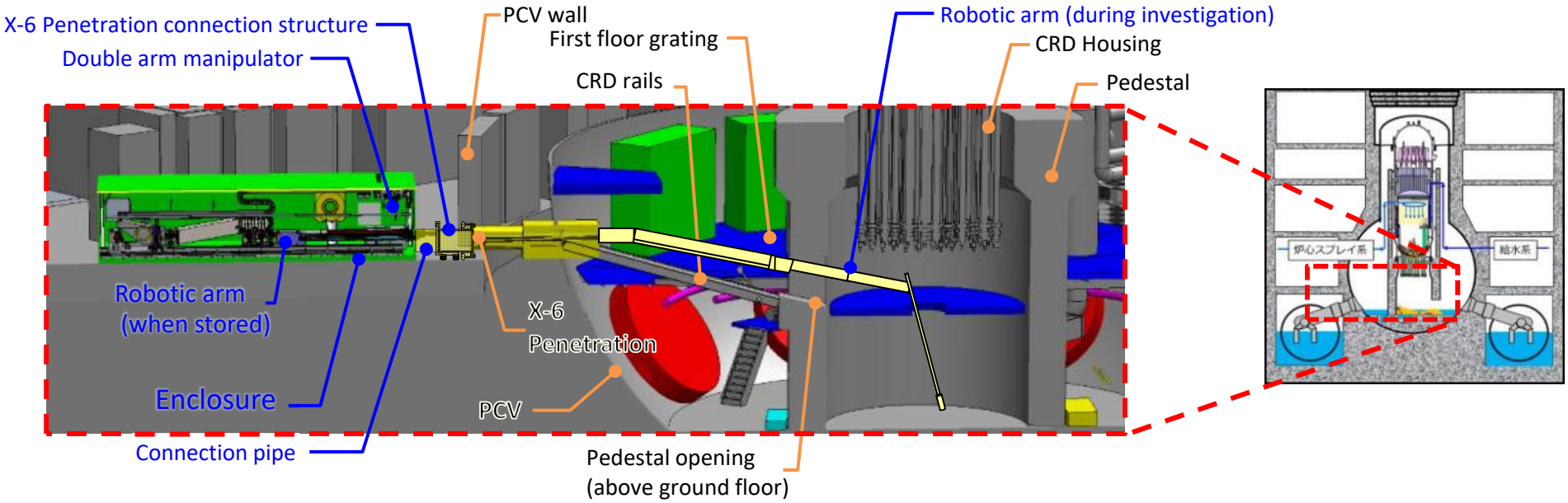
Fukushima Daiichi Nuclear Power Station
Unit 2 PCV Internal Investigation/
Status of Fuel Debris Trial Retrieval

October 31, 2024

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.
  - The X-6 Penetration connection structure isolates the inside of the PCV from the outside
  - The connection pipe shields radiation
  - A metal box that contains the telescopic device and 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. Field Preparation Work Progress
Primary Steps of the Fuel Debris Trial Retrieval (Internal Investigations/Debris Sampling)

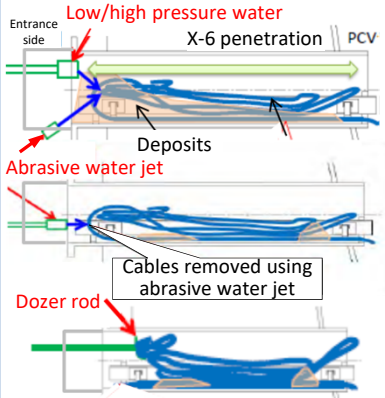
IRID TEPCO

1. Isolation chamber installation

2. Opening of the X-6 penetration hatch

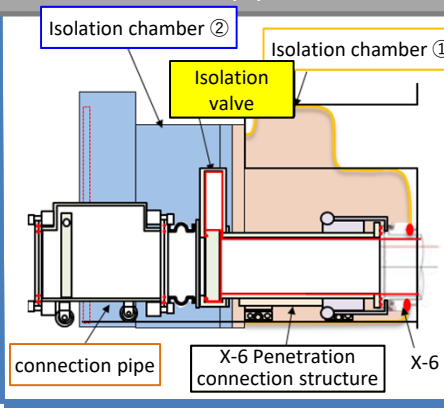
3. Removal of deposits from inside the X-6 penetration

Removing deposits/cables from inside the X-6 penetration



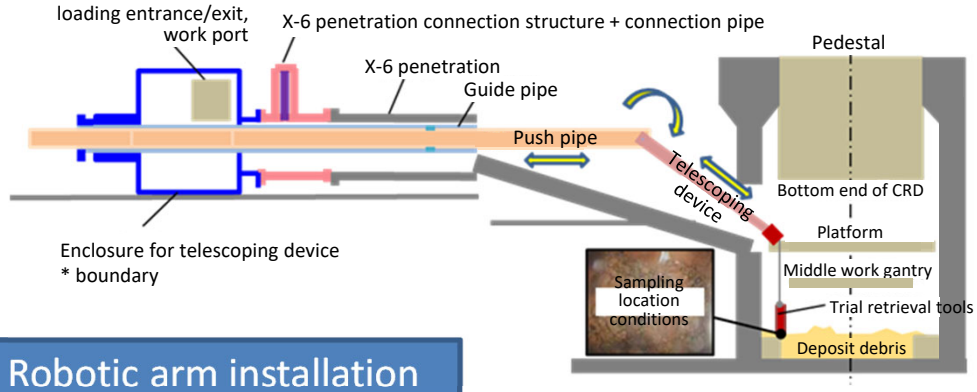
- Deposits pushed with low/high-pressure water
- Cables removed with Abrasive water jet
- Cables pushed with dozer rod

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

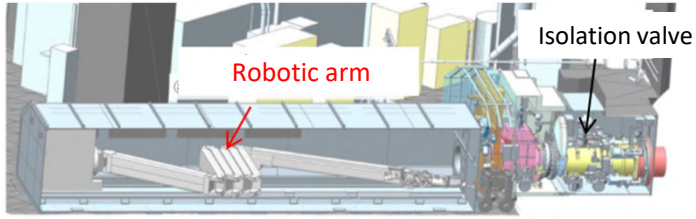


The connecting structure and connection pipe will be installed at the X-6 penetration and the boundary will be changed from the isolation chamber to the connection structure.

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

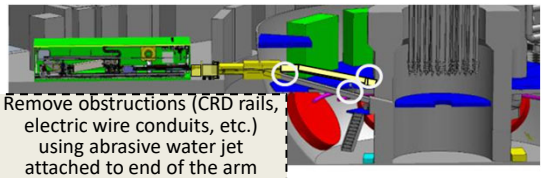


7. Robotic arm installation

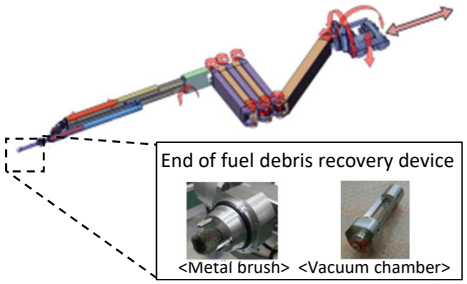


8. Internal investigation/debris sampling using robotic arm

① Internal investigation



② debris sampling using robotic arm



(Note)

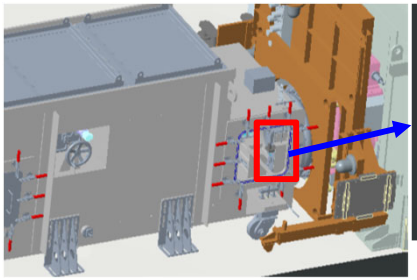
Isolation valve: Valve installed to separate the inside of the PCV from the outside

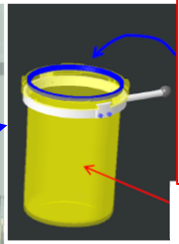
Abrasive Water Jet: Combines high pressure water with an abrasive to improve cutting ability

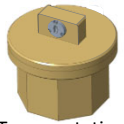
2-2. Field Preparation Work Progress
Primary Steps of the Fuel Debris Trial Retrieval (Internal Investigations/Debris Sampling)

(From Step 6 on the previous slide)

9-1. Collection of fuel debris





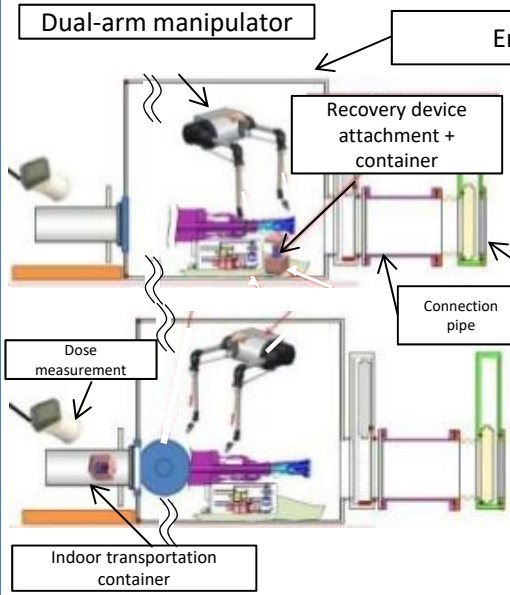


Transportation box

Indoor transportation container (DPTE container)

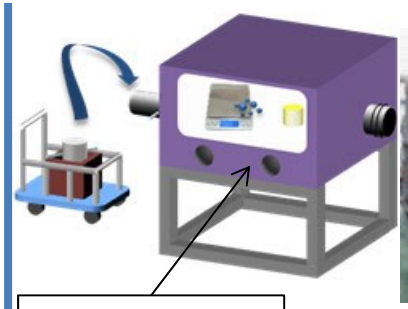
(From Step 8 on the previous slide)

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

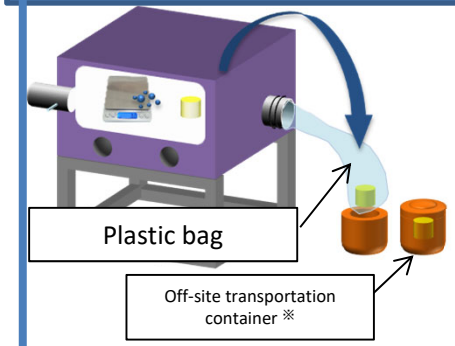


Glovebox

<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



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

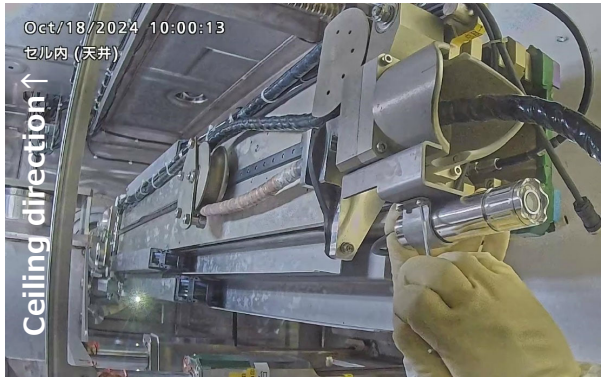
12. Off-site transport and off-site analysis

(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 th
same time, it allows the items to be transferred while maintaining a sealed environment.

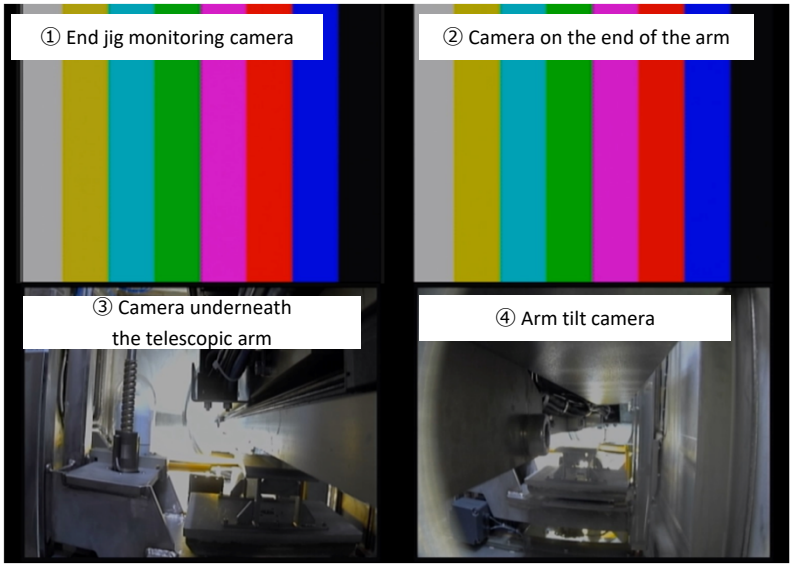
3. Field Work Progress Status (Replacing the Cameras)

■ After completing the final check of the camera replacement procedures, we commenced to replace the cameras on October 16, we conducted cable conduction tests for the end jig monitoring camera (camera ①) and the camera on the end of the arm (camera ②), and replaced cameras ① and ②. There were no problems with cable conductivity, and we have confirmed that the camera footage from both of the new cameras is being sent properly to the remote operations room.

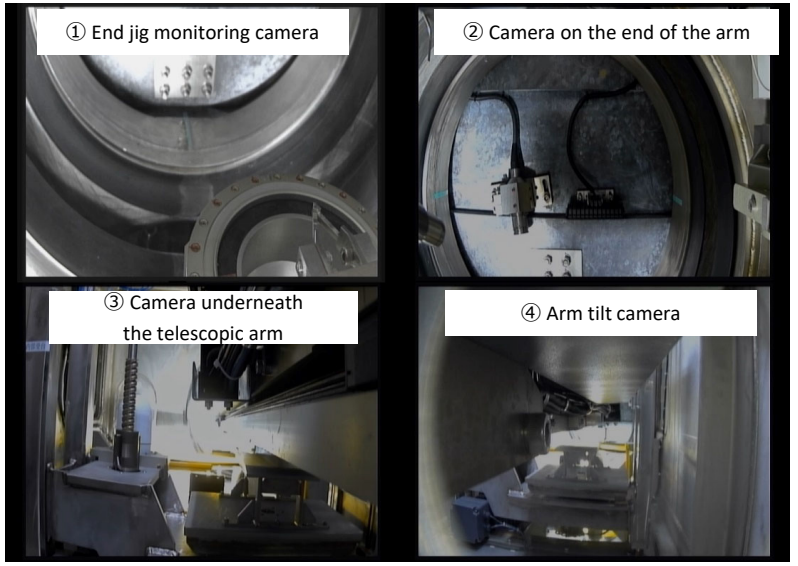
Working on the end jig monitoring camera (camera ①)



Working on the camera on the end of the arm (camera ②)



Prior to camera replacement



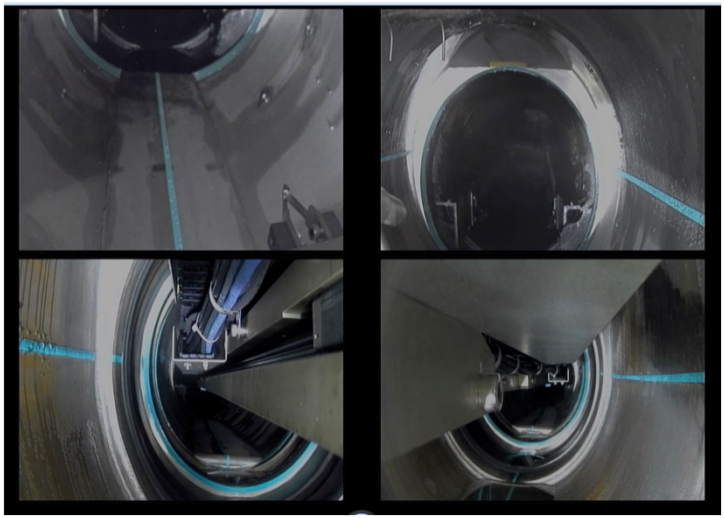
After camera replacement

4-1. Field Work Progress Status (Fuel Debris Trial Retrieval)

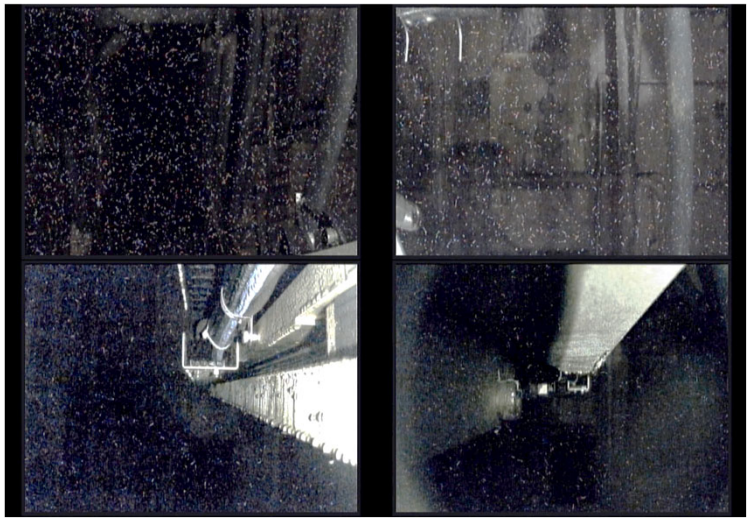
■ As the replacement of cameras, pre-consideration and final check of procedures for the recommencement of work have been completed, trial retrieval of fuel debris has recommenced since October 28. The isolation valve of X-6 penetration structure was opened, and the guide pipe were inserted.

TEPCO witnessing the work
in the remote operations room

Connecting push pipe ② to push pipe ①



Guide pipe insertion work in progress (October 28)

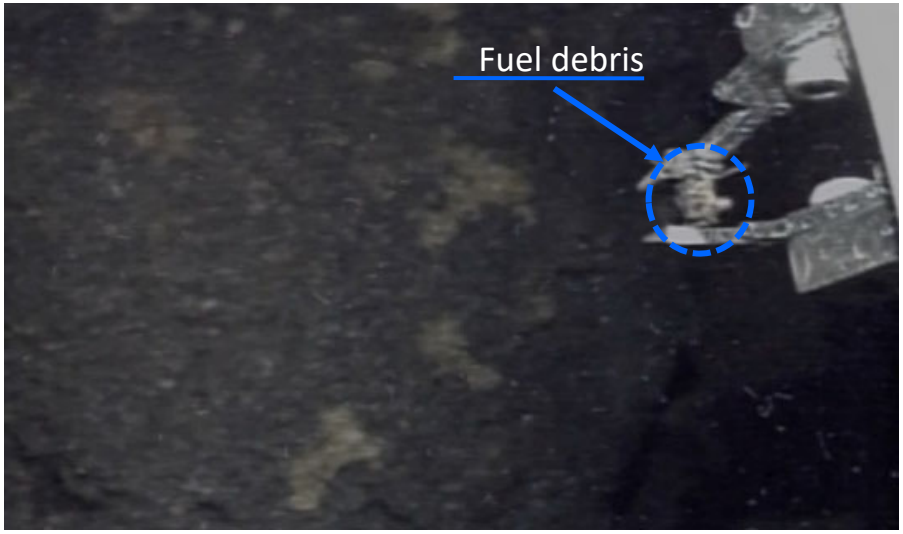


Guide pipe insertion work in progress (October 29)

4-2. Field Work Progress Status (Fuel Debris Trial Retrieval)

- On October 30, the end jig of the telescopic device was lowered to perform a fuel debris grasping work at the bottom of the pedestal.
- The end jig returned to the position before work starts while its gripper still holds the fuel debris and the grasping work was completed.
- The guide pipe is being removed, and radiation of the fuel debris will be measured after the end jig is returned inside the enclosure.

At the remote operations room



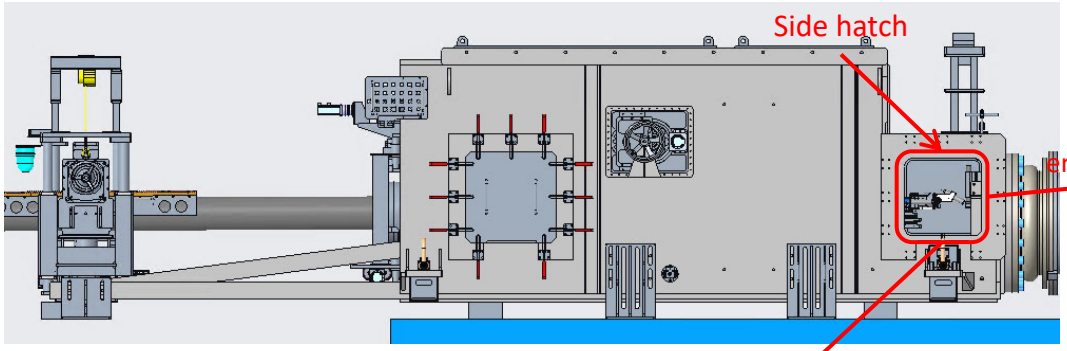
End jig grasping fuel debris

[Reference] Field Work Progress Status (Camera Replacement Simulation)

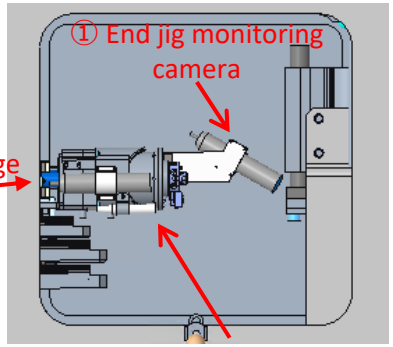
■ In consideration of workability and worker exposure, we deliberated replacing the cameras by accessing them through the side hatch on the enclosure and examined whether replacing the cameras through the side hatch was feasible.

<Examinations>

- A mockup of the enclosure was used to examine the accessibility and feasibility of camera replacement both within and outside the enclosure
- We checked if the cameras could be replaced wearing the same personal protective equipment (PPE) that was needed in the field (cotton gloves and three layers of rubber gloves)

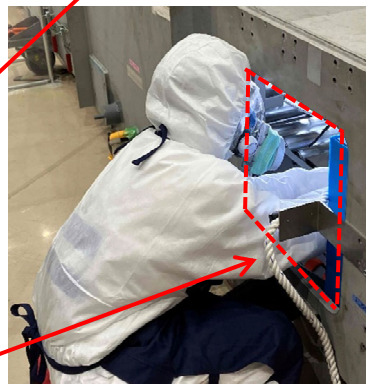


Camera Arrangement

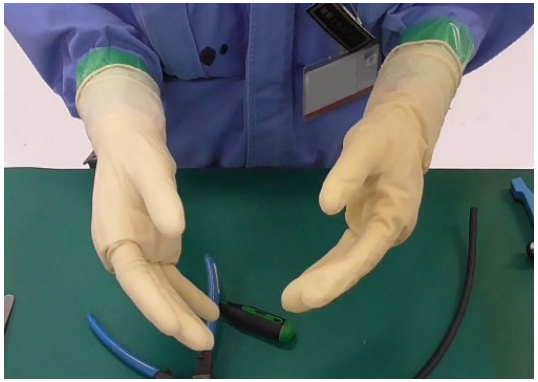


A mockup of the enclosure
(Mitsubishi Heavy Industry Kobe Factor

Side hatch
(same dimensions as on the actual enclosure)



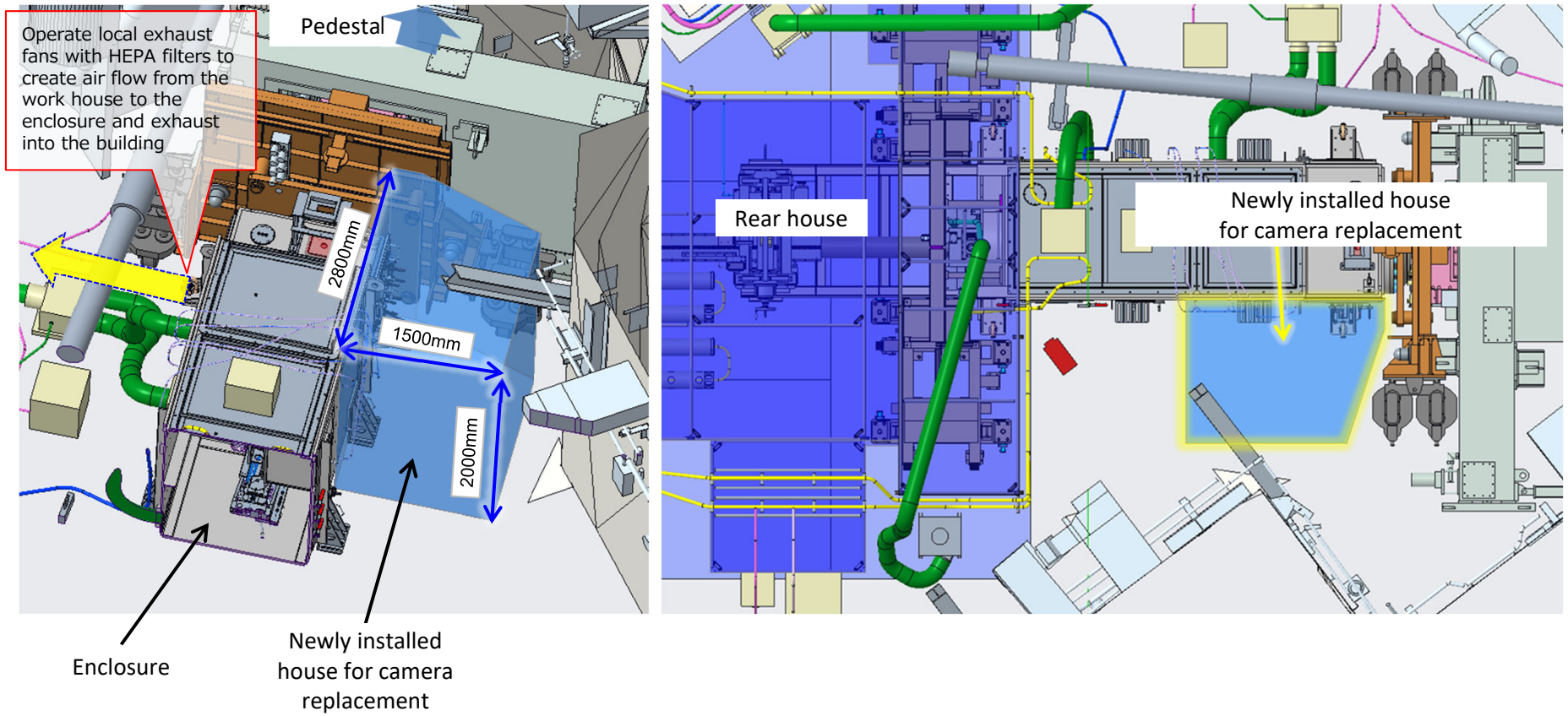
Reviewing accessibility
(Naraha Center for Remote Control Technology Development)



PPE worn during camera replacement
(cotton gloves and three layers of rubber gloves)
*Leather globes are also used when connecting cables.

[Reference] Field Work Progress Status
（Replacing the Cameras to Prevent the Spread of Contamination）

- To prevent the spread of contamination, we installed a house on the side of the enclosure for to be used during camera replacement
- Work tables were set up inside the house to improve the workability for workers when replacing the cameras

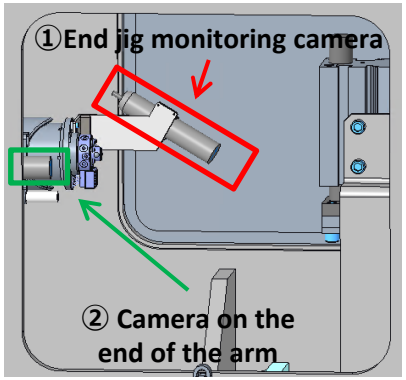


Installing a house on the side of the enclosure for camera replacement

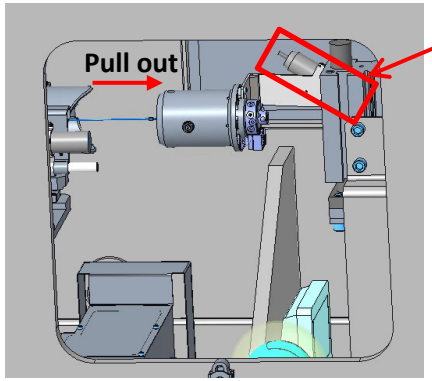
[Reference] Field Work Progress Status (Camera Replacement Procedure)

■ Since the "① end jig monitoring camera" can be removed from inside the enclosure*1, this was conducted outside the enclosure. "② camera on the end of the arm" is fixed to the arm, therefore it took place inside the enclosure.

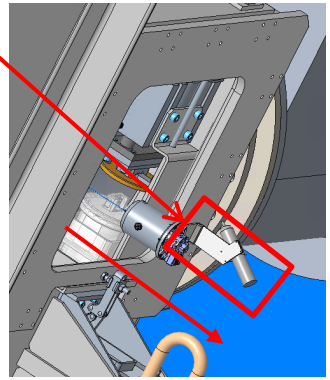
*1 ① end jig monitoring camera is lowered to the bottom of the pedestal with the end jig during fuel debris retrieval, allowing the cable to be pulled out.



[① End jig monitoring camera]



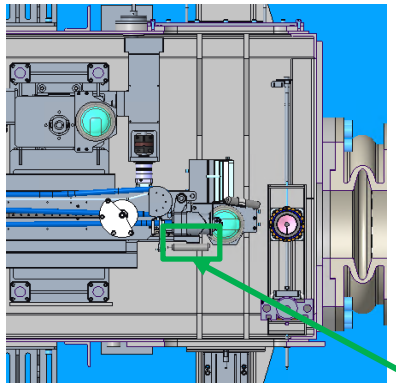
①End jig monitoring camera



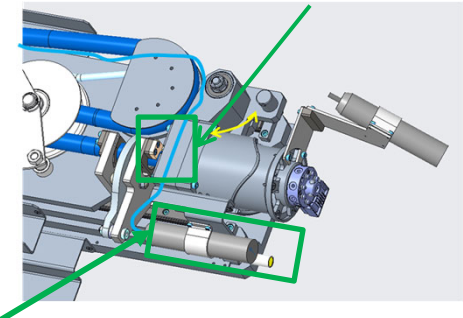
Work performed outside the enclosure

After the cables are connected, the cameras will be re-secured in its original position

[② Camera on end of the arm]



Location where cable is to be cut

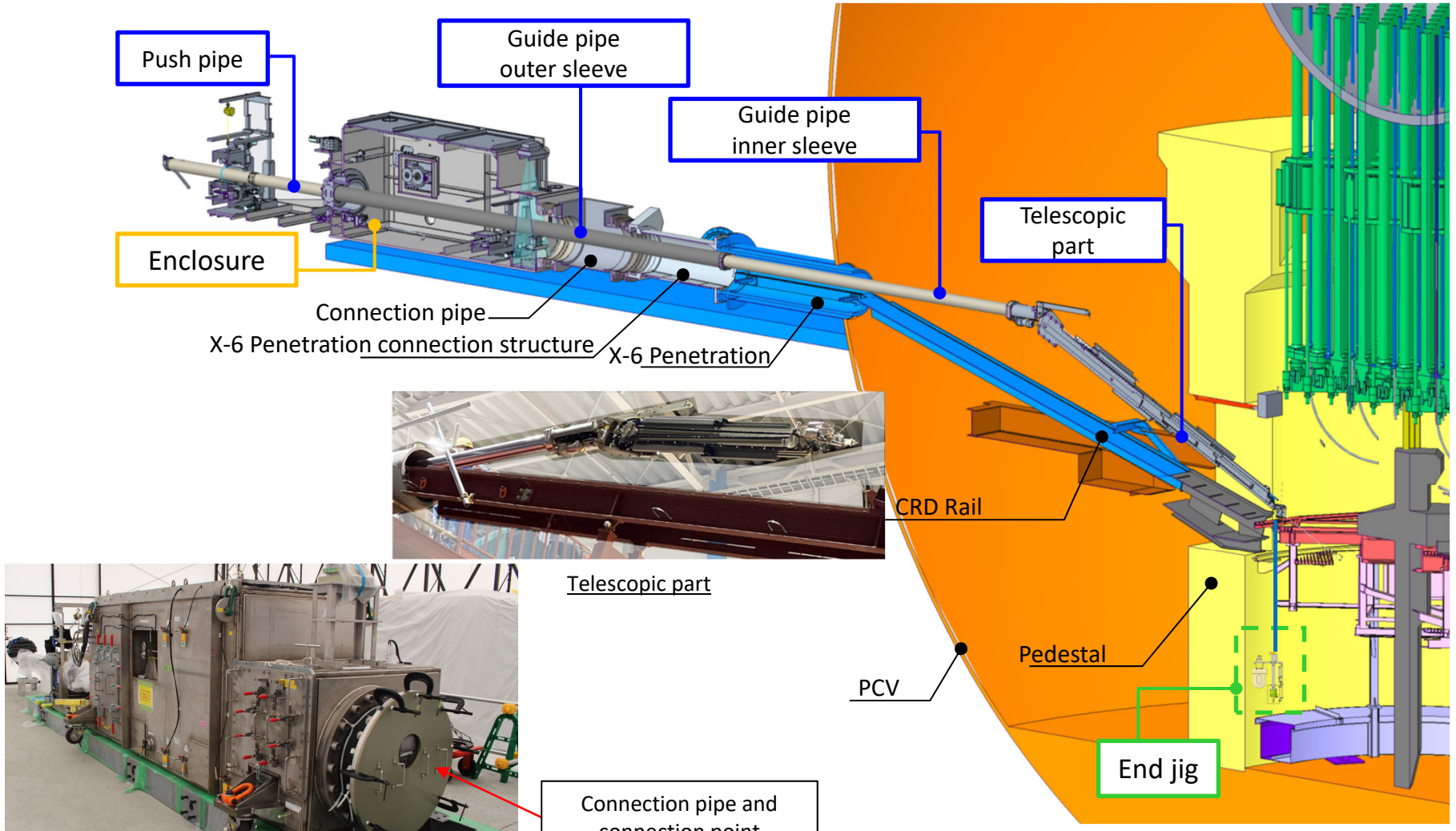


Work performed inside the enclosure

Camera on the end of the arm

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

- The telescopic device will be used for the trial retrieval of fuel debris by accessing the inside of the PCV from the X-6 penetration
- Since it will be connected to the connection pipe, the enclosure will serve as a PCV boundary during the trial retrieval of fuel debris.

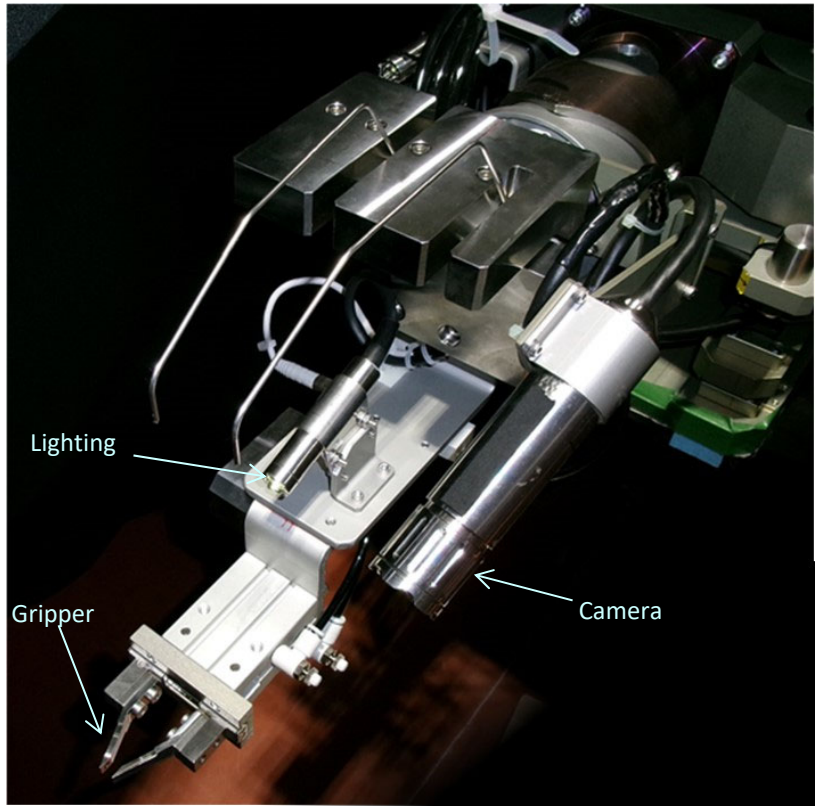


Telescopic part

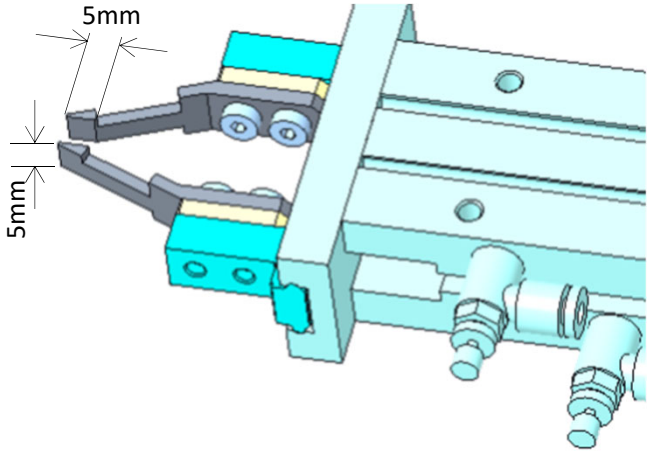
Telescopic device

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

- The gripper tool has been selected as the end jig that will be used during the trial retrieval of fuel debris with the telescopic device
- The end jig camera will be used to determine the size of the fuel debris sampled



Gripper tool

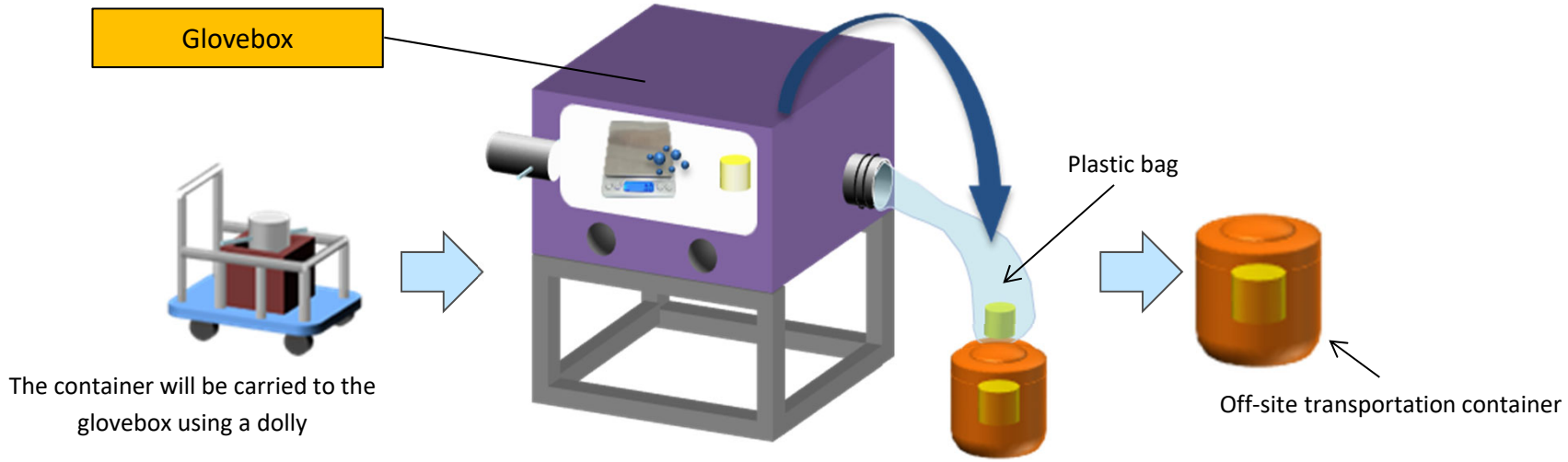


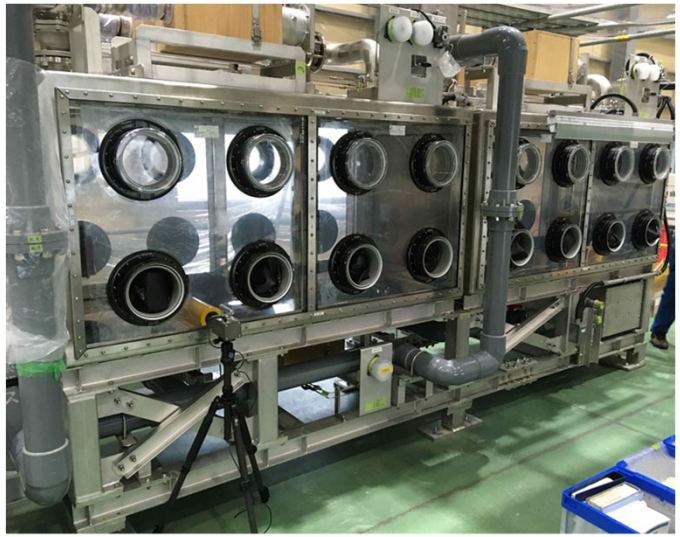
Gripper claws will be used to determine the size (gripper tool)

Camera footage of the gripper tool holding a sphere and a cube shaped mock debris (gripper tool)

[Reference] Glovebox

- The sampled fuel debris will be subjected to dose measurements when it is taken out from the enclosure of the telescopic device or the robotic arm, and then transported to a glovebox inside the reactor building where it will be subjected to various measurements. After measurements have been taken, measures to prevent the spread of contamination shall be implemented and it will be transported off-site





- 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
- 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

[Reference] Safety during Off-site Transport

- The fuel debris sampled during trial retrieval will be transported to an off-site analysis facility (JAEA Oarai)
- We have confirmed that the transport container will remain sealed even when subjected to various test conditions as legally required by law.
- The fuel debris placed inside the specimen container (polyethylene).Then it placed inside a vase-like container (polypropylene, lead).After that it will be sealed inside a bag made of polyvinyl chloride and placed inside the transport container.
- Furthermore, prior to transport we will confirm that surface dose rates and surface contamination density levels fall below legal limits with the fuel debris inside the container.
- Countermeasures have been put in place to prevent the leak of radioactive substances even in the event of an accident.
- In case of a radioactive substances leak, radiation measurements shall be taken and ropes/signs will be used to restrict the area from access after which it will be decontaminated thereby preventing exposure to the general public. All relevant agencies will also be immediately notified.
- Education and training will be provided to parties involved in transport

Legally required technical standards

Item	Standard
Amount of reactivity	Sum of A2 level ratios is below 1 (Approx. 3.7×10^{10} Bq)
Dose equivalent rate	Surface of transported item: below 2mSv/h 1m from surface of transported item: 100μSv/h
Surface contamination density	Alpha nuclide: 0.4Bq/cm^2 All other nuclides: 4Bq/cm^2
Transport container test conditions	Freefall test, compression test, penetration test, etc.

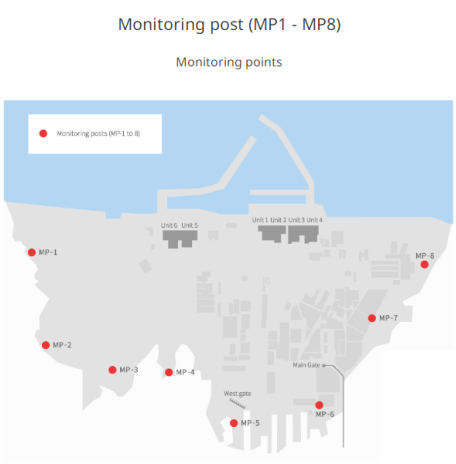
A-type transport container

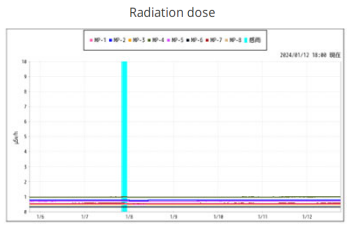
[Reference] Environmental Impact (1/2)

- Although the removal of deposits from inside the Unit 2 X-6 penetration has been ongoing since January 10, and we are planning to begin the trial retrieval of fuel debris in the future, but we have not seen any radiological impact on the surrounding environment.
- During investigations, 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.



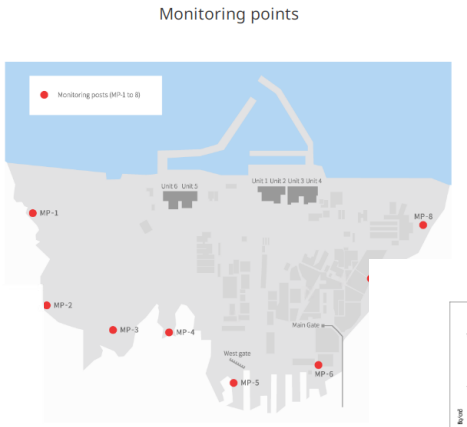


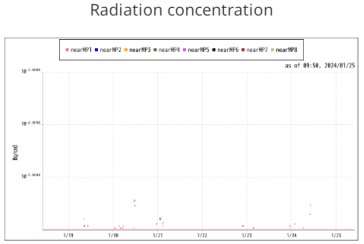
MP Unit : μSv/h Wind Velocity Unit : m/s
Measurement value (2024/01/12 18:00)

MP-1	MP-2	MP-3	MP-4	MP-5	MP-6	MP-7	MP-8	風向	風速	感雨
0.517	0.783	0.490	0.987	0.703	0.315	0.566	0.530	北北西	1.4	無

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.





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)

- Although the removal of deposits from inside the Unit 2 X-6 penetration has been ongoing since January 10, and we are planning to begin the trial retrieval of fuel debris in the future, plant parameters are continuously monitored. We have seen no significant fluctuations in primary containment vessel temperature neither prior to or after work, and there's been no change in the status of cold shutdown state.
- 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

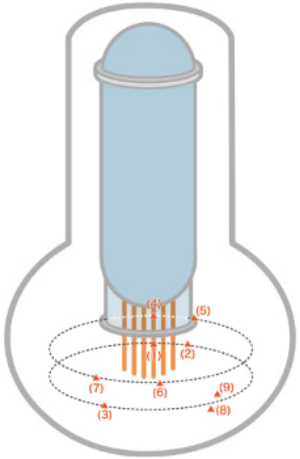
[Reference] Screen image of our website

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

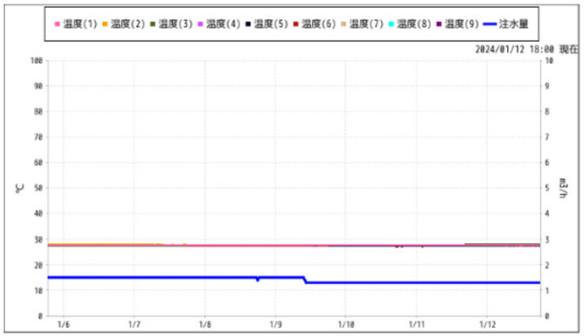
Here are the measurement results of temperatures inside the Unit 2 Primary Containment Vessel at Fukushima Daiichi Nuclear Power Station.

Monitoring points

Unit 2 reactor containment vessel



Temperature



Temperature Unit:℃, Water Injection Unit : m³/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