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

December 25, 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.

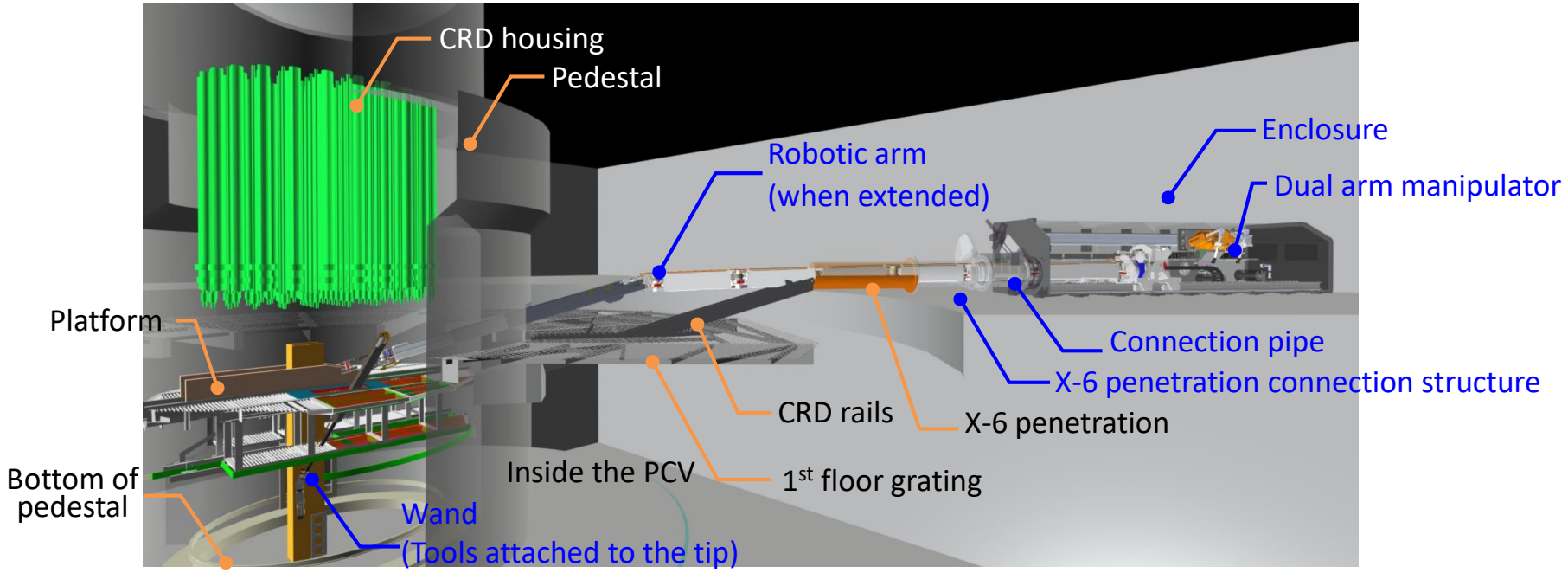
  ＜Already installed＞

  - 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 going forward＞

  - 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. Status of robotic arm tests (performance tests)

- Tests using a mockup of the Fukushima Daiichi on-site (combined once-through tests) were completed at the Naraha mockup facility in February 2025.
- The comprehensive inspection of the robotic arm, including replacement of parts that were found during testing to have deteriorated with age and other similar parts, has been completed as planned.
- Movement checks that were commenced after completion of the comprehensive inspection are 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.

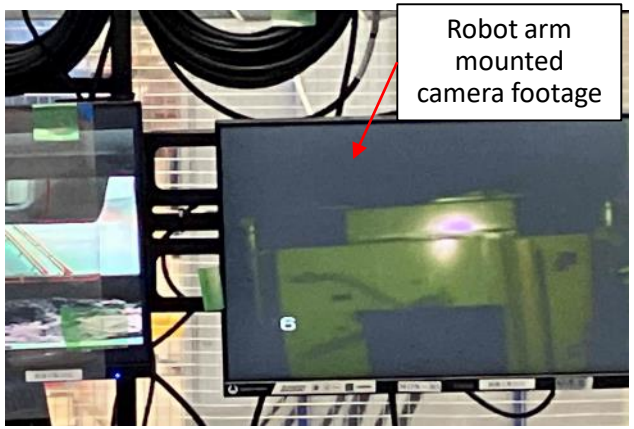
Performance tests

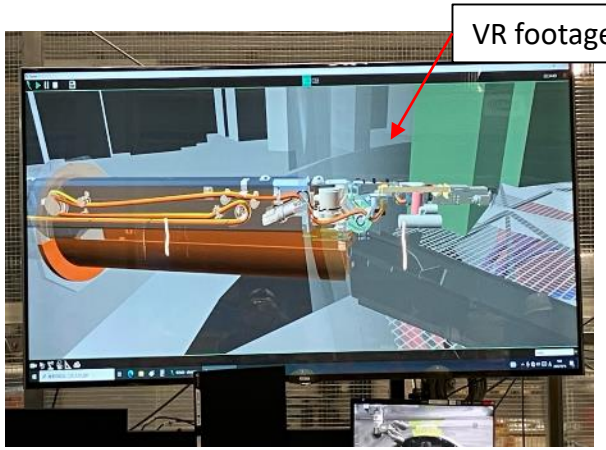
| Test category | Test | JAEA Naraha |
|---|---|---|
| Robotic arm-related | Ability to pass through the X-6 penetration | Completed |
| | Removing obstructions at the exit for the X-6 penetration using the AWJ | Completed（Work efficiency being examined） |
| | Function tests (deflection measurements, etc.) | Completed |
| | Ability to access the inside of the PCV (accessing the top and bottom of the pedestal) | Completed |
| | Removing obstructions inside of the PCV (Cutting obstructions inside the PCV after passing through the X-6 penetration) | Completed（Work efficiency being examined） |
| Dual arm manipulator-related | 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 obstructions using the AWJ) | Completed |
| Comprehensive inspection | Comprehensive inspection (maintenance) | Completed |
| Combined verification tests | Movement checks after comprehensive inspection (maintenance) | Underway |

# 2-2. Status of robotic arm tests (post-maintenance function tests )

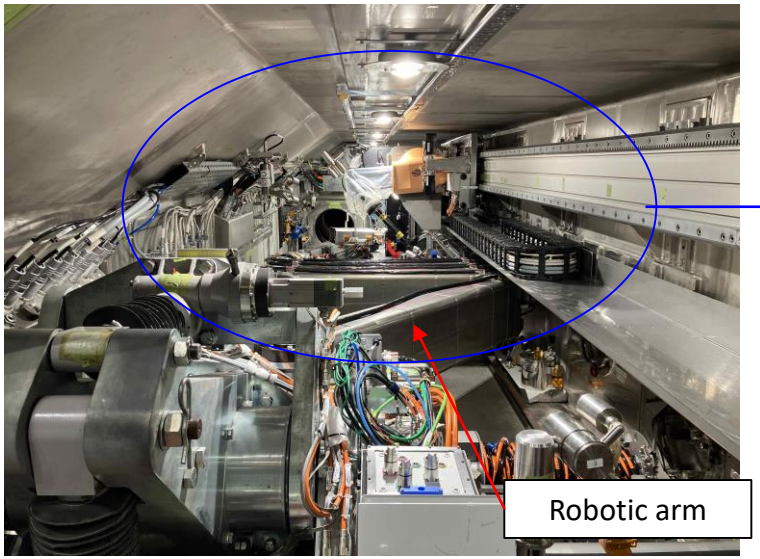
- Post-maintenance function tests on the robotic arm are underway.
- Additional inspections are being performed simultaneously in conjunction with changes made to the Cameras mounted on the robotic arm.

Performing operation from the remote operations room (simulated)

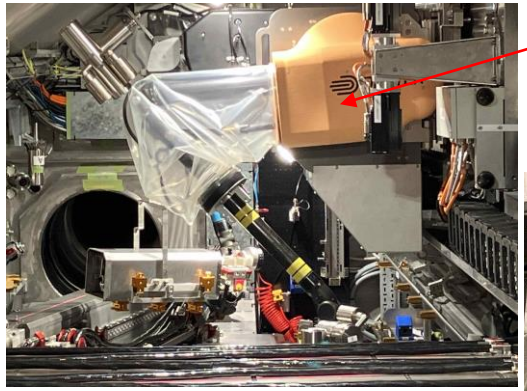


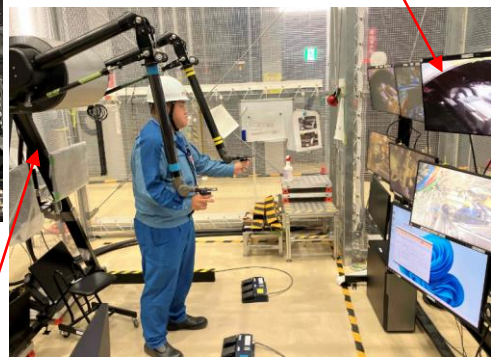

Performing operations while checking camera footage and virtual reality feed




※ Photographed from the rear of the enclosure



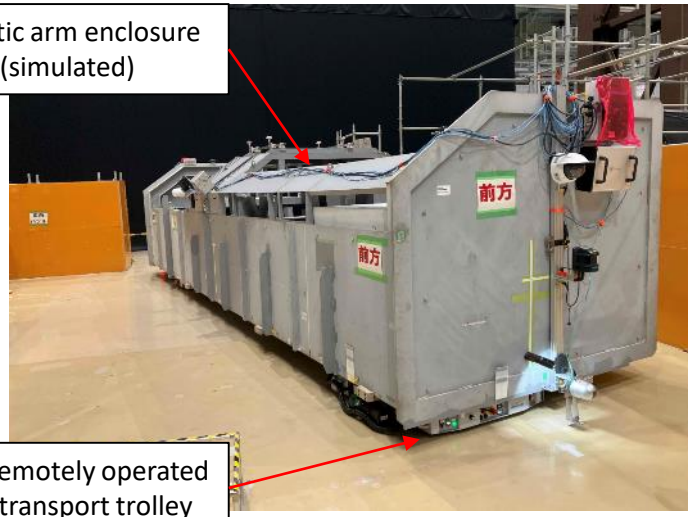

Manipulator operations

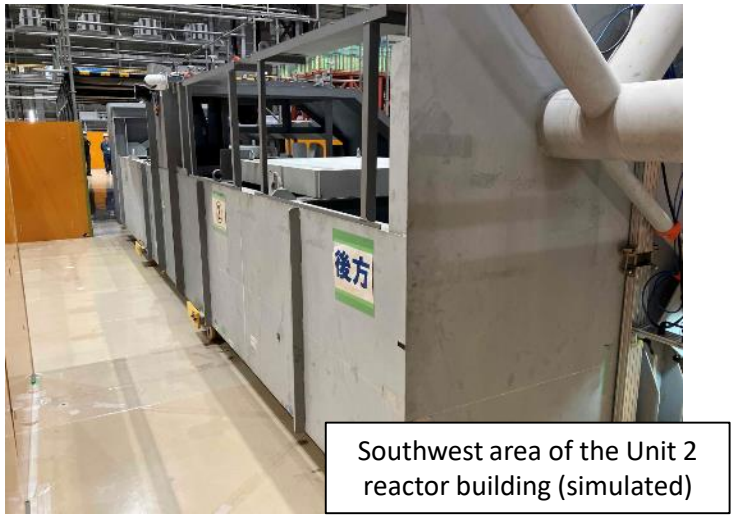



※Remote operation room (simulated)

# 2-3. Status of robotic arm test (inspecting enclosure transport)

- Enclosure transport is being inspected in preparation for installation of the robotic arm to the site.
- Work training in a simulated environment is underway in preparation for enclosure transport/installation on site.



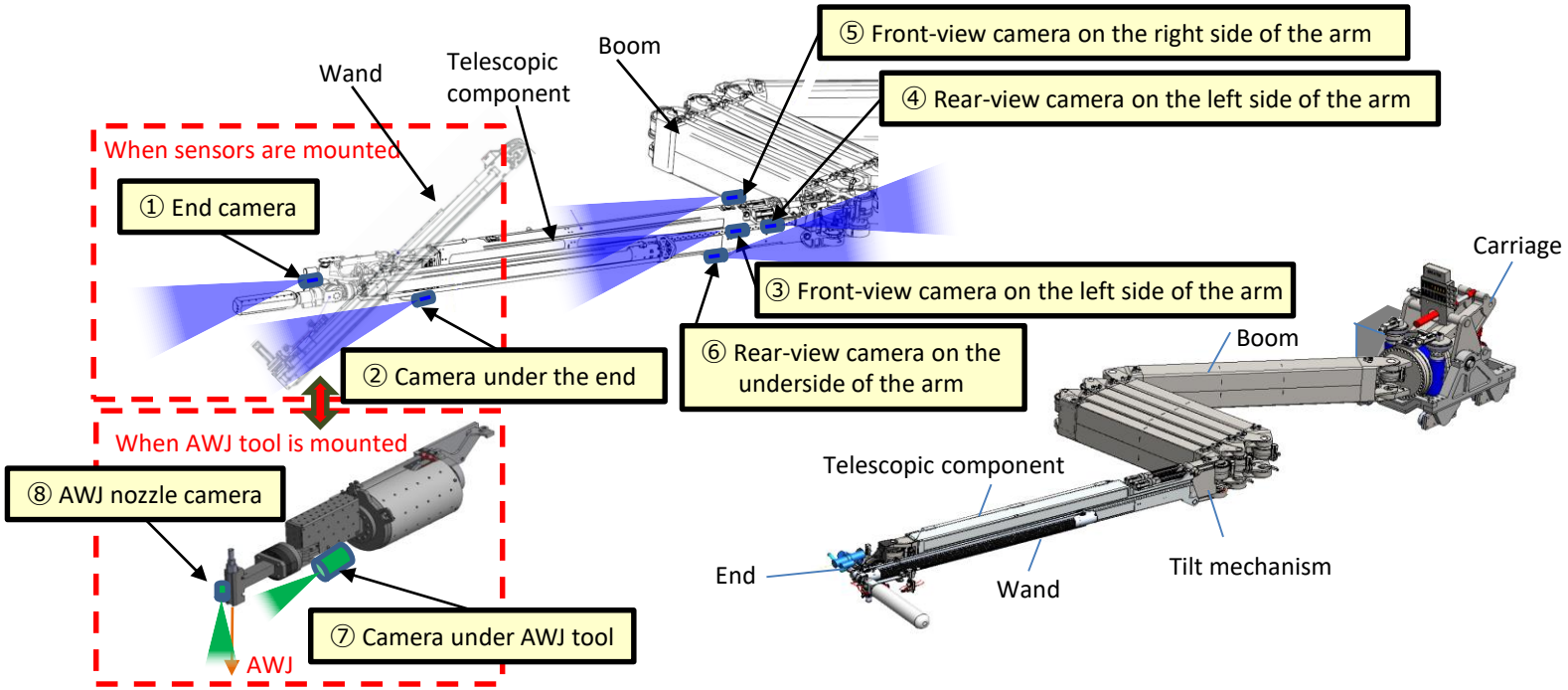






Inspecting enclosure (simulated) transport

# 2-4. Cameras mounted on the robotic arm (horizontal deployment of the telescopic device)

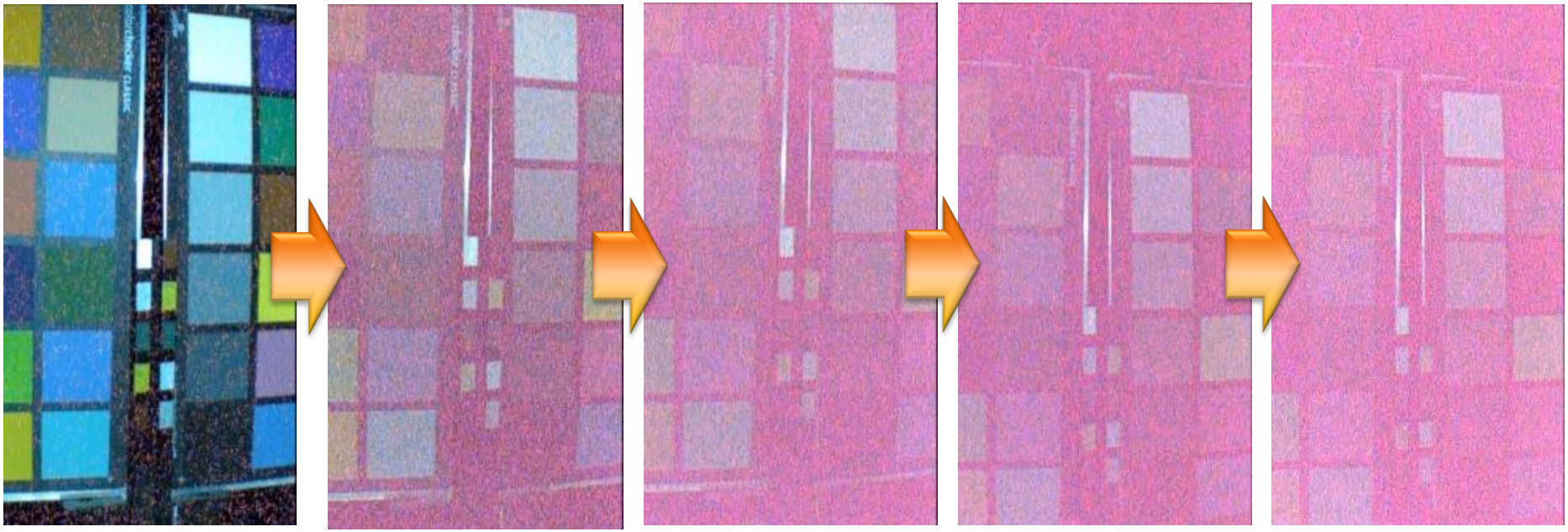
- In light of the camera malfunctions on the telescopic device, irradiation tests of the cameras mounted on the robotic arm are being implemented.
- We were unable to confirm the radiation resistance as noted in the manufacturer's specifications. Since it has been impossible to acquire spare cameras, we have changed the cameras that was subjected to high accumulated doses during field work to ones that have been adopted in our previous works.
- The radiation resistance of the replaced cameras was confirmed to be in line with the manufacturer's specifications. However, since the radiation resistance was lower than the planned dose for on-site work, they will be replaced remotely using a manipulator as needed, and operations will continue.
- Currently, additional tests are being conducted at the mockup facility, such as checking visibility following camera changes and using a manipulator to replace cameras.
- In addition, during the test, it was confirmed that even if all the cameras mounted on the robotic arm stopped, the arms could be retrieved to the enclosure using the control program and VR.




Cameras mounted on the robotic arm

# 2-5. Cameras mounted on the robotic arm (irradiation tests of the new cameras)

- Irradiation tests of the new cameras are underway using the on-site environment conditions (inside the PCV).
- During work in the field, deterioration of the video feeds will be monitored and the manipulator will be remotely operated to switch out cameras when necessary in order to continue operations.



# 3. Work schedule

- In light of the camera malfunctions on the telescopic device, irradiation tests of the cameras mounted on the robotic arm are being implemented.
- We were unable to confirm the radiation resistance as noted in the manufacturer‘s specifications. Since it has been impossible to acquire spare cameras, we have changed the cameras that was subjected to high accumulated doses during field work to ones that have been adopted in our previous works.
- The radiation resistance of the replaced cameras was confirmed to be in line with the manufacturer's specifications. However, since the radiation resistance was lower than the planned dose for on-site work, they will be replaced remotely using a manipulator as needed, and operations will continue.
- On-site work will be performed using large devices that are completely remotely operated, and the difficulty level of the work is extremely high, so maintenance tasks are being performed on a mockup of the facility that assumes the risks.
- Currently, visibility during camera replacement is being checked, and training on using the manipulator to replace the cameras, as well as operations to withdraw the camera in the event of emergency, are under way. Furthermore, based on the telescopic device troubles, a simulated environment is being used to conduct training on robotic arm and ancillary equipment installation.
- If verification tests go smoothly, the robotic arm will be transported to Fukushima Daiichi Nuclear Power Station at the end of FY2025 and installed on-site.

| | | FY2025 | | | | FY2026 |
|---|---|---|---|---|---|---|
| | | Q1 | Q2 | Q3 | Q4 | |
| Robotic arm | Inspection/maintenance, etc., and any additional development required based upon once-through tests/test results | | | Additional inspections in conjunction with camera replacement | | |
| | Installation preparation, etc./ access route construction | | | | | |
| | Internal investigation/debris sampling | | | | | |

: Completed

: Commencement and completion dates under review

# 4. Telescopic device transport

- The telescopic device was disconnected from the X-6 penetration connection structure and connection pipe, removed from the Unit 2 reactor building and transported to a storage location on site at Fukushima Daiichi Nuclear Power Station.
- Training on transport work was conducted in advance in a simulated environment prior to actual transport on-site.


Removing the telescopic device from the reactor building (November 5)


Loading the telescope device onto a vehicle for transport (November 5)

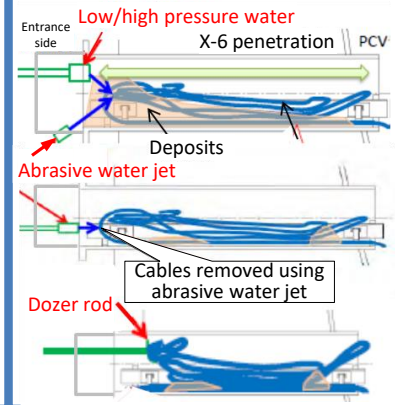
# [Reference] Field Preparation Work Progress
# Primary Steps of the Fuel Debris Trial Retrieval (Internal Investigations/Debris Sampling)

## 1. Isolation chamber installation

## 2. Opening of the X-6 penetration hatch

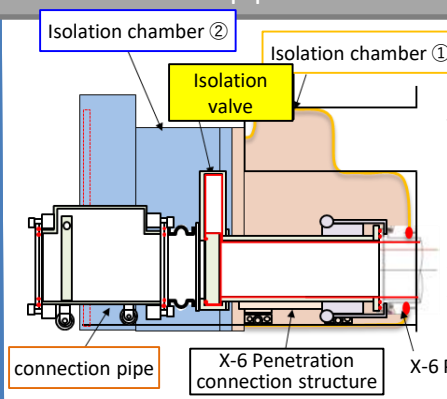
## 3. Removal of deposits from inside the X-6 penetration

Removing deposits/cables from inside the X-6 penetration



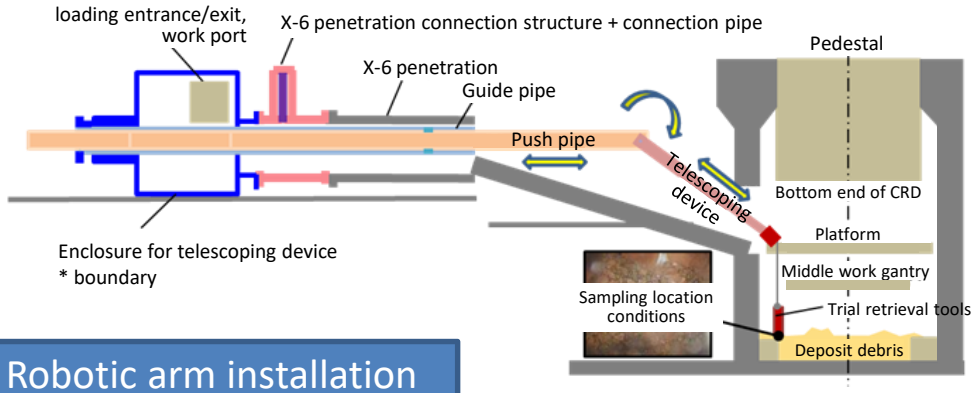

- Deposits pushed with low/high-pressure water
- Cables removed with Abrasive water jet
- Cables pushed with dozer rod

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

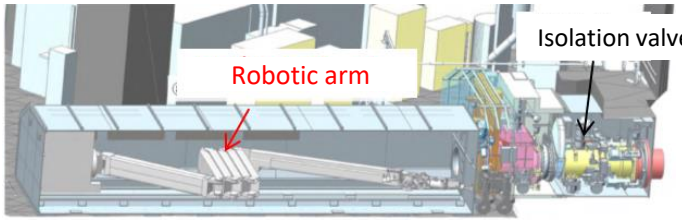



The connecting structure and connection pipe will be installed at the X-6 penetration and the boundary will be changed from the isolation chamber to the connection structure.

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

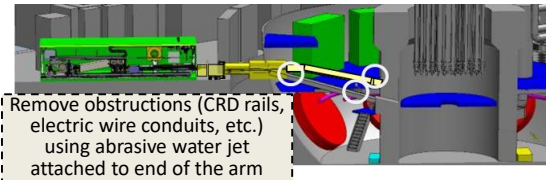



## 7. Robotic arm installation

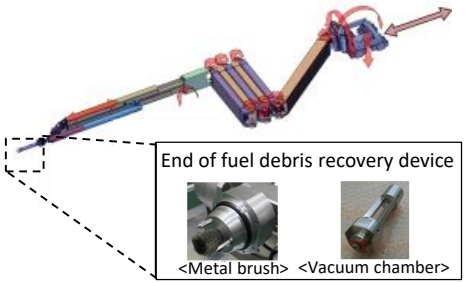



## 8. Internal investigation/debris sampling using robotic arm

① Internal investigation




② debris sampling using robotic arm




(Note)

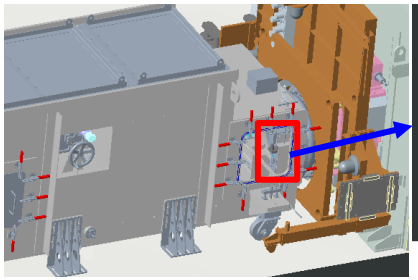
Isolation valve: Valve installed to separate the inside of the PCV from the outside

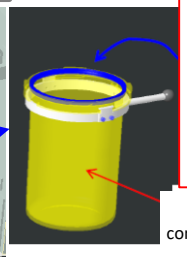
Abrasive Water Jet: Combines high pressure water with an abrasive to improve cutting ability

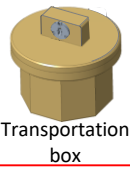
# [Reference] Field Preparation Work Progress
# Primary Steps of the Fuel Debris Trial Retrieval (Internal Investigations/Debris Sampling)

(From Step 6 on the previous slide)

## 9-1. Collection of fuel debris





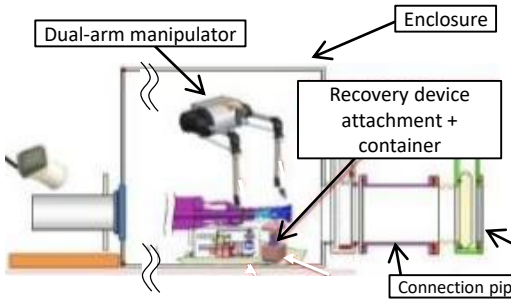


Transportation box

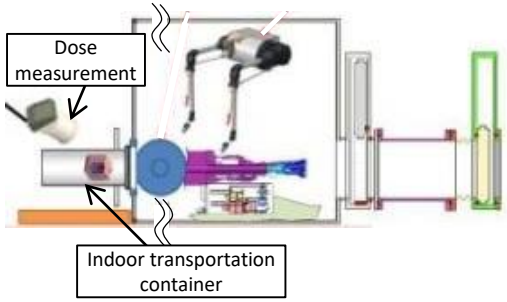
Indoor transportation container (DPTE container)

(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

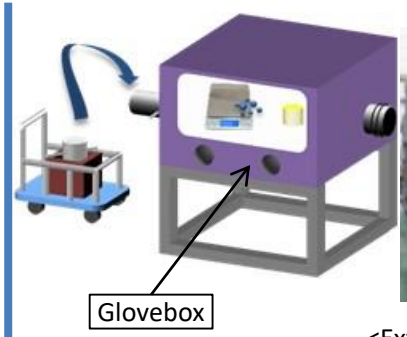



- The fuel debris recovery device attachment will be put into a container using the dual-arm manipulator inside the enclosure




- 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

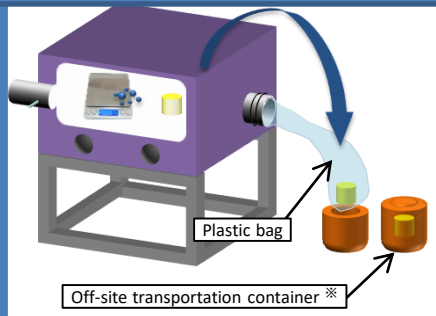
## 10. Insertion into glovebox/Measurement




<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




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.