Fukushima Daiichi Nuclear Power Station
Unit 3 PCV Internal Investigation
(non-submerged area) using Micro-drones

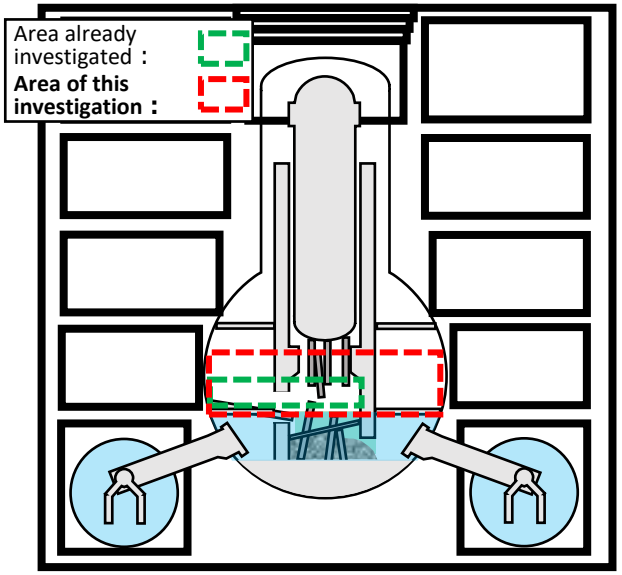
December 25, 2025

TEPCO

Tokyo Electric Power Company Holdings, Inc.

1. Summary

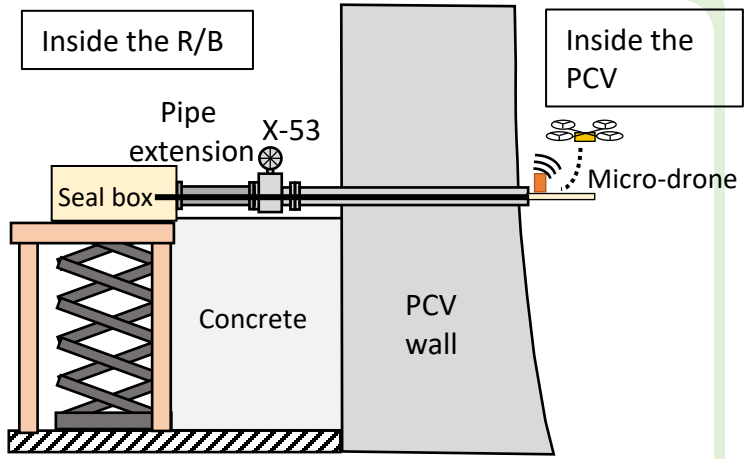
- In July 2025 we announced that we were deliberating design plans for the retrieval of fuel debris from Unit 3, and **that more information needs to be gathered about the inside of the PCV as we prepare for full-scale debris retrieval**.
- However, the water level inside the PCV has remained high since the accident and the penetrations we can use are limited with the **small X-53 penetration (Diameter: Approximately 140mm) being the only penetration currently available for access.**
- Therefore, the investigation devices that have proved successful at other units cannot be used and a new larger diameter access route must be constructed. However, this would require time so **our current plan is to conduct a PCV internal investigation using a small "micro-drone."**
- During this investigation, we plan to investigate the **as of yet unexamined first floor of the D/W and also perform a more meticulous investigation of the inside of the pedestal** that was investigated in 2017 using a submersible ROV.



Cross-sectional diagram of the Unit 3 PCV internal investigation area

Micro-drone

Use: Photography (2.7K)
Dimensions: 130×120×40[mm]
Weight:95[g](Including battery)
Flight time: Approx. 13min. (Investigation is planned to take 10min.)



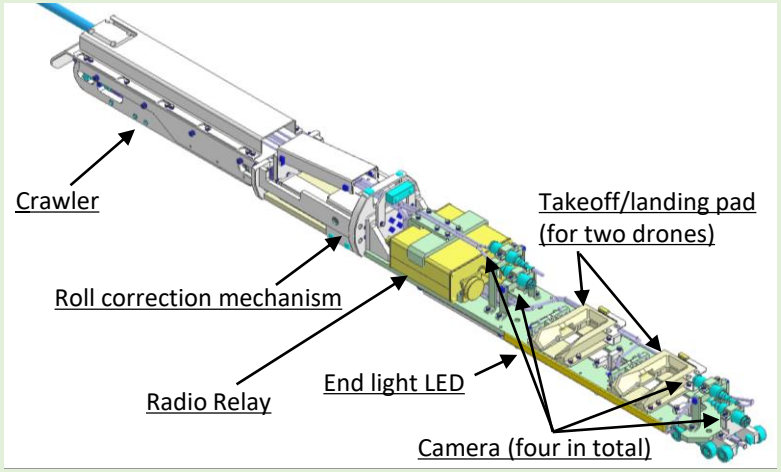
Inserted through the small X-53 penetration (Diameter: Approximately 140mm)

Concept diagram of Unit 3 micro-drone investigation

2. The insertion device unable to move forward

- When conducting function tests of the investigation device **it suddenly became impossible to move the insertion device forward inside the X-53 penetration.**
- Several attempts were made at insertion, but **the device was unable to move forward past a certain point (approximately 50cm into the X-53 penetration).**
- The device could be moved backwards, so **normal procedures for withdrawal were conducted and the insertion device was returned to the seal box** (Since the device was withdrawn to the seal box, the isolation valve, which is the PCV boundary, did not have to be opened or closed).

insertion device



- Two drones can be loaded onto the takeoff and landing pad on the tip
- The device is moved backward and forward by driving the crawler mechanism at the rear
- Drones are carried into the PCV from the seal box
- Dimensions: Approx. 1.3m×Φ130mm
- Weight: Approx. 20kg

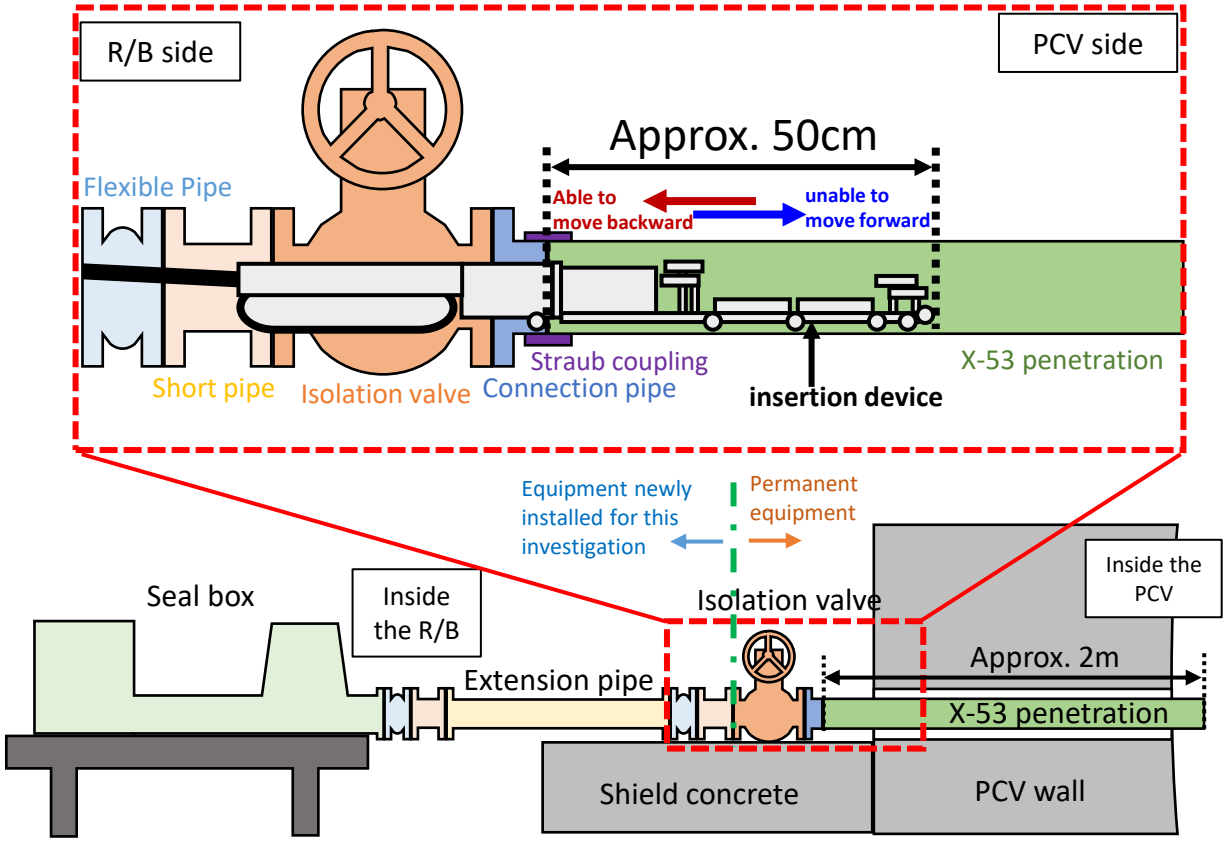
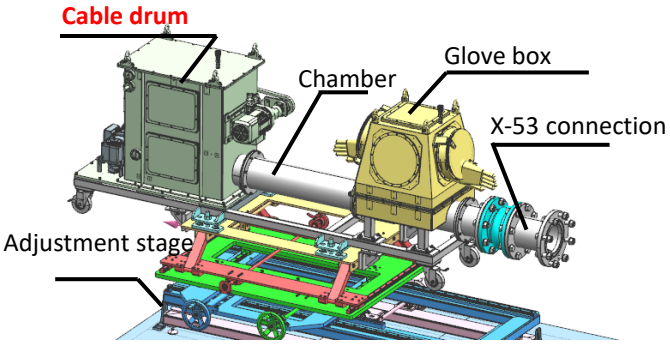


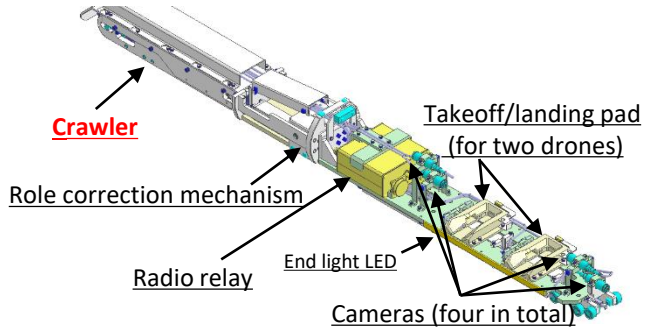
Diagram showing the unable to move the insertion device forward

3. Analyzing the cause of the insertion device unable to move forward

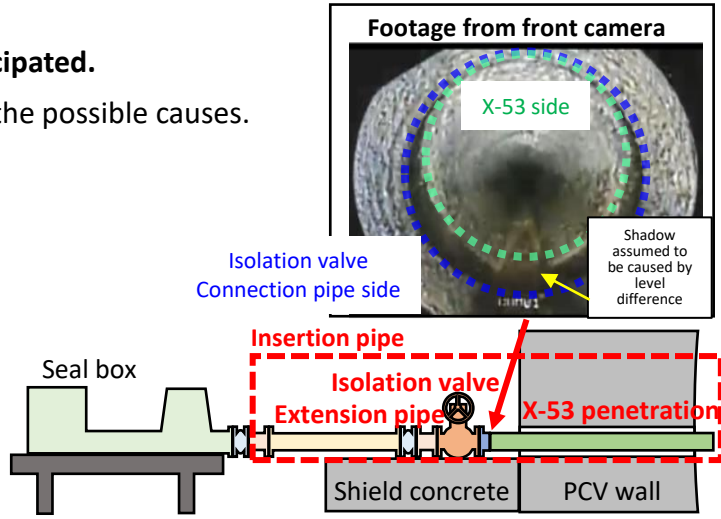
- In order to identify the cause of this event conditions on-site were inspected and the causes were analyzed from the perspectives of the "**investigation" device** and the "**on-site environment**".
- As a result, **we now assume that the conditions inside the insertion pipe differ from those anticipated.**
- A detailed inspection of the inside of the insertion pipe was conducted in order to narrow down the possible causes.



Seal box diagram



Insertion device diagram

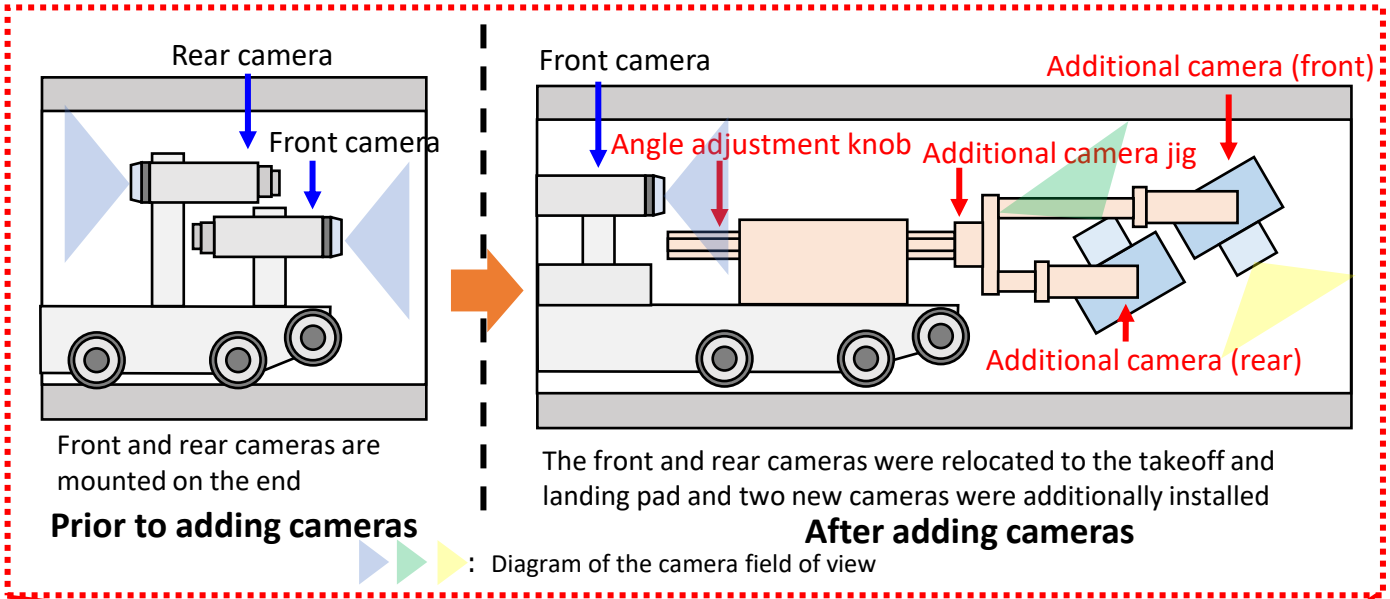


Insertion pipe diagram

Cause 1	Cause 2	Assumed cause	Confirmed on-site conditions or assumed conditions	Possible
Investigation devices	Cable drum	Drum malfunction	【On-site condition check】 Camera footage from the cable drum and the fact that the torque abnormality interlock has not tripped suggests they are working correctly even in the face of this problem.	×
		Caught cable	【On-site condition check】 An external examination found no evidence of the cable being caught on anything. And camera footage of the cable behavior shows that it is working correctly even in the face of this problem.	×
	Insertion device	Crawler track malfunction	【On-site condition check】 An external examination found no deformation or derailment. Function checks showed that the device can be repeatedly moved back and forward with no problem.	×
		Crawler drive system malfunction	【Field condition check】 Function checks showed that the device can be repeatedly moved back and forward with no problem.	×
On-site environment	Insertion pipe	Part of the insertion route is smaller in diameter due to a level difference	【Assumed conditions】 We cannot deny that a level difference at the pipe coupling may have caused the access pathway to become narrower and the insertion device to get caught. **【Field condition check】 A shadow that is assumed to be caused by a level difference between the isolation valve connection pipe and the X-53 penetration was found.**	○
		The current crawler cannot move forward any further due to the level difference	【Assumed conditions】 If there is a level difference that exceeds the crawler's capabilities or prevents it from fully performing, we cannot deny the possibility that the device may not be able to pass this point.	○

4. Detailed inspection of the inside of the insertion pipe

- **Two cameras were added to the end of the insertion device** in order to perform a detailed inspection of the inside of the insertion pipe.
- Both cameras are angled slightly forward and to the rear to take photos of the **level difference inside the pipe and the shape of the inner walls of the pipe.**
- The cameras can also rotate along the axis of the pipe, so **turning each of them 90-degrees enables us to acquire footage of the entire inner circumference of the pipe.**



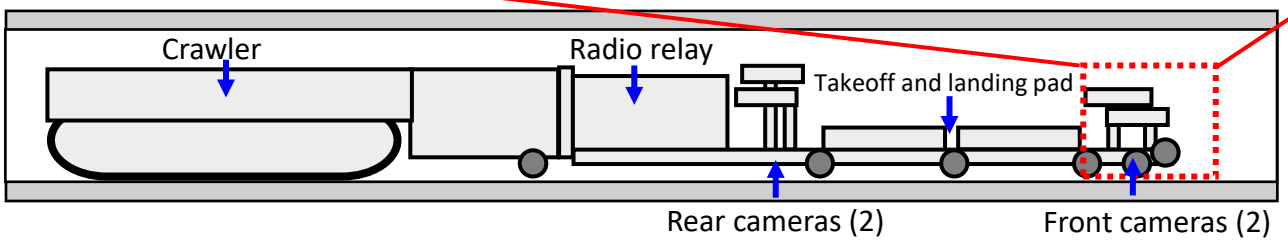


Diagram showing the insertion device (side view)

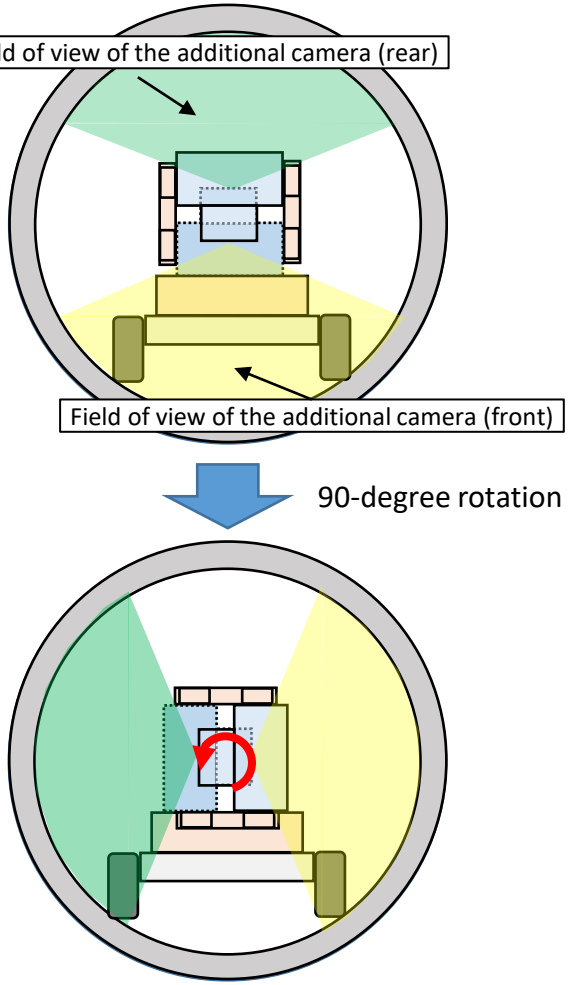
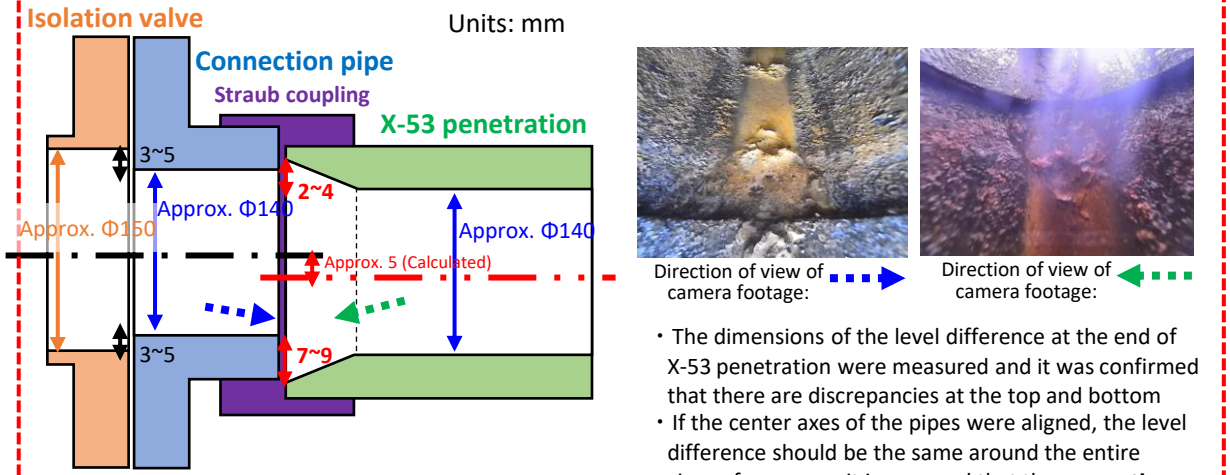


Diagram of additional camera rotation (front view)

5. Confirmed conditions inside the insertion pipe

- Analysis of obtained footage (footage from point grouping) shows that the center axes of the **connection pipe and X-53 penetration are slightly misaligned.**※1
- From these results we assume that the reasons why the insertion device cannot move passed this point is because the **cross-sectional area of the pathway becomes smaller** and **the crawler loses grip**. ※2
- Going forward, the obtained data will be further analyzed in detail and countermeasures deliberated.



※ **The measurements shown above were obtained from point group data** (The amount of misalignment is a calculation). Representative values have been shown since there may be discrepancies due to uneven surfaces caused by rust inside the pipes

- The dimensions of the level difference at the end of X-53 penetration were measured and it was confirmed that there are discrepancies at the top and bottom
- If the center axes of the pipes were aligned, the level difference should be the same around the entire circumference, so it is assumed that the **connection pipe and the X-53 penetration are slightly misaligned (the X-53 penetration is a little bit lower)**

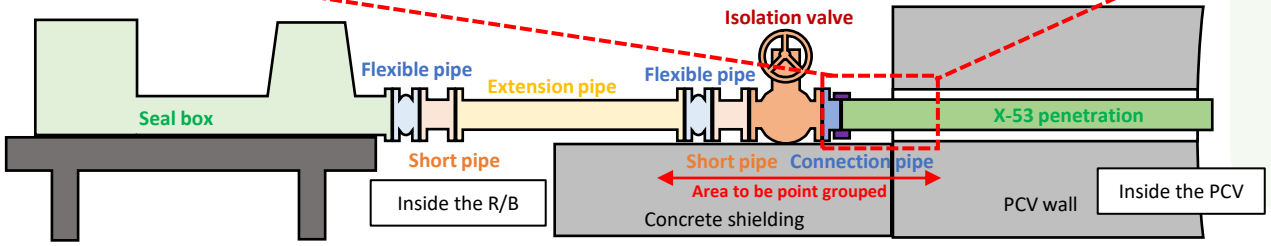
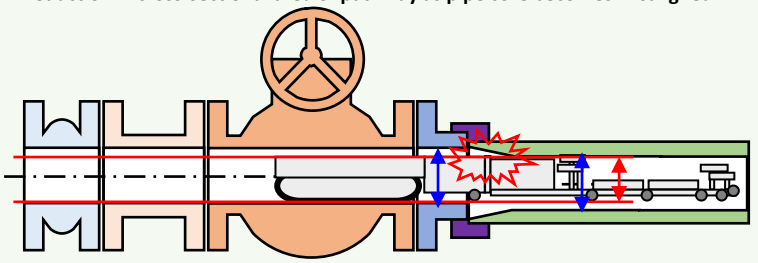


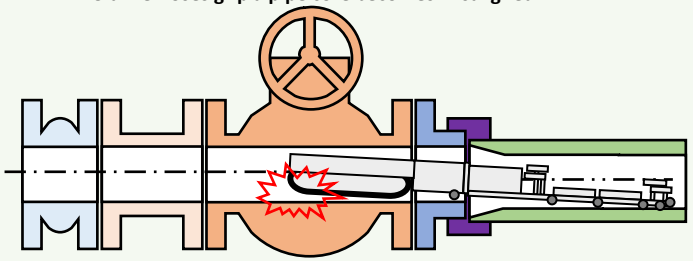
Diagram of confirmed conditions inside the insertion pipe

Reduction in cross-sectional area of pathway as pipe core becomes misaligned



- Reduction in cross-sectional area in longitudinal direction as pipe center axes becomes misaligned (red arrow)
- If the system is designed based on the minimum pipe diameter (blue arrow) then the device will not be able to pass the point where the cross-sectional area becomes narrower

Crawler loses grip a pipe core becomes misaligned



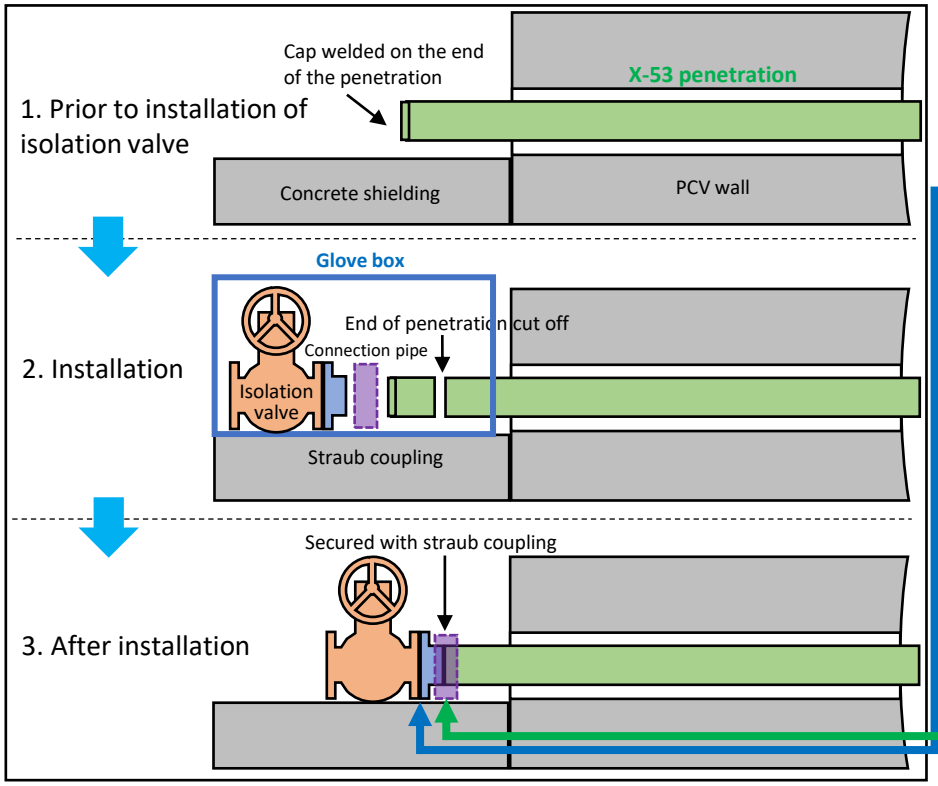
- The entire X-53 penetration is lower, relatively, due to the misalignment
- After the front of the device passes through the X-53 penetration, it tilts downward forcing the crawler to lift and lose grip thereby making it unable to move forward any further

Diagram illustrating why the insertion device cannot be moved forward (assumptions)

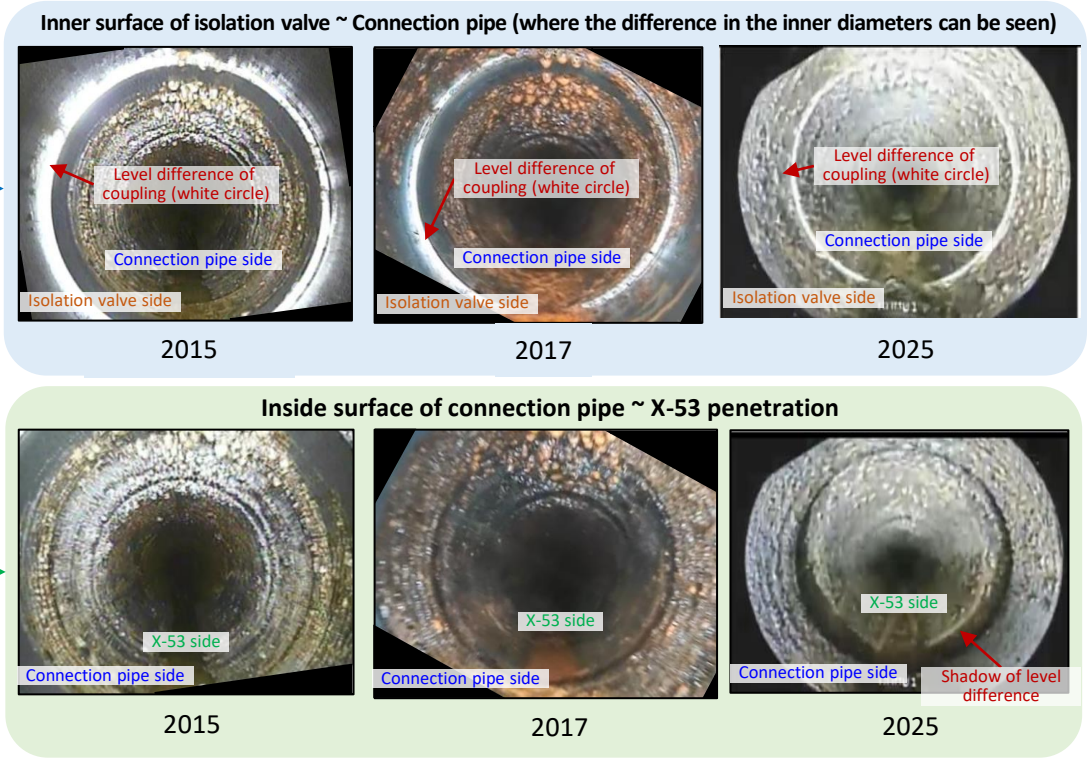
※1: There is no current impact on the PCV boundary.
※2: This is just an estimate at this stage, and there are other possibilities.

6. X-53 penetration isolation valve installation background

- **The X-53 penetration was used to access the inside of Unit 3 during the PCV internal investigation conducted in 2015,** and an isolation valve was manually installed using a glove box.
- At the time, the area around X-53 penetration still showed the impact of the accident and **field dose rates were high, so the cut end of the X53 penetration was secured to the isolation valve connection pipe using a straub coupling that did not require a lot of time to be installed.**
- The straub coupling can be affixed even if the joint is slightly misaligned, so **footage from recent PCV internal investigation (2017) were checked to see if we could see a level difference. However, we could not discern such things from the footage.** ※1



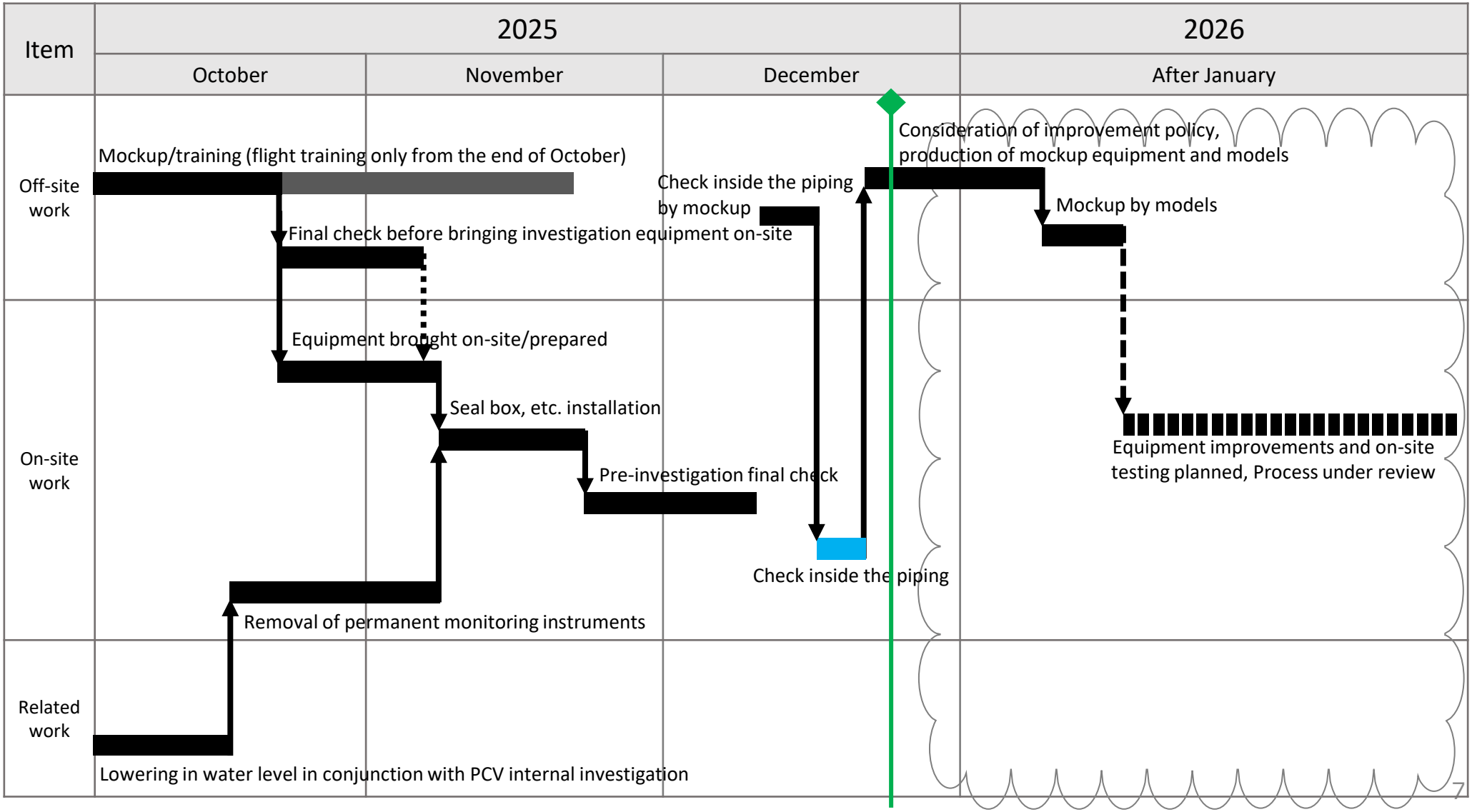
Isolation valve installation diagram (2015)



※1: In how the level difference appears due to the difference in lighting and the direction of the cameras in the footage from past investigations and this investigation.

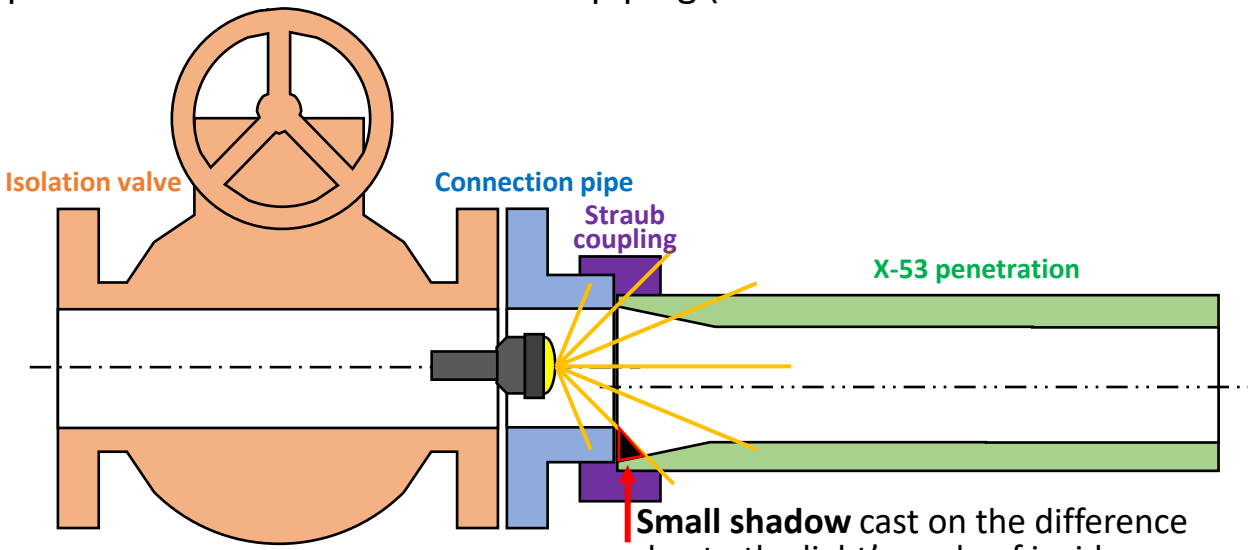
7. Investigation schedule

- Review the upcoming processes based on the status of the mockup by models.

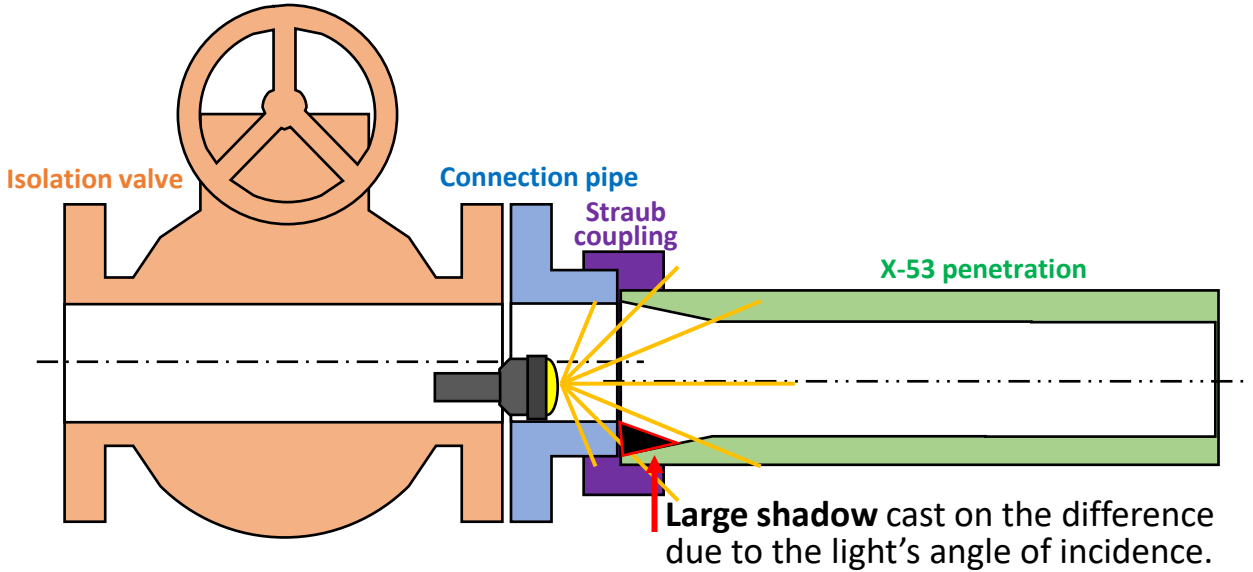


[Reference] Consideration on lighting position and level difference visibility

- When the lighting is positioned near the center of the piping (similar to the PCV internal investigations in 2015 and 2017).



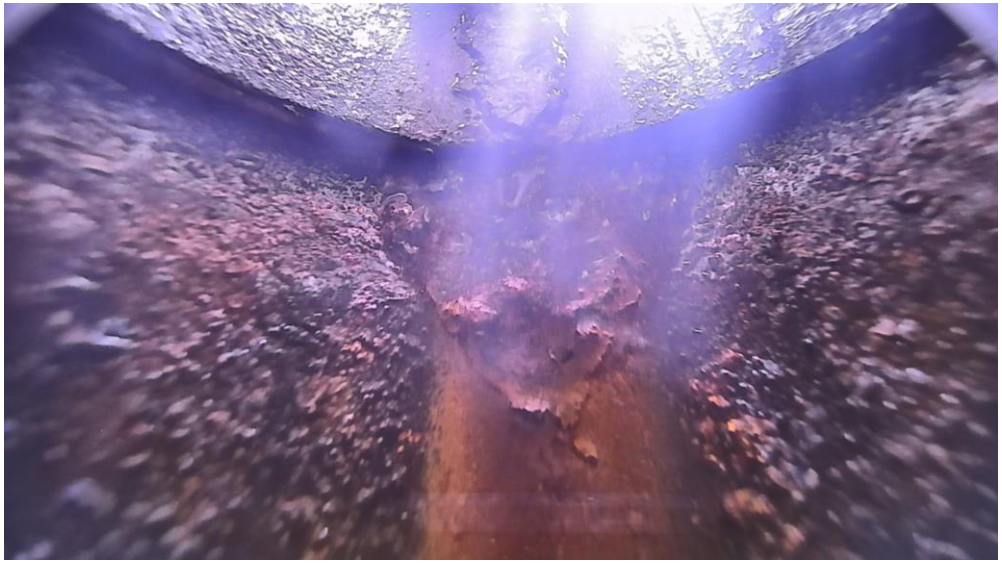
- When the lighting is positioned near the lower part of the piping (similar to the current PCV internal investigation).

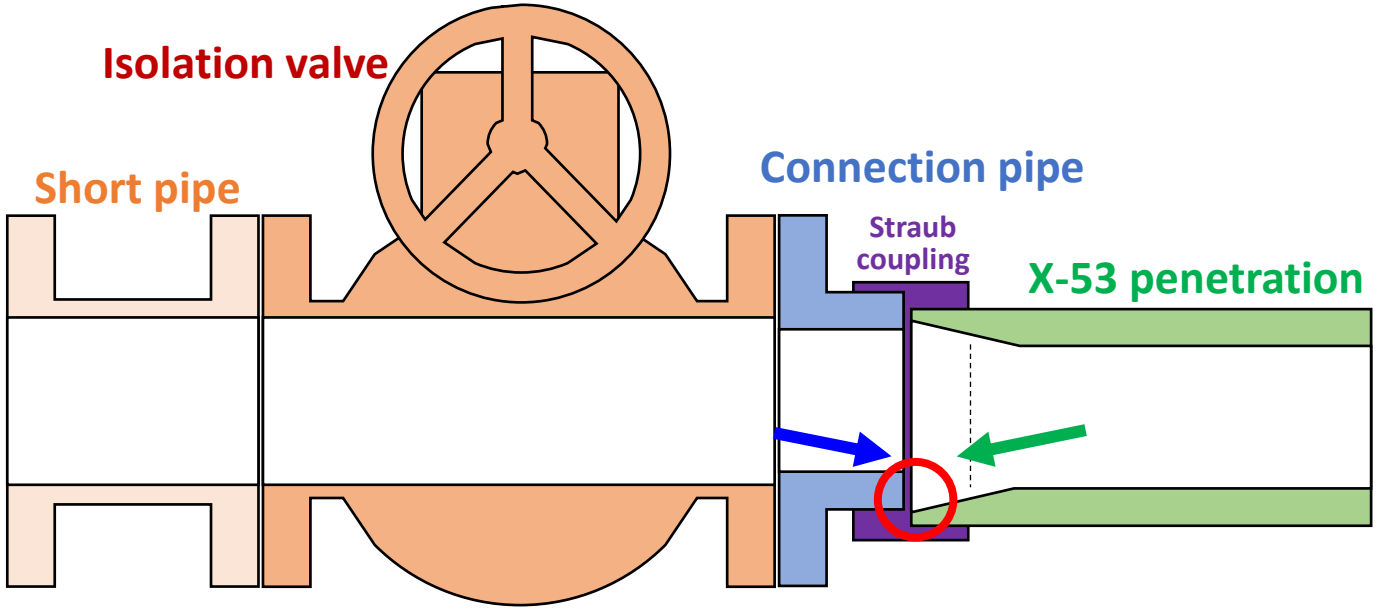


[Reference] Footage obtained through the inspection of the inside of the insertion pipe

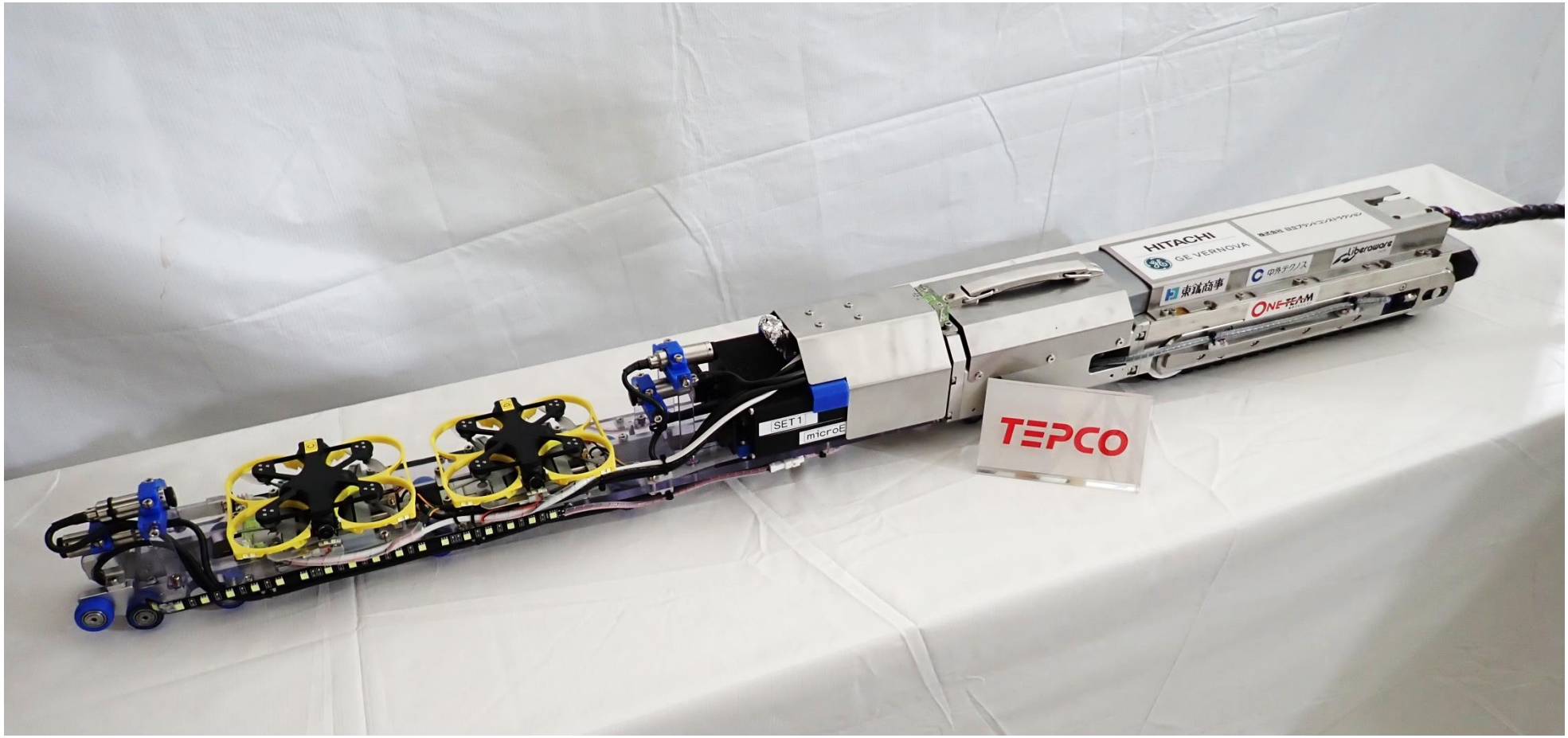
Direction of view: →

Direction of view: ←





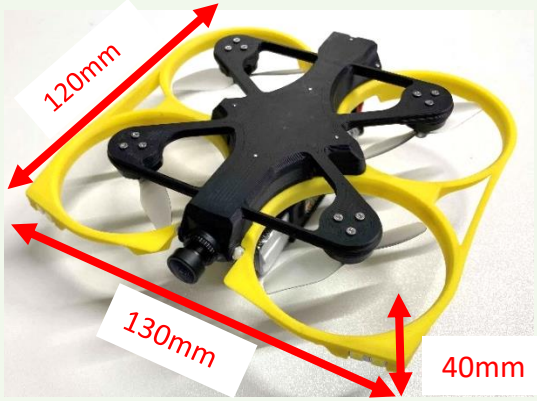
[Reference] External appearance of insertion device



[Reference] Investigation devices

- Since the area inside the PCV is cramped and dark, an extremely small and highly mobile **"micro-drone"** with photographic capabilities will be installed through the small X-53 penetration.
- As with past investigations**, a seal box will be attached to the X-53 penetration so as to allow the micro-drones to be inserted into the PCV while maintaining PCV isolation**.
- The seal box will contain a total of six drones, and two drones will be able to be inserted inside the PCV simultaneously (how the six drones are to be used will be determined during mockup/training).

Micro-drone



Held in the palm of the hand for size comparison

Use: Photography (2.7K)
Dimensions: 130×120×40[mm]
Weight:95[g](Including battery)
Communications method: Radio
Flight time: Approximately 13 minutes (the investigation is planned to take 10 minutes)
Camera performance: Image quality: 2.7K, frame rate: 60fps
Angle of view: diagonal 140°, Horizontal 135°, vertical 107°
Lights: 2 LEDs on the left and right sides (total: 380lm)
Radiation resistance: 200Gy
Notes: Corresponds to IP52, Two types of cameras: portrait and landscape

Seal box

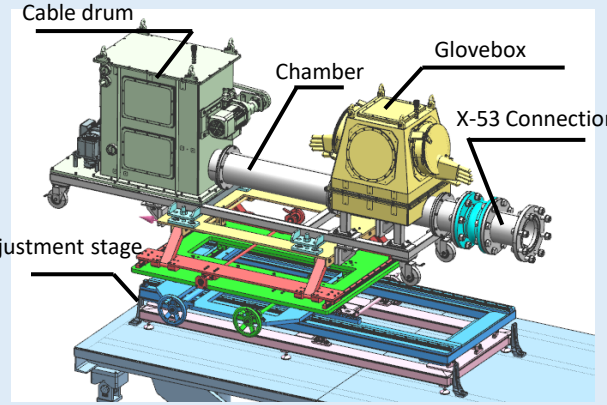


Diagram of seal box

The drones to be installed are housed in the chamber through which they are installed into the PCV.

Standby drones and recharging equipment are inside the glove box so that drones on the liftoff/landing pad can be switched out while maintaining airtightness.

Dimensions: Approx. 2.6m×0.6m×1.1m
Weight: Approx. 315kg

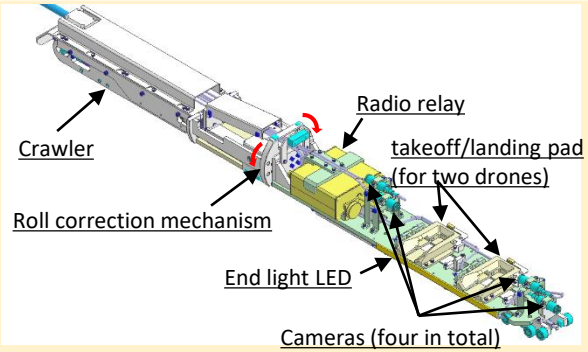


Diagram of insertion device

The crawler enables self-insertion thereby reducing worker exposure.

Two drones can be installed simultaneously.

Dimensions: Approx. 1.3m×Φ130mm
Weight: Approx. Approximately 20kg

[Reference] Overall workflow

- Permanent monitoring instruments (water level/temperature gauge) newly installed after the accident are currently inserted through the X-53 penetration.
- And, in order to fly the micro-drones inside the pedestal, the water level inside the PCV must be lowered to the bottom edge of the CRD replacement opening.
- Therefore, as preparations for the investigation, **PCV water level will be lowered, and permanent monitoring instruments will be removed after which the investigation devices will be installed and the investigation performed**.
- After the investigation is completed, the investigation devices will be removed, and the permanent monitoring instruments will be reinstalled.