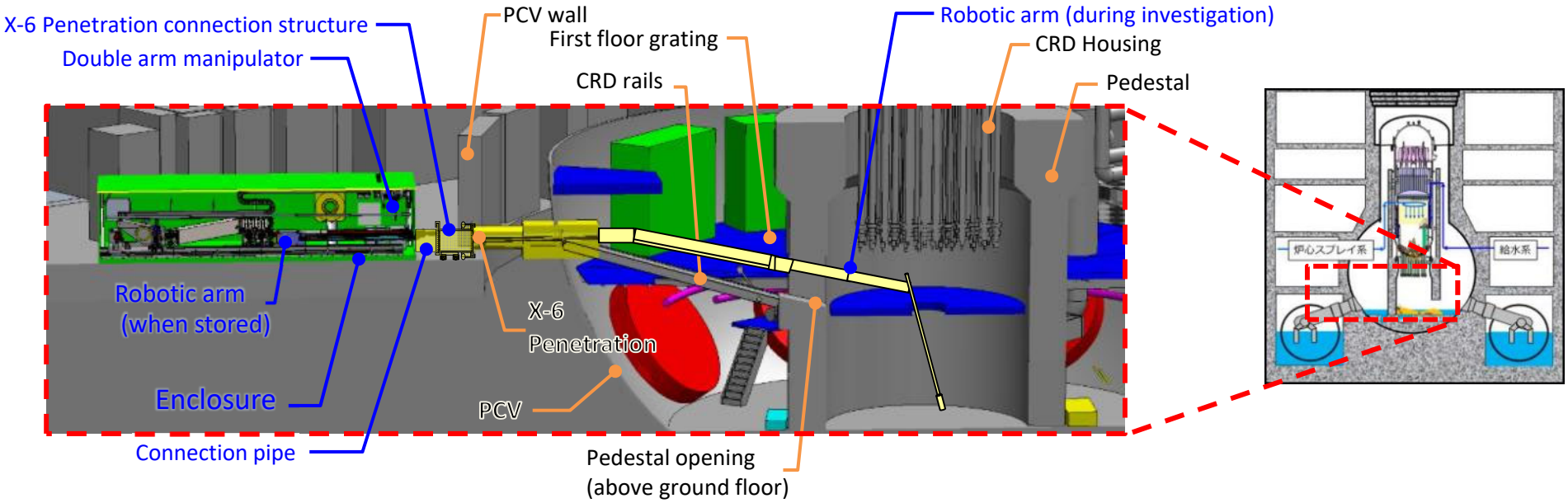
Fukushima Daiichi Nuclear Power Station
Unit 2 PCV Internal Investigation/
Preparation Status of Fuel Debris Trial Retrieval

July 25, 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

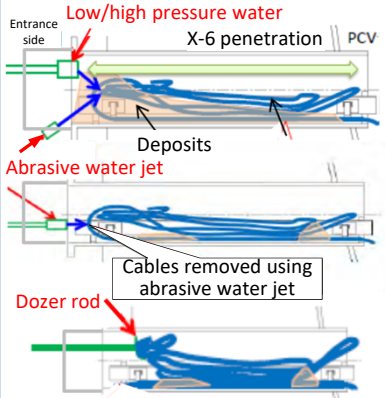
2-1. Field Preparation Work Progress
Primary Steps of the Fuel Debris Trial Retrieval (Internal Investigations/Debris Sampling)

1. Isolation chamber installation

2. Opening of the X-6 penetration hatch

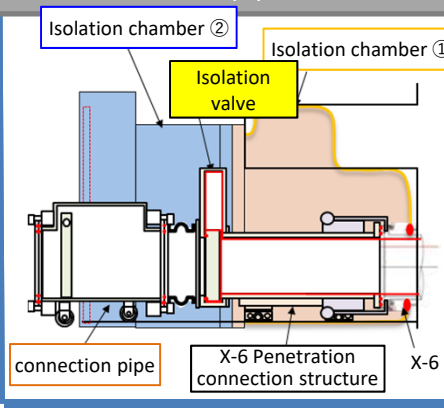
3. Removal of deposits from inside the X-6 penetration

Removing deposits/cables from inside the X-6 penetration



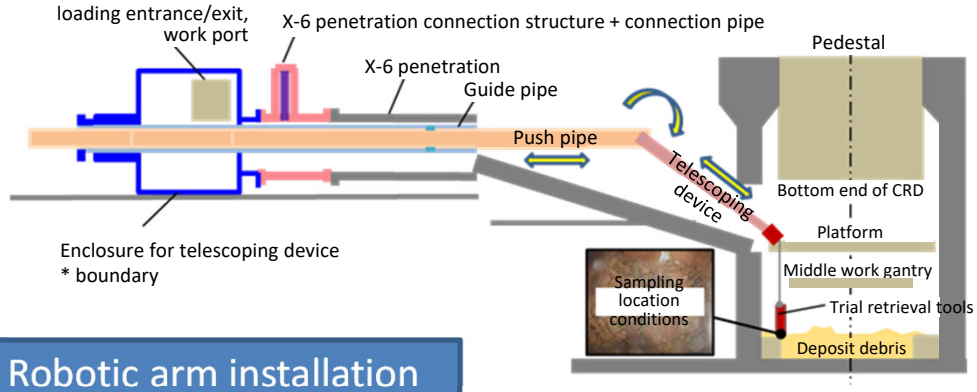
- Deposits pushed with low/high-pressure water
- Cables removed with Abrasive water jet
- Cables pushed with dozer rod

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

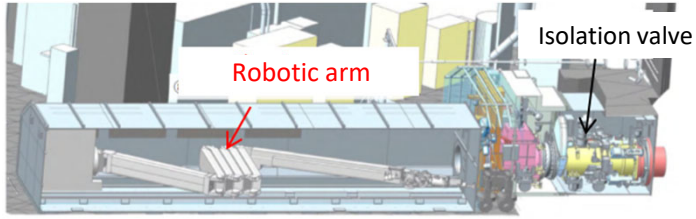


The connecting structure and connection pipe will be installed at the X-6 penetration and the boundary will be changed from the isolation chamber to the connection structure.

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

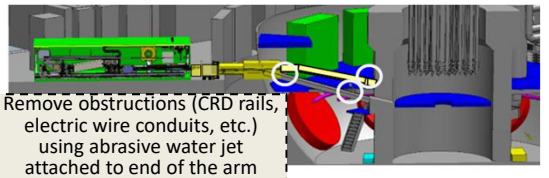


7. Robotic arm installation

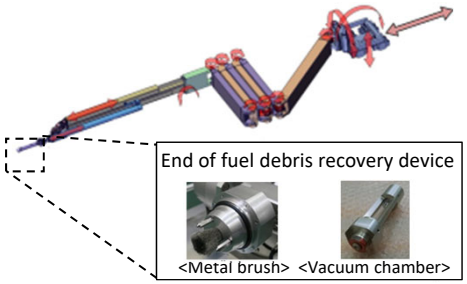


8. Internal investigation/debris sampling using robotic arm

① Internal investigation



② debris sampling using robotic arm



(Note)

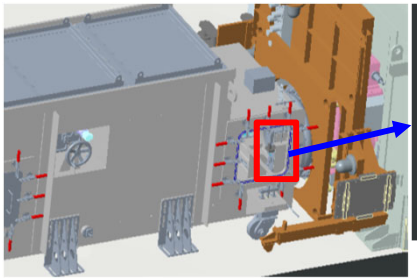
Isolation valve: Valve installed to separate the inside of the PCV from the outside

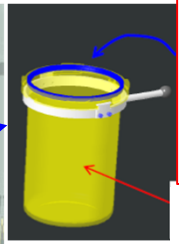
Abrasive Water Jet: Combines high pressure water with an abrasive to improve cutting ability

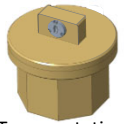
2-2. Field Preparation Work Progress
Primary Steps of the Fuel Debris Trial Retrieval (Internal Investigations/Debris Sampling)

(From Step 6 on the previous slide)

9-1. Collection of fuel debris





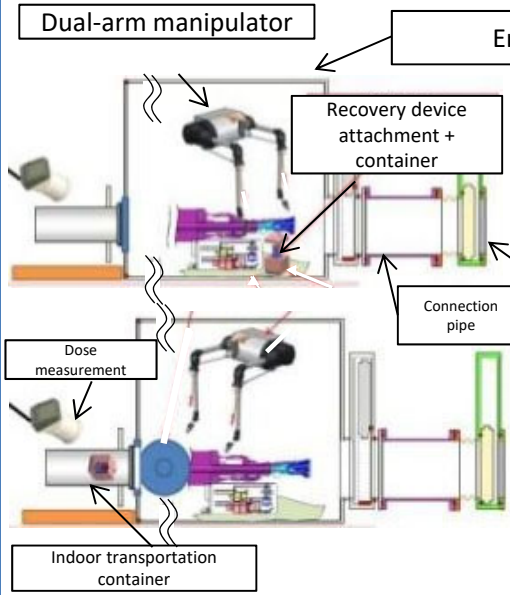


Transportation box

Indoor transportation container (DPTE container)

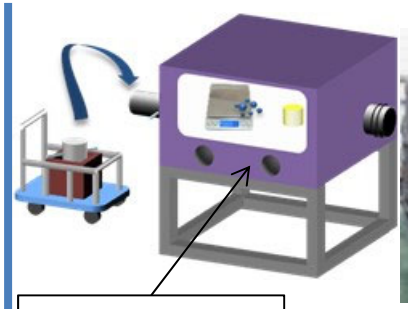
(From Step 8 on the previous slide)

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

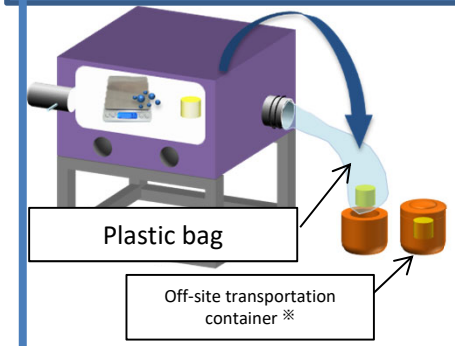


Glovebox

<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

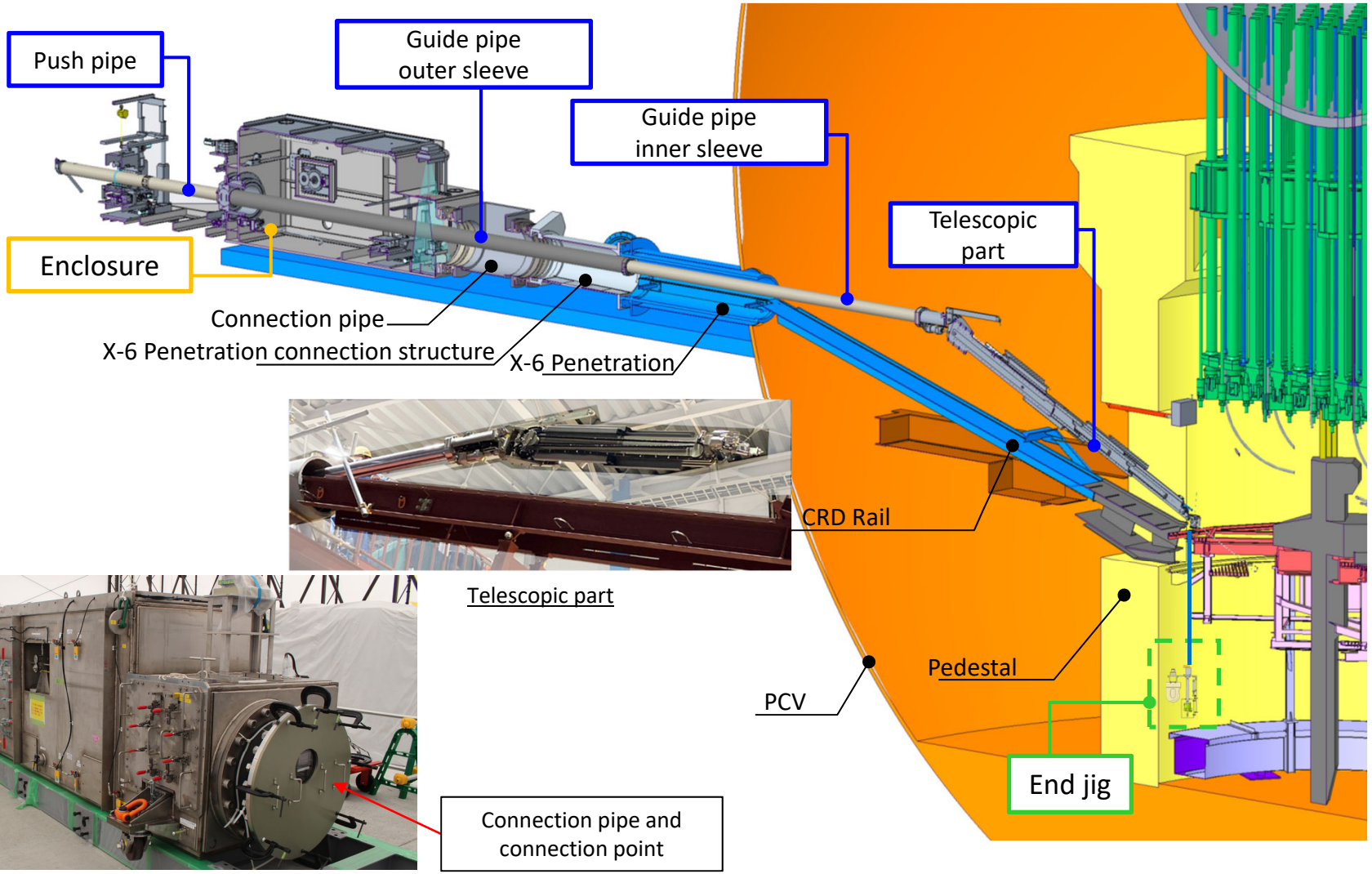
※ Prior to transport, the surface dose/contamination density, etc. of the container shall be measured to ensure that it meets legal requirements

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.

3-1. 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.

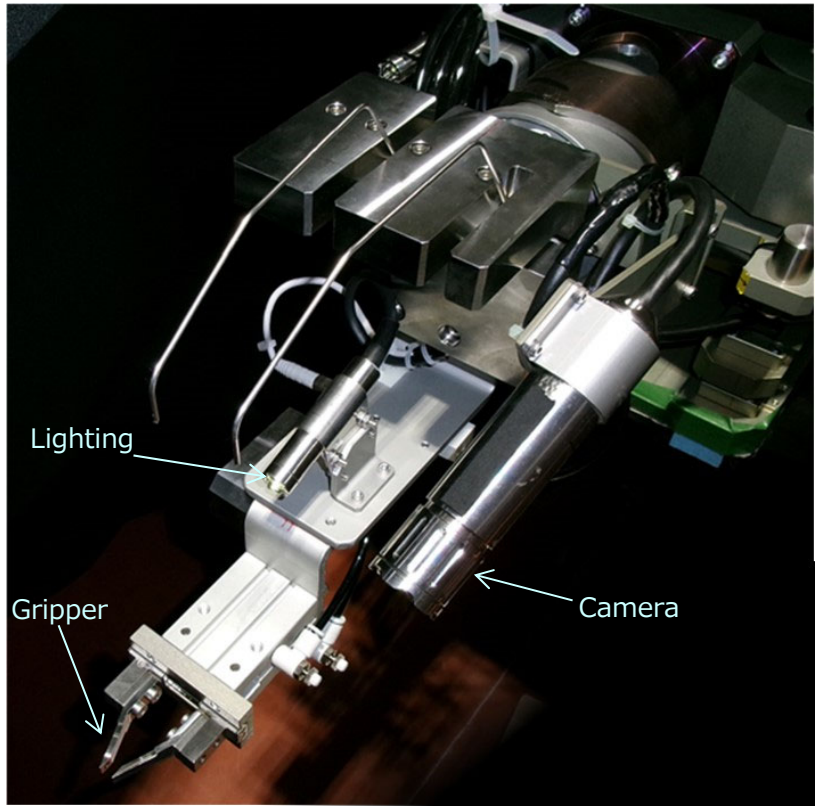


Telescopic part

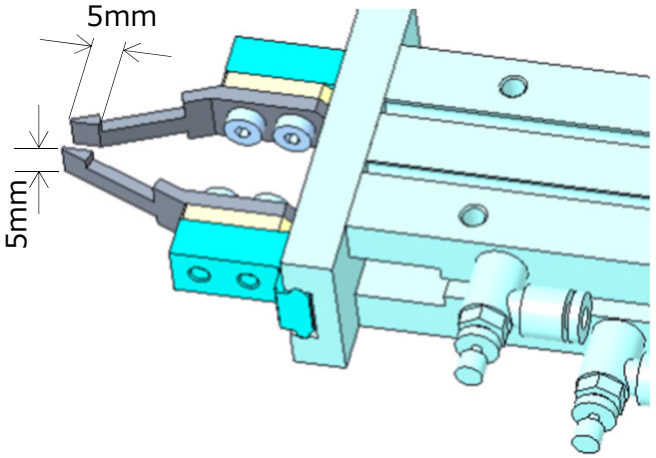
Telescopic device

3-1. 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

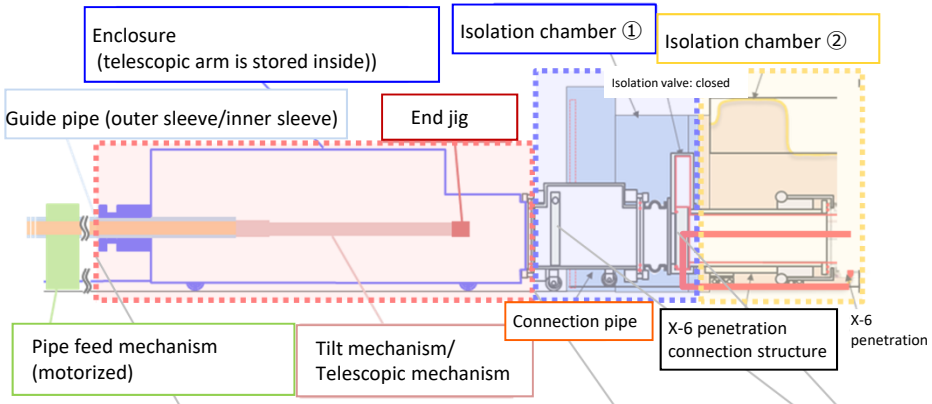


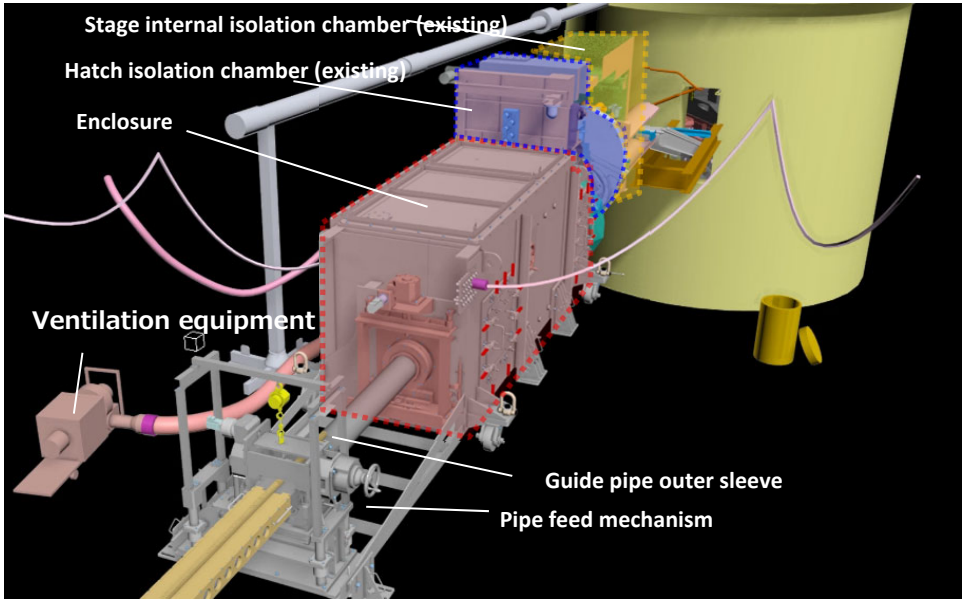
Gripper claws will be used to determine the size (gripper tool)

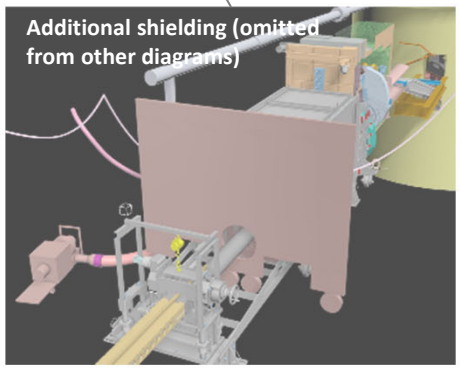
Camera footage of the gripper tool holding a sphere and a cube shaped mock debris (gripper tool)

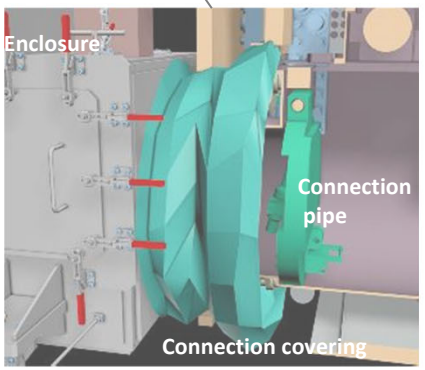
3-2. Work details: Loading and installation

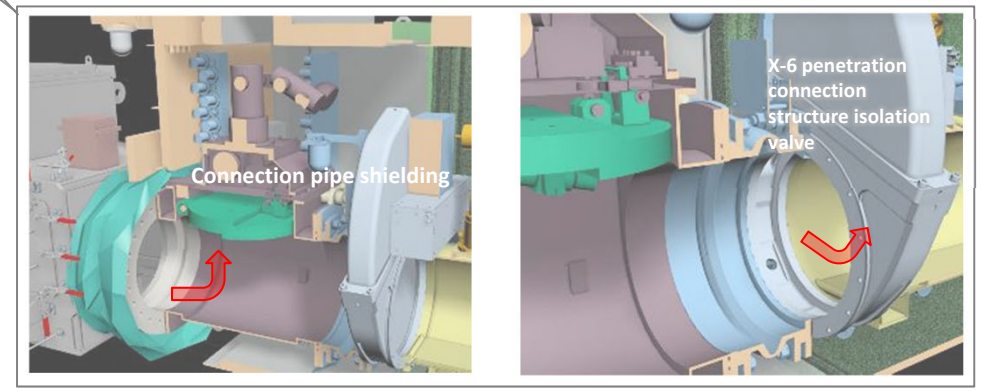
- The enclosure will be installed behind the X-6 penetration connection structure and connection pipe
- Ventilation equipment, plastic bags for covering the connections, additional shielding, and a rear contamination prevention house will also be installed
- After the atmosphere inside the enclosure is replaced with nitrogen and equalized, the connection pipe shielding and X-6 penetration connection structure isolation valve will be opened





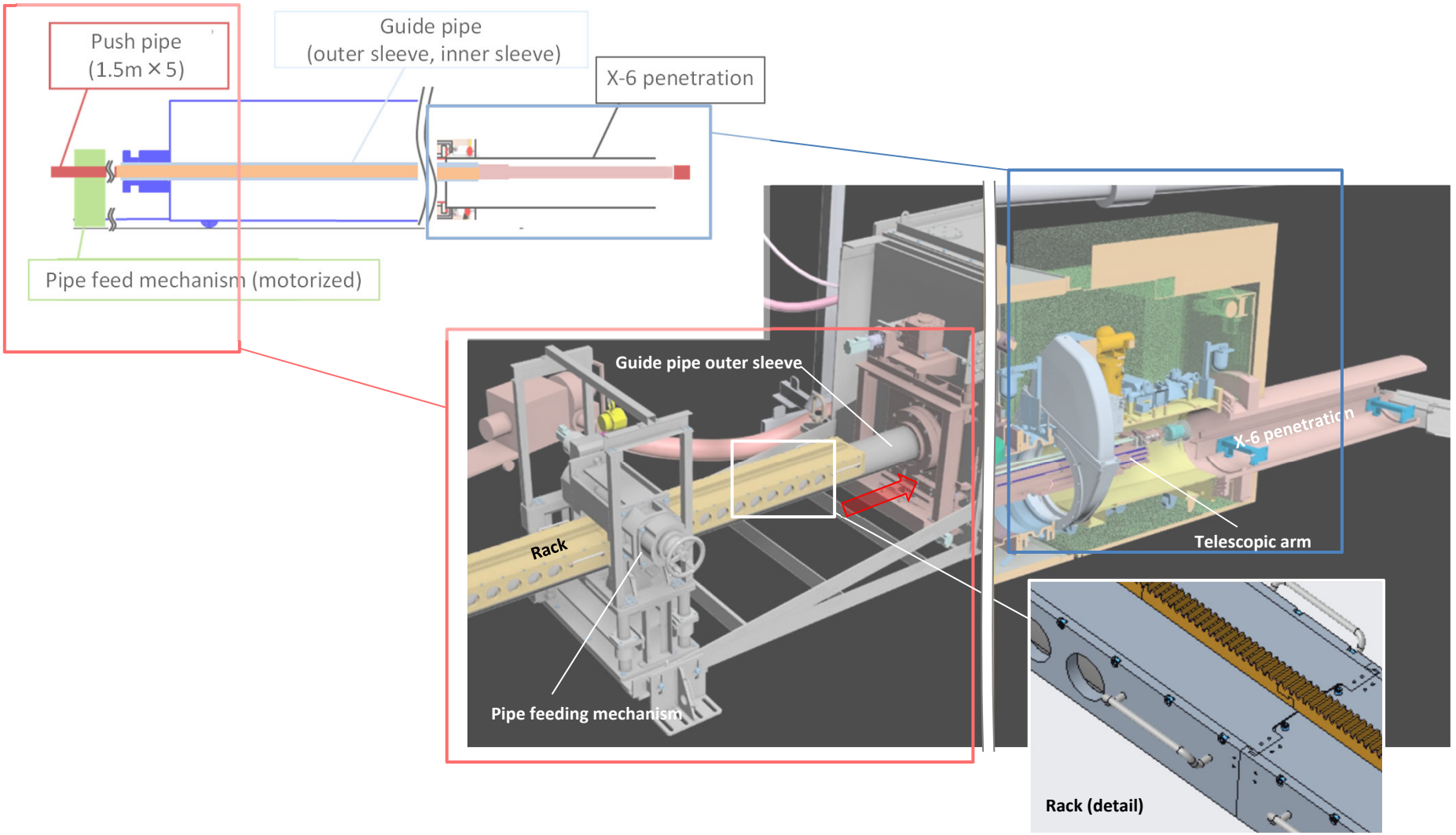






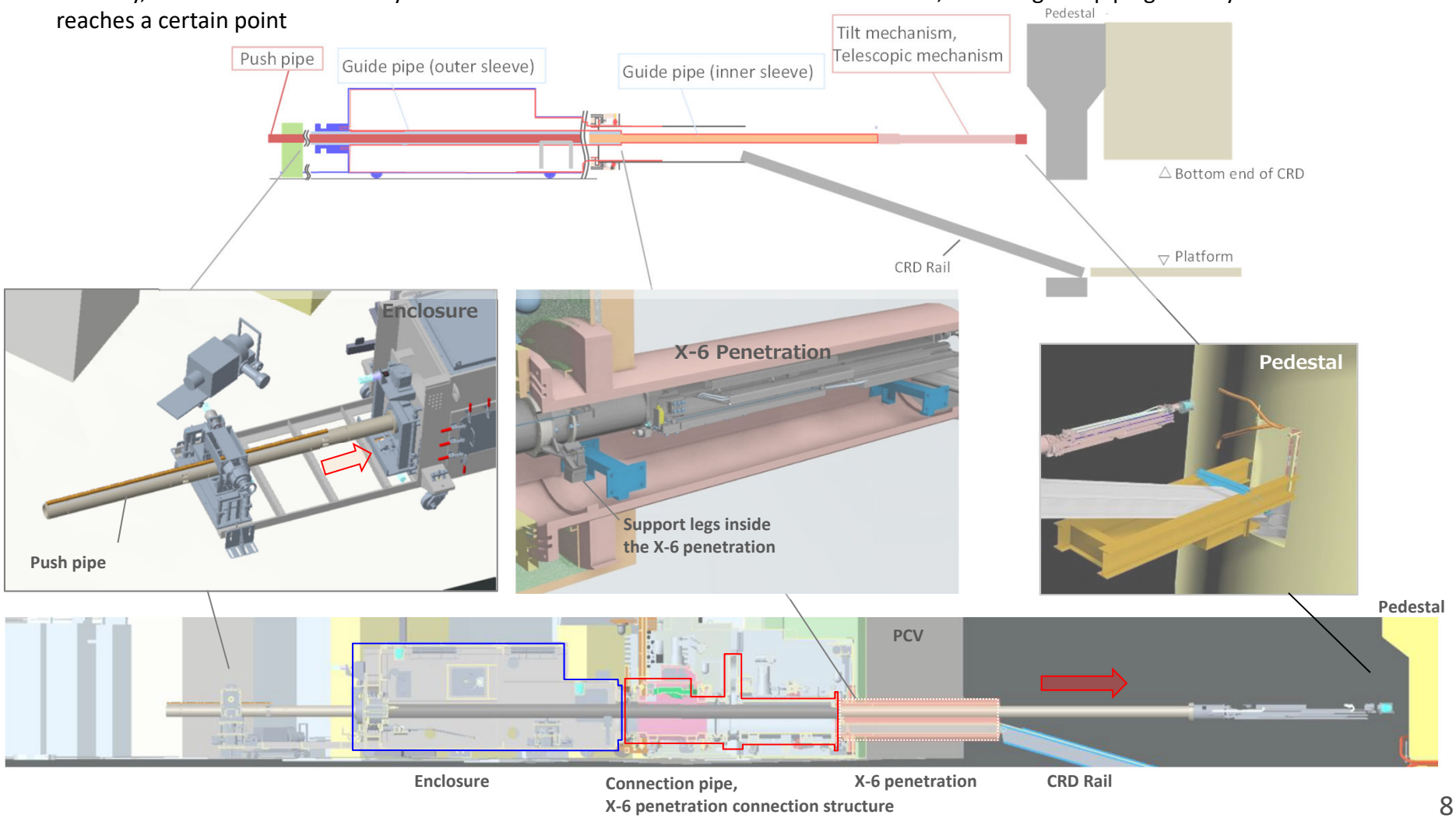
3-2. Work details: Outer sleeve installation and insertion

- The guide pipe outer sleeve will be inserted into the PCV using the pipe feed mechanism (motor-driven/remotely operated)
- The rack will be manually removed before it makes contact with the enclosure, and the guide pipe gradually fed in until it reaches the end of the outer sleeve of the guide pipe



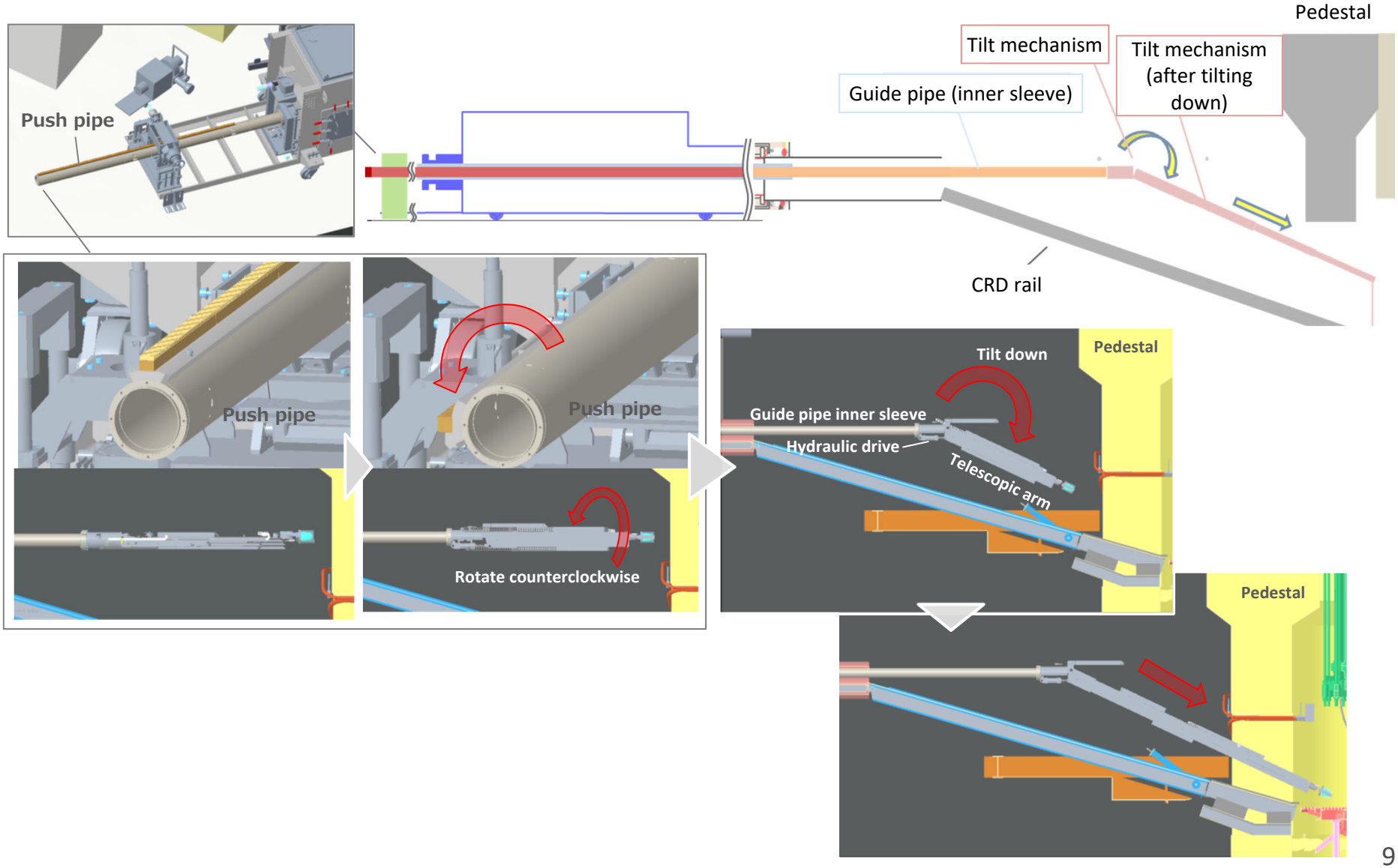
3-2. Work details: Inner sleeve insertion (1/2)

- The push pipe will be manually connected to the inner sleeve of the guide pipe, and the support legs inside the X-6 penetration will be used to support the outer sleeve of the guide pipe
- The pipe feed mechanism will be used to push out the push pipe that was used to install the rack and the inner sleeve of the guide pipe will be inserted into the PCV
- Similarly, the rack will be manually removed before it makes contact with the enclosure, and the guide pipe gradually fed in until it reaches a certain point



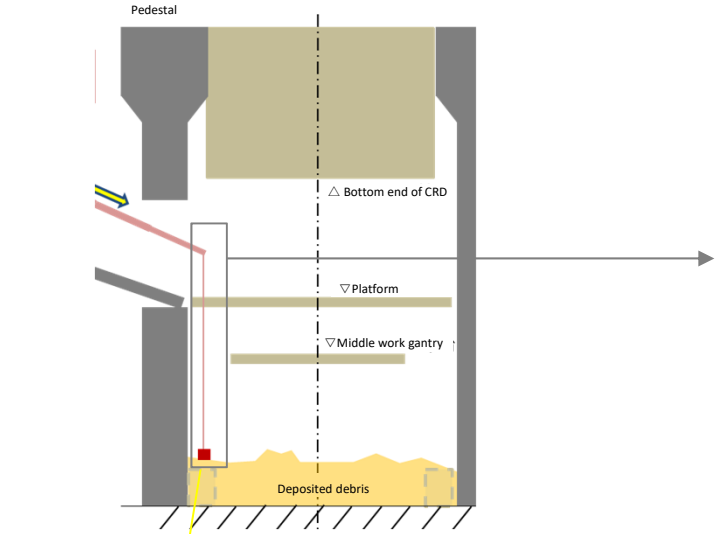
3-2. Work details: Inner sleeve insertion (2/2)

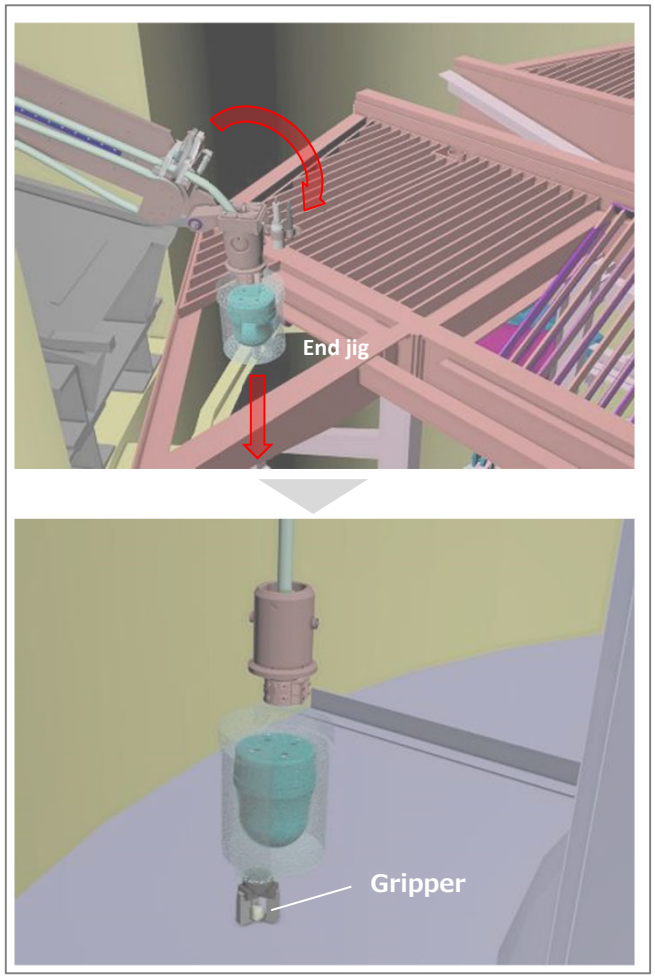
- The push pipe will be manually rotated 90° counterclockwise as seen from the back of the enclosure
- A hydraulic drive will be used to tilt the telescopic mechanism down and insert it towards into the pedestal



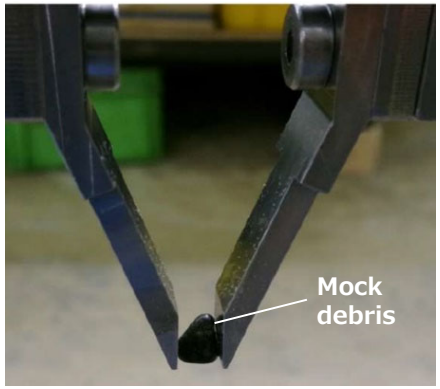
3-2. Work details: Fuel debris sampling

- The end jig shall be pointed downwards (motorized), and lowered towards the bottom of the pedestal
- 3g or less of fuel debris shall be sampled with the end jig (planned amount)
- After taking the fuel debris sample, the end jig will be hoisted up





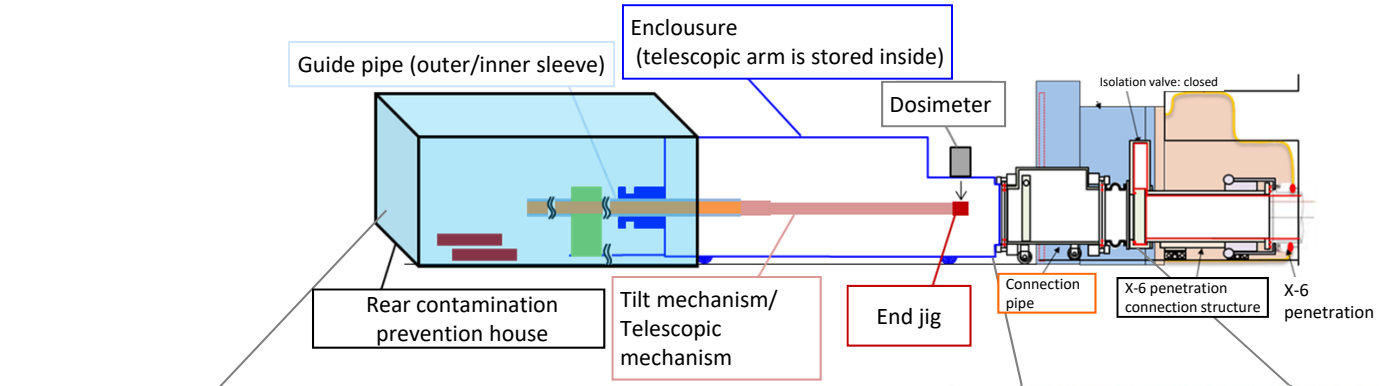
(Simplified schematic of conditions at the bottom of the pedestal)

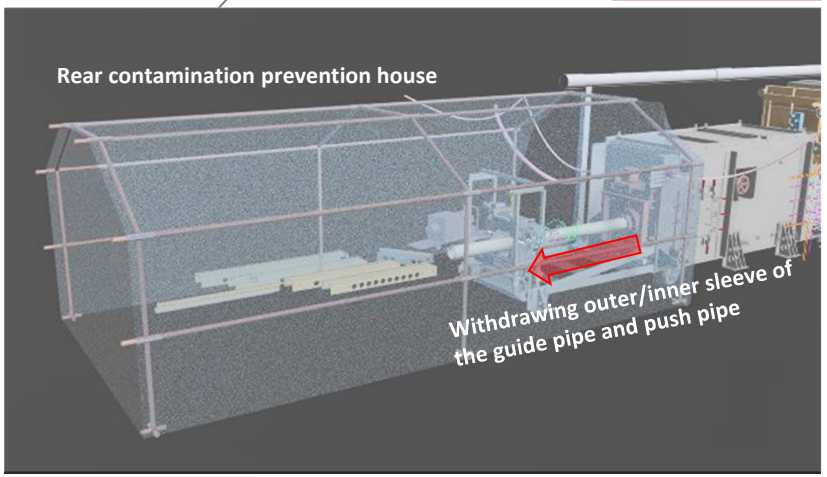


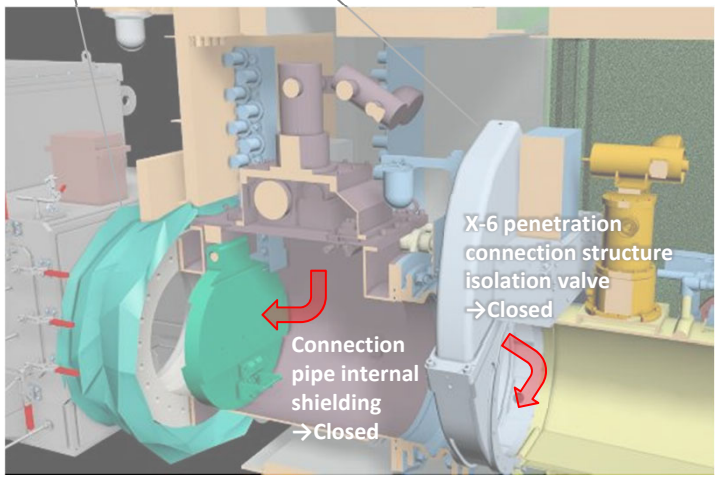
End jig (gripper type)

3-2. Work details: Removing the outer sleeve/inner sleeve

- The guide pipe (outer sleeve/inner sleeve) and push pipe shall be withdrawn using the reverse of the procedure for insertion
- The X-6 penetration connection structure isolation valve and connection pipe internal shielding shall be closed

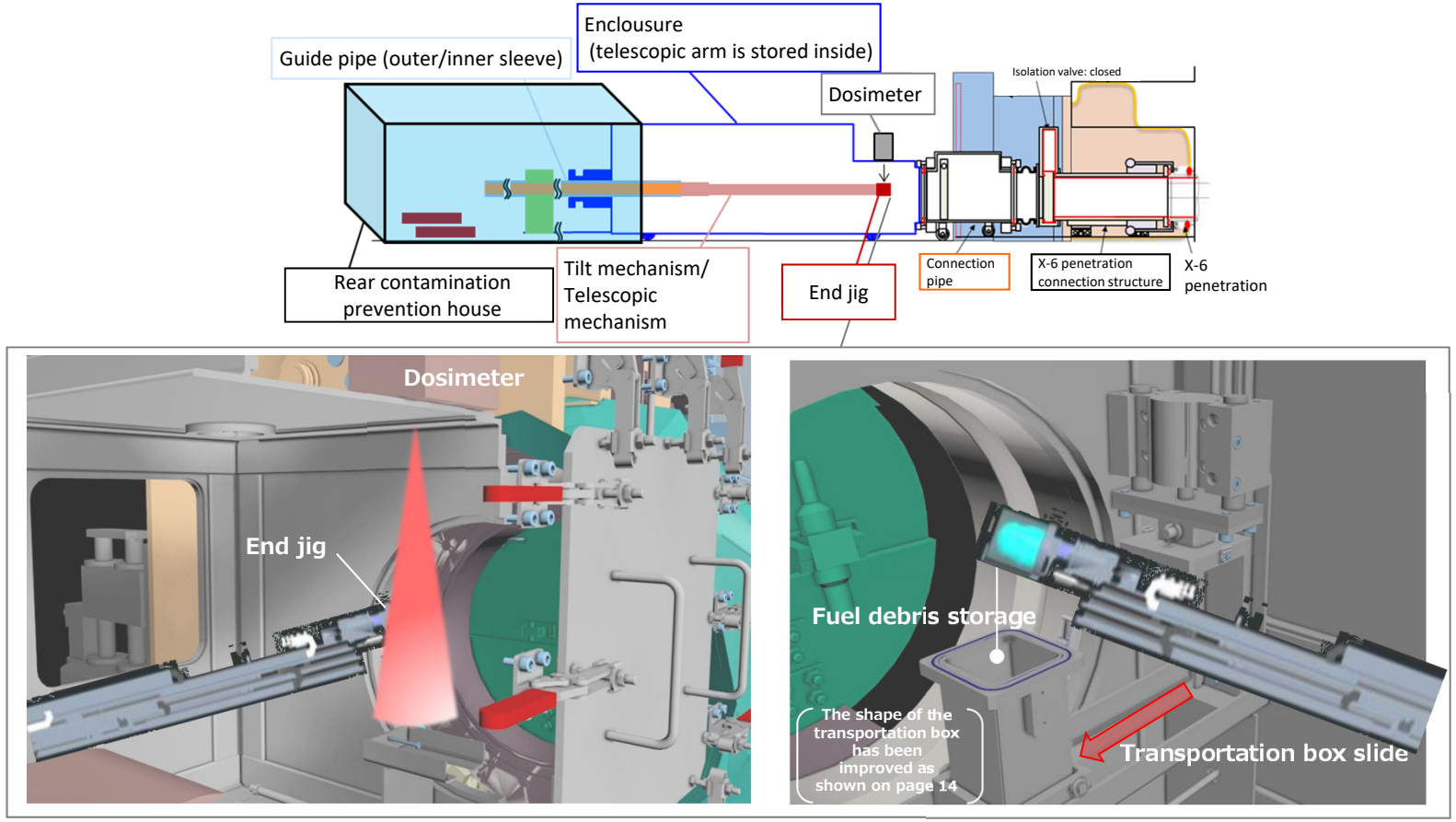






3-2. Work details: Fuel debris storage (1/3)

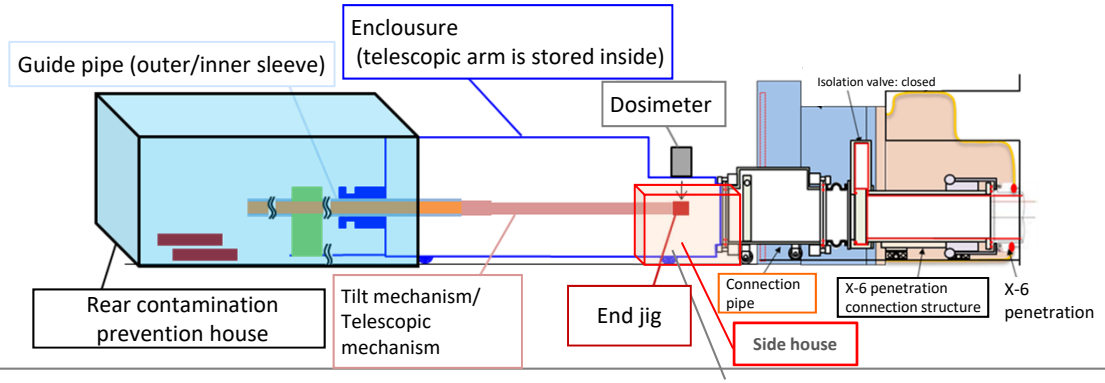
- The dose rate of the sampled fuel debris in the enclosure shall be measured by a dosimeter from outside of the enclosure (At a distance of 20cm. If the dose rate exceeds 24mSv/h, it will be returned to the PCV)
- The transportation box shall be slid under the end jig and the fuel debris shall be put inside the transportation box.

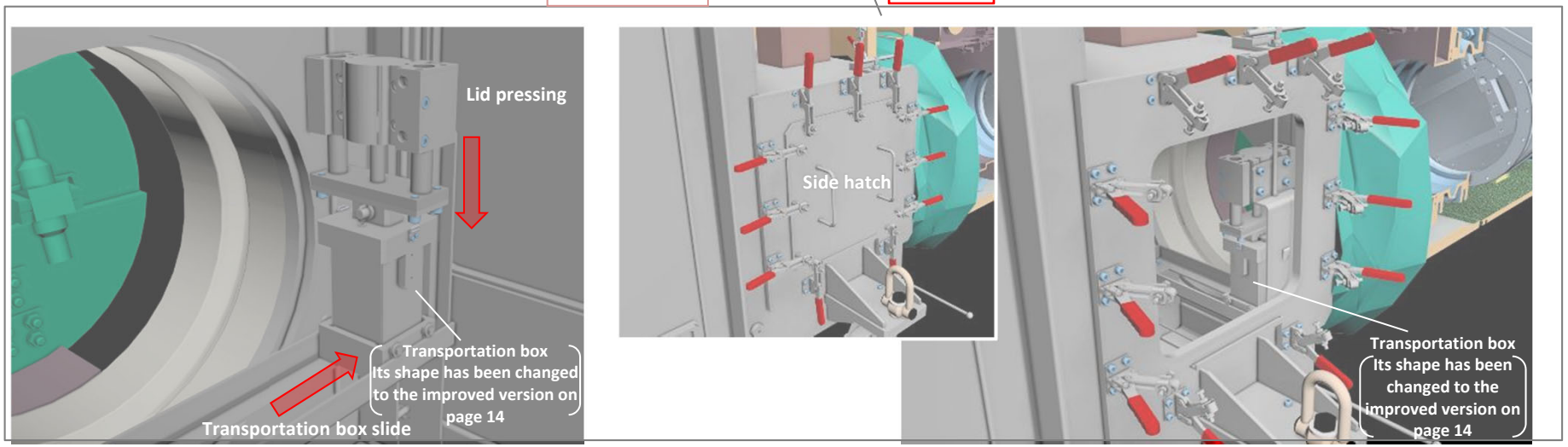


(Some components have been omitted to show the procedure)

3-2. Work details: Fuel debris storage (2/3)

- The enclosure shall be reduced to atmospheric pressure and the nitrogen replaced with atmosphere while radioactive dust is removed
- The transportation box shall be slid to the hatch side of the enclosure, the lid pressed (hydraulic drive), and conditions formed so that no new dust is churned up
- By using localized exhaust fans to suck out to the atmosphere from inside the enclosure, air will flow from the outside into the enclosure after which the side house will be installed in front of the hatch on the side of the enclosure and the side hatch opened

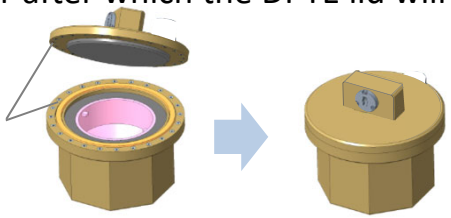




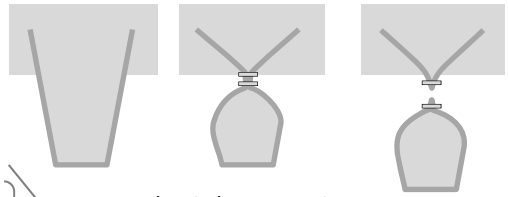
(Side house is omitted from the schematic)

3-2. Work details: Fuel debris storage (3/3)

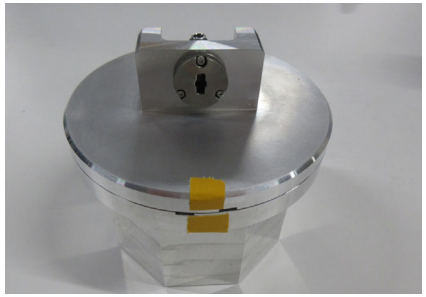
- The transportation box lid press will be released (the box is designed to automatically close by the force of neodymium magnets)
- The transportation box shall be covered as it is manually removed from the open side hatch, and loaded into a DPTE container after which the DPTE lid will be closed. The DPTE container will then be transported to a glovebox.



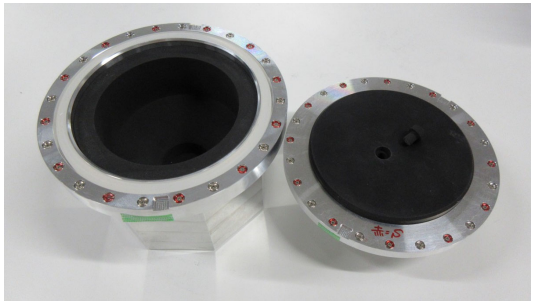
Automatically closes by the force of neodymium magnets



Plastic bag overview

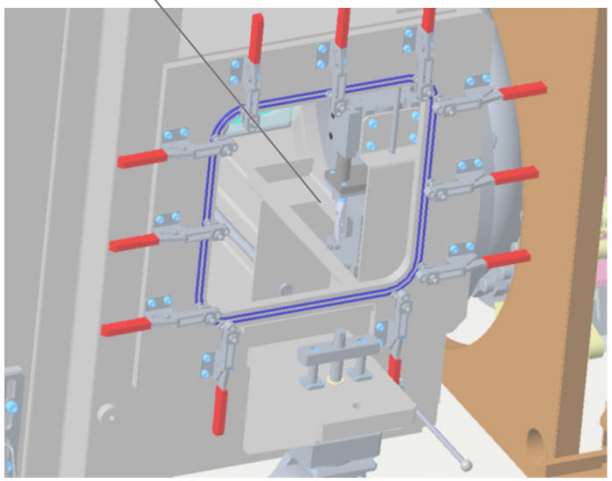


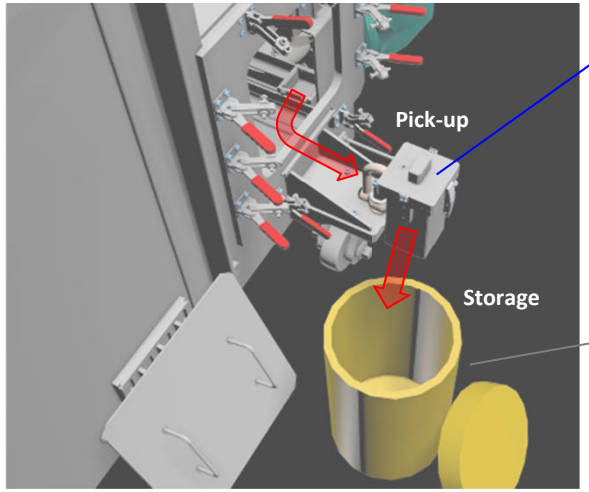
Improved transportation box



Improved transportation box (with the lid open)

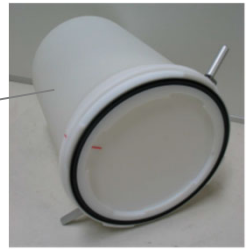
Transportation box Improved transportation box shown above





The improved transportation box shown above will be used

The DPTE container

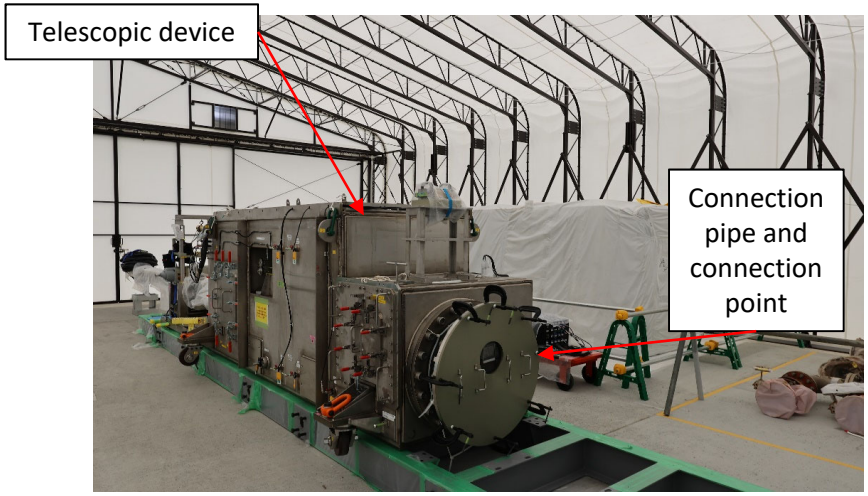


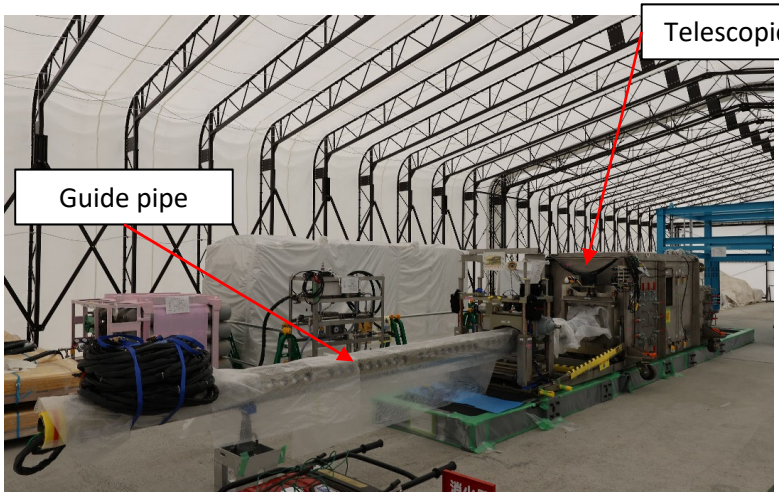
4. Field Work Progress Status (Telescopic device)

- The telescopic device was subject to pre-use inspections (pressure resistance check) at the manufacturer's factory on June 18, and was given "good" marks.
- The telescopic device departed the manufacturer’s factory on July 3, and was transported into the site of Fukushima Daiichi Nuclear Power Station on July 10.

Departed manufacturer’s factory on July 3

Departed manufacturer’s factory on July 3





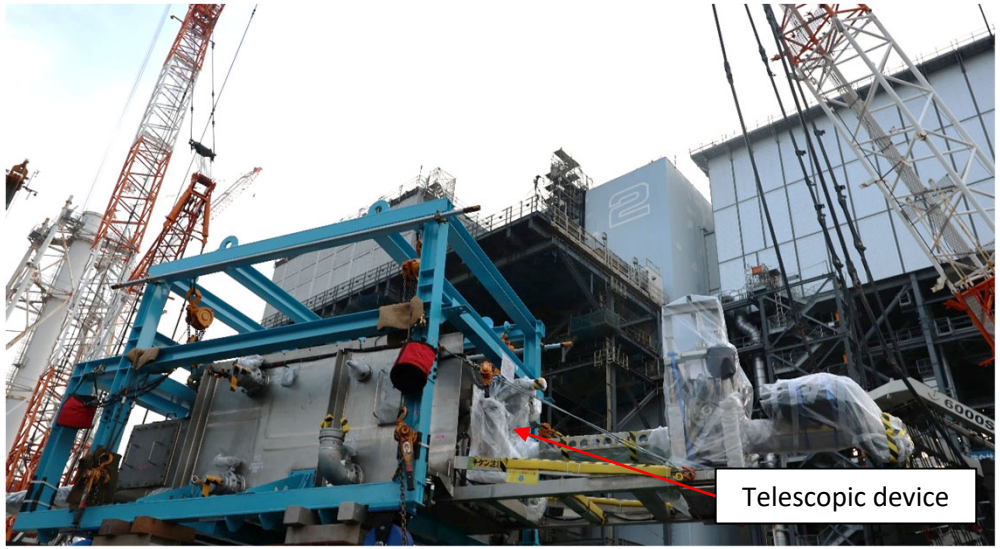
Transported into the tent inside the Fukushima Daiichi Nuclear Power Station on July 10

4. Field Work Progress Status (Telescopic device)

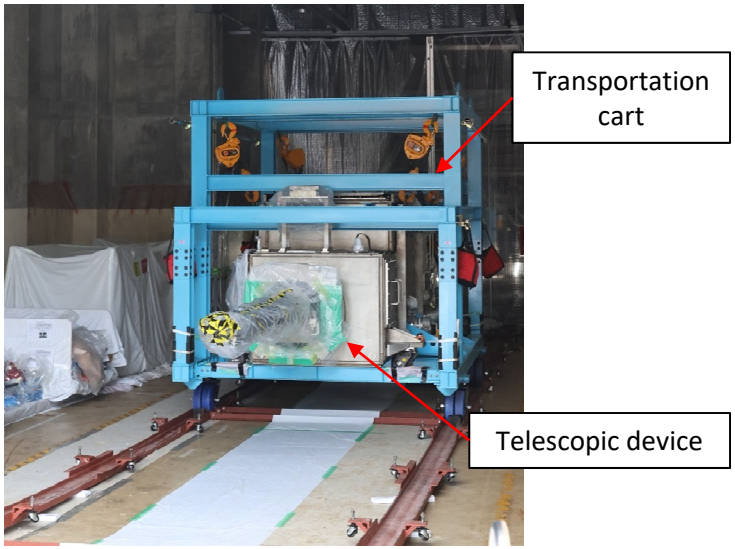
- Transportation rails were installed inside the Unit 2 reactor building on July 18, and preparations for carrying the device inside the reactor building was completed.
- Telescopic device was carried into the rector building on July 19.

Installing transportation rail on July 18

After installing transportation rail on July 18



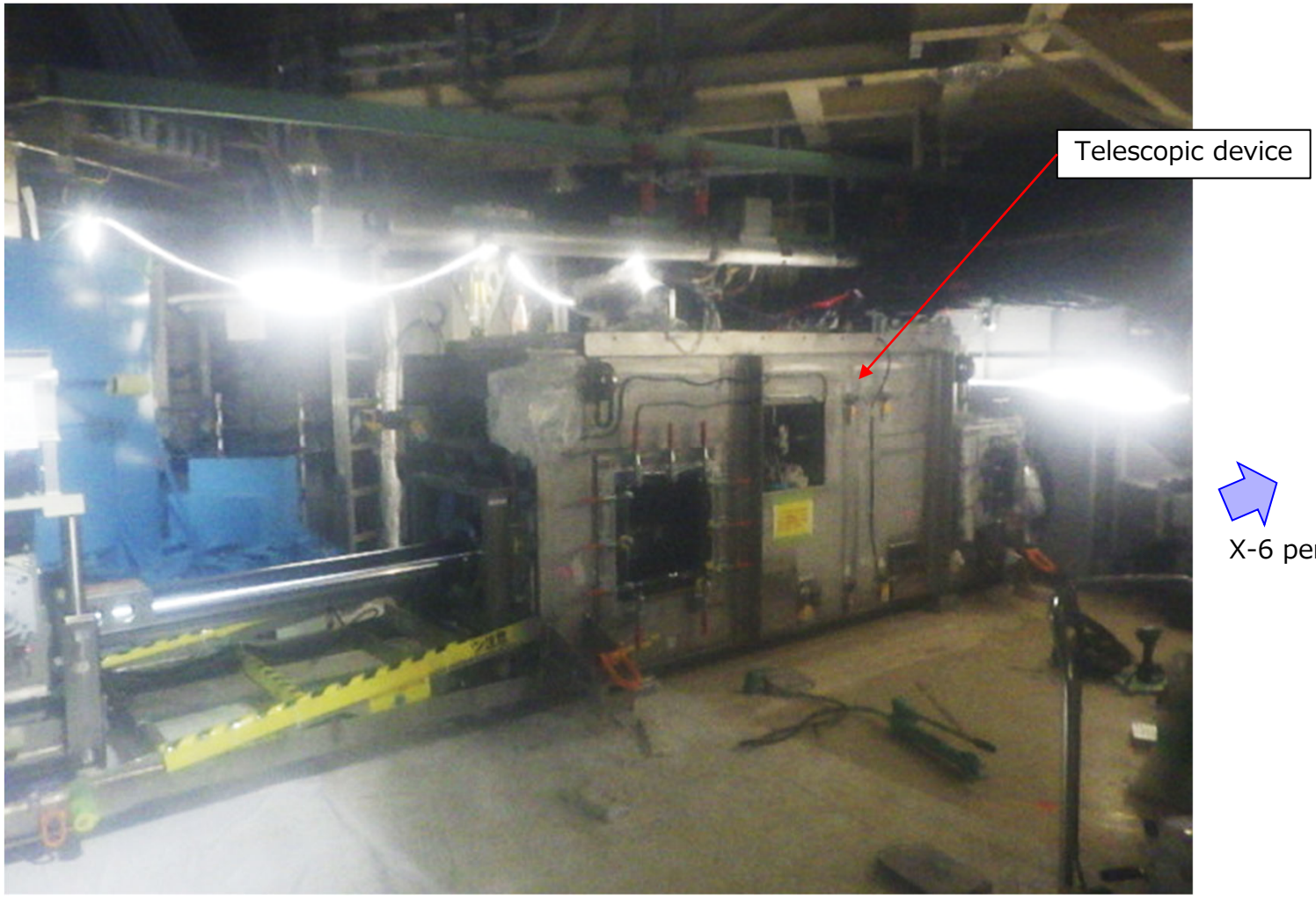
Carrying the telescopic device inside the rector building on July 19



After carrying the telescopic device inside the rector building（Guide pipe side)

4. Field Work Progress Status (Telescopic device)

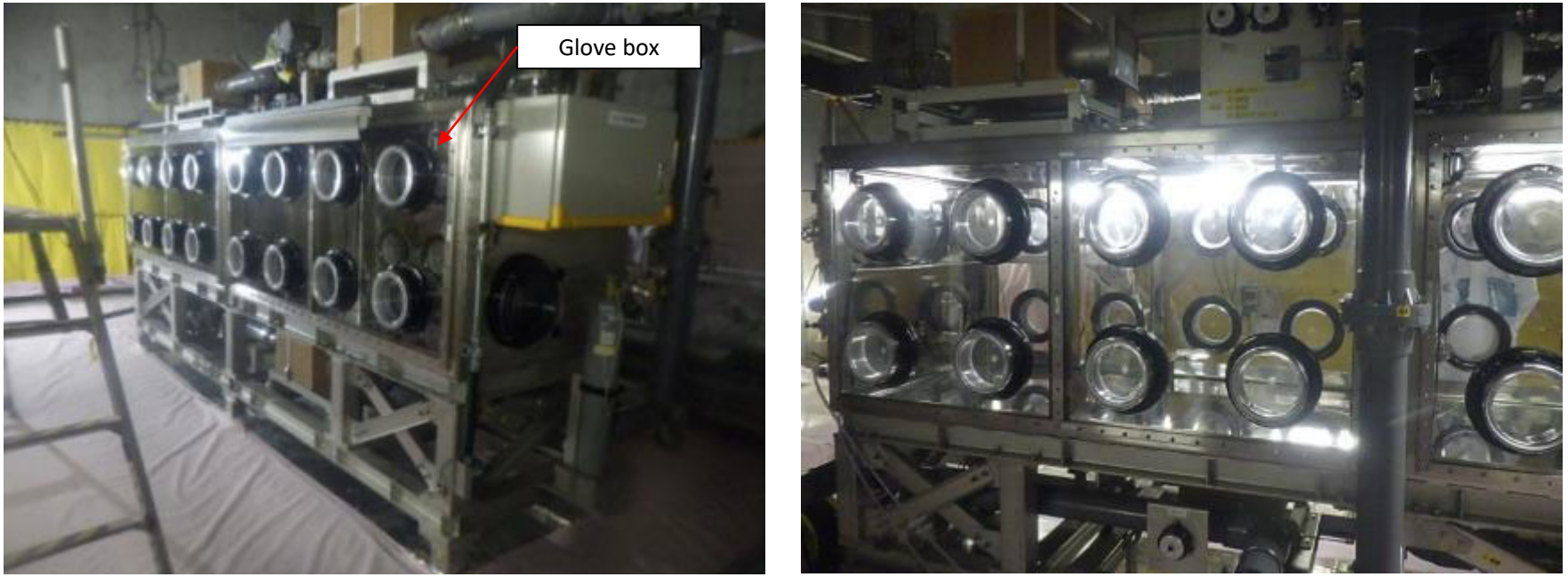
- Transportation of the telescopic device inside the reactor building and installation to X-6 penetration and connection pipe has been underway since July 20.



Work status inside the reactor building on July 24
(Northwestern area)

4. Field Work Progress Status (glove box installation)

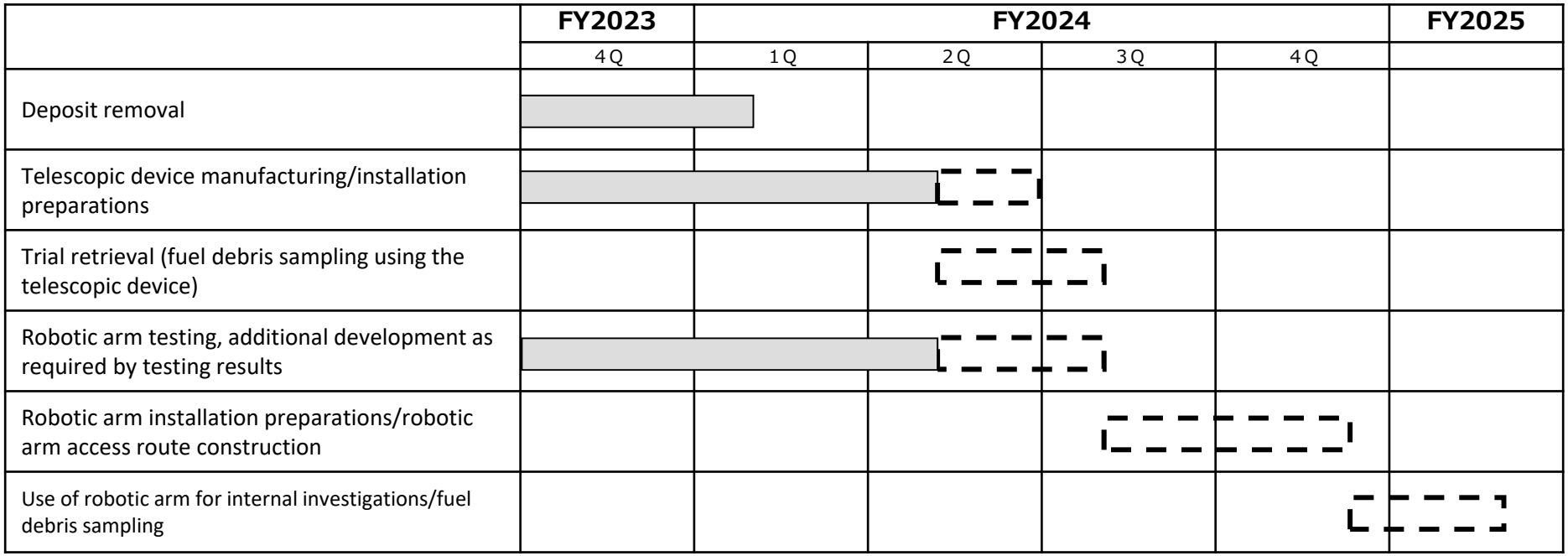
- A glove box has been installed inside the Unit 2 reactor building
- The glove box was subject to pre-use inspections (airtightness check, etc.) on site on July 17, and was given "good" marks.



Glove box installation status

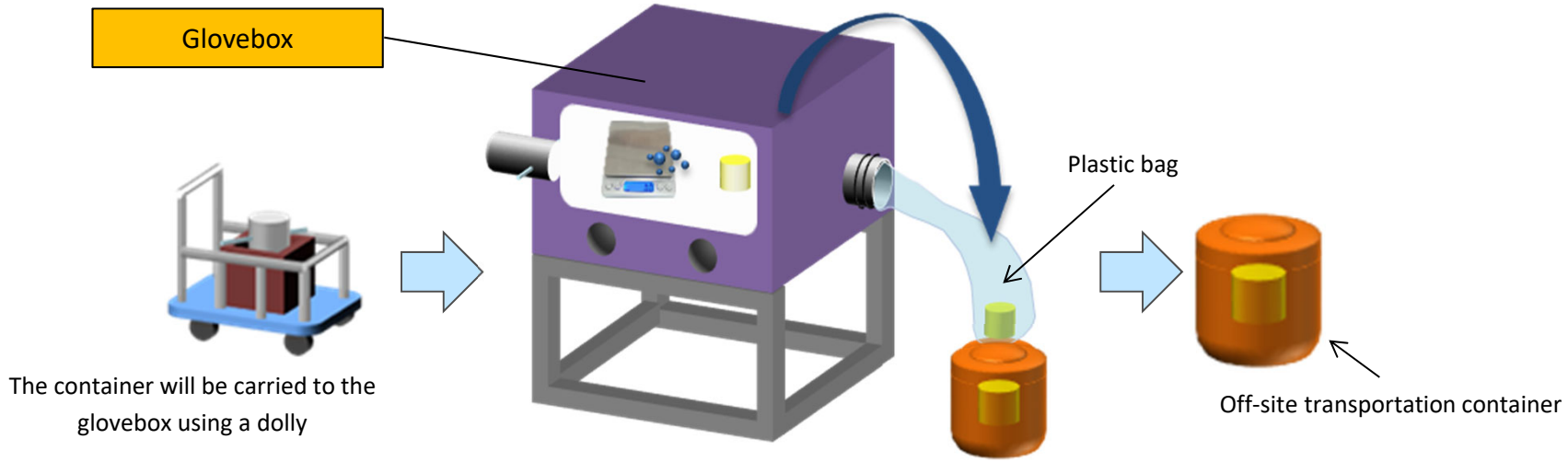
5. Schedule

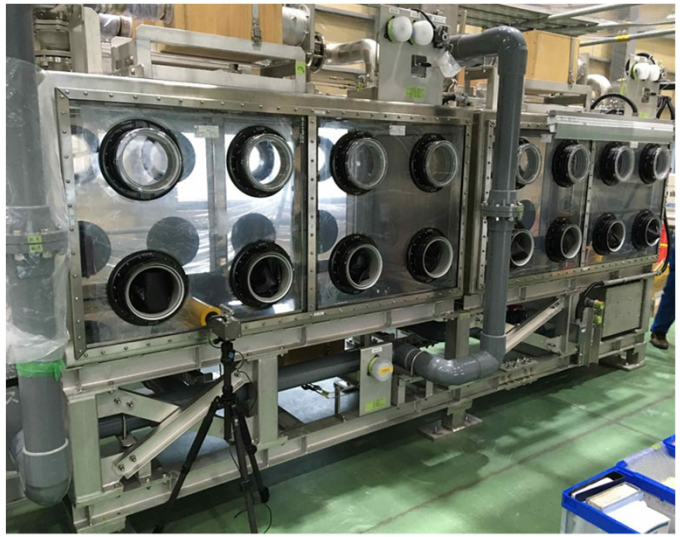
- The telescopic device was transported from the manufacturer's factory to the Fukushima Daiichi Nuclear Power Station . In preparation for installation, on-site inspections is being conducted after which the device will be brought into the Unit 2 reactor building and connected to the X-6 penetration connection structure/connection pipe.
- The gripper tool has been selected as the end jig that will be used during the first attempt to retrieve fuel debris with the telescopic device.
- We are planning to begin the trial retrieval of fuel debris at some point between August and October 2024.
- We will continue to steadily move forward and prioritize safety during the trial retrieval of fuel debris.



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



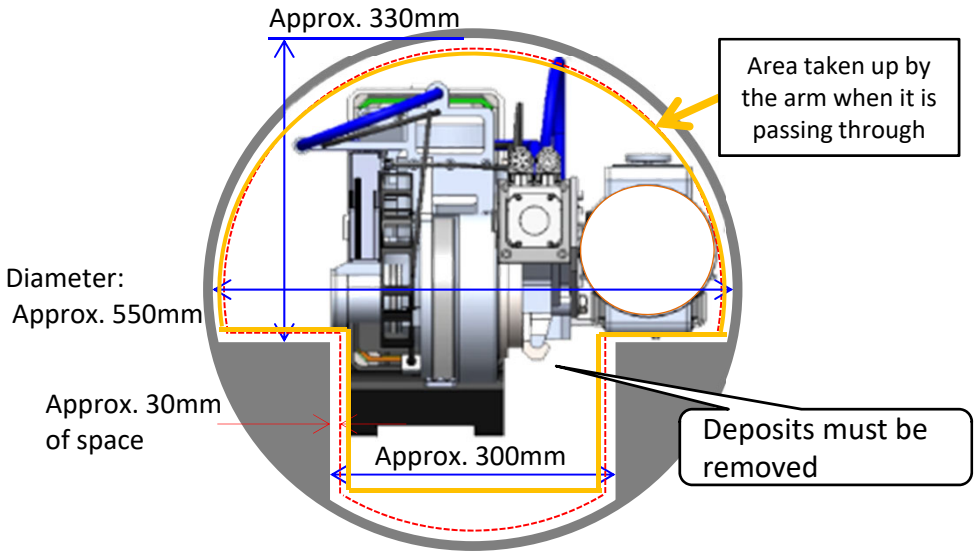


- The collected samples will be put into a negative pressure glovebox
- The samples will be subjected to various measurements inside the glovebox and then put into a container
- The container will be removed from the glovebox while preventing the spread of contamination by using a plastic bag
- The container will then be inserted into an off-site transportation container and loaded onto a transport vehicle

Reference. Robotic arm and telescopic arm when passing through the X-6 penetration

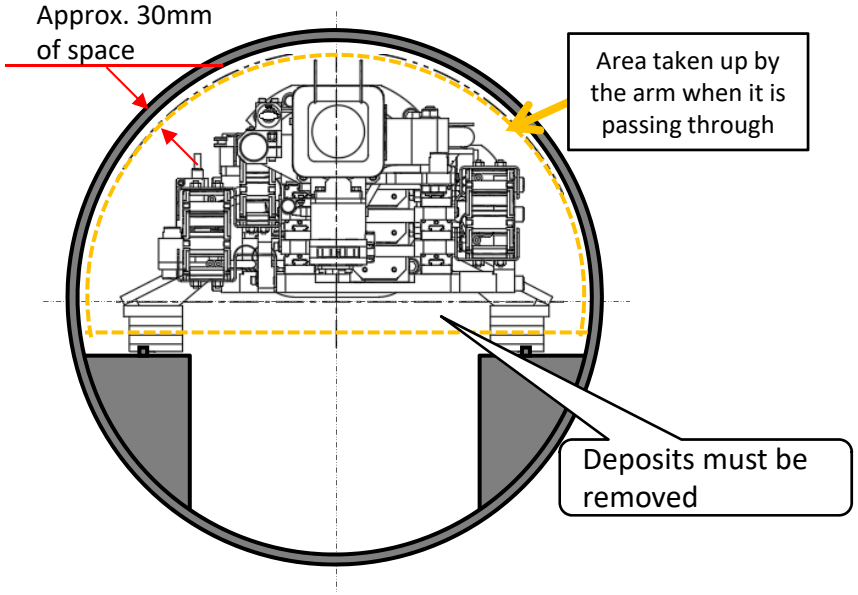
Robotic arm

(cross-section of the X-6 penetration when the arm is passing through)



Telescopic arm

(cross-section of the X-6 penetration when the arm is passing through)



X-6 penetration after the removal of deposits

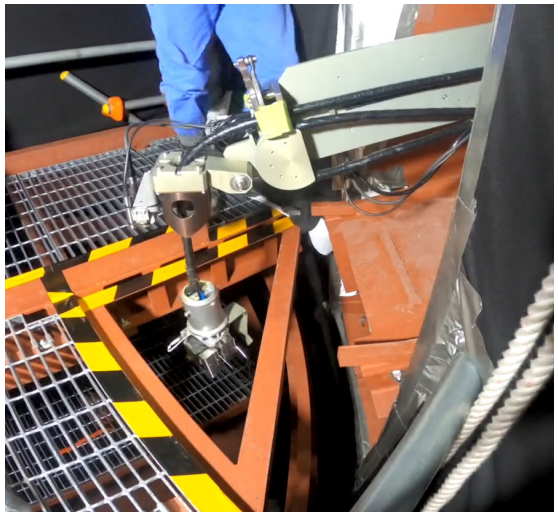
Reference. Status of Mockup of the Telescopic Trial Retrieval Equipment

- Mockup testing is currently underway at the manufacturer's factory in preparation for the Unit 2 fuel debris trial retrieval .

Telescopic trial retrieval equipment (photo taken from above the equipment)

Inserting the guide pipe

Inserting the equipment into the pedestal opening



Suspending and lowering the end jig through the grating opening

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

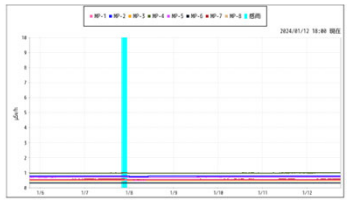
Radiation Dose measured at Monitoring Post of Fukushima Daiichi Nuclear Power Station

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

Monitoring post (MP1 - MP8)

Monitoring points

Radiation dose



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

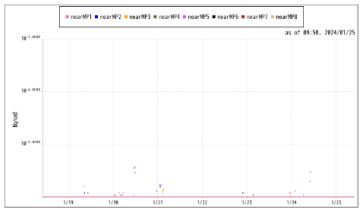
MP-1	MP-2	MP-3	MP-4	MP-5	MP-6	MP-7	MP-8	風向	風速	感雨
0.517	0.783	0.490	0.987	0.703	0.315	0.566	0.530	北北西	1.4	無

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.

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)

- 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

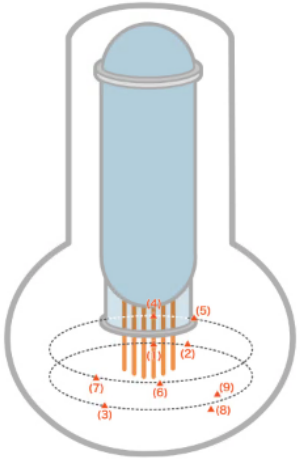
[Reference] Screen image of our website

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

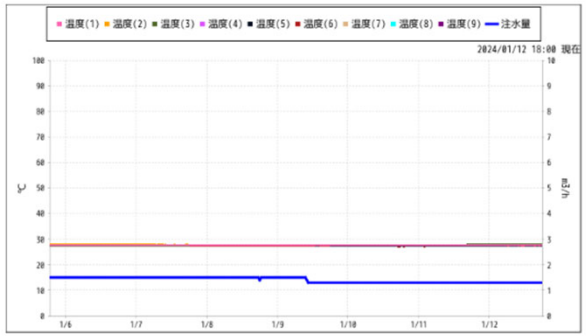
Here are the measurement results of temperatures inside the Unit 2 Primary Containment Vessel at Fukushima Daiichi Nuclear Power Station.

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