Fukushima Daiichi Nuclear Power Station
Unit 2 PCV Internal Investigation/
Status of Fuel Debris Trial Retrieval

February 27, 2025

International Research Institute for Nuclear Decommissioning
Tokyo Electric Power Company Holdings, Inc.

1. PCV internal investigation and trial retrieval plan overview

- In order to guarantee work safety and prevent the spread of contamination, the following equipment will be installed at the penetration to the Unit 2 primary containment vessel (hereinafter referred to as, "X-6 penetration") that will be used for the PCV internal investigation and also as a preparatory stage of trial retrieval.

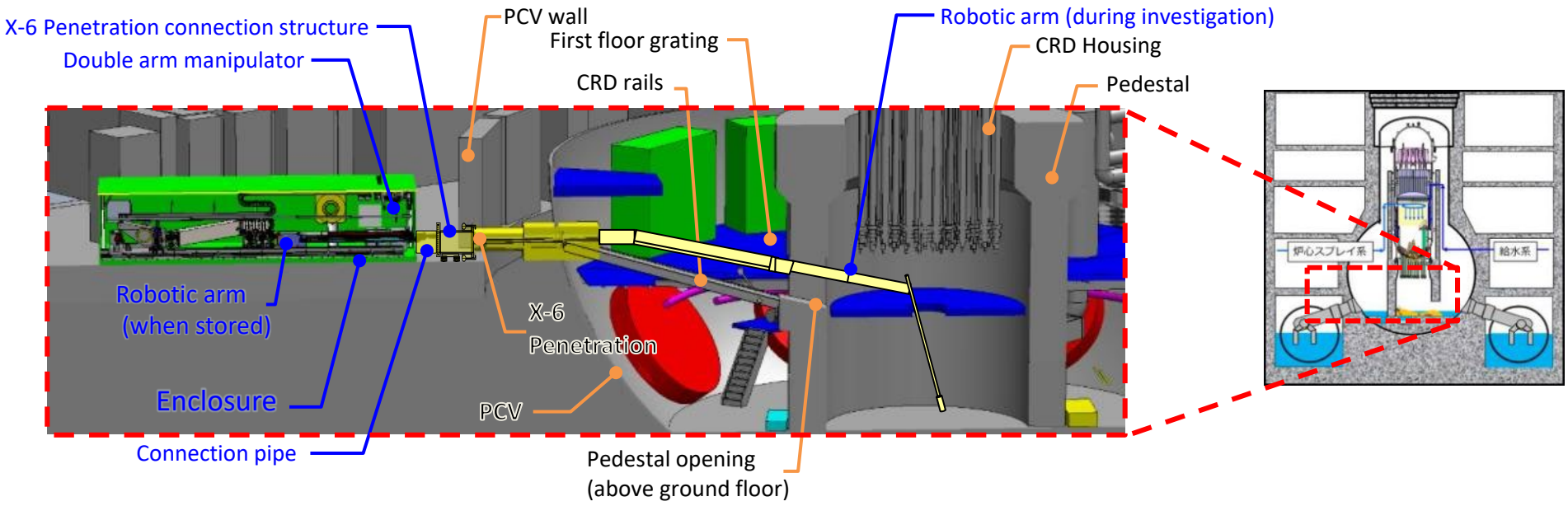
  ＜Already installed＞

  - The X-6 Penetration connection structure isolates the inside of the PCV from the outside
  - The connection pipe shields radiation
  - The telescopic device

  ＜To be installed＞

  - A metal box that contains the robotic arm (enclosure)

- After installation of the aforementioned equipment, the robotic arm shall be fed into the PCV through the X-6 penetration to remove obstacles inside the PCV while also conducting internal investigations and moving forward with the trial retrieval of fuel debris.



Unit 2 internal investigation/trial retrieval plan overview

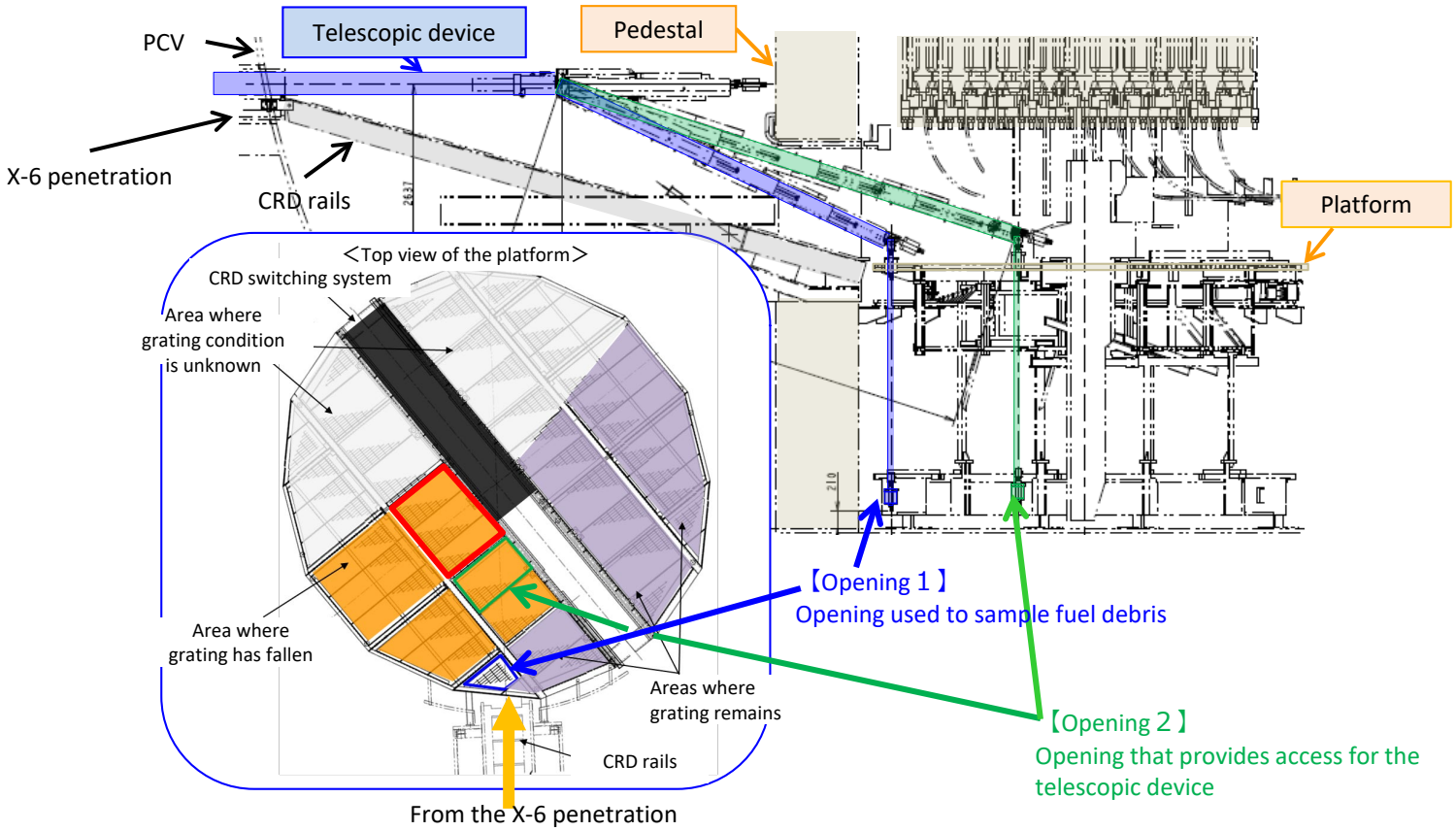
2-1. Workplan for retrieval fuel debris with the telescopic device

- There are two openings in the platform that provide access to the bottom of the pedestal with the telescopic device (openings 1 and 2 in the figure below).
- During work in October 2024, the tip jig was lowered through the front-most opening 1 in the pedestal (CRD rail side), and sampled fuel debris.
- The details of opening 2 on the far side in the pedestal have not been confirmed in previous Investigation.
- The second trial retrieval is planned from two viewpoint, that are understanding the internal condition of the pedestal and sampling from a different point than the first retrieval point.

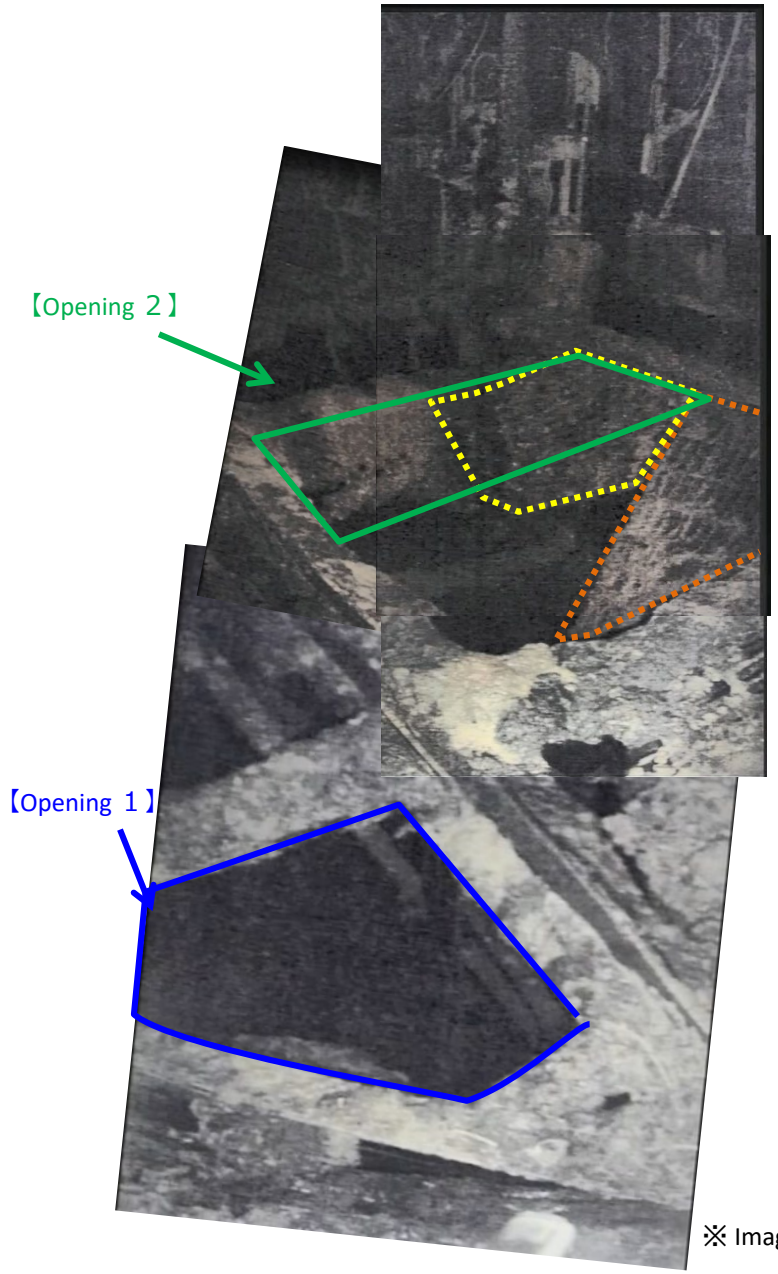
① Investigate the condition of opening 2 on the platform.

② Fuel debris sampling is planned from opening 2. However, since the remaining grating on the platform is confirmed in previous Investigation, the status of opening 2 will be checked on the day of trial retrieval to determine whether access to the bottom of the pedestal is possible from opening 2.

③ If the bottom of the pedestal cannot be accessed through opening 2, as with the last retrieval, the end jig will be lowered through opening 1 and fuel debris sampled from the bottom of the pedestal.



2-2. Workplan for retrieval fuel debris with the telescopic device (Condition of platform around opening 2 in the PCV)



- The conditions of opening 2 (shown in green on the left) were confirmed using photos taken with the telescopic device camera during work in September 2024.
- Grating shown in the yellow dotted area on the left can be seen around opening 2.
- However, it's difficult to see the borders of the grating and the outline of it can be just barely seen by the light reflecting off of it.
- If the grating completely fills in the yellow dotted area, that will mean that the grating will obstruct almost half of opening 2.
- We have confirmed that grating still exists right in front of opening 2 in the area shown by the orange dotted line.

※ Image created by stitching together camera photos

3-1. Status of robotic arm tests (Performance tests)

- Tests using a mock-up of the Fukushima Daiichi site have concluded at the Naraha mock-up facility (combined once-through tests).
- It was confirmed that the AWJ tool attached to the arm can be remotely operated to remove obstructions and construct an access route, that sensors and retrieval devices attached to the arm can be used to acquire data and sample mock debris from within the pedestal, and that the dual arm manipulator can be used to remove/attach sensors and tools, etc., thereby confirming work feasibility.
- However, in order to ensure that the work is done to the best, components found to show degradation during testing are being replaced and a full inspection of the arm is underway.
- Furthermore, in addition to robotic arm developing, we are also confirming this technology applicability to the actual worksite by looking at procedures that simulate actual work tasks, operator operability, and equipment reliability.

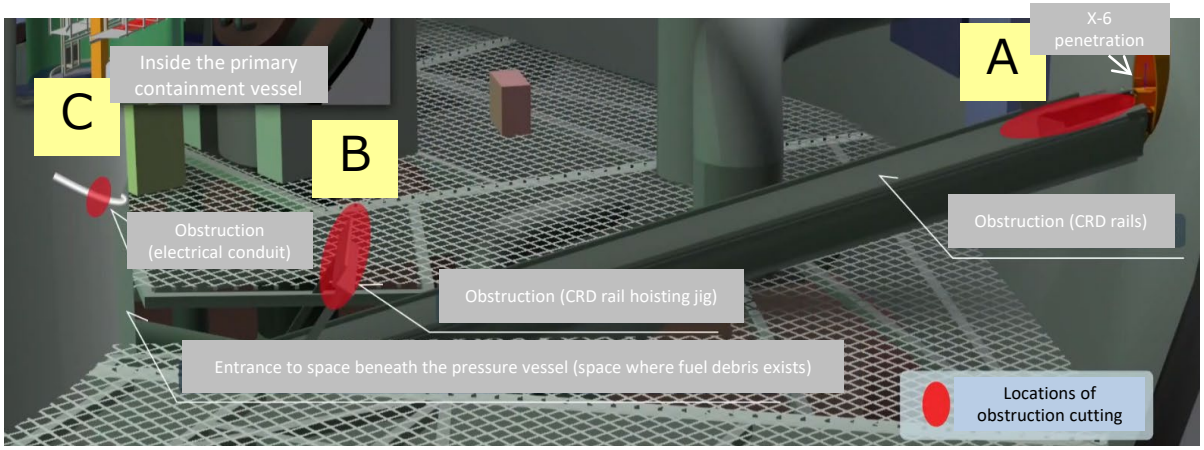
Performance tests

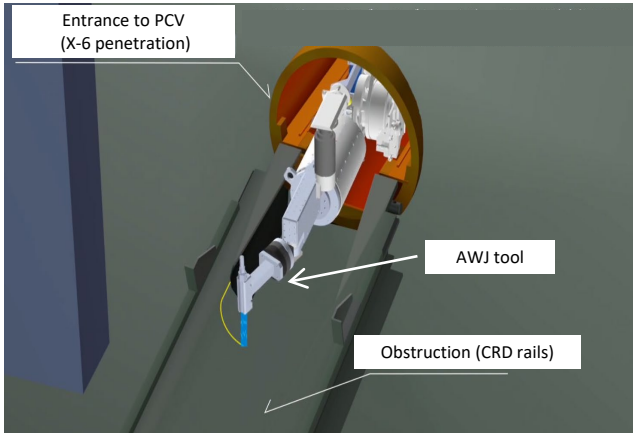
Test category	Test	JAEA Naraha
Robotic arm-related tests	Ability to pass through the X-6 penetration	Completed
	Removing obstacles at the exit for the X-6 penetration using the AWJ	Completed（Work efficiency being examined）
	Function tests (deflection measurements, etc.)	Completed
	Ability to access the inside of the PCV (accessing the top and bottom of the pedestal)	Completed
	Removing obstacles inside of the PCV (Cutting obstacles inside the PCV after passing through the X-6 penetration)	Completed（Work efficiency being examined）
Double arm manipulator-related tests	Connecting sensor tools to the arms	Completed
	Connecting/removing the external cables to/from the arms	Completed
	Bringing in and removing sensor tools	Completed
	Removing the fixed arm jig	Completed
	Replacing arm cameras/lighting	Completed
	Changing the position of the enclosure camera	Completed
	Forced withdrawal of the arm	Completed
Combined once-through tests (robotic arm + double arm manipulator)	sensors/external cables, tools/Installing external cables at the arm	Completed
	Investigation of the top of the pedestal (sensors and wand are installed)	Completed
	Investigation of the bottom of the pedestal (sensors and wand are installed)	Completed
	Constructing an access route (removing obstacles using the AWJ)	Completed
Full inspection	Full inspection (maintenance)	Underway
Combined verification tests	Operations check to be implemented after the full inspection (maintenance)	TBD

Added this time

3-2. Robotic arm tests status (access route construction)

- A test was performed where the AWJ tool on the robotic arm was used cut through obstructions, such as the CRD rails, hoisting jig, and electrical conduits, etc., and the robotic arm was passed through the constructed access route. Results confirmed that the body of the robotic arm can pass through the access route without being hindered.



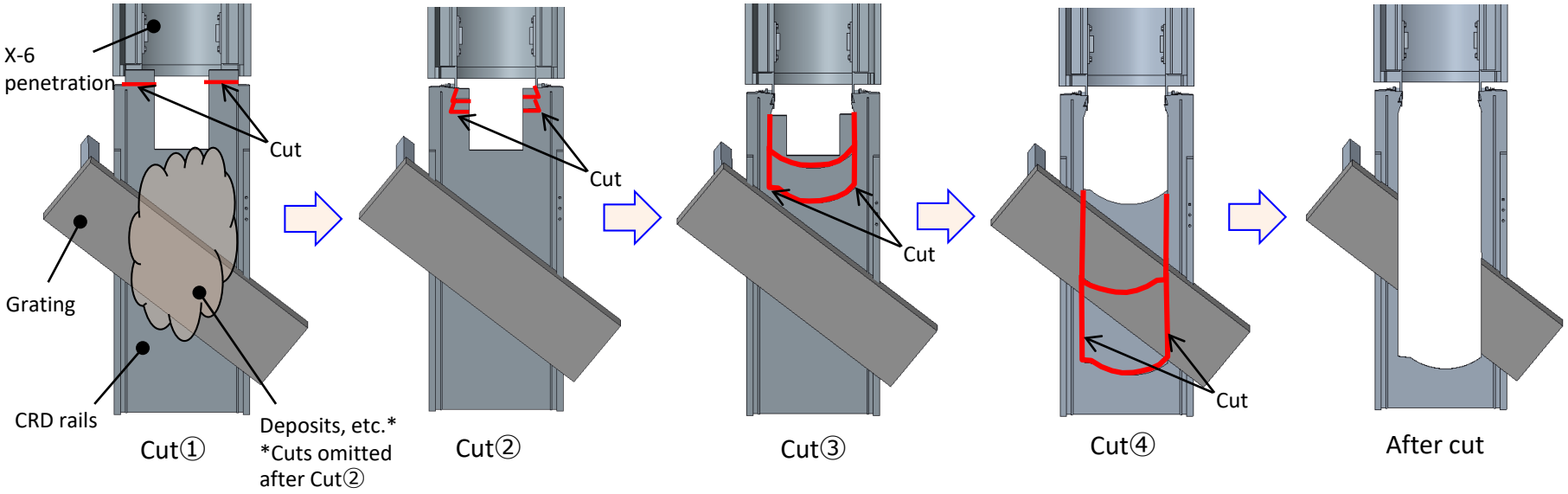


Electrical conduit removal(C)	Hoisting jig removal(B)	CRD rails Cut(A)
		

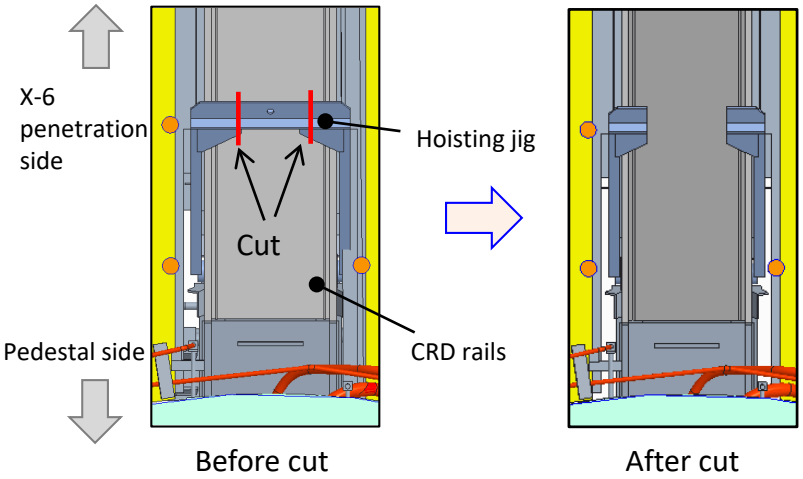
※Photo shows the situation during mock-up testing

Reference. Robotic arm tests status (access route construction)

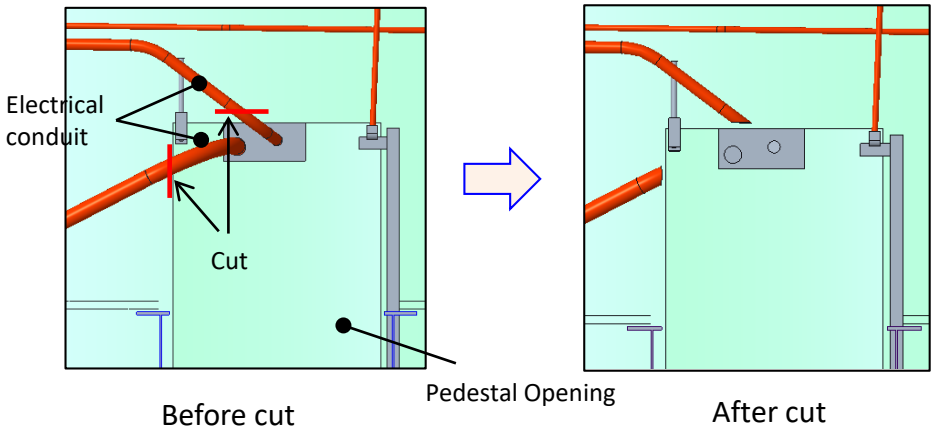
CRD rail removal (cutting) procedure (Top view)



CRD rail hoisting jig cut procedure (Top view)

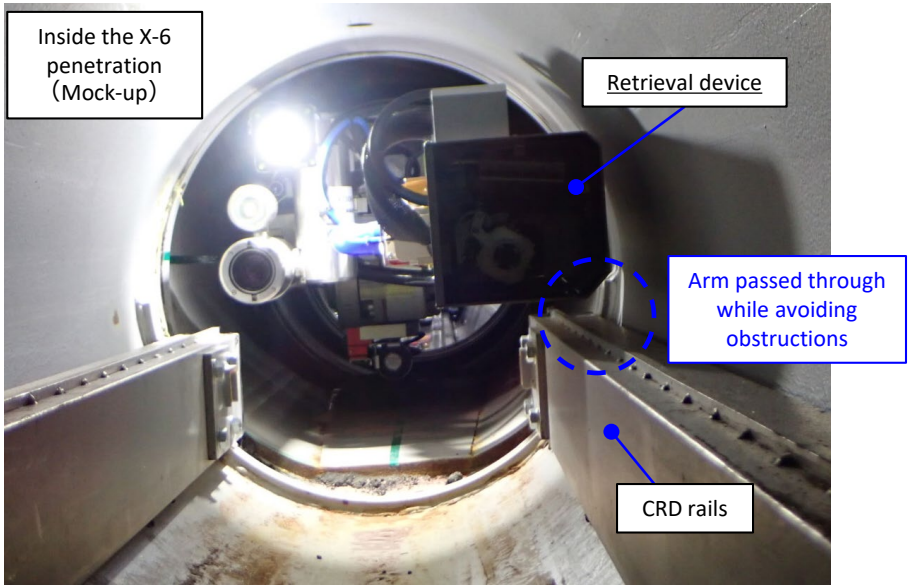


Electrical conduit cut procedure (cross-sectional view)

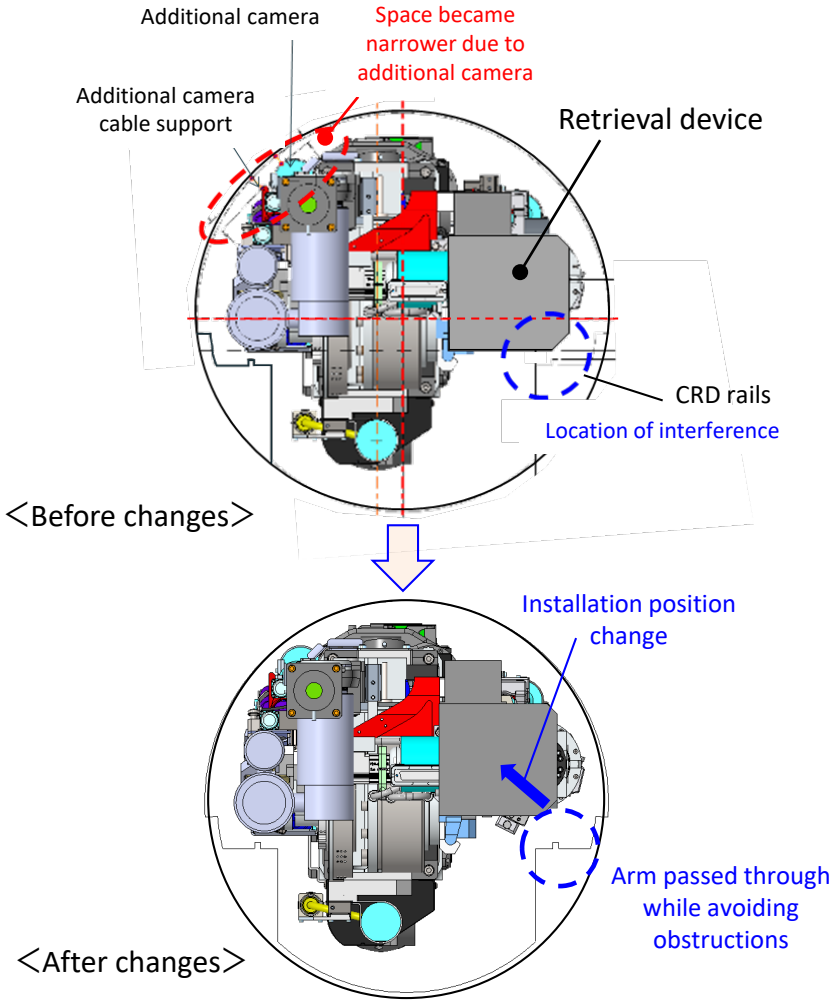


3-3. Robotic arm tests status (retrieval work)

- A retrieval device was mounted on the robotic arm and when it was extended from the enclosure into the mock PCV, we found that the retrieval device interfered with the CRD rails of the X-6 penetration.
- The camera that was added to improve visibility reduced the gap between the device and the wall of the X-6 penetration and caused the arm to sag, so the installation position of the retrieval device was changed and we confirmed that the arm can now pass through without issue.



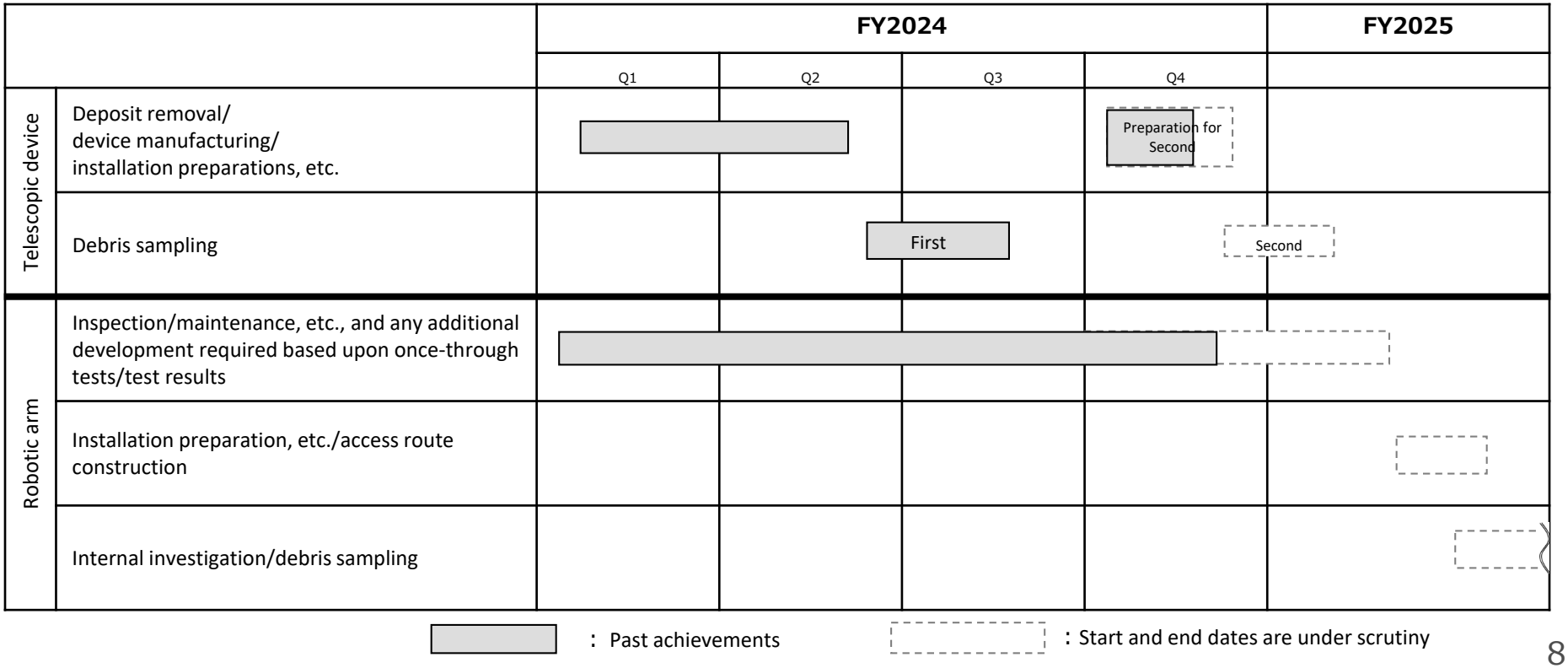
Passing the retrieval device through the X-6 penetration
(As seen from the mock PCV side)



Passing the retrieval device through the X-6 penetration

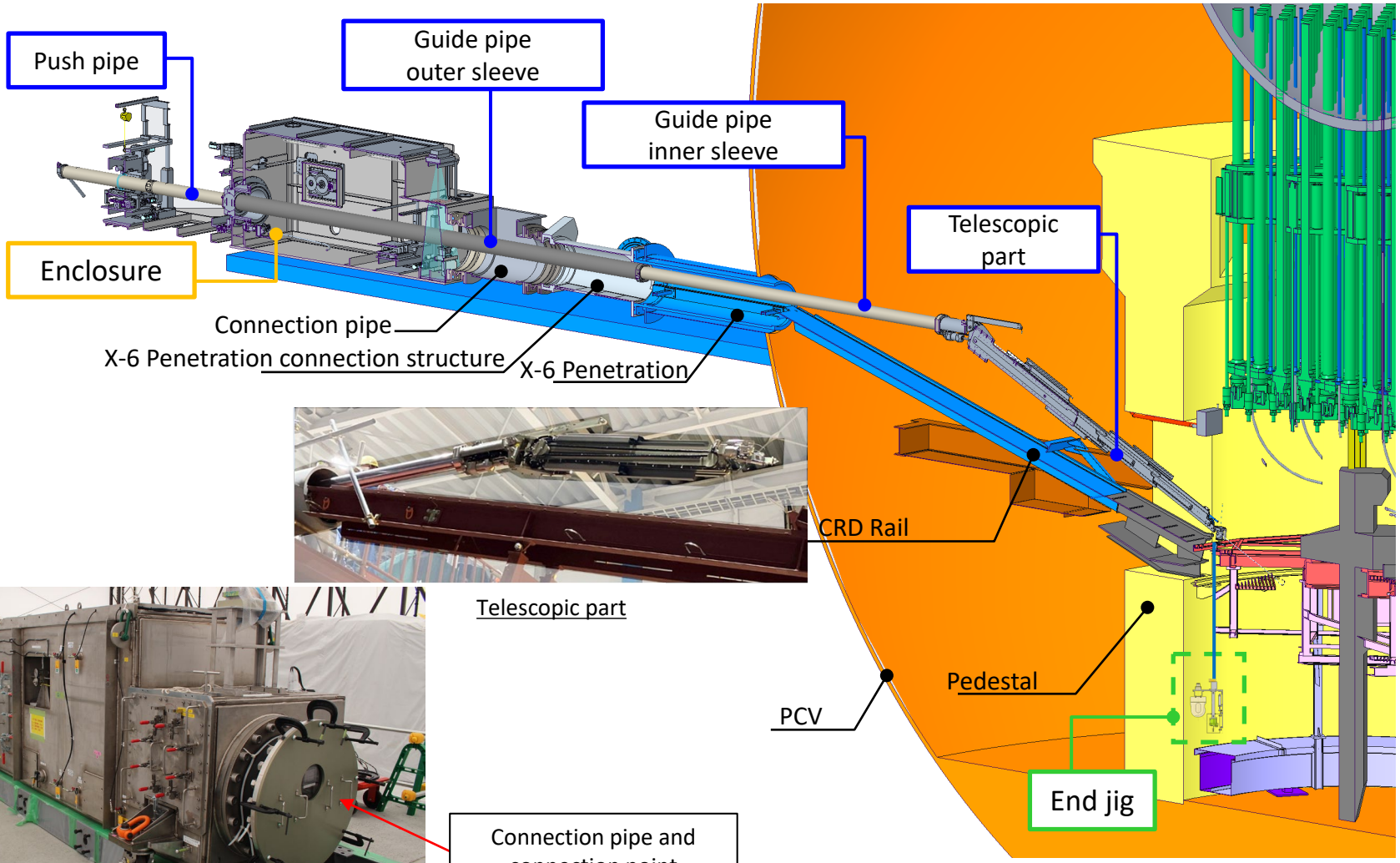
4. Work schedule

- In preparation to sample additional fuel debris with the telescopic device we will the process of studying improvements to conduct improvements to replace camera attached to the end of the telescopic device and to stabilize lowering of the end jig at the end of the device and mastery training. In the future, workers which is based on previous work results as we aim to begin taking more samples in the spring of 2025.
- Based on information ascertained through the mock-up tests at the Naraha mockup facility using of the work environment, the control program for the robotic arm was improved and combined once through tests completed.
- In light of the discovery of degrading components found during testing, similar components have been replaced and a full inspection of the robotic arm is underway. We are also deliberating how to share information with other sites in light of the telescopic device camera nonconformity.
- Based on additional fuel debris trial retrieval using the telescopic device and the test status of the robot arm, we will closely examine the details of the process so that we can safely and carefully proceed with the trial retrieval.



[Reference] Sampling Debris with the Telescopic Fuel Debris Trial Retrieval Device

- We assume that the attributes and distribution of fuel debris will be quite varied, so in order to increase sample size and expand our knowledge we will continue to use the telescopic device, which is already installed on site and has proven successful, to take additional fuel debris samples.



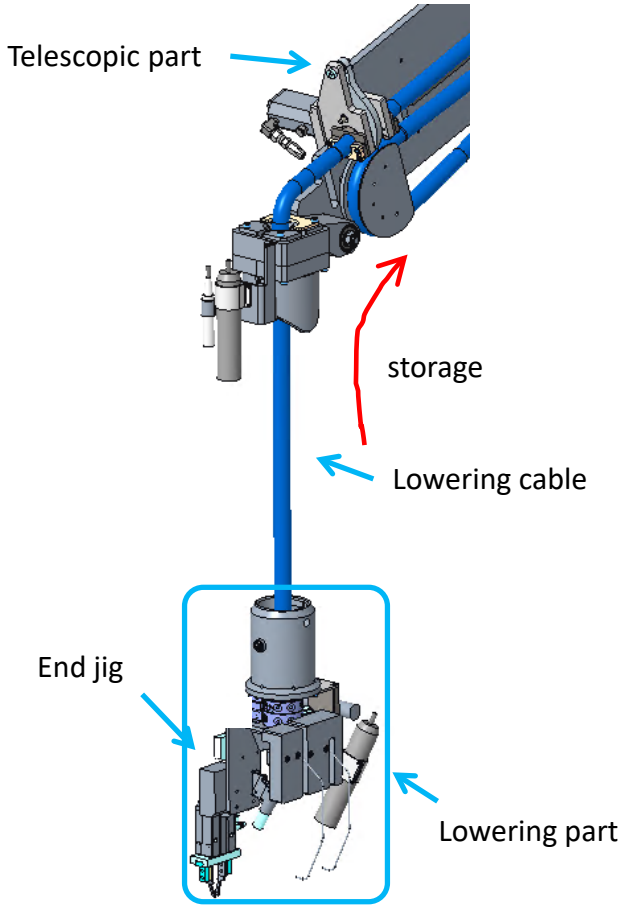
Telescopic part

Connection pipe and connection point

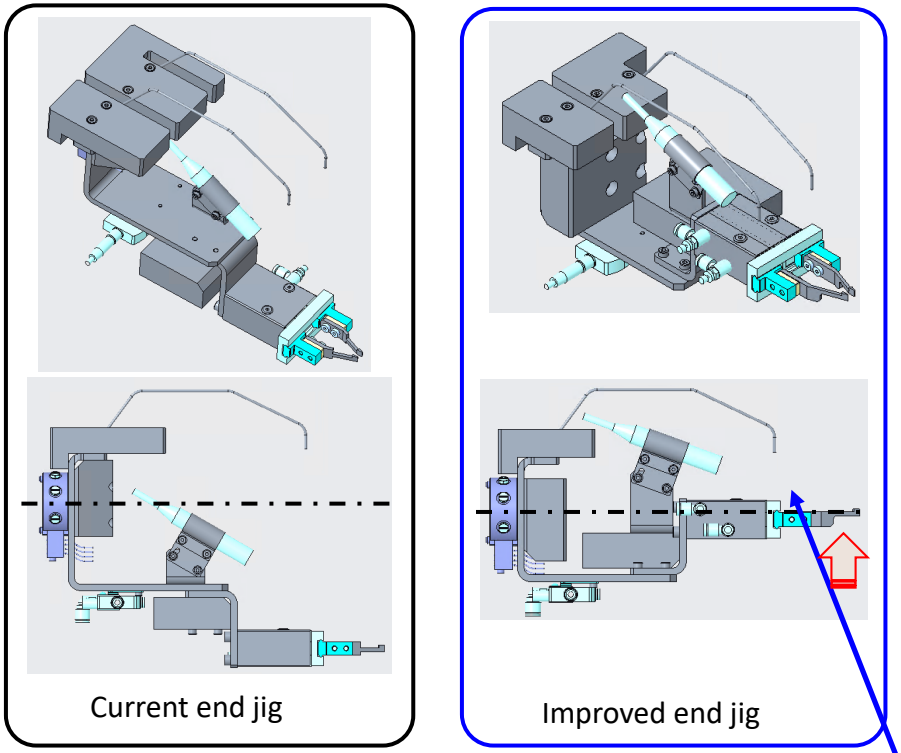
Telescopic device

[Reference] Additional Debris Sampling with the Telescopic Fuel Debris Trial Retrieval Device

- During the first fuel debris sampling, time was required to maneuver the end jig because the lowering part was not stable. So we are deliberating how to improve the maneuverability of the end jig before sampling additional fuel debris.



End jig components



Concept diagram of end jig improvements

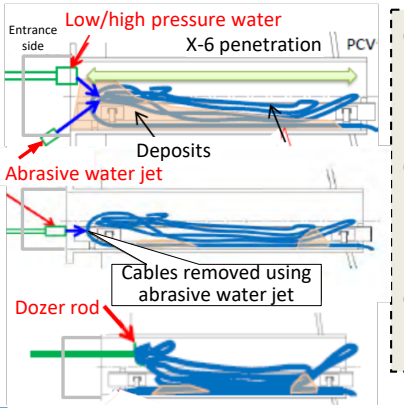
[Reference] Field Preparation Work Progress
Primary Steps of the Fuel Debris Trial Retrieval (Internal Investigations/Debris Sampling)

1. Isolation chamber installation

2. Opening of the X-6 penetration hatch

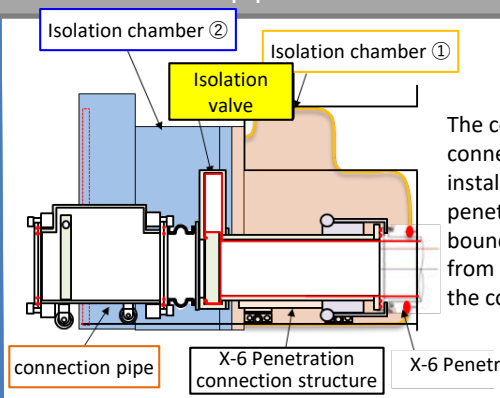
3. Removal of deposits from inside the X-6 penetration

Removing deposits/cables from inside the X-6 penetration



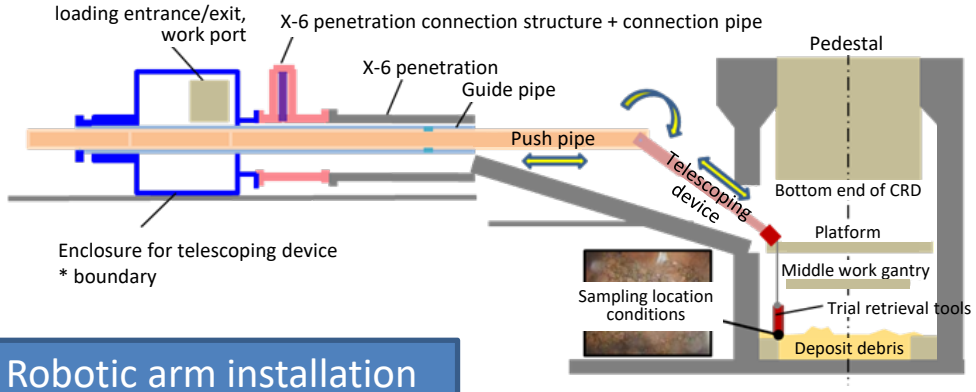
- Deposits pushed with low/high-pressure water
- Cables removed with Abrasive water jet
- Cables pushed with dozer rod

4. Installation of X-6 penetration connection structure and connection pipe

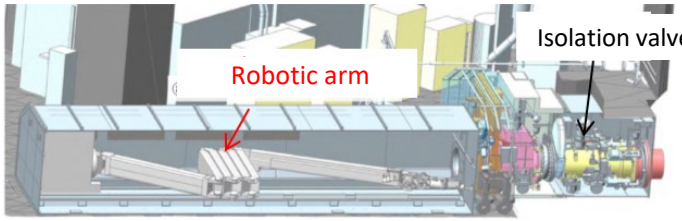


The connecting structure and connection pipe will be installed at the X-6 penetration and the boundary will be changed from the isolation chamber to the connection structure.

5. Installation of telescopic device
6. Trial retrieval (debris sampling using telescopic device)

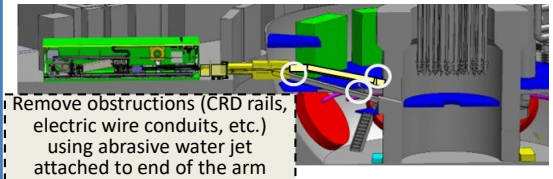


7. Robotic arm installation



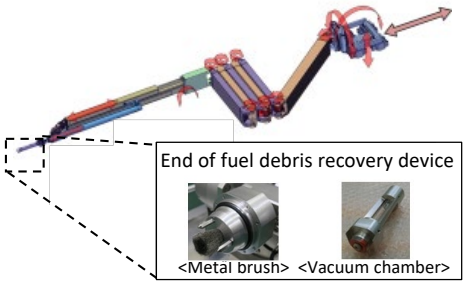
8. Internal investigation/debris sampling using robotic arm

① Internal investigation



Remove obstructions (CRD rails, electric wire conduits, etc.) using abrasive water jet attached to end of the arm

② debris sampling using robotic arm



(Note)

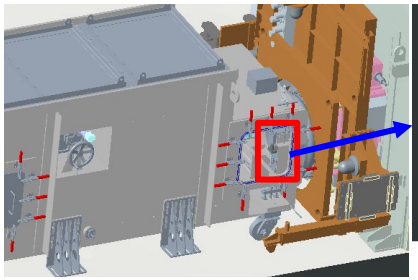
Isolation valve: Valve installed to separate the inside of the PCV from the outside

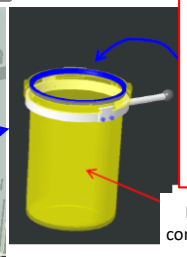
Abrasive Water Jet: Combines high pressure water with an abrasive to improve cutting ability

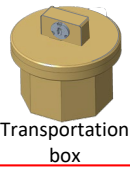
[Reference] Field Preparation Work Progress
Primary Steps of the Fuel Debris Trial Retrieval (Internal Investigations/Debris Sampling)

(From Step 6 on the previous slide)

9-1. Collection of fuel debris





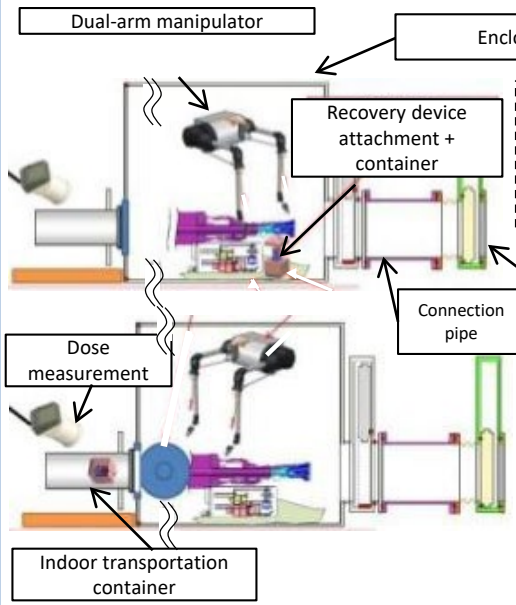


Transportation box

Indoor transportation container (DPTE container)

(From Step 8 on the previous slide)

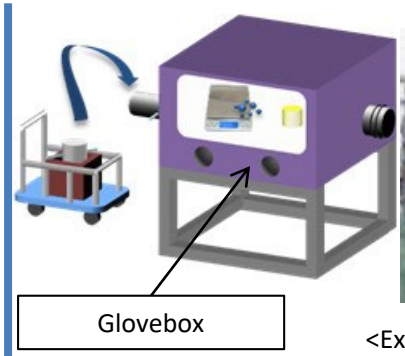
9-2. Inserting the fuel debris recovery device attachment into a container, Inserting into an on-site transportation container/Dose measurements



- The fuel debris recovery device attachment will be put into a container using the dual-arm manipulator inside the enclosure

- Inside the enclosure, the attachment will be put into an on-site transportation container after taking dose measurements
- This will be removed while attempting to prevent the spread of contamination

10. Insertion into glovebox/Measurement

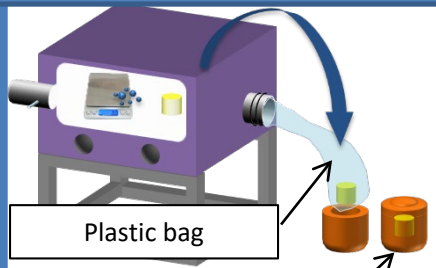


Glovebox

<Exterior view of glovebox>

- The collected samples will be put into a negative pressure glovebox
- The samples will be subjected to various measurements inside the glovebox and then put into a container

11. Container removal/Insertion into transportation container /Removal from premises



Plastic bag

Off-site transportation container ※

Carried to transport vehicle

- The container will be removed from the glovebox while preventing the spread of contamination by using a plastic bag
- The container will then be inserted into an off-site transportation container and loaded onto a transport vehicle

※ Prior to transport, the surface dose/contamination density, etc. of the container shall be measured to ensure that it meets legal requirements

12. Off-site transport and off-site analysis

(Note)
DPTE Container is an abbreviation of “Double Porte pour Transfert Etanche”.
By opening/closing the lid of the container and double door of the glove box at the same time, it allows the items to be transferred while maintaining a sealed environment.

[Reference] Environmental Impact (1/2)

- During fuel debris trial retrieval, the gas from inside the primary containment vessel was prevented from leaking to the outside environment through the construction of a boundary.
- There have been no significant fluctuations in data from monitoring posts or dust monitors neither prior to or after work.
- Data from monitoring posts/dust monitors near site borders can be found on TEPCO's website
  Reference URL: https://www.tepco.co.jp/en/hd/decommission/data/monitoring/monitoring_post/index-e.html
  https://www.tepco.co.jp/en/hd/decommission/data/monitoring/dustmonitor/index-e.html

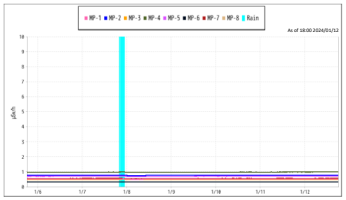
Radiation Dose measured at Monitoring Post of Fukushima Daiichi Nuclear Power Station

The following is the radiation doses of the air measured by the monitoring posts (MP1-8) at Fukushima Daiichi Nuclear Power Station.

Monitoring post (MP1 - MP8)

Monitoring points

Radiation dose



MP Unit : μSv/h Wind Velocity Unit : m/s
○Measurement value(2024/01/12 18:00)

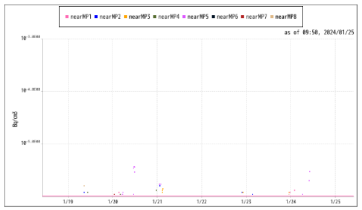
MP-1	MP-2	MP-3	MP-4	MP-5	MP-6	MP-7	MP-8	Wind Direction	Wind Velocity	Rain
0.517	0.783	0.490	0.987	0.703	0.315	0.566	0.530	North-northwest	1.4	No

Radioactive Concentration measured at Dust Monitors near the Site Boundary of Fukushima Daiichi Nuclear Power Station

The following are radioactive concentrations in the air measured near the monitoring posts (MP1-8) at the site boundary of Fukushima Daiichi Nuclear Power Station.

Monitoring points

Radiation concentration



Radioactive Particles Monitor Unit : Bq/cm³ Wind Velocity Unit : m/s
○Measurement value (2024/01/25 09:50)

nearMP1	nearMP2	nearMP3	nearMP4	nearMP5	nearMP6	nearMP7	nearMP8	Wind Direction	Wind Velocity
1.0E-06	1.0E-06	1.0E-06	1.0E-06	1.0E-06	1.0E-06	1.0E-06	1.0E-06	northwest	4.4

[Reference] Environmental Impact (2/2)

- During fuel debris trial retrieval, the work will be performed with constant monitoring of plant parameters.
- Primary containment vessel temperature data can be found on TEPCO's website.
  Reference URL: https://www.tepco.co.jp/en/hd/decommission/data/plant_data/unit2/pcv_index-e.html

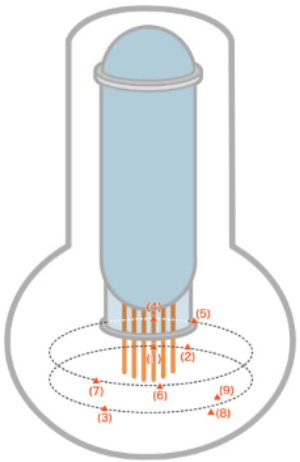
[Reference] Screen image of our website

Temperatures measured inside the Unit 2
Primary Containment Vessel at Fukushima
Daiichi Nuclear Power Station

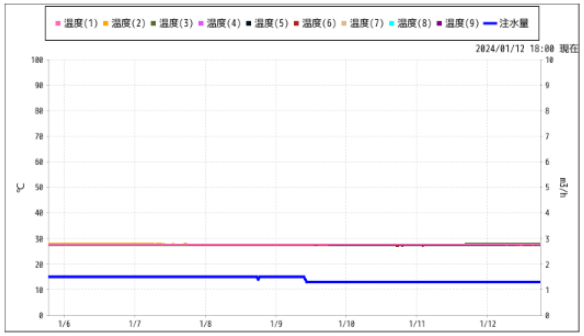
Here are the measurement results of temperatures inside the Unit 2 Primary Containment Vessel at Fukushima Daiichi Nuclear Power Station.

Monitoring points

Unit 2 reactor containment vessel



Temperature



Temperature Unit:℃, Water Injection Unit : m^3/h

○Measurement value (2024/01/12 18:00)

温度(1)	温度(2)	温度(3)	温度(4)	温度(5)	温度(6)	温度(7)	温度(8)	温度(9)	注水量
27.5	27.8	27.9	27.7	27.4	27.3	27.2	-	-	1.3