Causes and Countermeasures for Suspension of Unit 2 PCV Fuel Debris Trial Retrieval

September 5, 2024

Tokyo Electric Power Company Holdings, Inc.

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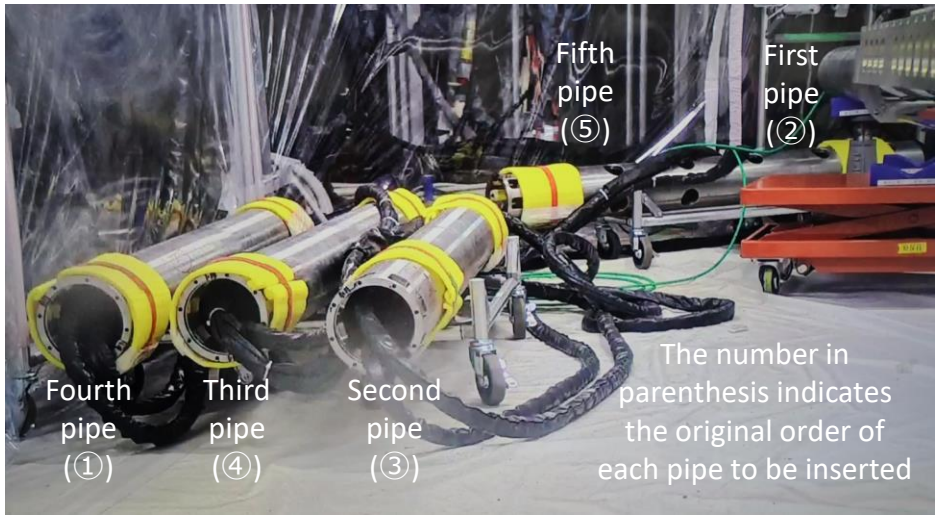
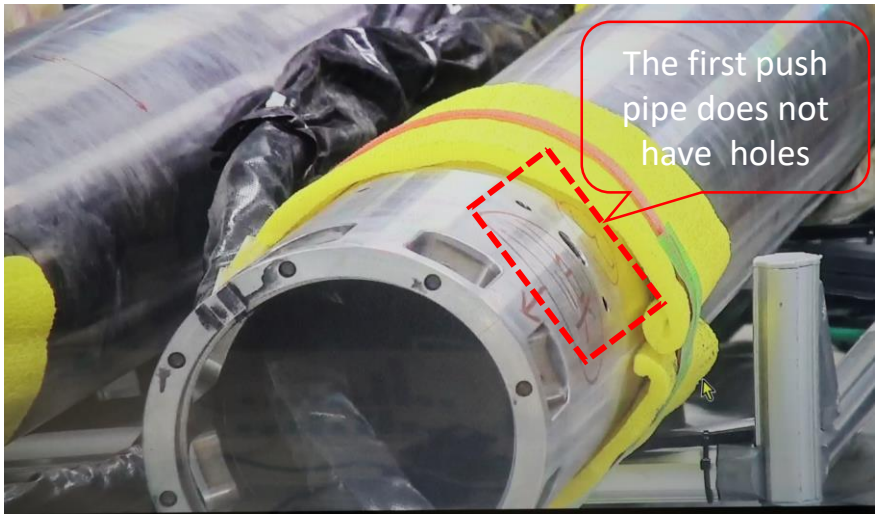
1. Incident overview

- On August 22, guide pipe of the telescopic device was inserted at 7:49 a.m. as part of Unit 2 fuel debris trial retrieval work.
- Afterwards, telescopic mechanism at the head of the guide pipe was inserted to the front of the isolation valve. When the first push pipe (the first of five push pipes to be used) was prepared to be connected to the other end of the guide pipe, it was noticed during the final checking process at site that the order of the first push pipe was different from the planned order. Therefore, the work was stopped at the point before the isolation valve. (Work was done until 8:53 a.m.)
- At the site, it was confirmed the push pipe that should have been in the first position was in the fourth position. (The order was ②→③ → ④ →① → ⑤ , whereas it should have been ①→ ② → ③ →④ → ⑤)
- There were no work safety or nuclear safety issues that needed to be addressed, and the incident had no impact on the surrounding environment.



Installation status of push pipes

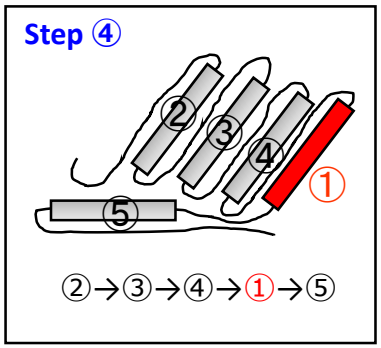


Reference：The end of the second push pipe (③)

2. Sequence of events

July 27
• The push pipes (①-⑤) are carried from the large freight loading entrance on the first floor to the southwest area of the Unit 2 reactor building and are temporarily stored. Thereafter, four of the pipes (②-⑤ are carried to the west side passageway of the Unit 2 reactor building.
• Since exposure doses were nearing the planned doses for that day, work was terminated.
July 28
• Four pipes (②-⑤) transported to the west side passageway are unpacked and carried near the telescopic device. Cable is inserted to the pipes.
• The push pipe that was left in the southwest area (①) is carried to the west side passageway
July 29
• The pipe that was transported to west side passageway were unpacked and carried near the telescopic device. Cable is inserted to the pipe.
August 22
• The isolation valve is opened
• The guide pipe of the telescopic device is inserted
• When preparations are made to connect the first push pipe, a final checking process at site reveals that this first guide pipe is in the wrong order. Therefore, task is suspended.

3. Chronological order of events for push pipe installation and field conditions (July 27-29)



Step 1. (July 27)
- Transport and temporary store push pipes (five in total) (from large freight loading entrance to southwest area)

Step 2. (July 27)
- Transport four push pipes (from southwest area to west side passageway)

*One push pipe was left in the southwest area due to exposure dose management considerations

Step 3. (July 28)
- Cable insertion begins while one of the push pipes is still in the southwest area

Step 4. (July 28, 29)
- The push pipe that was left in the southwest area (①) is unpacked at west side passageway and carried near the telescopic device. The pipe is positioned in front of push pipe (⑤) , and cable is inserted inside.

PCV

X-6 penetration

Northwest area

Telescopic device (enclosure)

×2.0～4.0

West passageway

Step ③

×1.5～3.0

②

⑤

Transport

Step ②

Transport

Push pipe ①

Push pipe ②-⑤

×3.0~4.0

Step ①

Transport

Push pipe ②

Push pipe ④

Push pipe ②-⑤

Push pipe ③

Push pipe ⑤

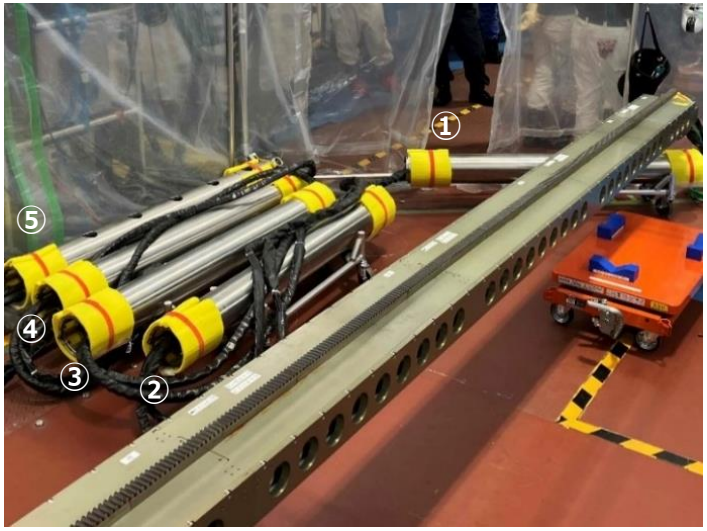
Southwest area

×0.5

Large freight loading entrance

× : Air dose rate (mSv/h)

[Reference] Photos of field conditions



Outer appearance of push pipe
（During training at the factory in a simulated environment）
（May 27, 2024）

After arrival at the Fukushima Daiichi Nuclear Power Station site
（July 10, 2024）

Transporting at the push pipes from the large freight loading entrance on the first floor of the reactor building to the west passageway
（July 27, 2024）

Inserting the cable into the push pipes
（July 28, 2024）

Transporting the push pipe from the west passageway on the first floor of the reactor building to near the telescopic device
（July 29, 2024）

4. Results of the investigation into this incident (1/2)

- The cable was to be inserted after all five push pipes (①～⑤) were laid out in order, but during this incident, one push pipe ① was replaced after the cable had been inserted into the other four push pipes (②～⑤)

- **Tasks that were performed from push pipe transportation to the insertion of the cable into the four push pipes (②～⑤)**

a. On July 27, contractor workers were supposed to transport all five push pipes. However, since exposure doses were nearing planned doses, the task was terminated after only four of the push pipes (②～⑤) had been carried, leaving one of them (push pipe ①) temporarily stored in its original location.

b. The contractor workers became more concerned about leaving the worksite as quickly as possible since exposure doses were nearing planned doses for that day. They mistakenly assumed that all five push pipes had been carried in without performing a final check even though one of the push pipes (push pipe ①) was still in its original location, and they reported to the primary contractor work manager that all the push pipes had been carried.

c. Upon receiving this report from the contractor workers, the primary contractor work manager assumed that all five push pipes had been carried in as reported and did not directly perform a field check due to the high-dose environment of the site.

d. On July 28, Assuming that all five push pipes had been carried in the primary contractor work manager gave instructions to the contractor workers to start inserting the cable. The contractor workers followed the instructions from the primary contractor and started inserting the cable into the push pipes. Even though there were only four at the worksite (push pipes ②～⑤), they mistakenly recognized that push pipe (①) was already installed in the telescopic device and inserted the cable into the push pipes in the order of ②③④⑤.

4. Results of the investigation into this incident (2/2)

- **Placing push pipe ① in the fourth position**

e. On July 28, the primary contractor work manager checked cable insertion work in the field and found that the cable had been inserted into only four push pipes with one missing.

f. The primary contractor work manager found the missing push pipe in the southwest area and carried it to the west side passageway, but did not directly check the identification number on the push pipe.

g. The primary contractor work manager mistakenly assumed that the push pipe he had found was push pipe ② mentioned in the report he received from contractor workers. At this time, he did not directly check the push pipe at the worksite and did not realize that the aforementioned push pipe was actually push pipe ①.

h. Since push pipes ②③④ are of the same design, the primary contractor work manager decided that inserting the aforementioned push pipes without ⑤ (actually ① which he thought was ②) would not cause any functional problems and would be logical from the perspective of reducing exposure, so he gave instructions to insert the aforementioned push pipes without ⑤ (actually ① which he thought was ②) , and the contractor workers complied with his instructions. The contractor workers positioned the push pipes as instructed by the primary contractor work manager and the task was completed.

i. The primary contractor work manager assumed that the push pipes were in their correct position and did not directly check the order in which they had been laid out.

j. TEPCO assumed that cable insertion work would be carried just like training, since training on this task had been conducted in a mockup environment. Although TEPCO confirmed that the cable had been inserted, it did not confirm the correct order.

4. Results from the investigation into this incident (Underlying causes)

- Underlying causes

- TEPCO was focusing on work pertaining to nuclear safety/work safety and did not perform checks of general preparatory work such as the transportation and unpackaging of pipes. Furthermore, during cable insertion, although it was confirmed that the cable had been inserted, it was assumed that the push pipes had been laid out in the correct order as they were during training, and the identification numbers were not checked.
- Even though push pipe ① is of different specifications than push pipes ②～④, the outer appearance is the same. Therefore it is difficult for workers wearing full protective equipment＊1 necessary in high-dose＊2 environments to identify each push pipe based on its outer appearance. And, even though each push pipe is marked, the markings are not always clearly visible to workers wearing full protective equipment, and the numbers cannot be seen by operators in the remote operations room.
- Knowing that the trial retrieval of fuel debris would be carried out within the reactor building, which is a high-dose environment requiring full protective equipment, the primary contractor conducted prior training on this task in a simulated environment that focused on nuclear safety and work safety. However, since the transporting of push pipes is considered general preparatory work, such as unpackaging, etc., training on these tasks was not performed in the simulated environment. Furthermore, cable insertion training was conducted in accordance with guidance from the primary contractor and with the push pipes laid out in their correct order, so confirming the identification numbers on the push pipes was not included in the training.

＊1：Full face mask, anorak suit, coveralls, etc.
＊2：Approx. several mSv/h

5. Summary of causes

[Main cause] Lack of checking process

- ✓ General preparations, such as the transportation and unpackaging of pipes, and the insertion of the cable into the pipes, were not tasks slated to be checked by TEPCO.

Other causes of this incident was a lack of consideration for field conditions/field workers and insufficient training in simulated environments.

[Other related causes]

1. Lack of "field workers' perspective"

- ✓ There was lack of consideration for the need to plan work process and procedures with an awareness of the actual field conditions, which involve a high-dose environment requiring a heavy protective gear. (For example, improving the visibility of the work and finding ways to complete the work quickly)

2. Insufficient training in simulated environments

- ✓ Task training on preparatory tasks performed in simulated environments was insufficient. (Workers that are to carry out preparatory tasks were not subject to task training in a simulated environment.)

6. Initiatives for recommencing the fuel debris trial retrieval (1/2)

- As for countermeasures to main causes, TEPCO will thoroughly perform checks.

Addressing primary causes: TEPCO shall perform checks

- We will re-examine the process for implementing checks (check method and system for each task to be checked, etc.) throughout the entire fuel debris trial retrieval process, and we will perform checks in accordance with its findings. If it cannot be confirmed that the task was performed as planned, we will stop the task to prioritize safety above all else and check work conditions.

- Furthermore, as for basic premise, re-checking/examining of the entire work process and checking/examining of training in the simulated environment should be conducted from "field workers' perspective", in preparation for the recommencement of the fuel debris trial retrieval.

[Other related causes]

1. Re-Checking and examining of the entire process including preparatory tasks from the perspective of field workers

- We will reconfirm and newly examine the entire fuel debris trial retrieval process, including preparatory tasks, from the perspective of field workers. (Personnel that have experienced performing difficult tasks in the field have been recruited to help with this re-checking and process examining)
- Upon doing this, work processes shall be revised if necessary with more consideration for actual conditions in the field.
  For example,
  ✓Cleary noting the position of the push pipes and the order of inserting the cables in the work procedures
  ✓Attaching additional identification markings to the push pipes
  ✓Rearranging the push pipes into the correct positions and inserting cables

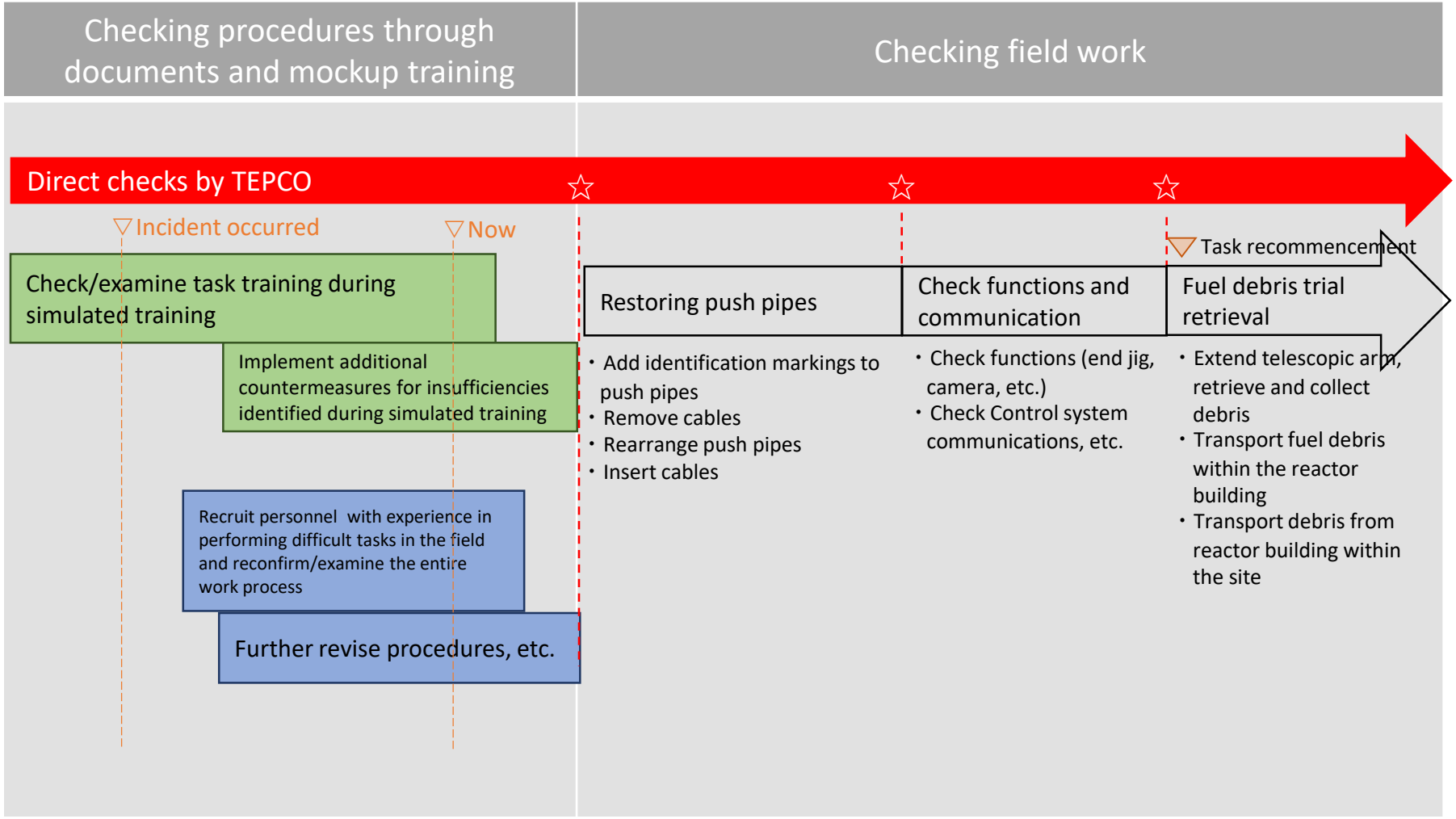
2. Checking/examining task training in simulated environments, identifying insufficiencies and implementing additional countermeasures

- We will identify differences between the simulated environment and the actual work environment, and scrutinize the work procedures to avoid issues during the actual work.
- Insufficiencies shall be identified during training, and additional countermeasures shall be implemented to address these insufficiencies (transporting the fuel debris within the reactor building, on-site transport from the reactor building).
- We will identify insufficiencies from training conducted so far and implement additional countermeasures to address these insufficiencies (transporting the fuel debris within the reactor building, on-site transport from the reactor building).

- **Furthermore, in light of the lessons learned from this incident we will directly check Fukushima Daiichi decommissioning tasks performed in extremely harsh work environments, such as high-dose areas, etc.**

6. Initiatives for recommencing the fuel debris trial retrieval (2/2)

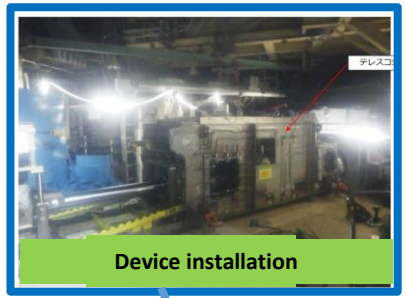
- The following issues shall be checked in preparation for the recommencement of fuel debris trial retrieval:



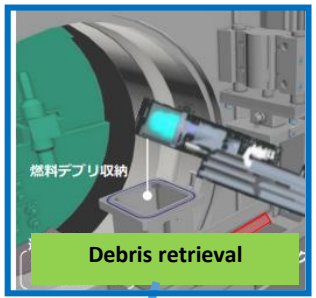
[Reference] Progress status of fuel debris trial retrieval using telescopic device


Factory mockup: Completed


Reactor building loading


Device installation

Isolation valve opened



Debris retrieval

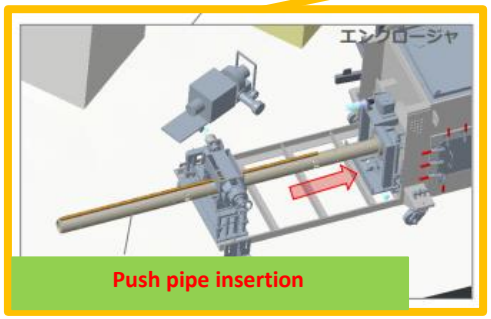
Now▼

Manufacturing the telescopic device/
Preparation for the installation

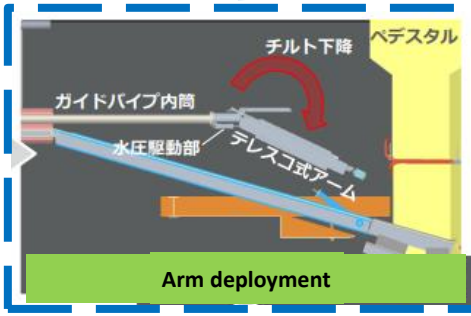
Trial retrieval


Transport from factory

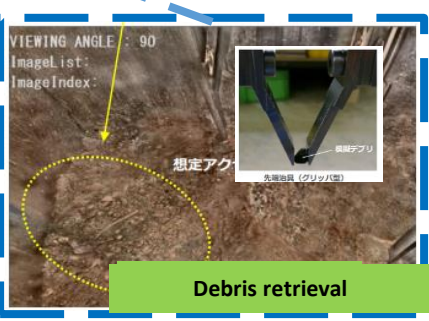

Carrying into FDNPSA



Push pipe insertion



Arm deployment



Debris retrieval

: works already trained

: manual work in high-dose area

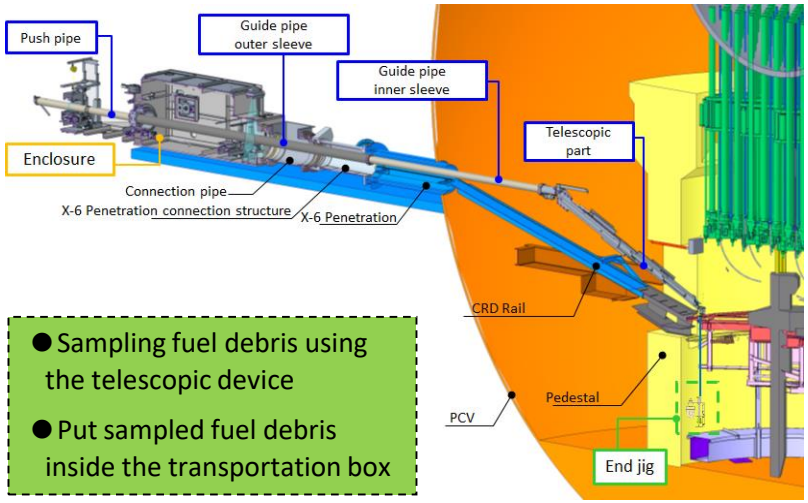
[Reference] Fuel debris trial retrieval to be conducted

: works already trained

: works to be trained

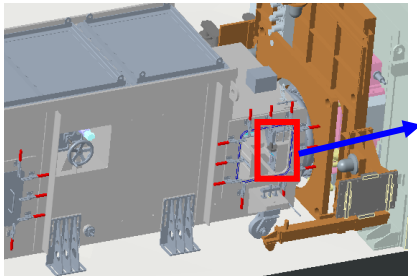
: manual work in high-dose area

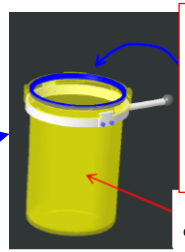
Trial retrieval (Sampling debris with the telescopic fuel debris trial retrieval device)

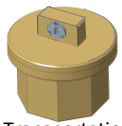


- Sampling fuel debris using the telescopic device
- Put sampled fuel debris inside the transportation box

Collection of fuel debris





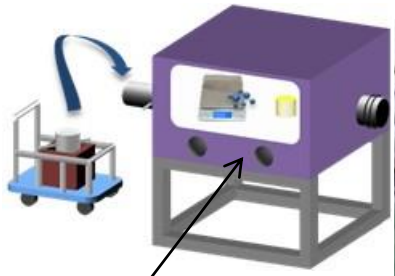


Transportation box

Indoor transportation container (DPTE container)

- Put the transportation box inside an on-site transportation container
- Transport on-site transportation box to the glovebox

Insertion into glovebox/Measurement

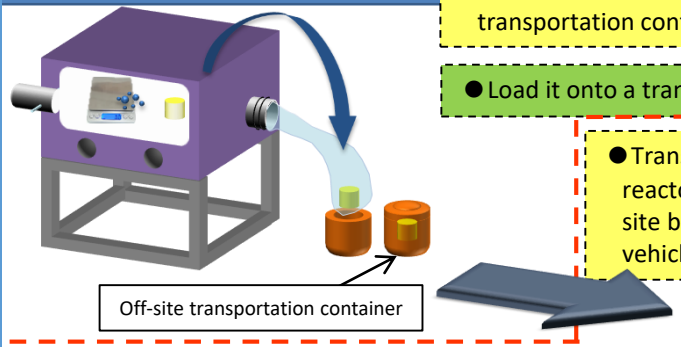


Glovebox

<Exterior view of glovebox>

- Put the transportation container inside the glovebox
- Measure the sample and put it into a container

Container removal/Insertion into transportation container /Removal from premises

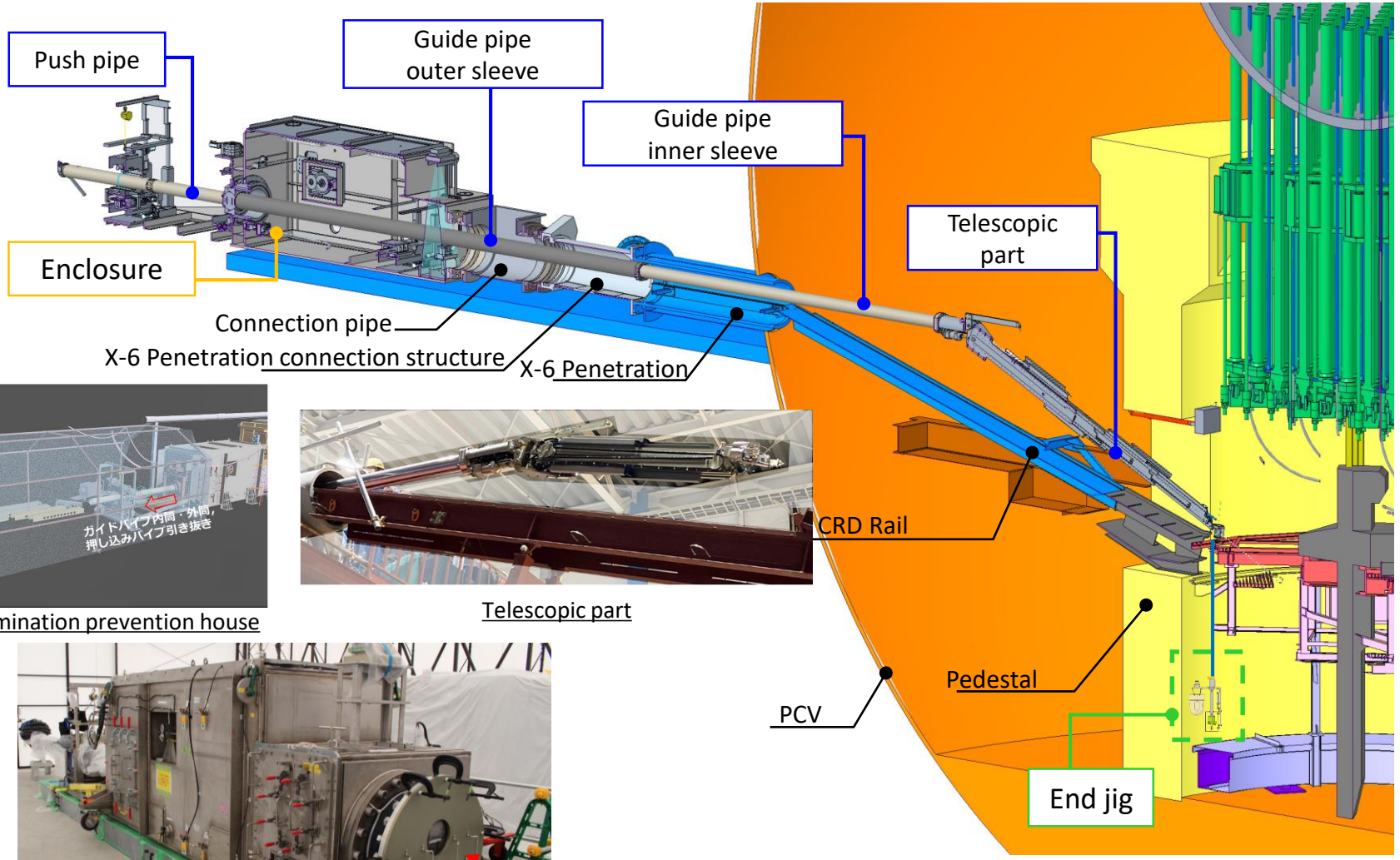


- Put the container into an off-site transportation container
- Load it onto a transport vehicle
- Transport it from the reactor building within the site by the transport vehicle

Off-site transport and off-site analysis

[Reference] Diagram of the telescopic device(1/3)

- 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.



Rear contamination prevention house

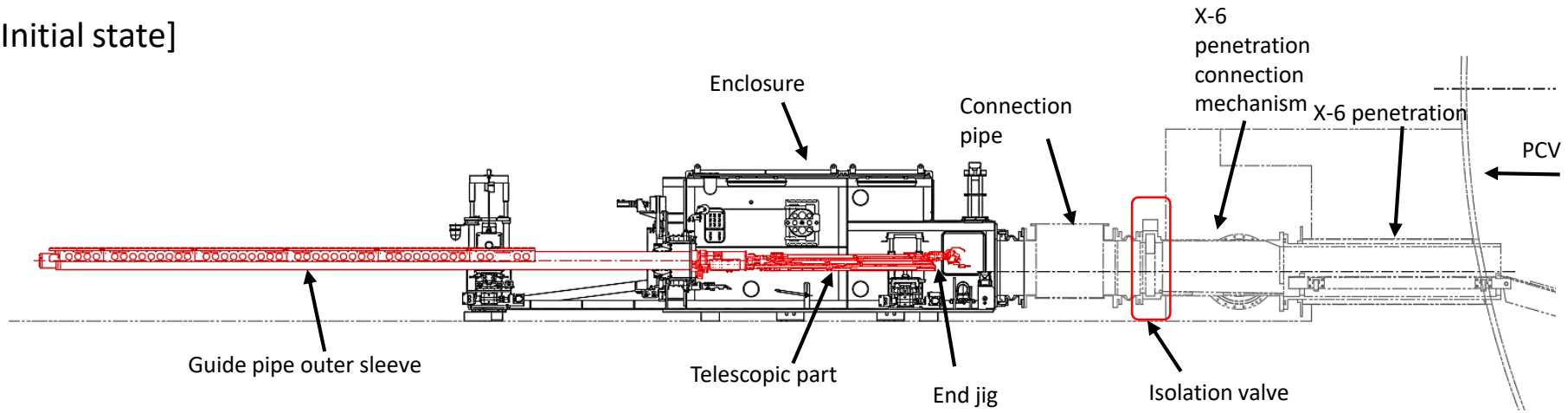
Telescopic part

Telescopic device

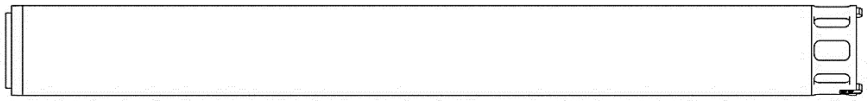
Connection pipe and connection point

[Reference] Diagram of the telescopic device(2/3)

[Initial state]

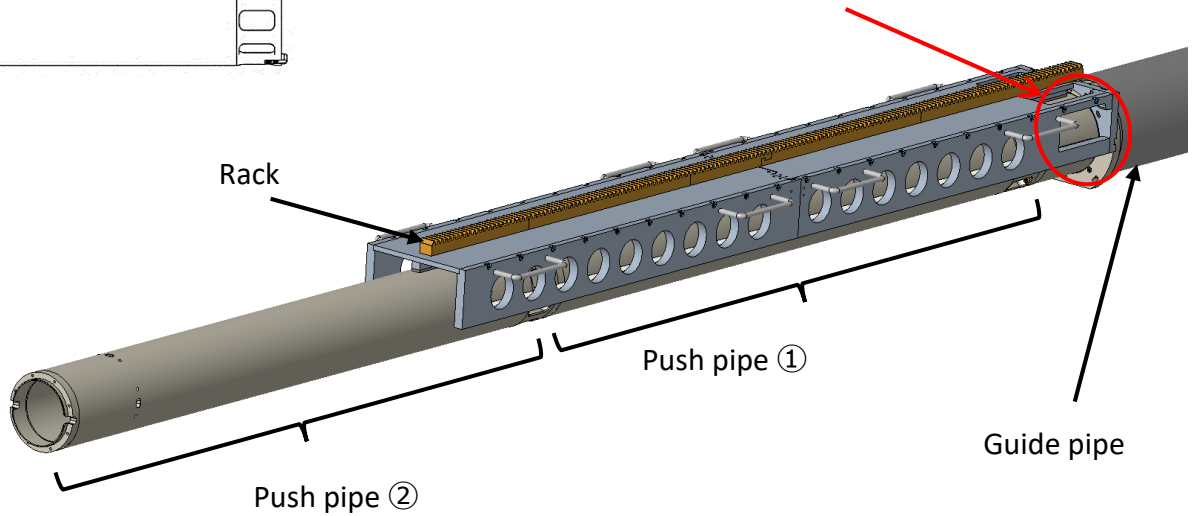


[Shape of push pipe ①]



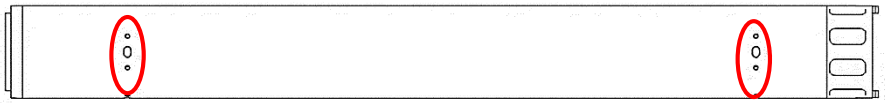
Top view

There are no screw holes for rack installation in the push pipe ①.
(Rack is installed on the flange at the rear of the guide pipe)

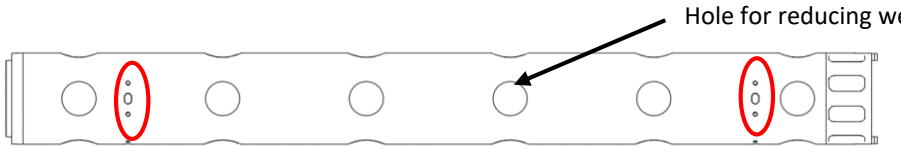


[Reference] Diagram of the telescopic device(3/3)

【Shapes of push pipes ②-⑤】

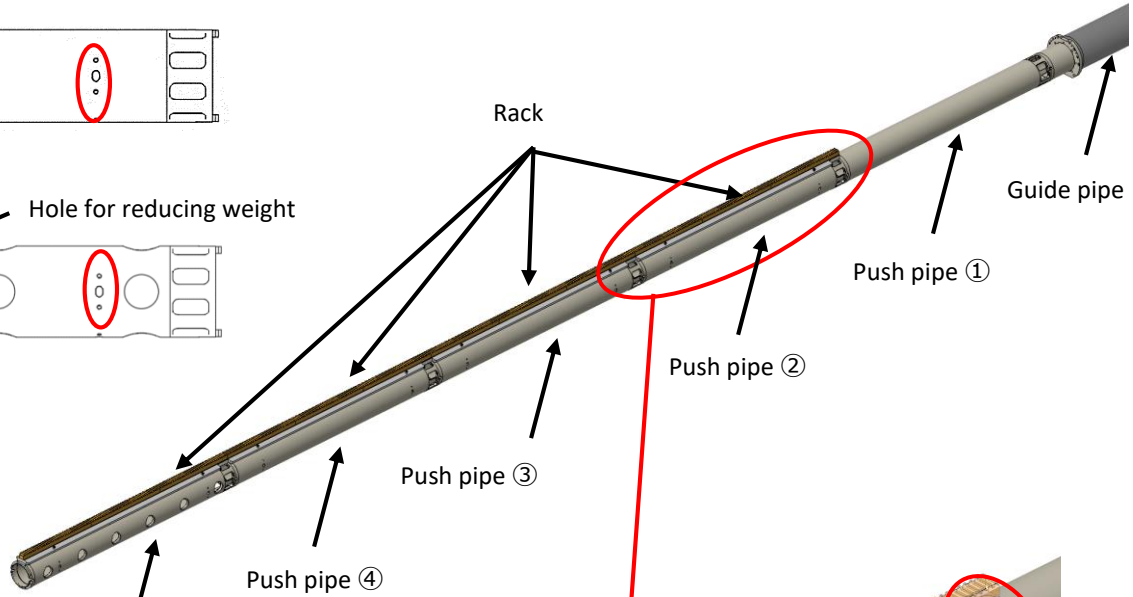


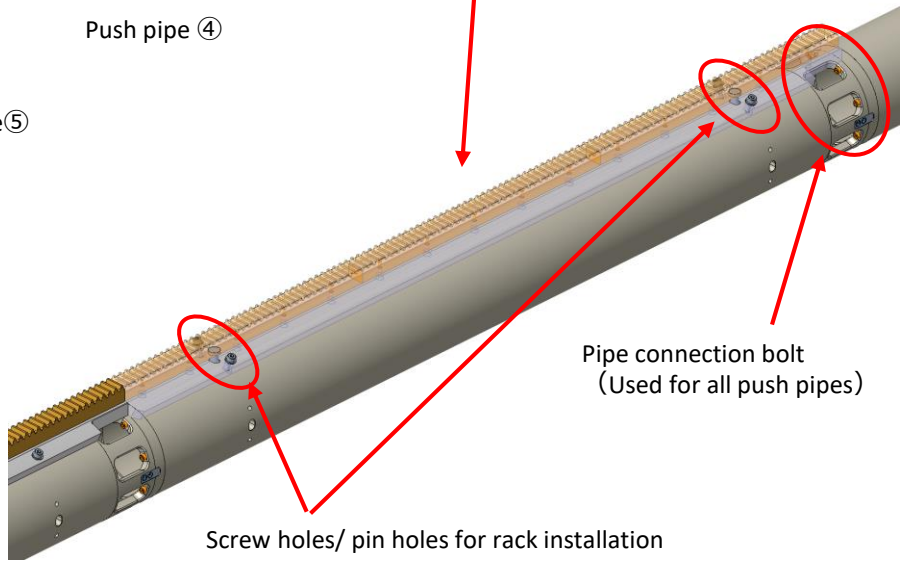
Top view of push pipes ②-④



Top view of push pipe ⑤

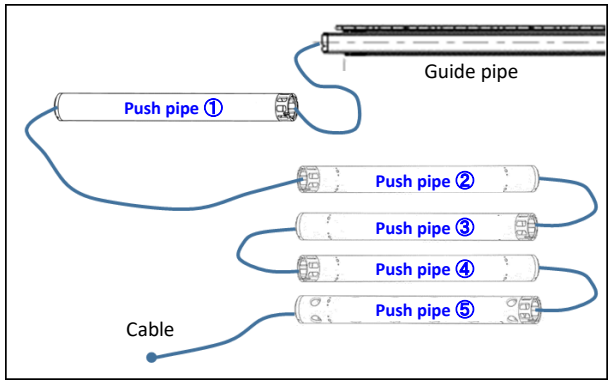
：Screw holes/ pin holes for rack installation

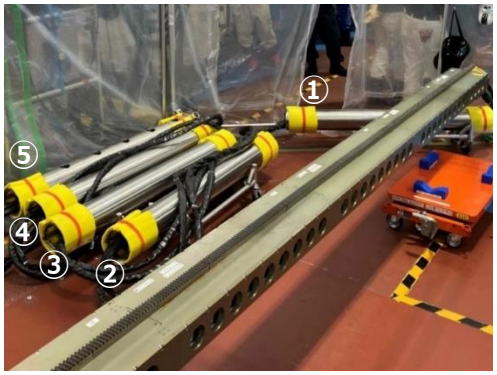




[Reference] Installation status of push pipes

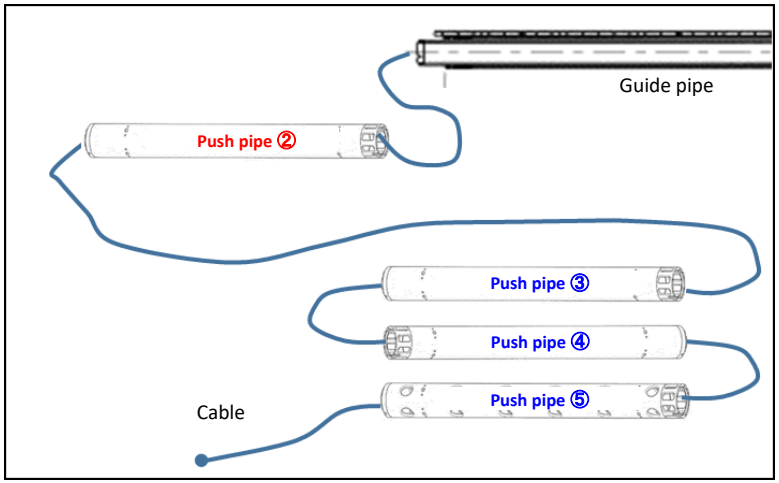
Position of the push pipes during the training in simulated environment (Correct position)



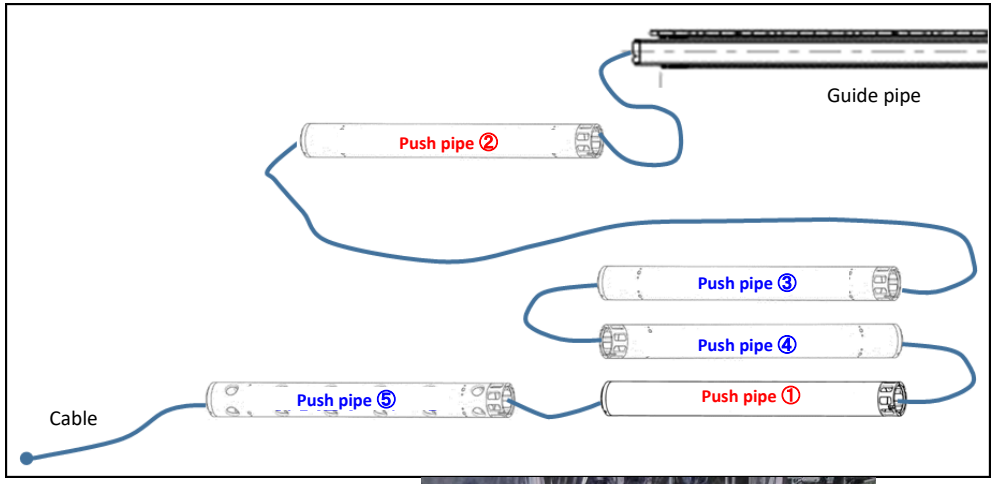


Five push pipes were positioned while considering the cable wiring

Position at the site (As of July 28)



Position as of July 29 (when the push pipe ① was added)



The push pipe ① was positioned between the push pipes④ and ⑤, changing the position as of July 28.
The photo of the position is as on the right.