

Unit: mSv/h

【Surroundings of Unit3 reactor building】

A number of past facilities and buildings remain, hampering tasks such as the installation of retrieval equipment



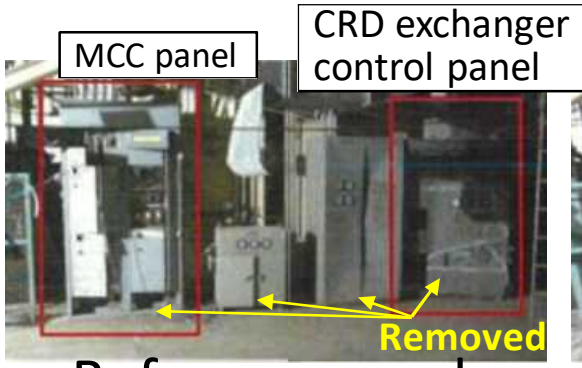
2.Environmental improvement in reactor building 〈Dose reduction〉

■ Object of radiation dose reduction

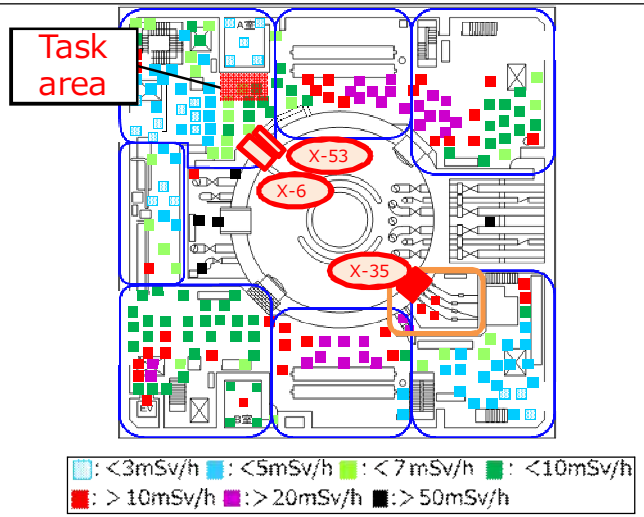
➢ Dose reduction is essential to minimize exposure risk as much as possible, both during the installation of retrieval equipment and the actual retrieval.

【Example of removing equipment installed before the March 11 earthquake】

Equipment：4 pieces including MCC panel, CRD exchanger control panel
Work period：Nov. 2020 to Mar. 2021 (about 5 months)
Total dose：272.5 person-mSv
Average dose(per actual number of workers)：3.8 mSv/person
Maximum individual dose：12.1 mSv
Cumulative number of people：1,228 person-entries(actual number of workers：71 workers)



Before removal　　After removal



Dose rate in the vicinity
Before removal：3.6mSv/h
→After removal：3.5mSv/h
－0.1mSv/h

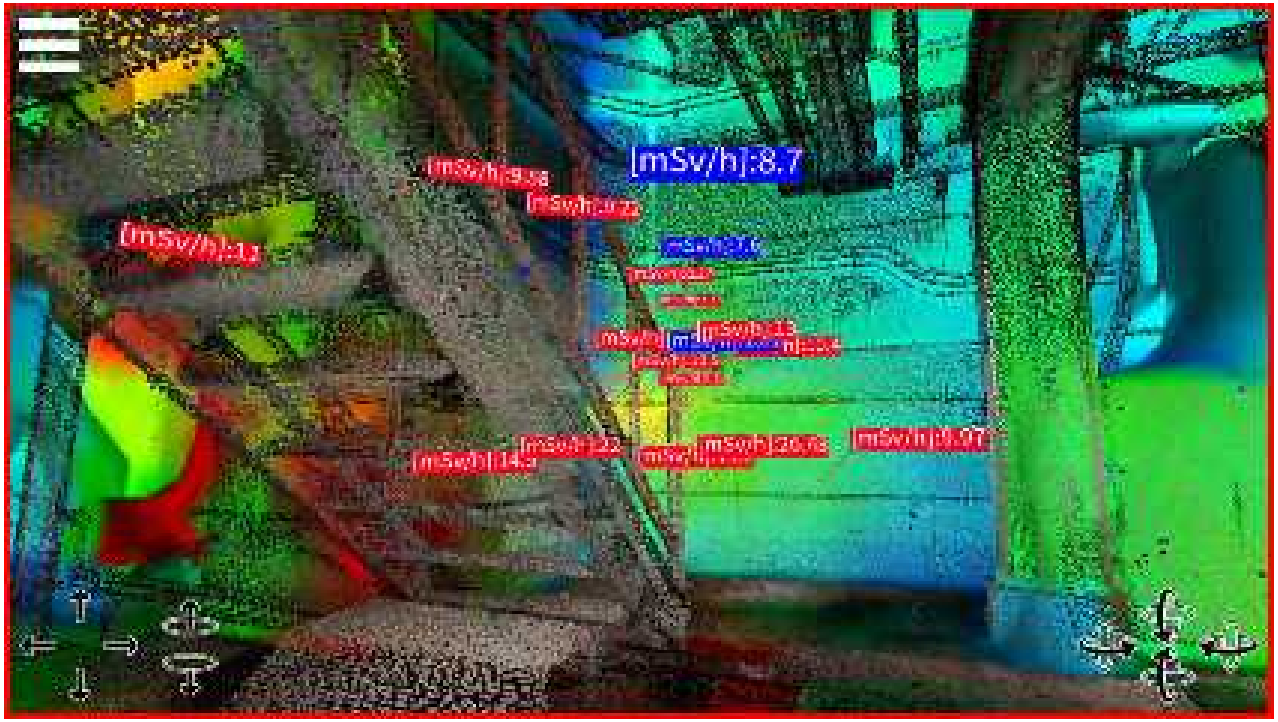
Detecting radiation source is essential in effective dose reduction

2. R&D for dose reduction

- Reverse inference of radiation dose （Visualization of risk）

  As a method for radiation source detection, R&D for obtaining dose data inside buildings and reverse inference analysis is underway.

【Part of Screen currently being developed】



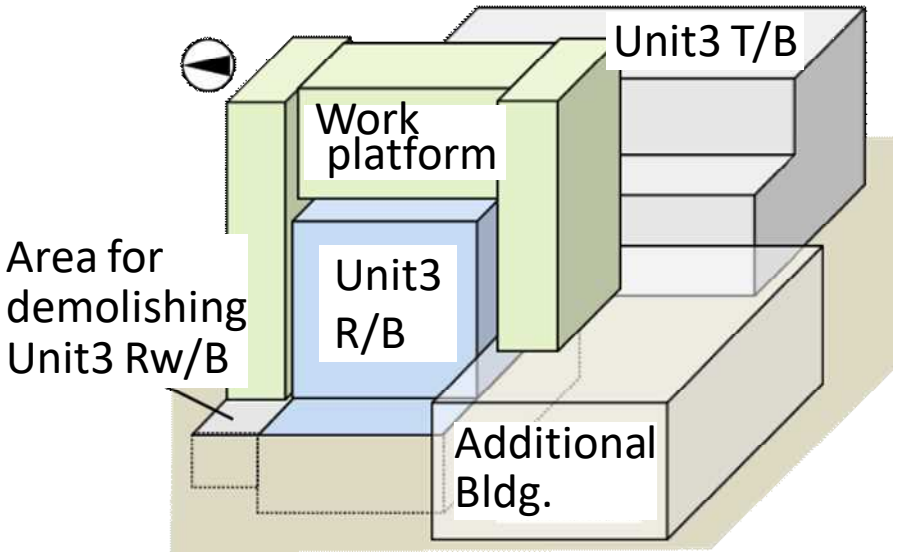
2. Environmental improvement 〈Arrangement of surrounding area〉

TEPCO

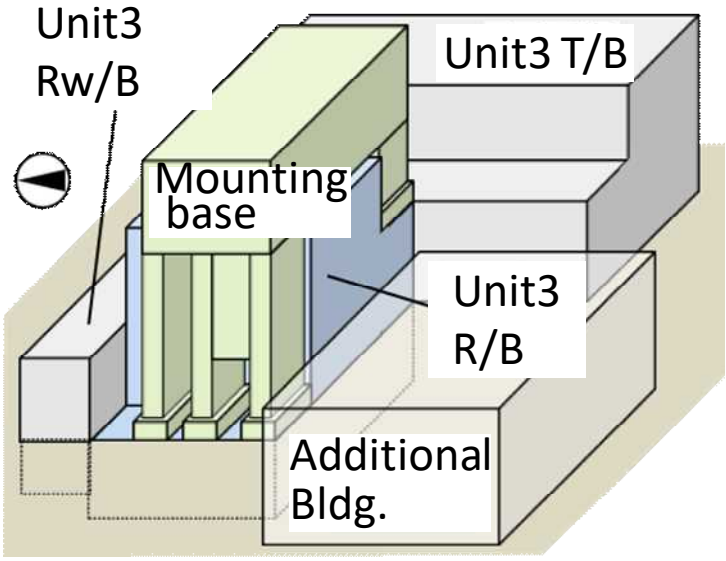
- North-south oriented work platform or east-west oriented mounting base is being considered as a supporting structure for the equipment that will enter the top of the reactor to access fuel debris inside the RPV
  ⇒ Environmental improvement in the surroundings is essential

Current situation of area surrounding reactor building →

【North-south oriented work platform option】



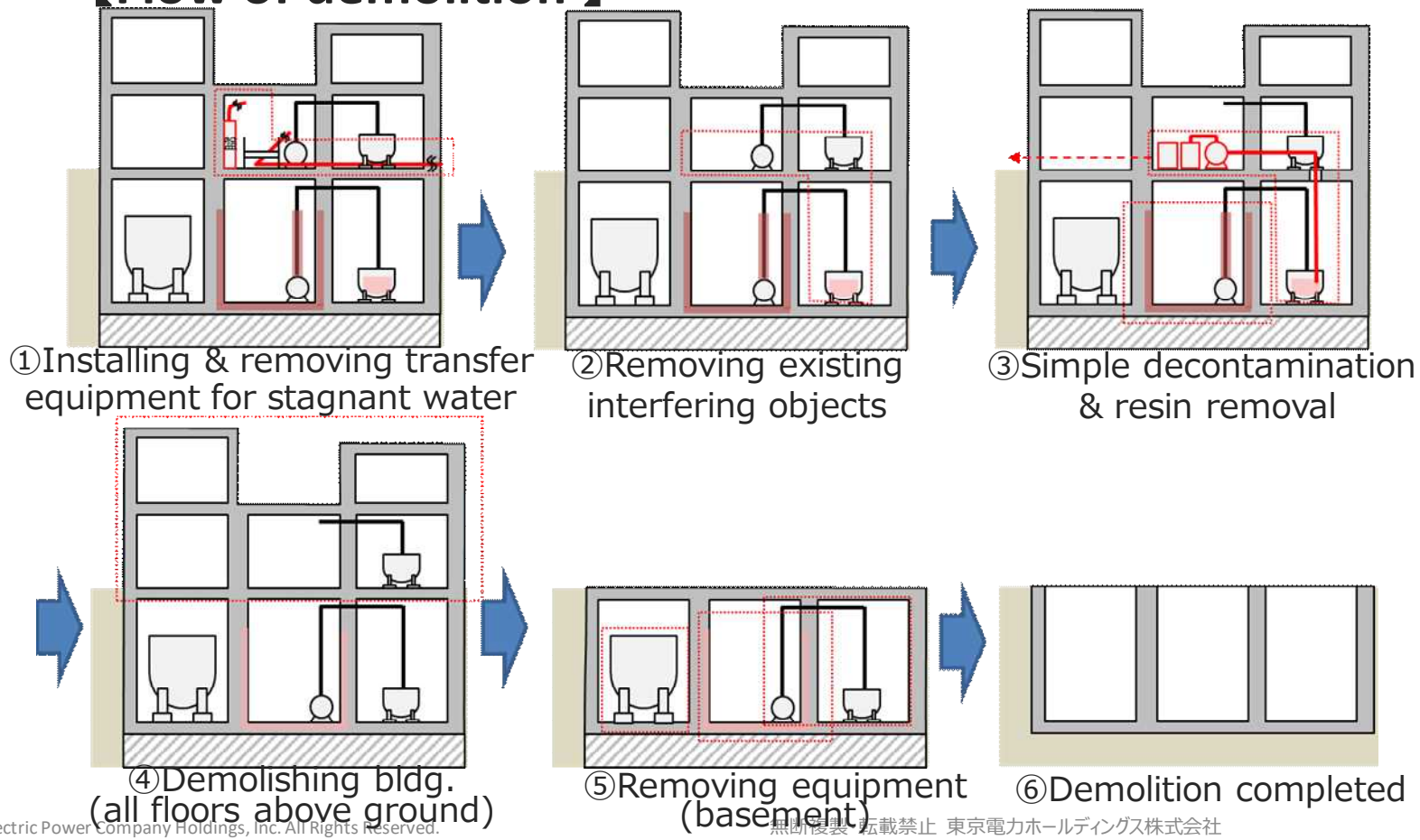
【East-west oriented mounting base option】



2.Demolition of radioactive waste treatment building

- There remain tanks and equipment that were used before the March 11 earthquake on the basement and first floor.
- Removing them before demolition reduces the risk of radioactive materials being dispersed into the environment.
  - Initially, investigations and sampling to ascertain the properties of resin will be conducted, utilizing remote technologies and others.

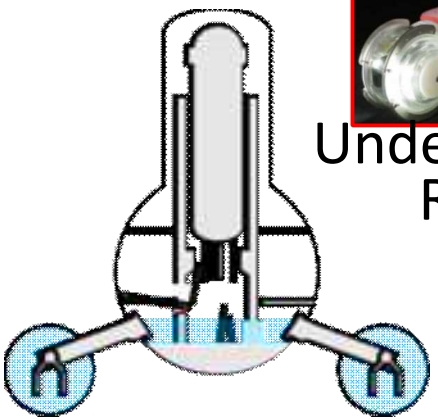
【Flow of demolition 】



2. Initiative for full-scale retrieval〈Internal investigation〉

TEPCO

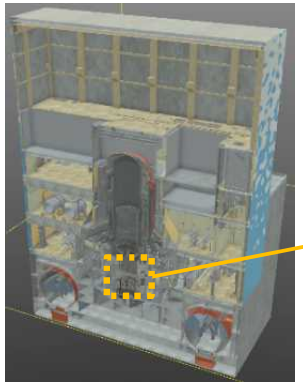
- In order to design and secure safety for fuel debris retrieval, it is imperative to obtain internal investigation of both PCVs and RPVs, the information of which remains obscure.
- TEPCO has so far obtained footage and radiation dose of some part inside PCVs.
- Expansion of investigation areas inside PCVs as well as RPV internal investigation, is planned for the future.



Underwater ROV

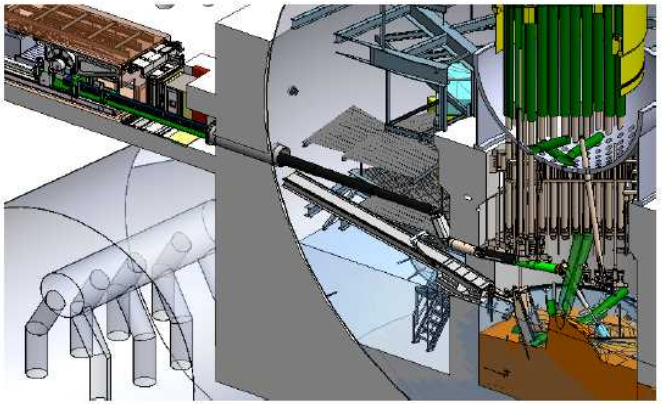
Drone

Robotic arm



Creation of 3D model from video footage & point cloud data

Design study

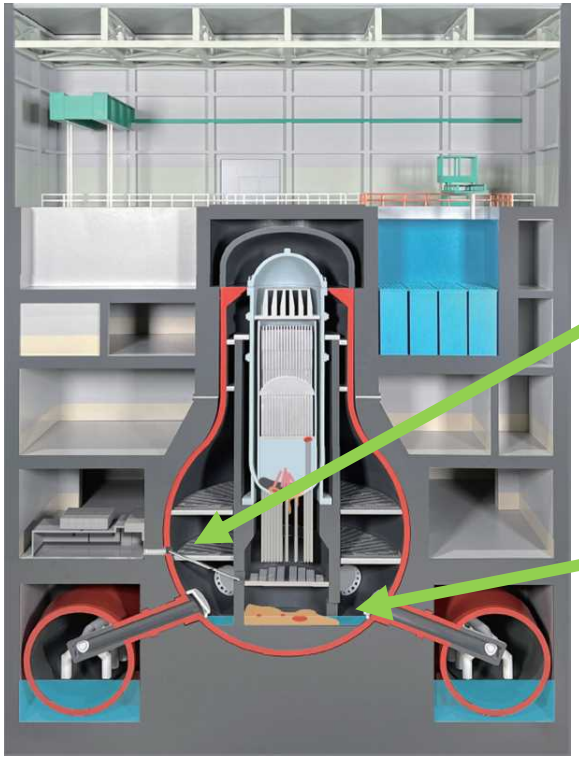


Design study of retrieval method by utilizing 3D model

2. Unit 3 PCV internal investigation by side entry

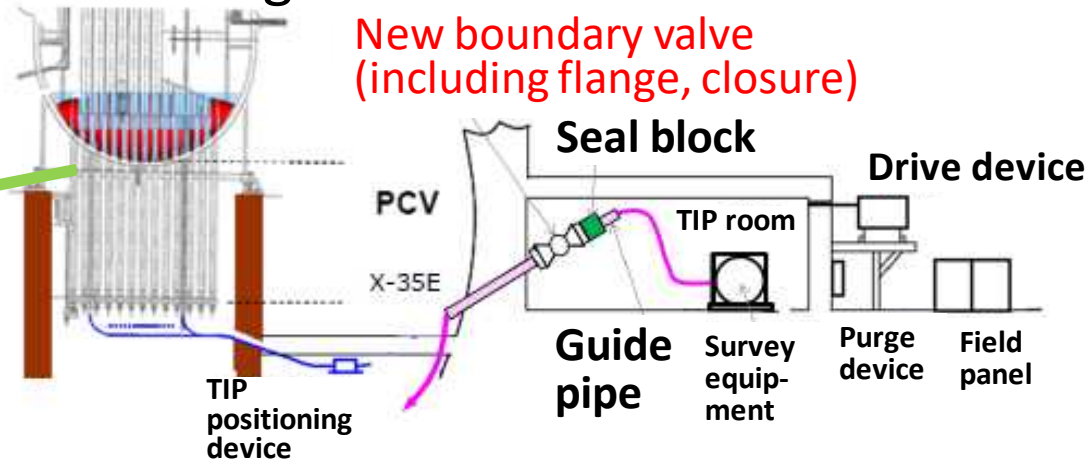
- Internal investigation by side entry method is planned to be conducted, utilizing small drones and endoscopes.

【Illustration of PCV internal investigation 】



Drone investigation

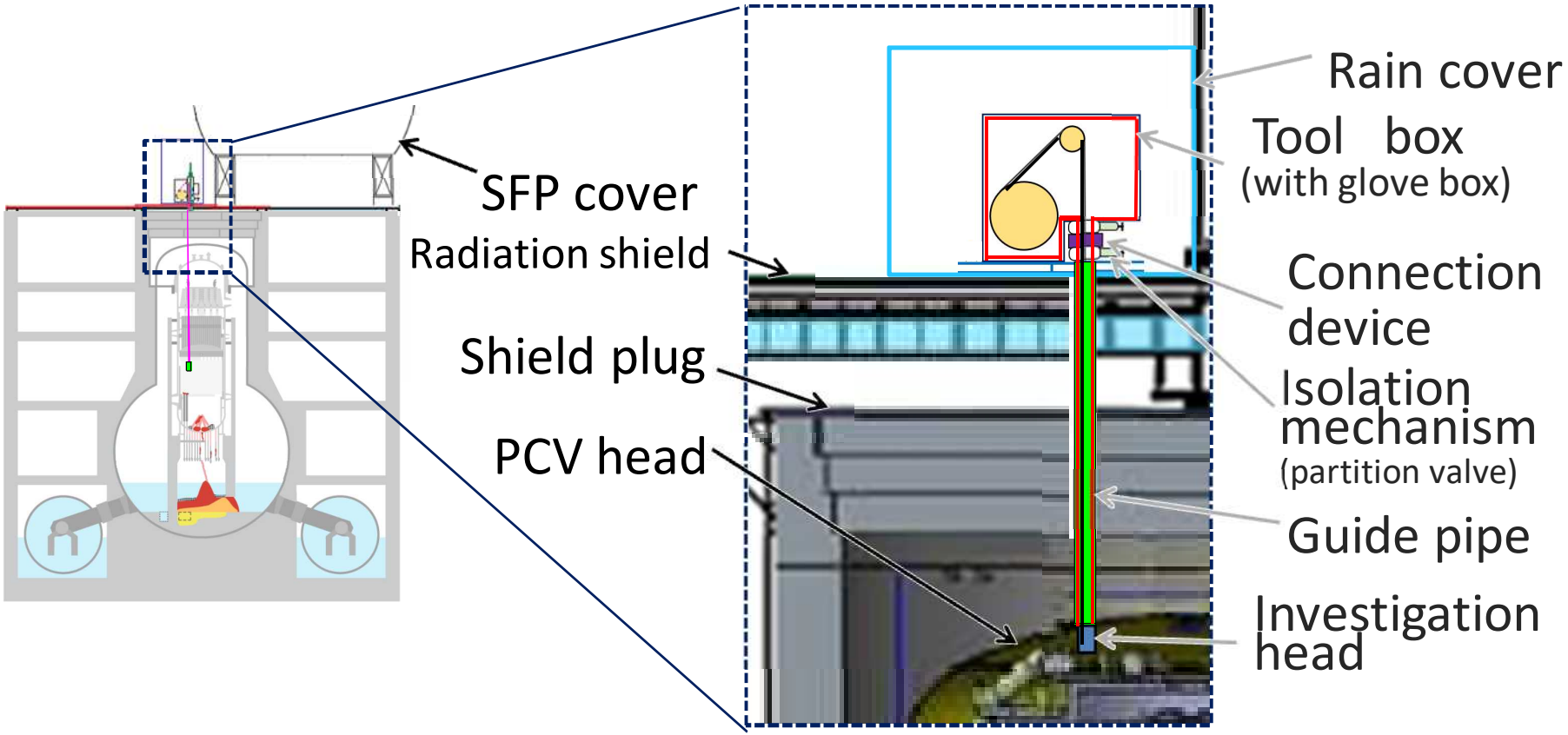
Endoscope investigation



2. Unit 3 RPV internal investigation by top entry

- After arranging an route to the PCV head by drilling a shield plug that is both highly radioactive and damaged, the investigation will be conducted by entry into PCV/RPV.

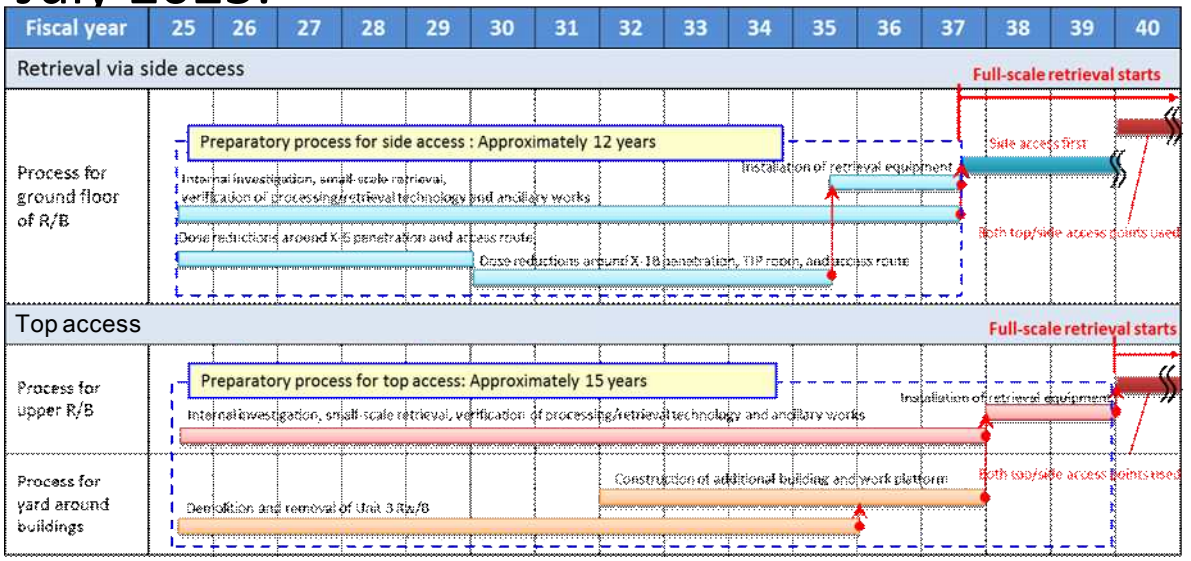
【Illustration of RPV internal investigation 】



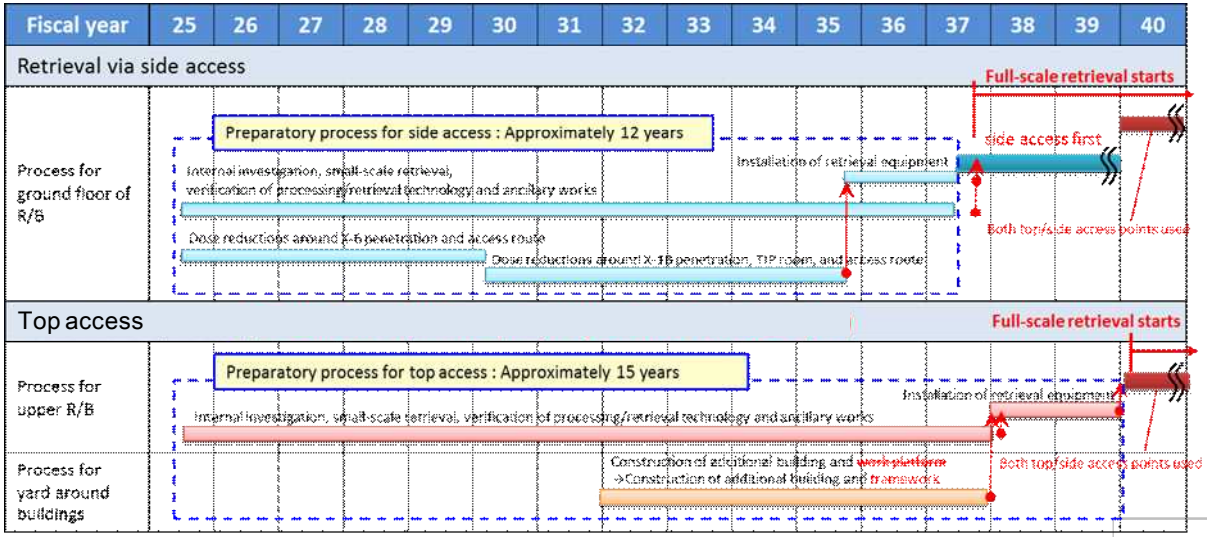
2. Work process in the run up to full-scale retrieval (Preparatory phase)

- After its deliberation, the preparatory work process was reported to NDF's subcommittee in July 2025.

【Work process for North-south oriented work platform】



【Work process for East-west oriented mounting base】



〔Source〕TEPCO Press Release：https://www.tepco.co.jp/en/hd/newsroom/press/archives/2025/pdf/250729e0101.pdf

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3. Key points for full-scale retrieval

- TEPCO is aiming to achieve the major goal of full-scale fuel debris retrieval.
  - By learning from past decommissioning experiences, we have identified key points for the future initiative.

Point 1 : Further reduction of exposure risk

Point 2 : Addressing uncertainties

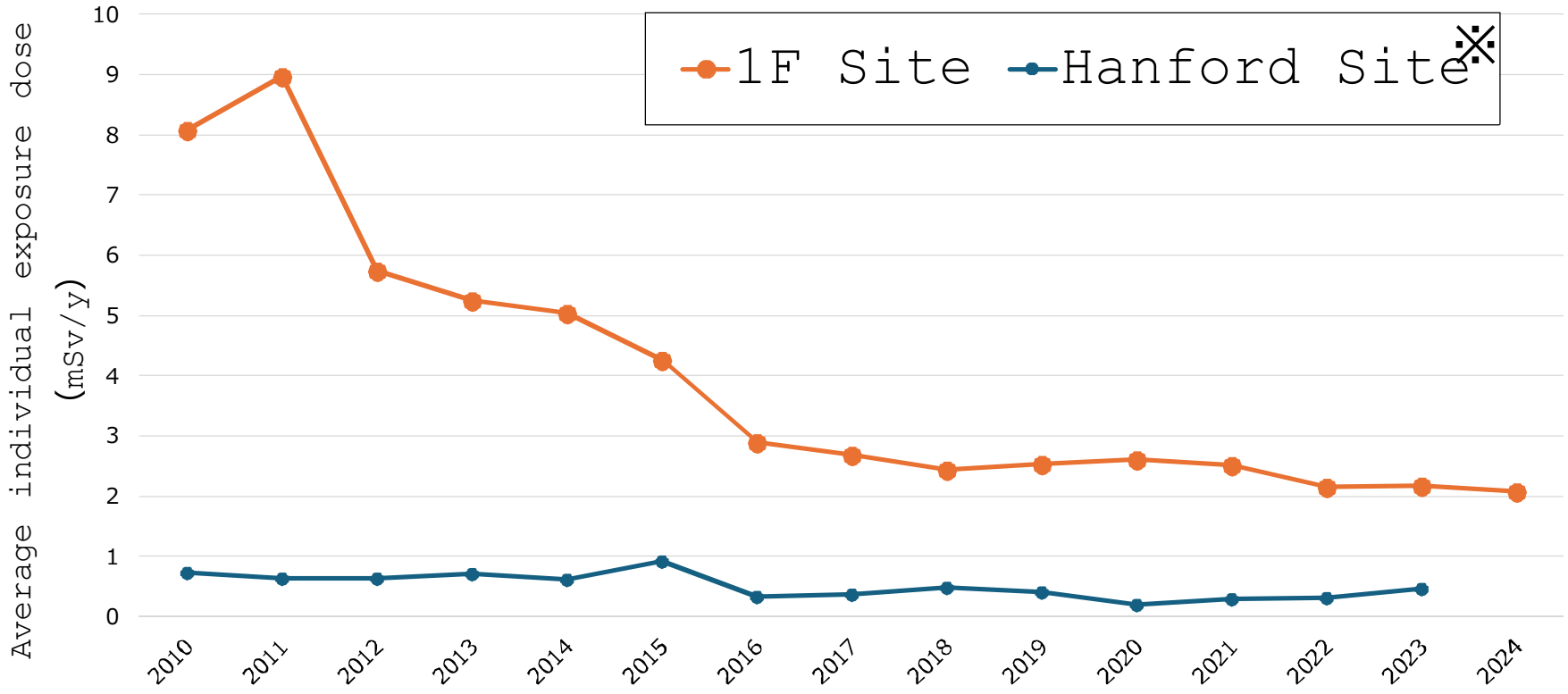
Point 3 : Further enhancement of technological capabilities and safety & quality, and symbiosis between decommissioning and reconstruction

3. Further reduction of exposure risk

<Trend in exposure levels at Fukushima Daiichi >

■ The graph shows the changes in radiation exposure levels.

- Due to decontamination and other measures, including those to reduce exposure, the exposure level has been reduced to about one-fourth of the peak.
- However, compared to other nuclear power stations undergoing decommissioning, the level remains high.



※ A fleet of nuclear facilities located in Washington State, U.S. Clean-up activities have been underway.

3. Further reduction of exposure risk

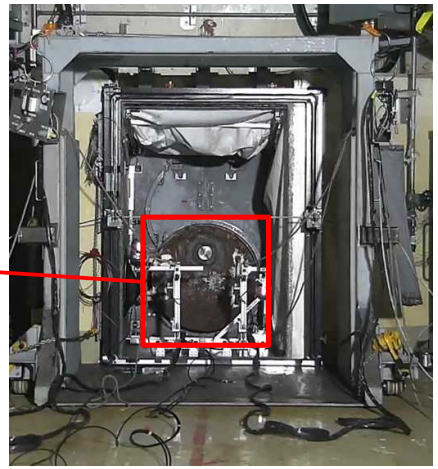
<Fuel debris retrieval >

- Two rounds of trial fuel debris retrieval, which involved tasks in the highly radioactive area of the reactor building, were successfully completed, using remote control technology.
  - Measures for exposure reduction were fully utilized, such as decontamination, shielding and isolation.
  - Off-site training using mock-up facilities was conducted.

Installation of isolation room →

Opening for fuel debris retrieval
(X-6 penetration)

Insertion of guide pipe



↓ Off-site mock-up facilities

Insertion of guide pipe

Telescopic equipment's entry

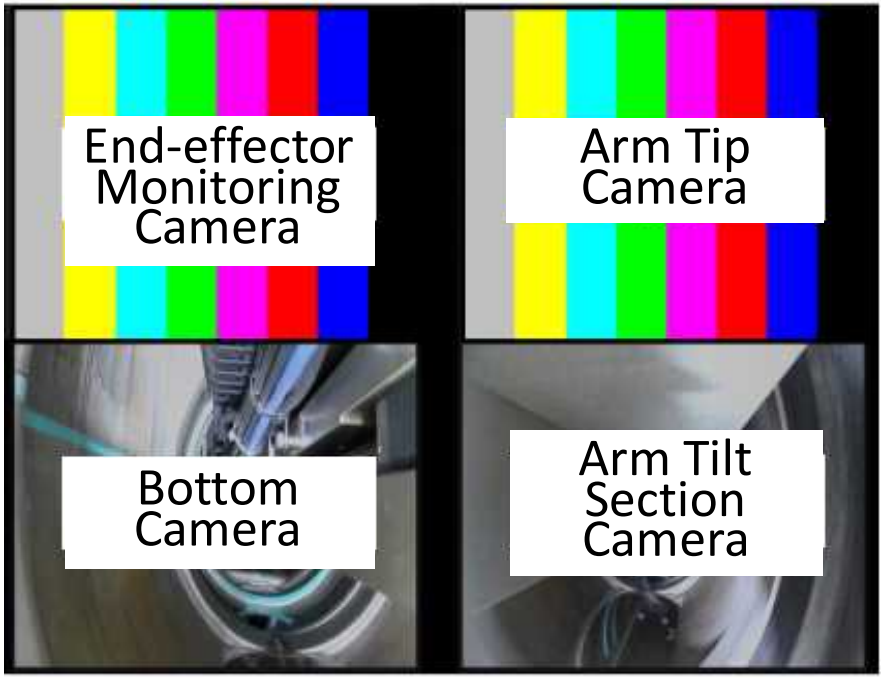
Lowering end effector from grating opening

3. Further reduction of exposure risk

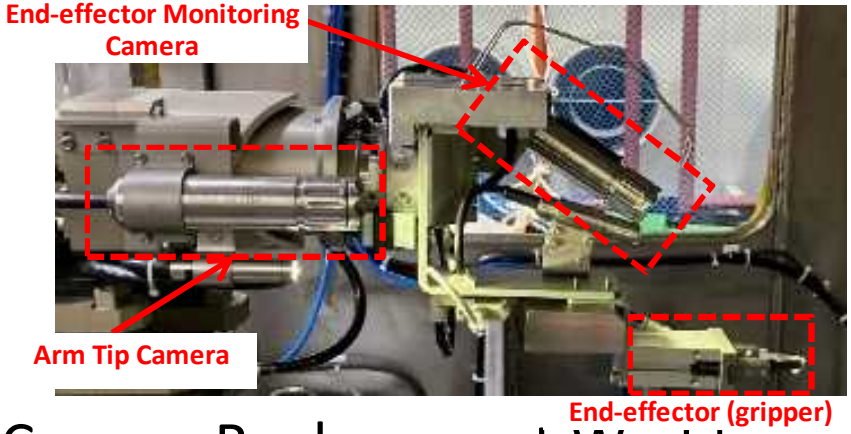
<Future initiative >

- During the first round of retrieval, the task was suspended due to a camera failure.
  - When a malfunction occurs, remotely controlled tasks should be shifted to on-site operations in the reactor
  - Full-scale retrieval, which will also be conducted by remote control, requires much more man-hours.

Considering on-site assignment, further reduction of exposure risk through thorough decontamination and shielding is essential



遠隔操作用カメラ映像のイメージ



[Camera Replacement Work]

Radiation exposure during replacement:
about 3 to 10 person-mSv (per day)

Work hours: about 2.5 to 4 hours (per day)

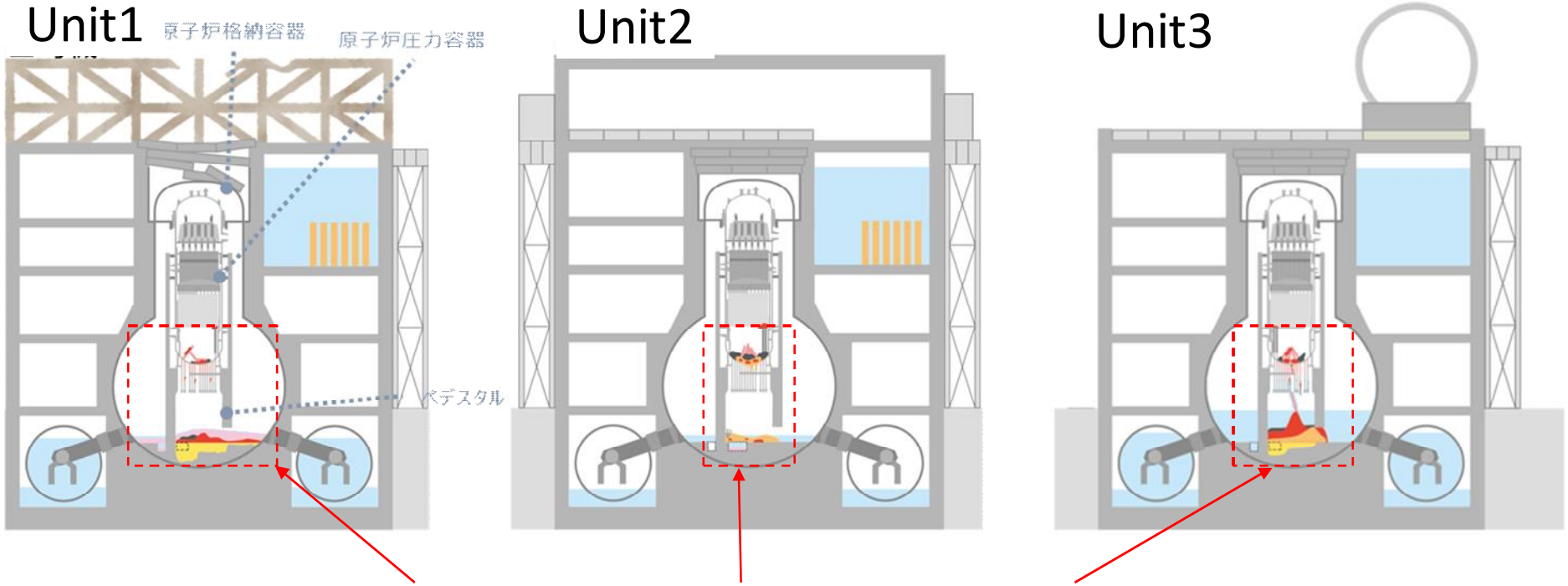
Work days: 7 days
(preparatory work included)

3. Addressing uncertainties

<Uncertainties at Fukushima Daiichi Site >

- There are still many uncertainties at the Fukushima Daiichi Site.
  - Due to the accident, many areas differ from those in operating plants.
  - High radioactivity has become one of the factors hindering investigations in some areas.

【Assumed distribution of fuel debris at each Unit】

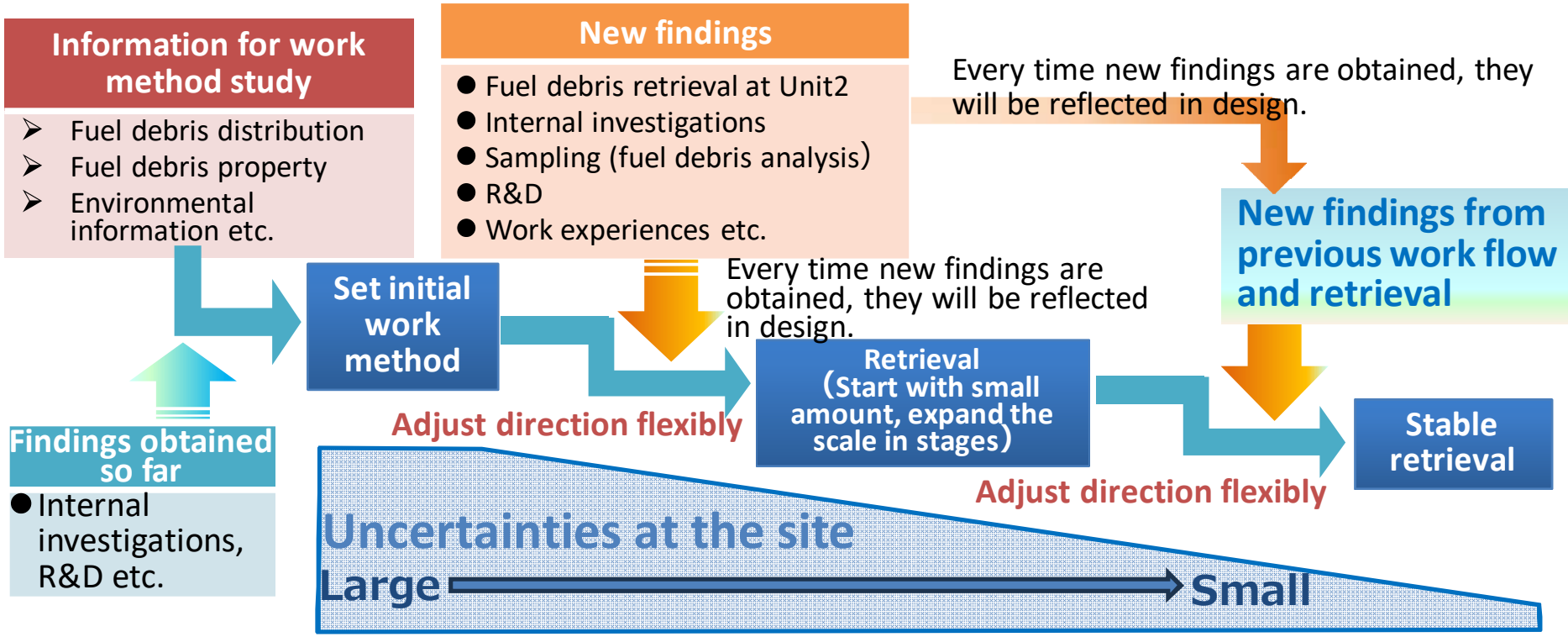


Even though this assumption is based on the information obtained so far, the available information for fuel debris retrieval remains insufficient.

3. Addressing uncertainties <Future initiatives>

- Meticulous investigations are essential for Unit3 full-scale retrieval.
  - Conduct on-site operations, while factoring investigation results into the design and study to enhance the precision of tasks.
  - If investigations are insufficient, there is a likelihood that it will take extra time to prepare larger equipment than is actually necessary.

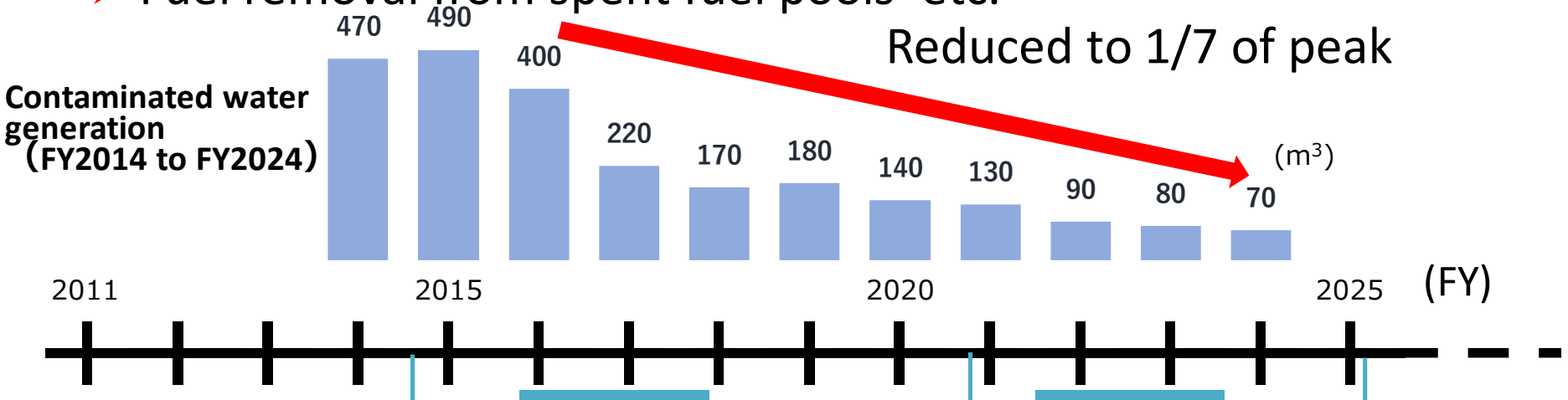
It is imperative to take Step by Step Approach to address uncertainties.



3. Further enhancement of technological capabilities and safety & quality, and symbiosis between decommissioning and reconstruction

<Decommissioning path taken so far >

- With the Mid-and-Long-Term Decommissioning Roadmap as a key objective, TEPCO has developed the fastest measures and processes in each area to steadily advance risk reduction.
  - Curb generation of contaminated water
  - Fuel removal from spent fuel pools etc.



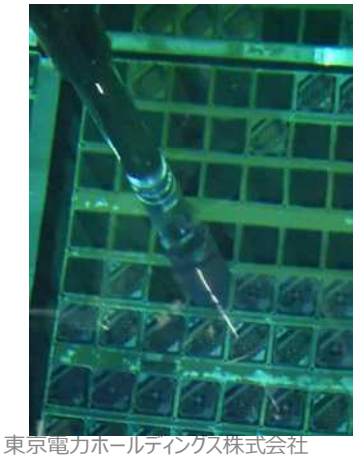
Dec. 2014

Fuel removal completed at Unit4

Feb. 2021

Fuel removal completed at Unit3

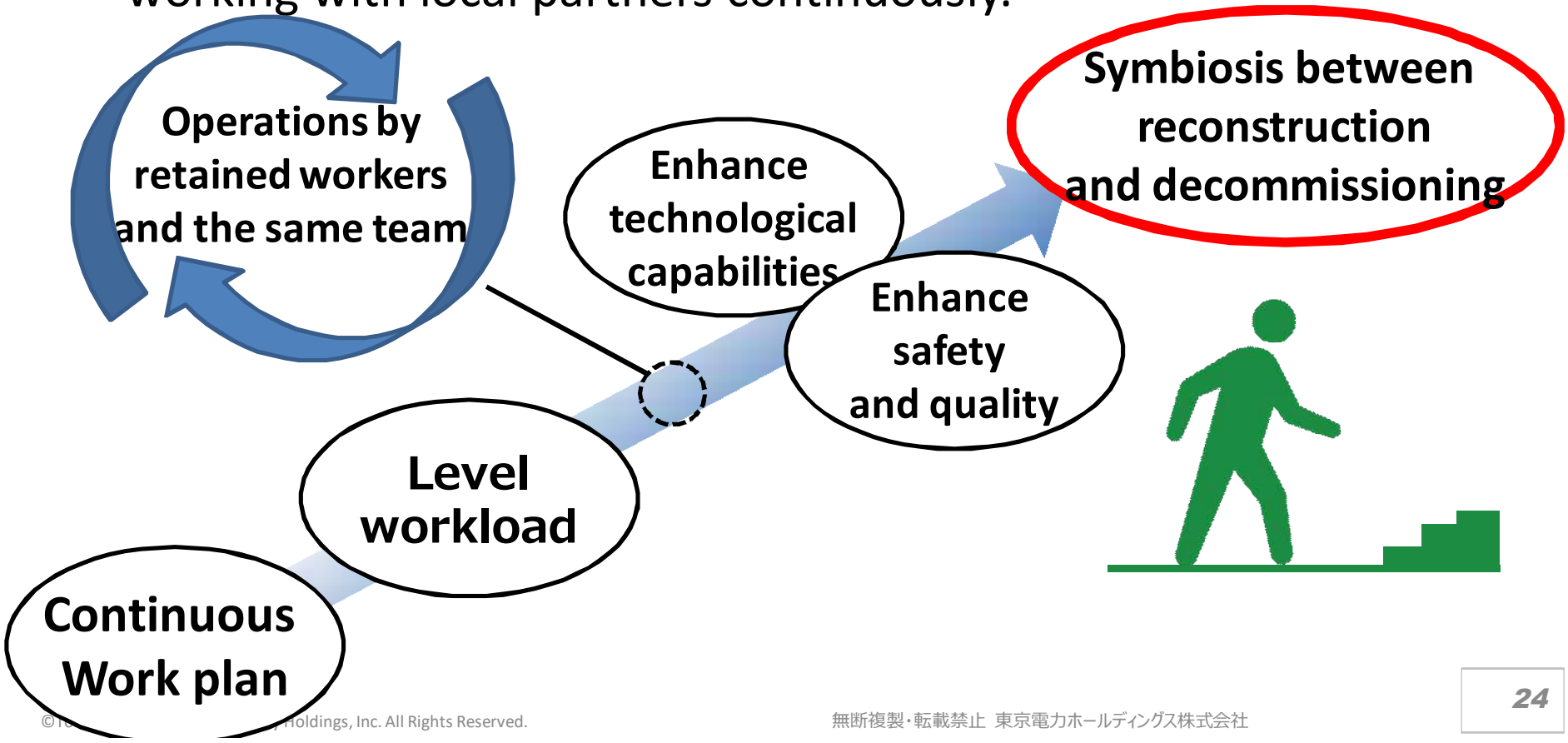
Apr. 2025



Spent fuel removal completed at Unit6

3. Further enhancement of technological capabilities and safety & quality, and symbiosis between decommissioning and reconstruction
<Leveling workload by continuous work plan >

- In addressing fuel debris retrieval, it is important to eliminate periods of operational overflow as well as periods of inactivity (to level workload) by creating a continuous work plan.
  - Retain workers and improve their skills to **enhance both technological capabilities and safety & quality** at the site.
  - **Symbiosis between reconstruction and decommissioning** by working with local partners continuously.



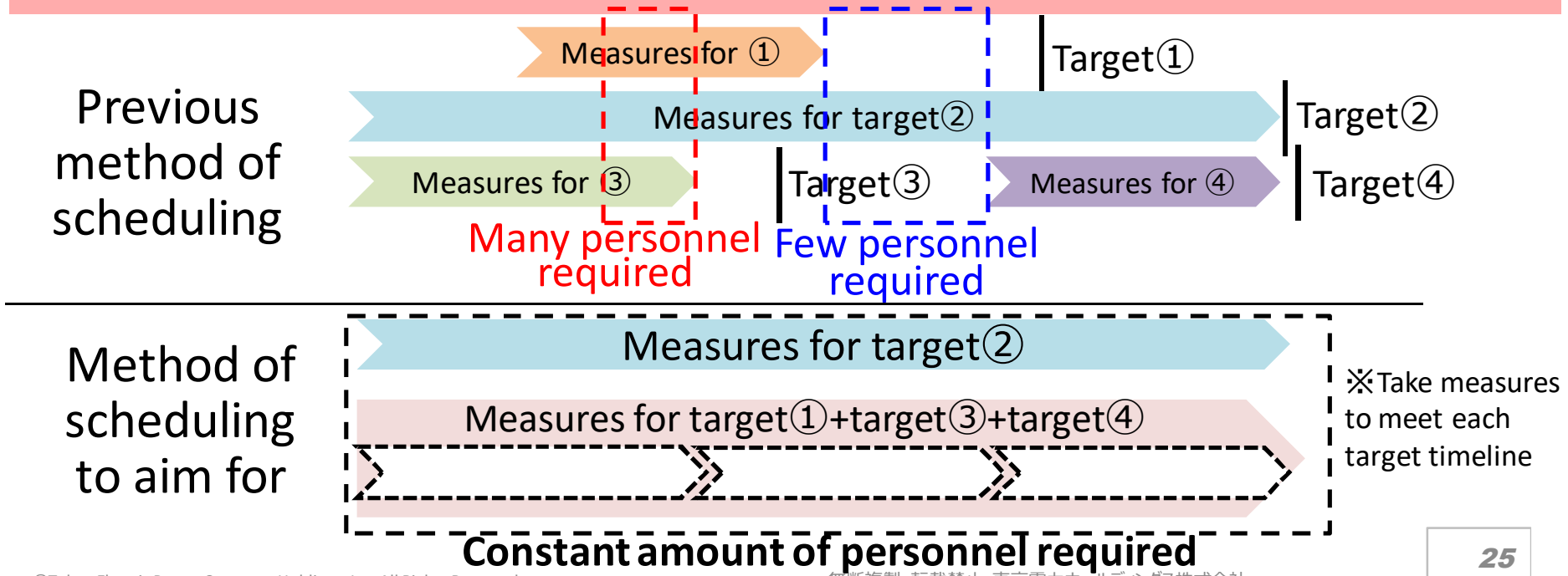
3. Further enhancement of technological capabilities and safety & quality, and symbiosis between decommissioning and reconstruction

<Future initiatives>

TEPCO

- It is important to conceive decommissioning work from a broader perspective, focusing on hands-on experiences at the site.
  - Case of success at TMI2:
    Realistic and practical scheduling based on on-site hands-on experiences.
  - It is necessary to determine the priority order of all decommissioning activities based on risk reduction and reflect it in a plan.
    ⇒To be reflected in "Mid-and-Long-Term Decommissioning Action Plan" which outlines the main work processes in the decommissioning work for the next 10 years.

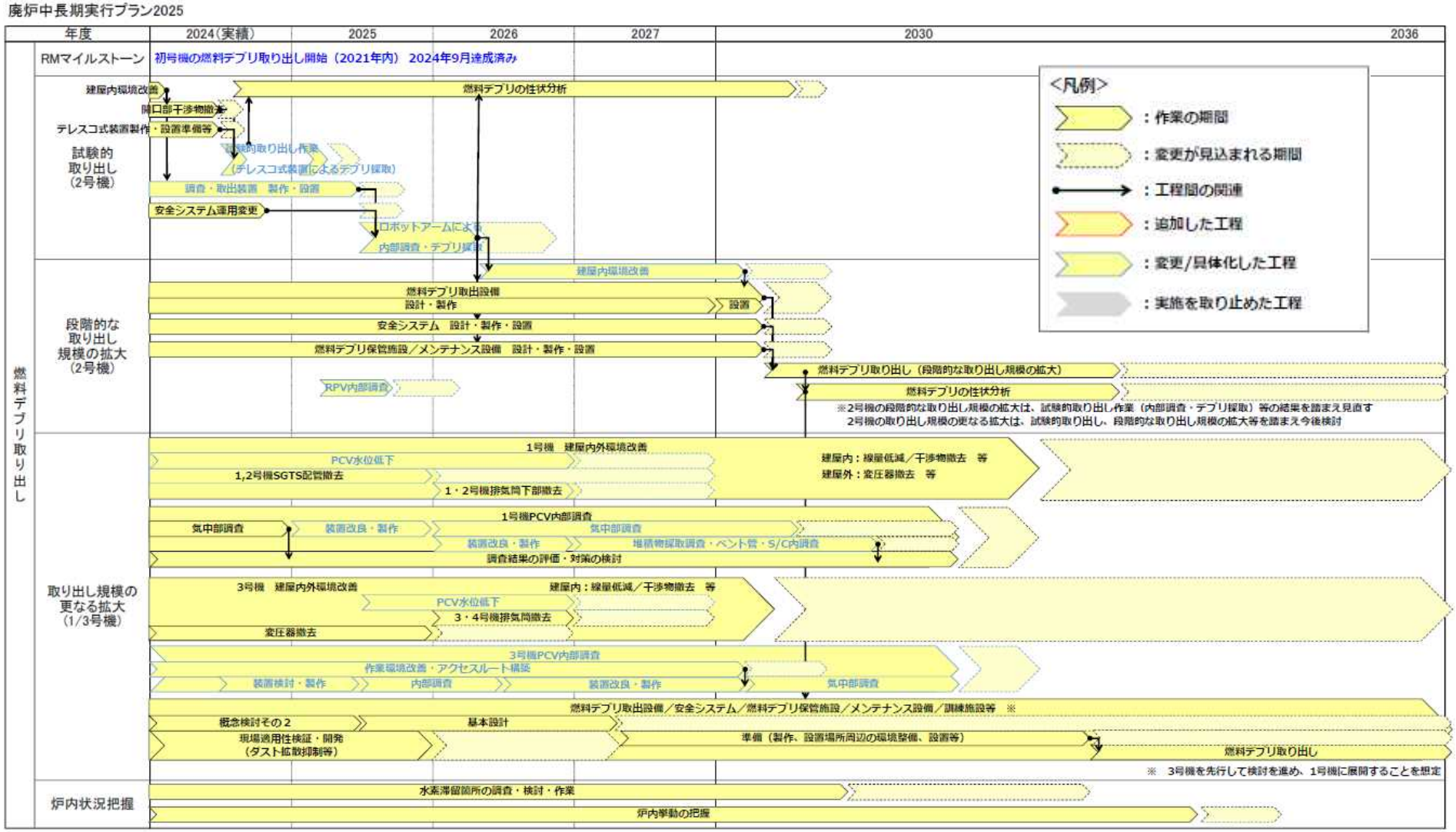
Develop a continuous work plan to further enhance technological capabilities and safety & quality



3. Further enhancement of technological capabilities and safety & quality, and symbiosis between decommissioning and reconstruction
<Mid-and-Long-Term Decommissioning Action Plan 2025 (extract)>

TEPCO

■ Work processes of fuel debris retrieval in the action plan

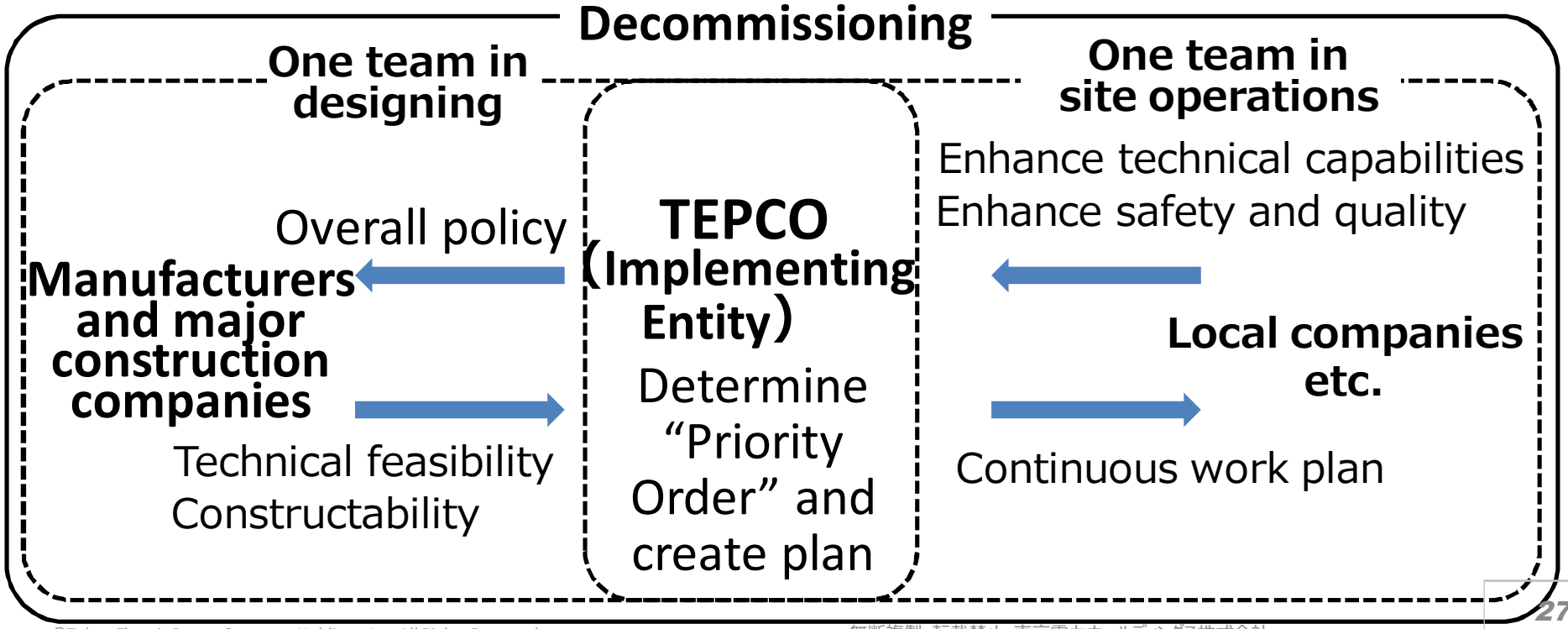


〔Source〕 TEPCO HP： https://www.tepco.co.jp/decommission/progress/plan/2025-j.html

3. Further enhancement of technological capabilities and safety & quality, and symbiosis between decommissioning and reconstruction

<One Team in designing and site operations>

- TEPCO will take the lead in developing a continuous work plan, aligned with partner companies.
  - In terms of technical feasibility and constructability in designing and engineering study, TEPCO will work closely with manufacturers and major construction companies as **One Team.**
  - TEPCO will proceed with site operations together with workers including those from local communities as **One Team**.
    ⇒Further enhance **technical capabilities** and **safety & quality**



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TEPCO

■ Future key points in view of full-scale fuel debris retrieval

Point 1：Further reduction of exposure risk
→Thorough decontamination & shielding

Point 2：Addressing uncertainties
→Step by Step Approach

Point 3：Further enhancement of technological capabilities and safety & quality, and symbiosis between decommissioning and reconstruction
→Development of continuous work plan for decommissioning

Based on the on-site physical facts, proceed with decommissioning work, **placing safety as the first priority,** while allowing for flexible adjustments in direction.

TEPCO remains committed to the slogan, “Symbiosis between reconstruction and decommissioning”, and will move forward together with local residents and companies, while maintaining their engagement.