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

August 28, 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.

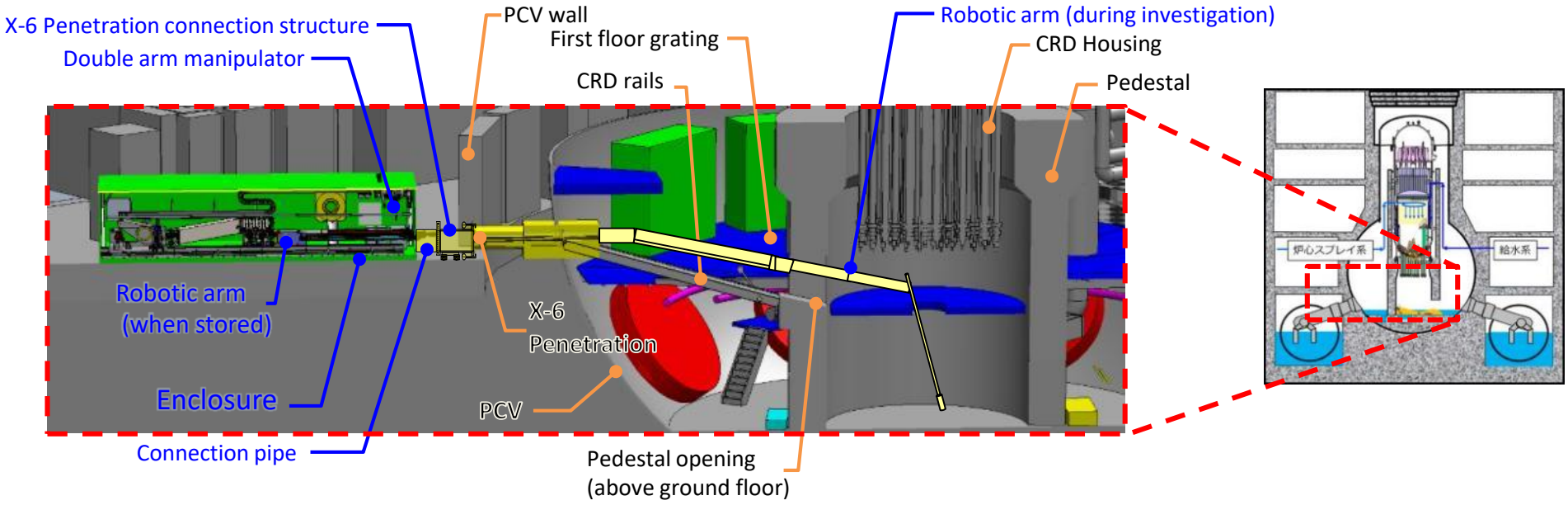
  ＜Already installed＞

  - 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. Status of robotic arm tests (Performance tests)

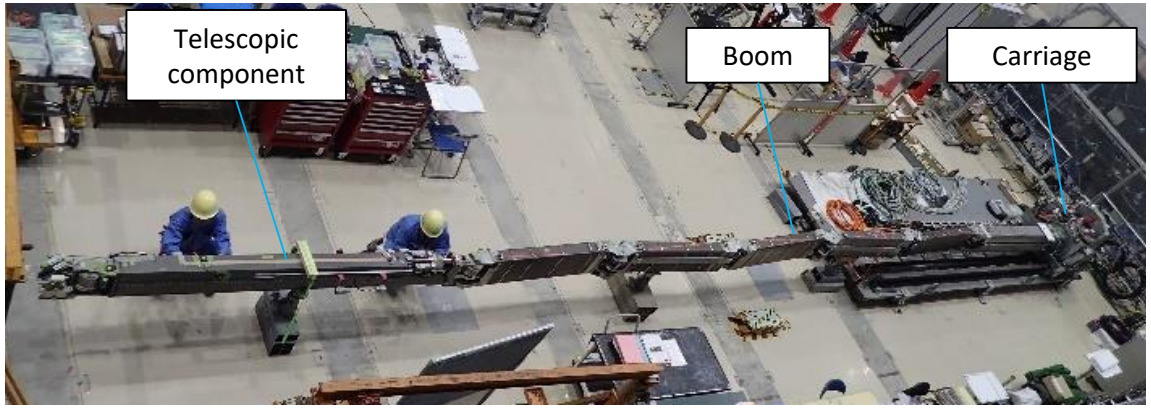
- Tests using a mockup of the Fukushima Daiichi on-site (combined once-through tests) were completed at the Naraha mockup facility (February 2025).
- Work feasibility was checked by confirming that the AWJ tool attached to the arm could be remotely operated to remove obstructions and create an access route, data from inside the pedestal can be acquired and simulated debris sampled using sensors and devices attached to the arm, and that the dual arm manipulator could be used to remove and attach sensors and tools, etc.
- However, in order to take every precaution, parts that were found to have degraded with age are being replaced along with other similar parts in the process of performing a comprehensive inspection of the robotic arm.
- 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

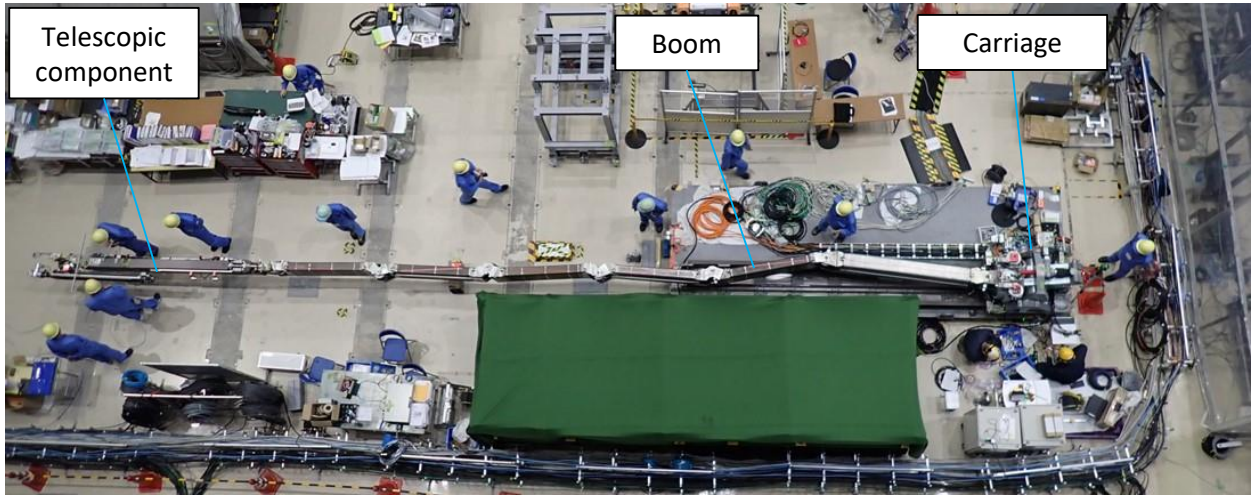
| Test category | Test | JAEA Naraha |
|---|---|---|
| Robotic arm-related | Ability to pass through the X-6 penetration | Completed |
| | Removing obstructions at the exit for the X-6 penetration using the AWJ | Completed（Work efficiency being examined） |
| | Function tests (deflection measurements, 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) | TBD |

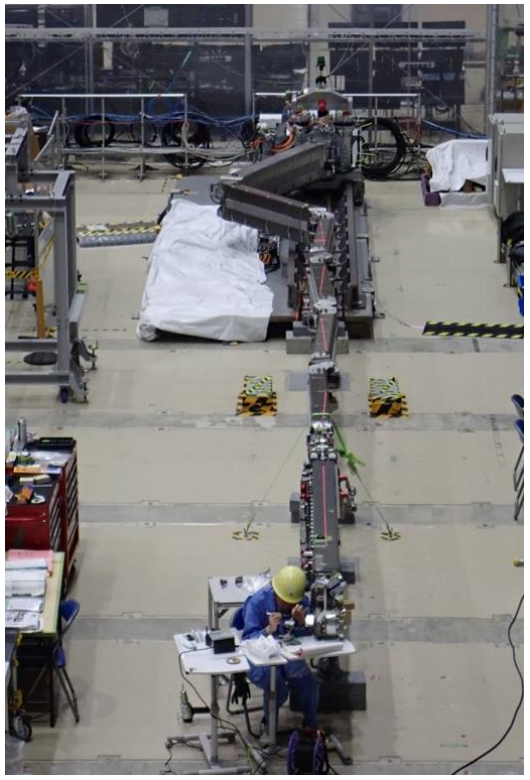
# 2.2 Status of movement checks after maintenance on the robotic arm

- Cables inside the arm had been replaced and a comprehensive inspection (maintenance) of the robotic arm has been completed as scheduled.
- Movement checks after the comprehensive inspection (maintenance) are underway.




Arm assembly

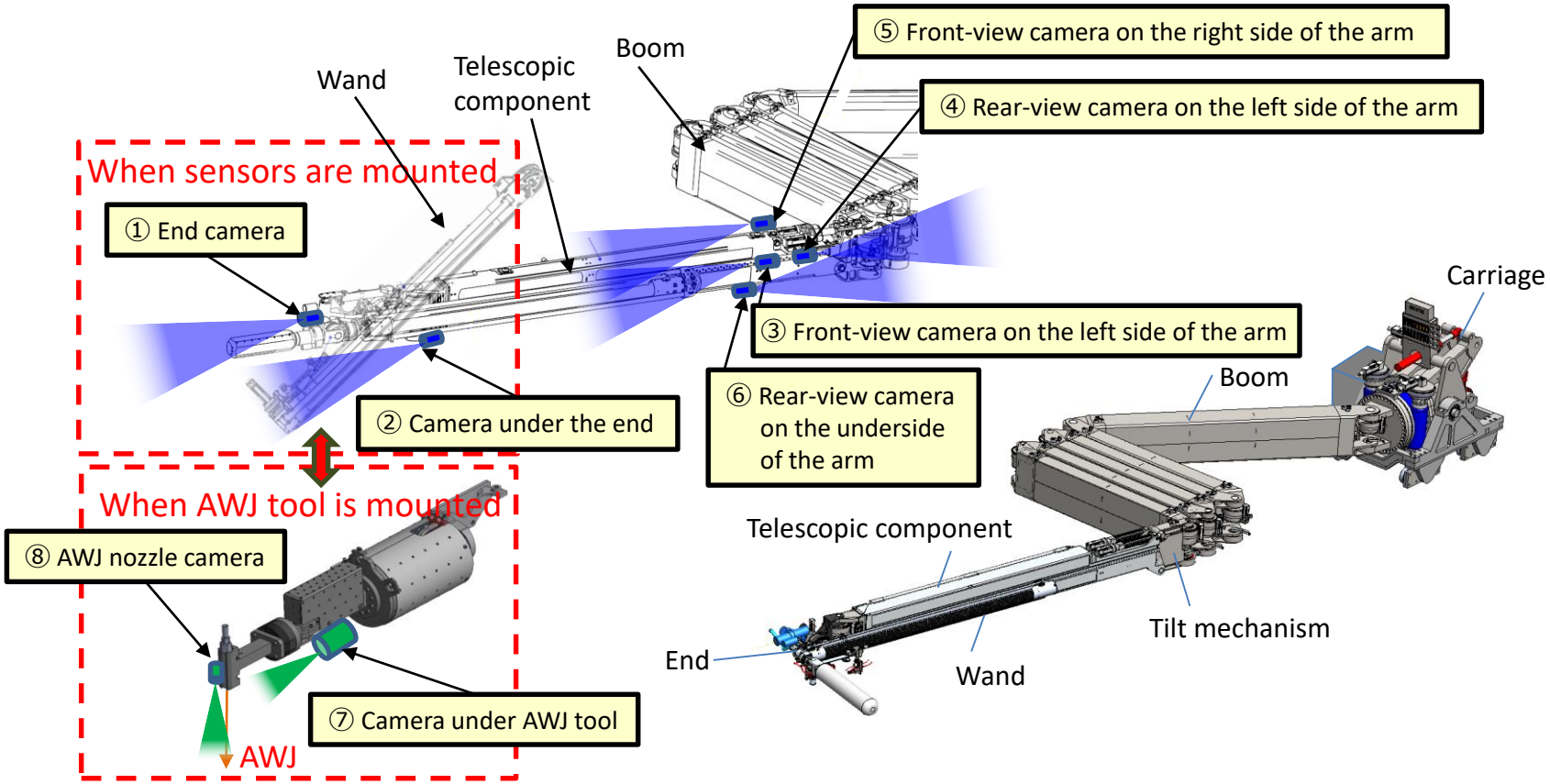


Movement checks after the comprehensive inspection (maintenance)

# 2-3. Cameras mounted on the robotic arm (horizontal deployment of the telescopic device)

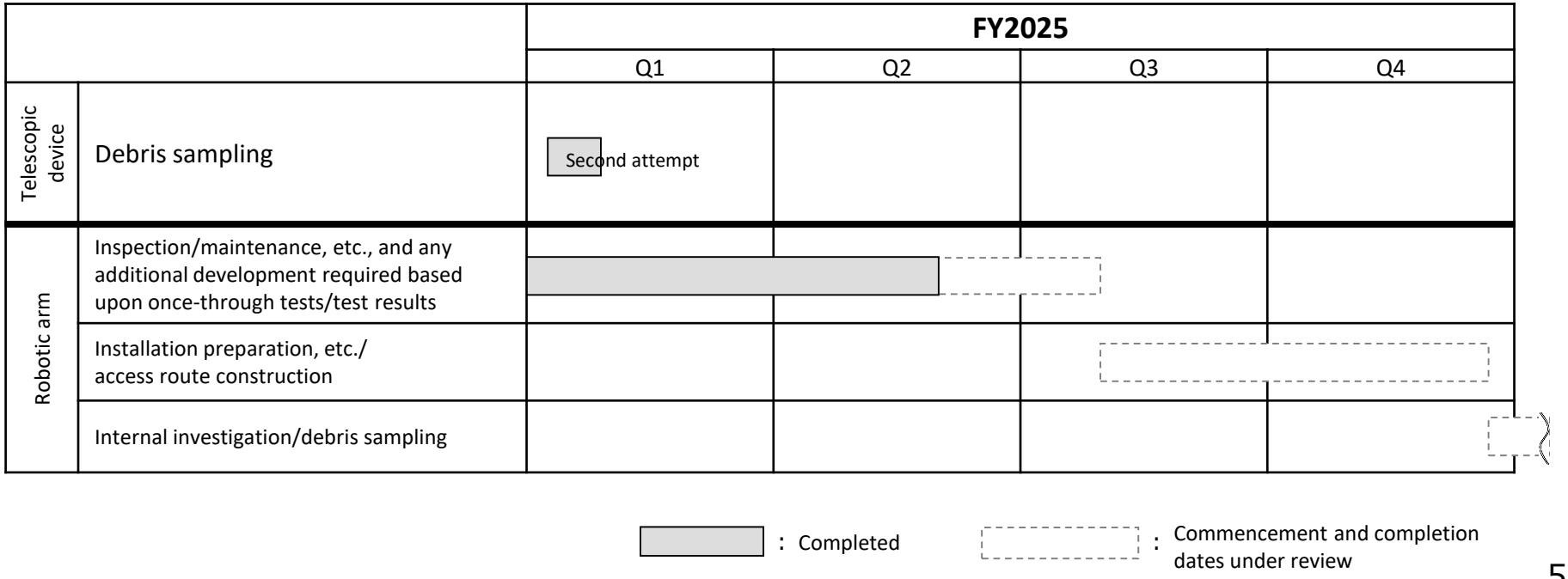
- In light of the camera malfunctions on the telescopic device, irradiation tests of the cameras mounted on the robotic arm are being implemented and the radiation resistance as noted in the manufacturer's specifications could not be confirmed under conditions more severe than that of the field environment in some cases. Irradiation tests of the cameras will be continued as we deliberate countermeasures, and the work schedule will be subject to a detailed review.




Cameras mounted on the robotic arm

# 3. Work schedule

- A comprehensive inspection including replacement of the internal cables of the robotic arm and all similar components, etc. was completed as scheduled. The movement checks after the comprehensive inspection is currently underway.
- Going forward, the arm will be installed to the enclosure and once-through tests will be performed and preparations will be made for operations in the field.
- In light of the camera malfunctions on the telescopic device, irradiation tests of the cameras mounted on the robotic arm are being implemented and the radiation resistance as noted in the manufacturer's specifications could not be confirmed under conditions more severe than that of the field environment in some cases. Irradiation tests of the cameras will be continued as we deliberate countermeasures.
- In light of the status of the robotic arm tests and the camera irradiation tests, and to move forward with trial retrieval safely and carefully, the work schedule going forward will be subject to a detailed review.



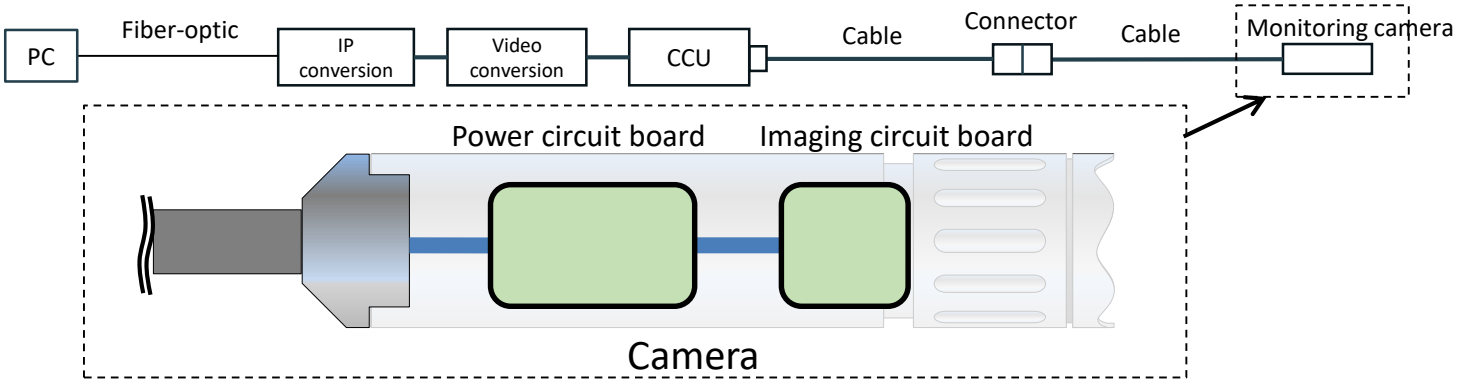
# 4. Telescopic device camera malfunction investigation results

<Camera malfunction cause analysis>

- The two cameras from which the video feeds were lost were decontaminated, removed from the site and disassembled. It was confirmed that are there are two circuit boards inside each camera.
- The circuit boards were replaced with working spare parts and it was checked that the video signal could be received. In other words, we tested that the video signal can be received if using either a working power circuit board or a working imaging circuit board.
- Test results found that the imaging circuit boards in both of the cameras were not working properly.

<Results of ascertaining of the cause>

- The two cameras from which the video feeds were lost were subjected to high levels of radiation inside the PCV. It is assumed that as a result, a charge was created on the imaging circuit boards inside the cameras and that charge affected the circuit boards.
- After the confirmation by the camera manufacturer, it was found that during the camera startup sequence, there were cases in which the power could not be turned on after the power was turned off due to high levels of radiation.
- As a countermeasure, it was decided to keep the cameras on at all times during fuel debris retrieval, and both two fuel debris retrieval attempts were completed without issue.
- Furthermore, the camera manufacturer has confirmed that this problem does not occur by improving the durability of the camera startup sequence, and these countermeasures have already been applied to products of the same model.




Position of circuit boards inside the monitoring camera

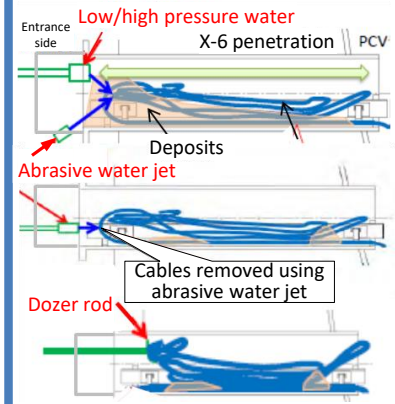
# [Reference] Field Preparation Work Progress
# Primary Steps of the Fuel Debris Trial Retrieval (Internal Investigations/Debris Sampling)

## 1. Isolation chamber installation

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

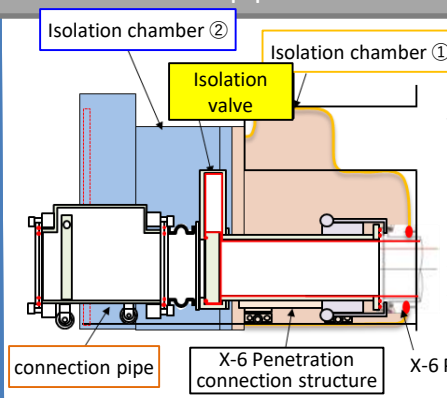
## 3. Removal of deposits from inside the X-6 penetration

Removing deposits/cables from inside the X-6 penetration



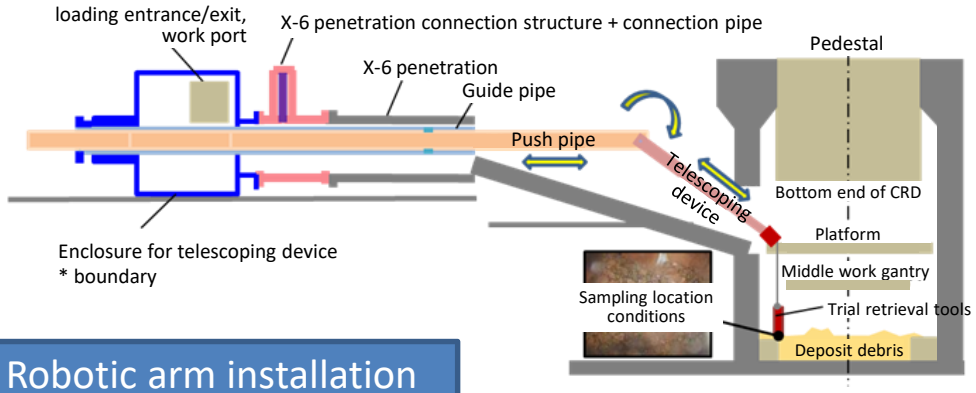

- Deposits pushed with low/high-pressure water
- Cables removed with Abrasive water jet
- Cables pushed with dozer rod

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

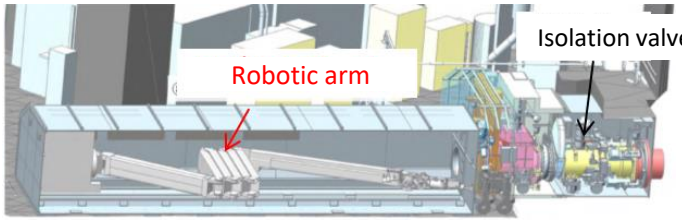



The connecting structure and connection pipe will be installed at the X-6 penetration and the boundary will be changed from the isolation chamber to the connection structure.

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

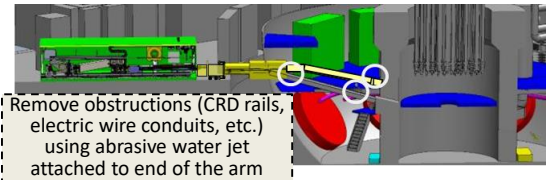



## 7. Robotic arm installation



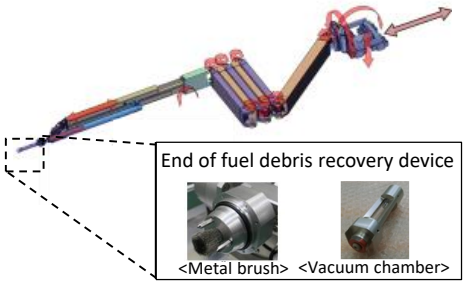

## 8. Internal investigation/debris sampling using robotic arm

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)

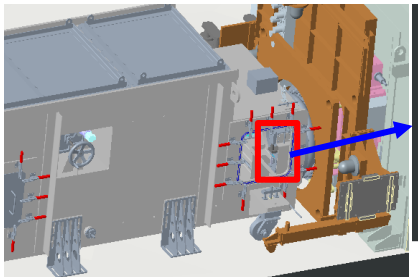
Isolation valve: Valve installed to separate the inside of the PCV from the outside

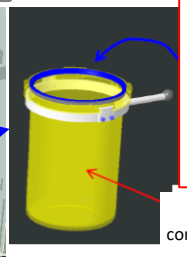
Abrasive Water Jet: Combines high pressure water with an abrasive to improve cutting ability

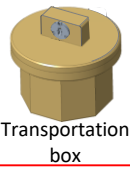
# [Reference] Field Preparation Work Progress
# Primary Steps of the Fuel Debris Trial Retrieval (Internal Investigations/Debris Sampling)

(From Step 6 on the previous slide)

## 9-1. Collection of fuel debris





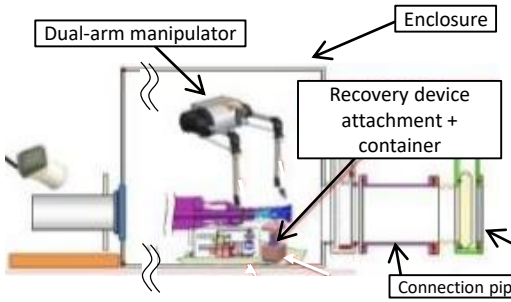


Transportation box

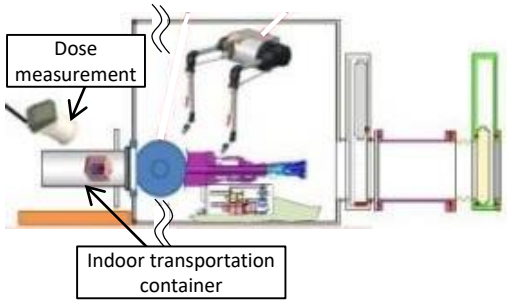
Indoor transportation container (DPTE container)

(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

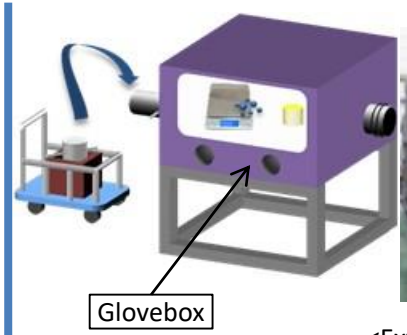



- The fuel debris recovery device attachment will be put into a container using the dual-arm manipulator inside the enclosure




- 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

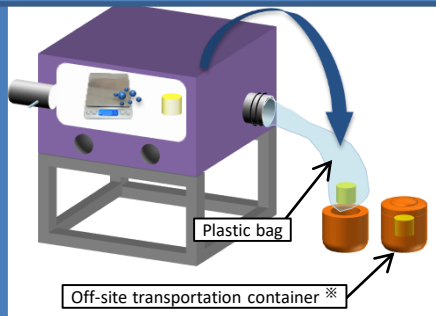
## 10. Insertion into glovebox/Measurement




<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.