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

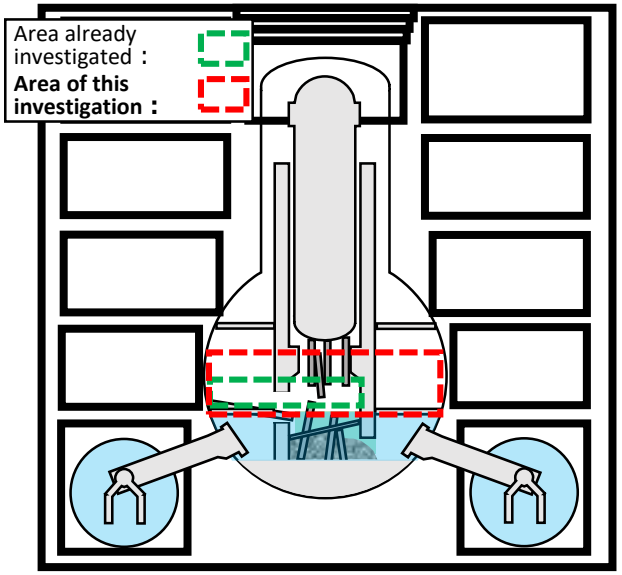
September 25, 2025

TEPCO

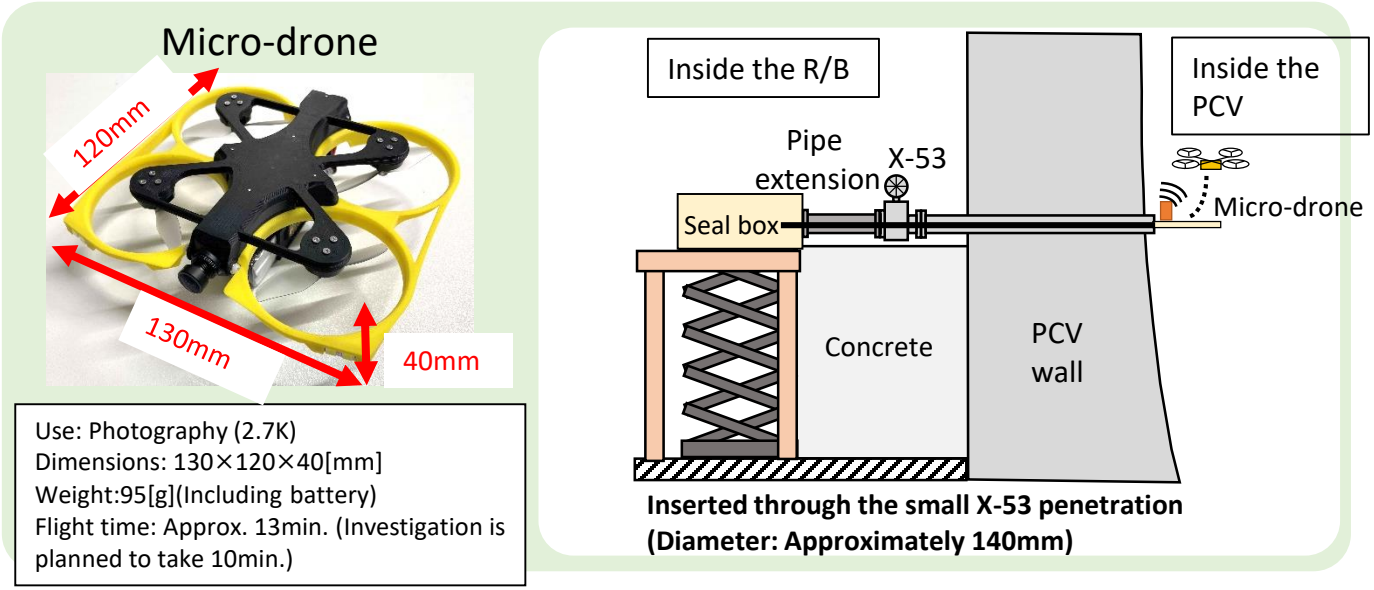
Tokyo Electric Power Company Holdings, Inc.

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.



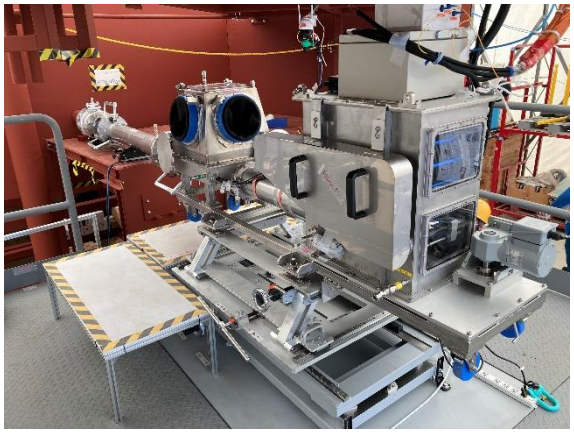
Cross-sectional diagram of the Unit 3 PCV internal investigation area



Concept diagram of Unit 3 micro-drone investigation

2. Status of mockup and training

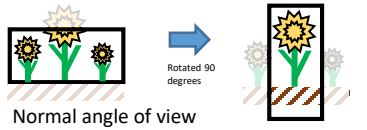
- **Mockup are being used to perform seal box work and micro drone flight training.**
- The objective is to gain expertise with seal box installation, the operation of installation equipment, and drone operation.
- In conjunction with gaining expertise, work procedures will be revised and flight routes closely examined.
- During the flight mockup, a **micro-drone equipped with a portrait camera is tested in order to make it easier to examine the structures at the top of the pedestal.** This is proving effective, so **adjustments are being made to use this during the investigation of the inside of the pedestal.**



Seal box installation to the mockup of the X-53 penetration

Operation of installation equipment

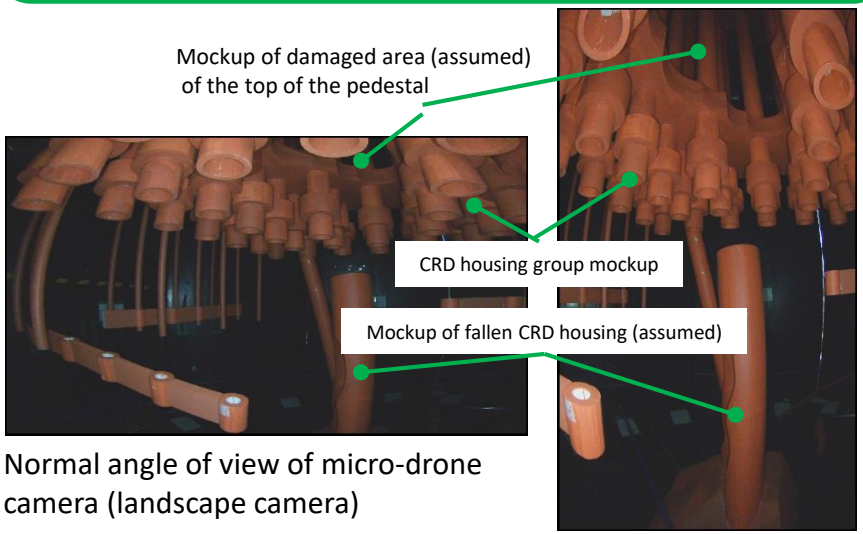
・Exterior appearance is the same as a normal micro drone
・Front camera has been rotated 90 degrees
・Rotating the camera makes it easier to see the top and bottom of tall structures



Portrait camera micro-drone

Flight inside the PCV mockup (in the dark)

Drone operation



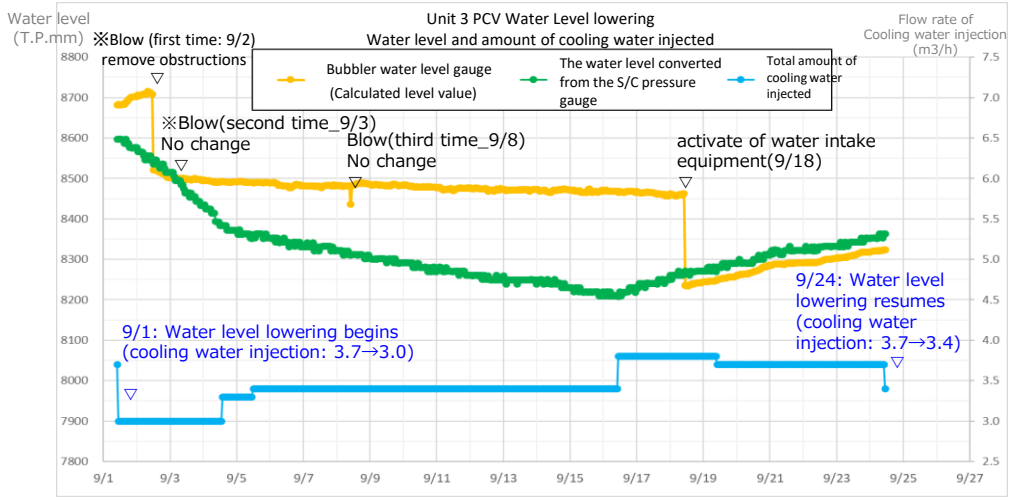
Normal angle of view of micro-drone camera (landscape camera)

Portrait angle of view of micro-drone camera

3. Lowering water level

- We started lowering the PCV water level on September 1 by lowering the amount of cooling water being injected, but it was determined that the new PCV water level gauge (bubbler water level gauge) was not showing the correct readings, so the lowering of the PCV water level was halted on September 16 and the water level is being maintained near the contact–type water gauge/temperature gauge (near T.P.8246). The water level gauge is functioning properly and there have been no instrument malfunctions.
- As a result of the work conducted to improve the interconnection between the RHR pipe and the PCV which is equipped with a bubbler water level gauge(activate of water intake equipment) , we will begin lowering the water level again on September 19 due to the bubbler water level gauge showing the same reading as the PCV water level gauge ,and the interconnection between the RHR pipe and the PCV.
- Furthermore, even if a similar phenomenon was observed, not only the bubbler water level gauge, but also the water level gauge correction readings converted from the S/C pressure gauge is possible for monitoring, we will continue the lowering of the water level down to the target level.

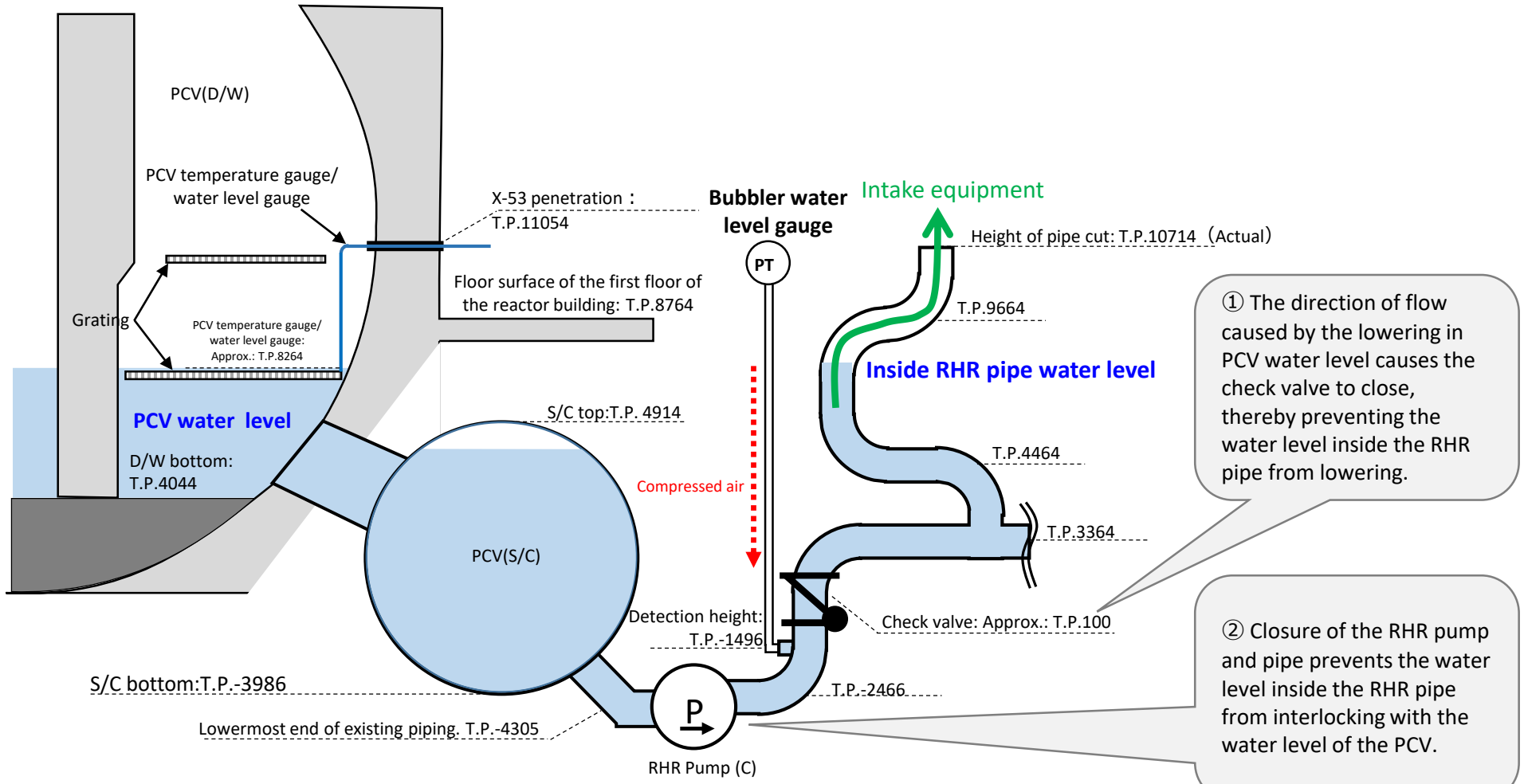
※1：Bubbler water level gauge measures the PCV water level indirectly by measuring the water level of the RHR pipe interconnecting with the PCV.
※2：The water level gauge correction readings converted from the S/C pressure gauge (+400mm)



※3：Forcing air at higher pressures than usual into the detector tube of the bubbler water level gauge in order to remove the clog its pipe.

[Reference] Considerations pertaining to bubbler water level gauge readings

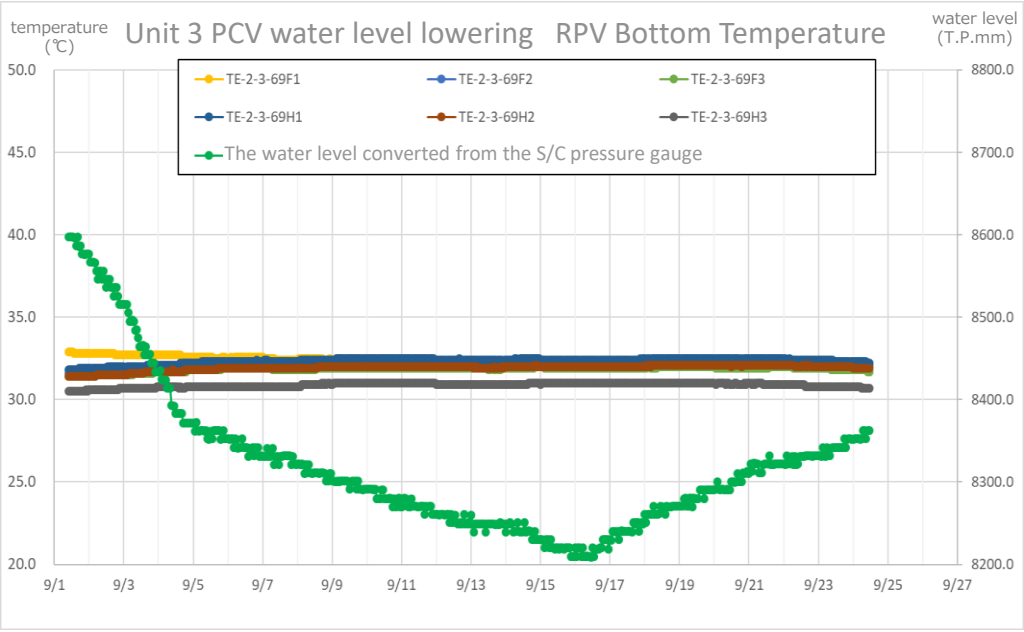
- It is assumed that the bubbler water level gauge is not accurately measuring PCV water level because the water level of the PCV is not interlocking with the water level of the RHR piping.
- It is assumed that the configuration of RHR system equipment is preventing both water levels from interlocking (① Impact of the positional relationship of the RHR pump outlet check valve and ② RHR pump, pipe closure).

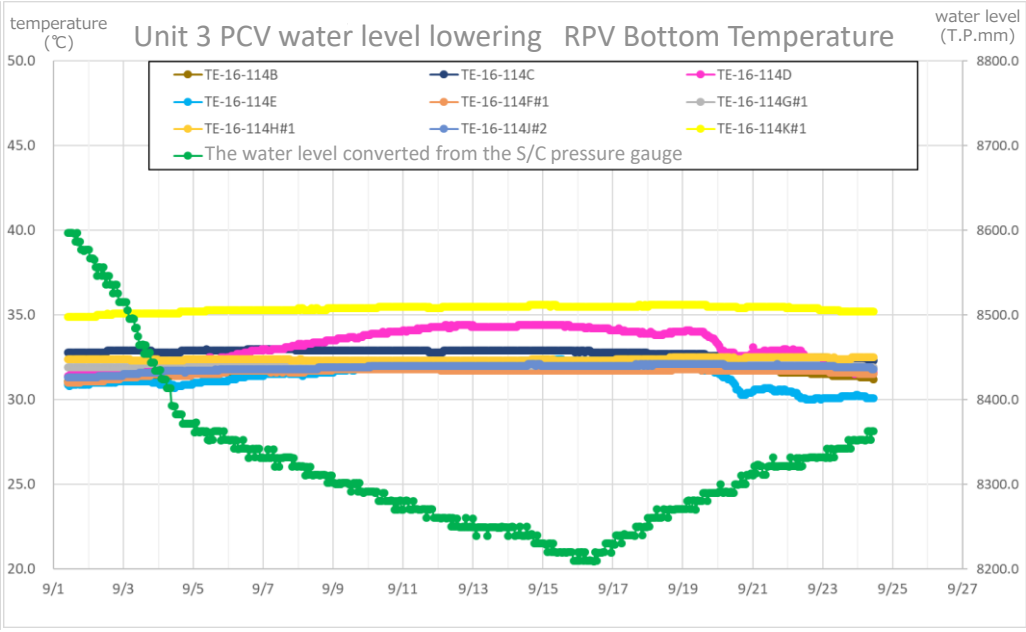


Bubbler water level gauge configuration diagram

4. Trends in RPV bottom/PCV temperature gauge (Temperature gauges noted in the implementation plan)

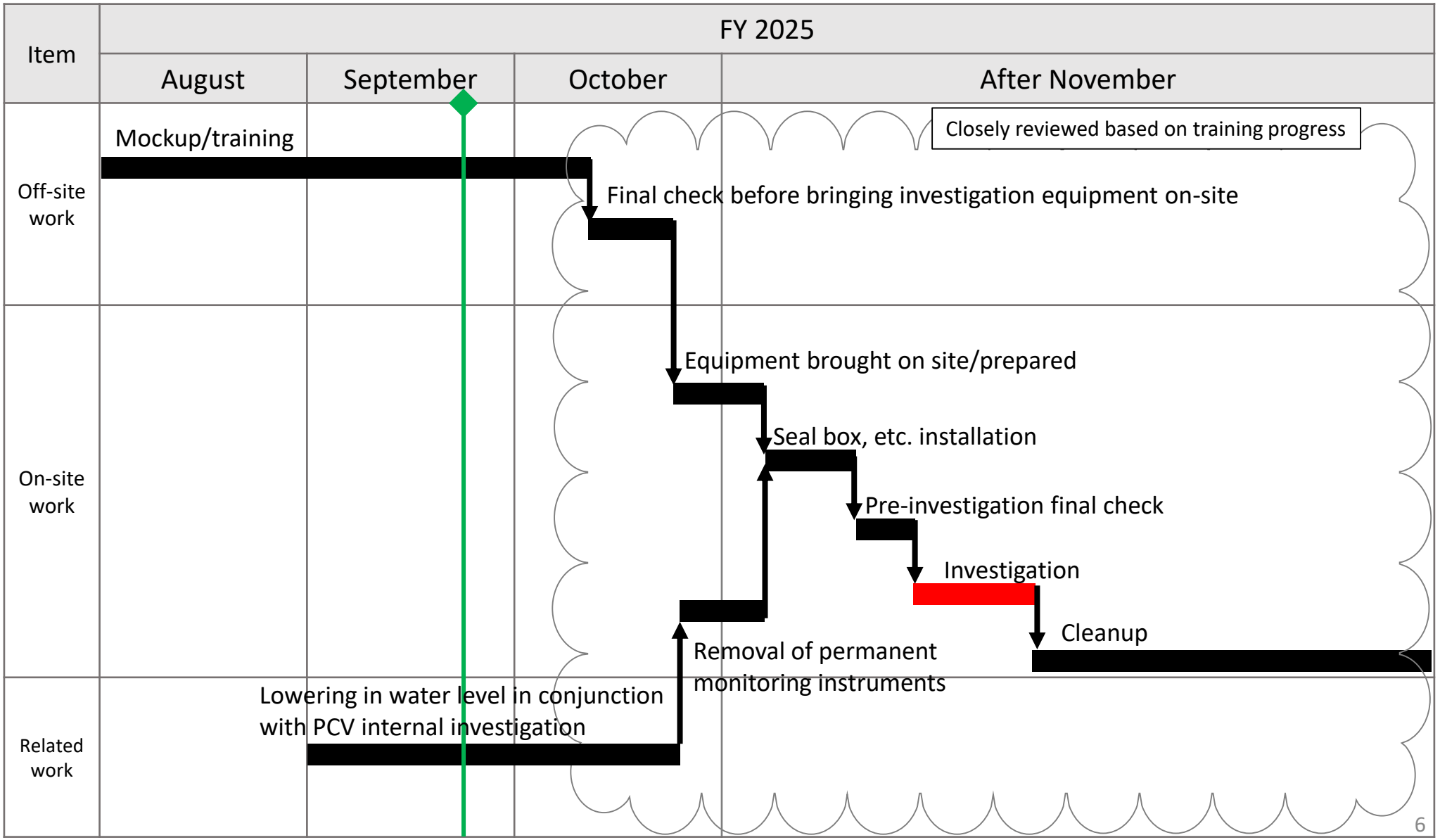
- Since there is a high possibility that RPV and PCV temperature gauge readings will change in conjunction with the lowering in PCV water level, a hold point of approximately T.P. 8000 will be set for the water level, and a temperature gauge reliability assessment will be conducted as necessary in accordance with a predetermined flow if changes are seen.
- As of September 24, a change of a few degrees was observed in the readings of some temperature gauges. Monitoring will be continued.





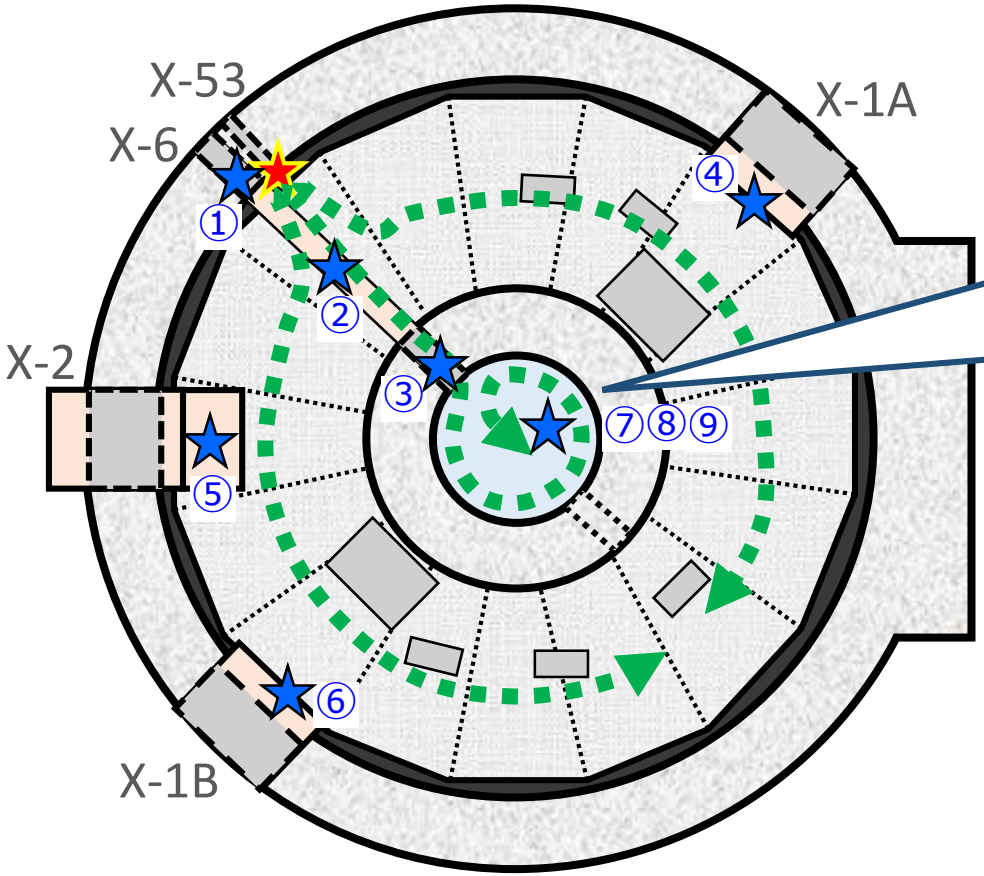
7. Investigation schedule

- Mockup/training and lowering in water level are underway in preparation for investigation implementation.

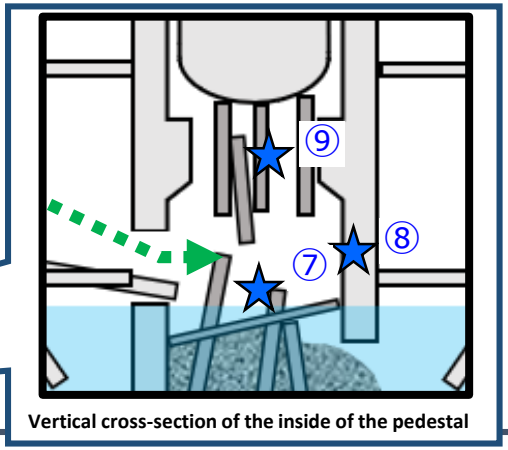


[Reference] Investigation details

- During this investigation the micro-drawn will be flown on **the first floor of the D/W and inside the pedestal to take footage.**
- The **primary objective of the investigation is to gather information about the inside of the pedestal and the area around the X-6 penetration,** which are important for the side-retrieval of fuel debris and future deposit investigations.
- As with the drone investigation of Unit 1, **the footage will be used to compile point cloud data and the radiation noise will be used to estimate dose rates.**
- Since operating the micro-drone is difficult, the scope of the investigation may be altered depending upon field conditions, however mockup/training is underway in order to acquire as much information as possible.



Plainview diagram of proposed flight route on the first floor of the Unit 3 D/W



Vertical cross-section of the inside of the pedestal

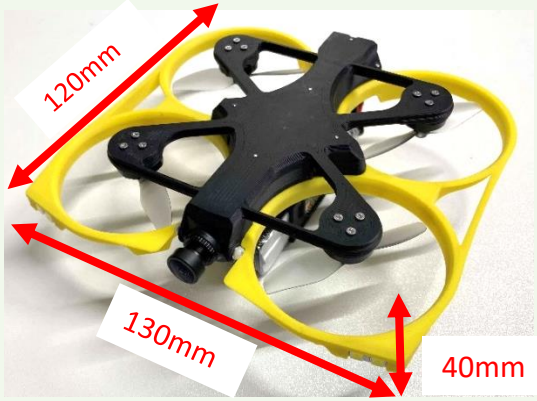
■Key
★: Radio and micro-drone takeoff/landing position
▶: Flight route
★: Areas of interest (red letters: high priority)
① : X-6 Penetration
② : CRD rails ※
③ : CRD Replacement opening ※
④ : X-1A Penetration
⑤ : X-2 penetration
⑥ : X-1B penetration
⑦ : Status of deposits/fallen objects + Water level ※
⑧ : Pedestal wall surface ※
⑨ : CRD housing, etc. ※

※ : Already partially investigated

[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-drone 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 installed 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

Seal box

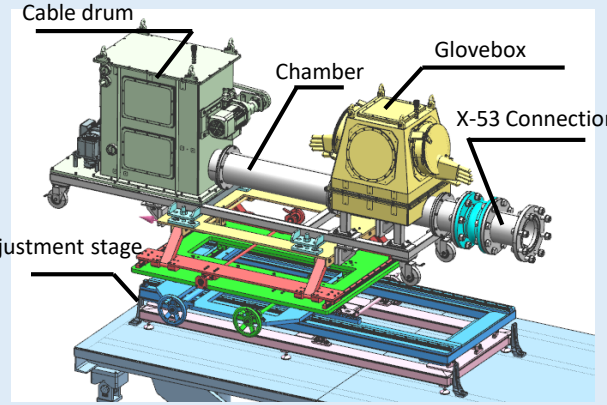


Diagram of Seal box

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

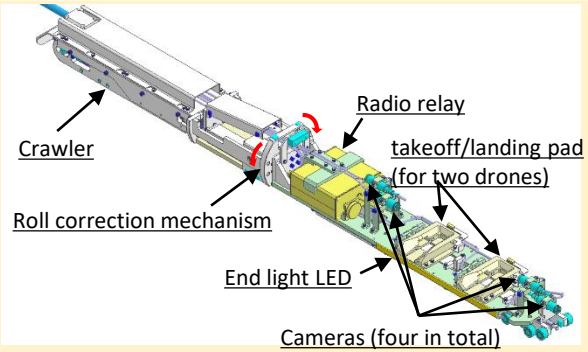


Diagram of installation equipment

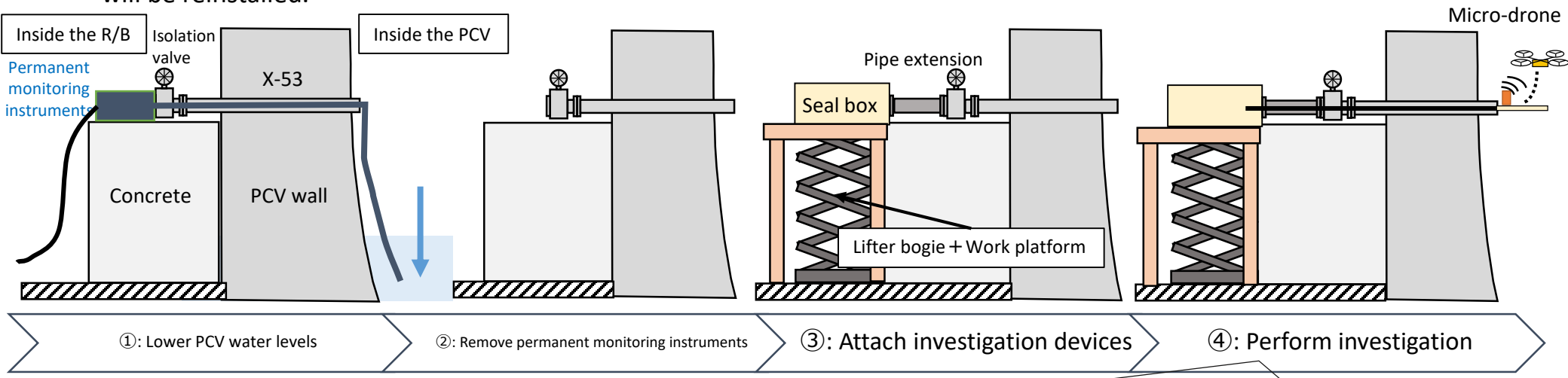
The crawler enables self-installation thereby reducing worker exposure.

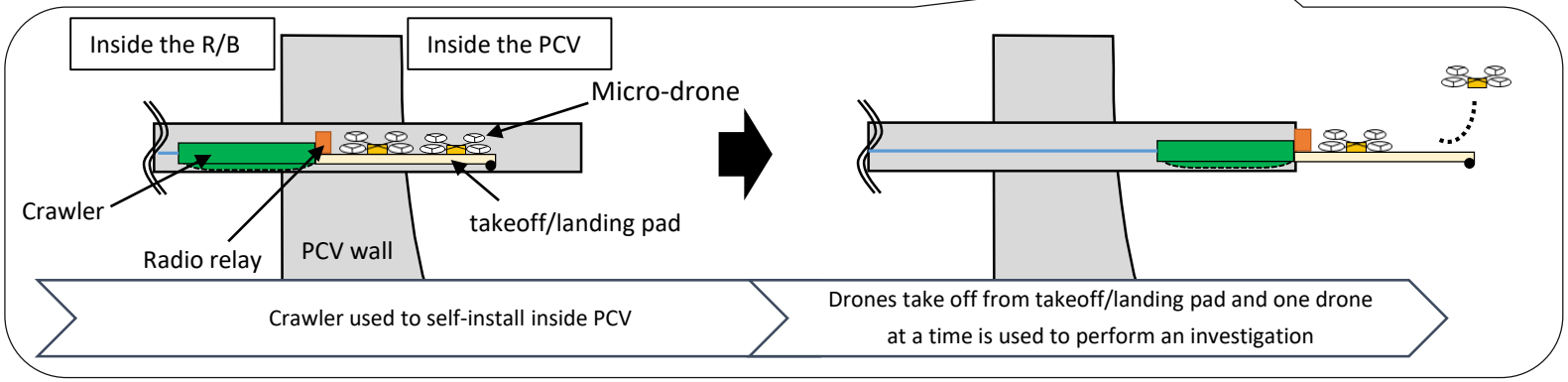
Two drones can be installed simultaneously.

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

[Reference] Work flow

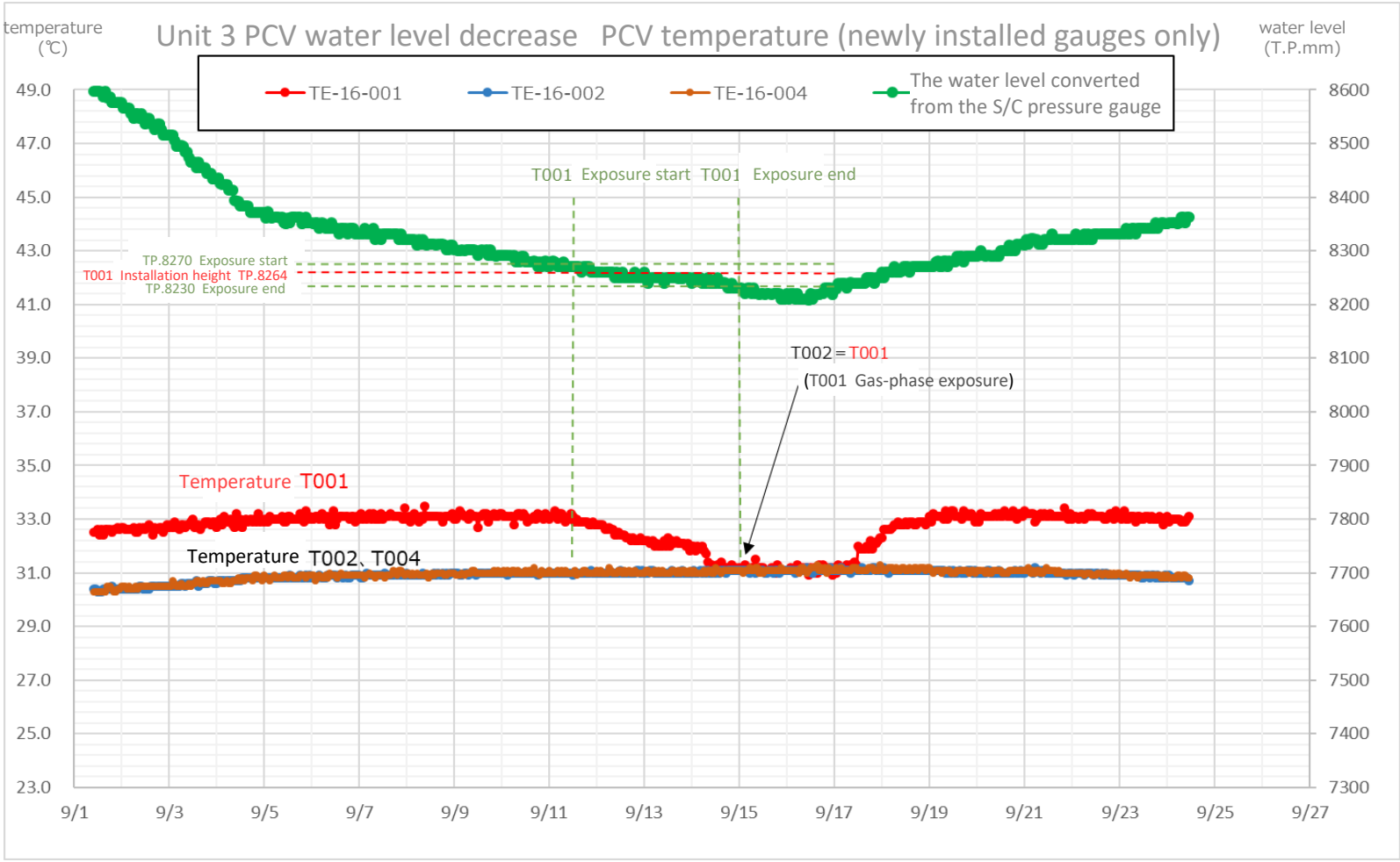
- Permanent monitoring instruments (water level/temperature gauge) newly installed after the accident are currently inserted through the X-53 penetration.
- And, in order to fly the micro-drone inside the pedestal, the water level inside the PCV must be lowered to the bottom edge of the CRD replacement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





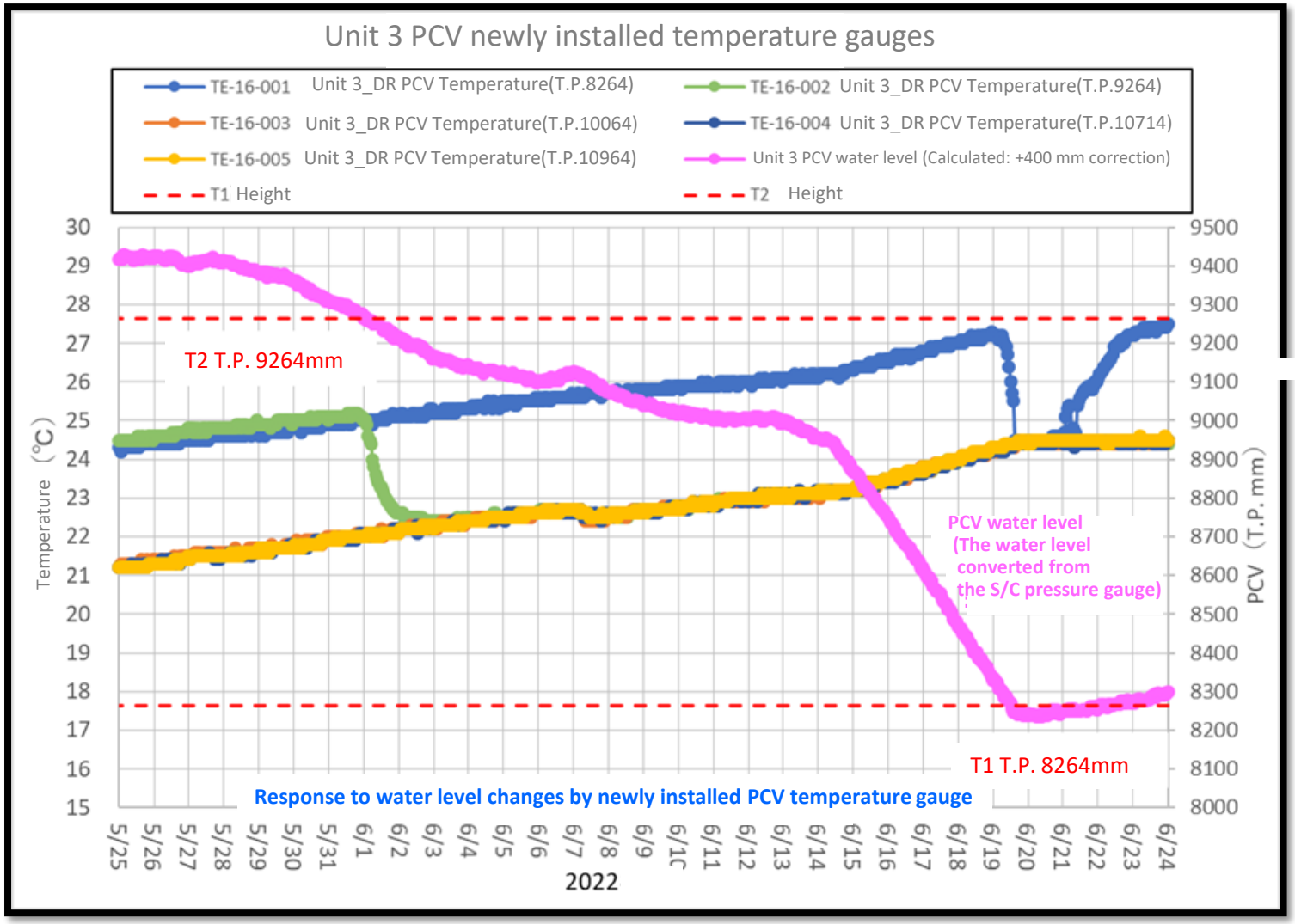
[Reference] Trends in the water level converted from the S/C pressure gauge and PCV temperature (newly installed)

- The reading of temperature gauge TE-16-001 became equivalent to temperature gauge such as TE-16-002 on September 15 thereby indicating that temperature gauge TE-16-001 had become exposed to the atmosphere due to the lowering in PCV water level (The temperature of the gas phase is slightly lower than the temperature of the liquid phase).
- The water level converted from the S/C pressure gauge approximately match the point in time (Submerged → non-submerged) when the change was observed with TE-16-001(T.P.8264).



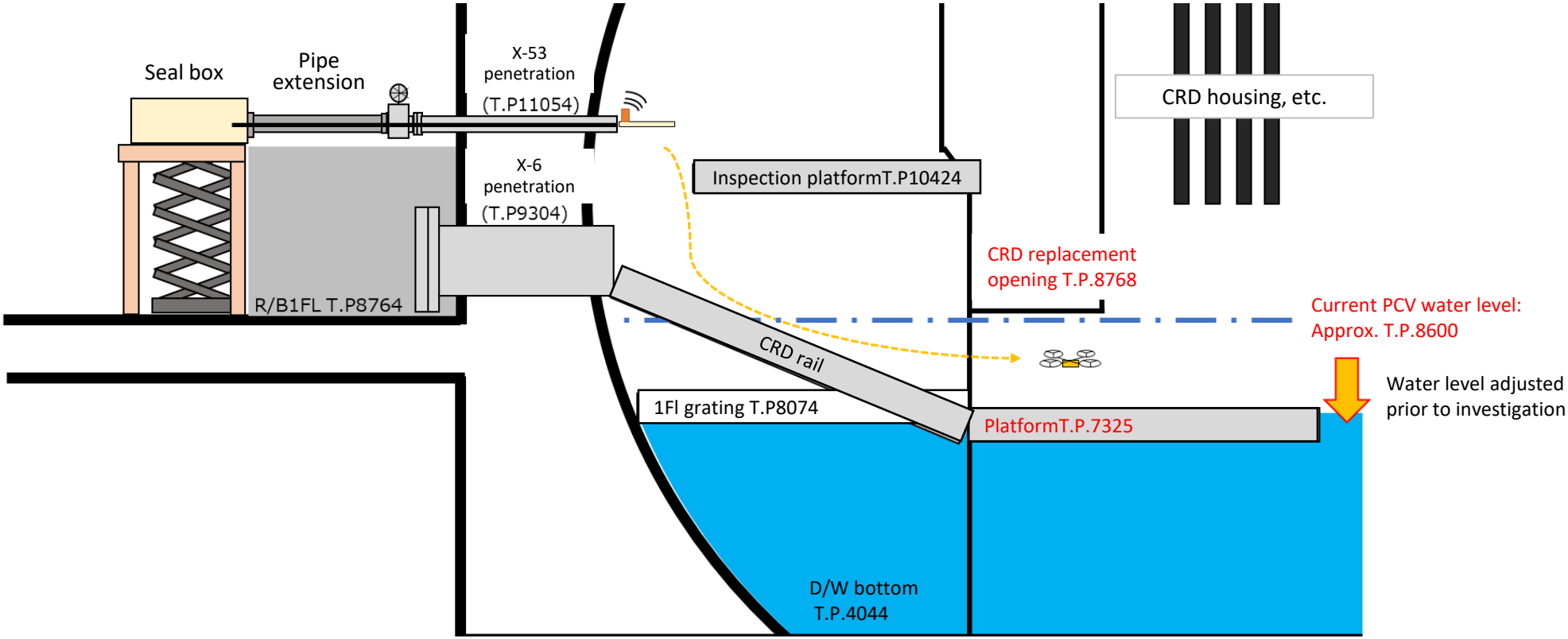
[Reference] Trend in the water level converted from S/C pressure gauge (2022)

- The water level converted from S/C pressure approximately match the point in time when PCV water level is indicated by changes in PCV newly installed temperature gauges TE-16-002(T.P.9264) and TE-16-001(T.P.8246) (Submerged → Non-submerged).



[Reference] Lowering water levels in conjunction with the PCV internal investigation

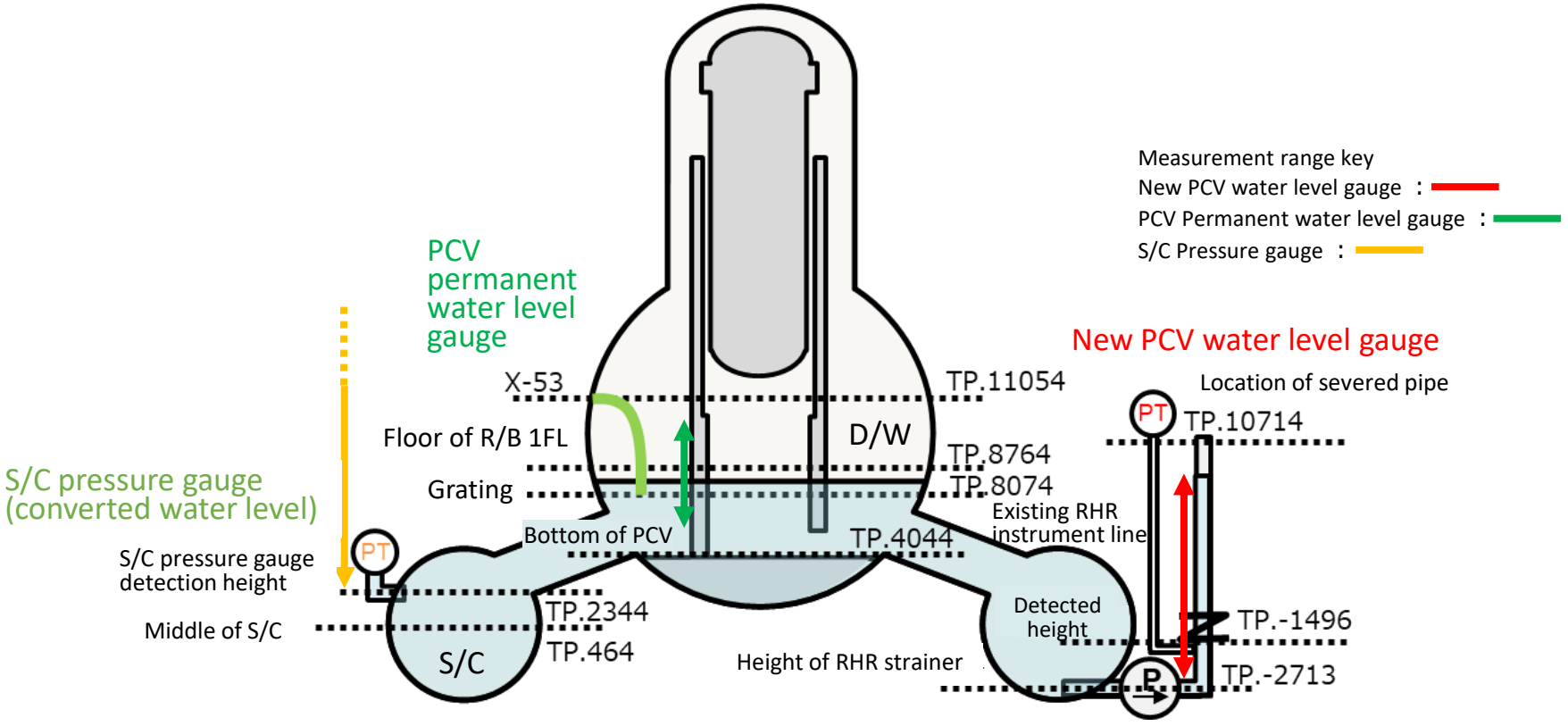
- The Unit 3 PCV water level is being kept at T.P.8264~9264 (Between permanent monitoring instruments L1~L2) and is currently at approx. T.P.8600.
- At this current water level, the CRD replacement opening, which is the access route into the pedestal, is submerged so the water level will be lowered to approximately T.P.7300 (the height of the platform) in order to expose the opening.
- Based on past experience, we know that it is highly possible that the RPV/PCV temperature gauge readings will fluctuate in conjunction with water level reductions. Therefore, a hold point will be established at approximately T.P. 8000 water level. If a change is confirmed, a temperature gauge reliability assessment will be conducted in accordance with a predetermined procedure as necessary.
- We will start decreasing the water level gradually from September with expected completion around October.



Drone flightpath and water levels during the investigation of the inside the pedestal (Concept diagram)

[Reference] Overview of Unit 3 PCV water level monitoring gauges

- A bubbler water level meter has been installed on the Unit 3 RHR pump discharge pressure instrument line.
  - ✓ Overview: A bubbler water level gauge akin to a bubbler tube has been installed on the RHR pump pressure instrument line.
  - ✓ Measurement range: From around the height of the X-53 penetration to the middle of the S/C (T.P. 10,714~-1,496).



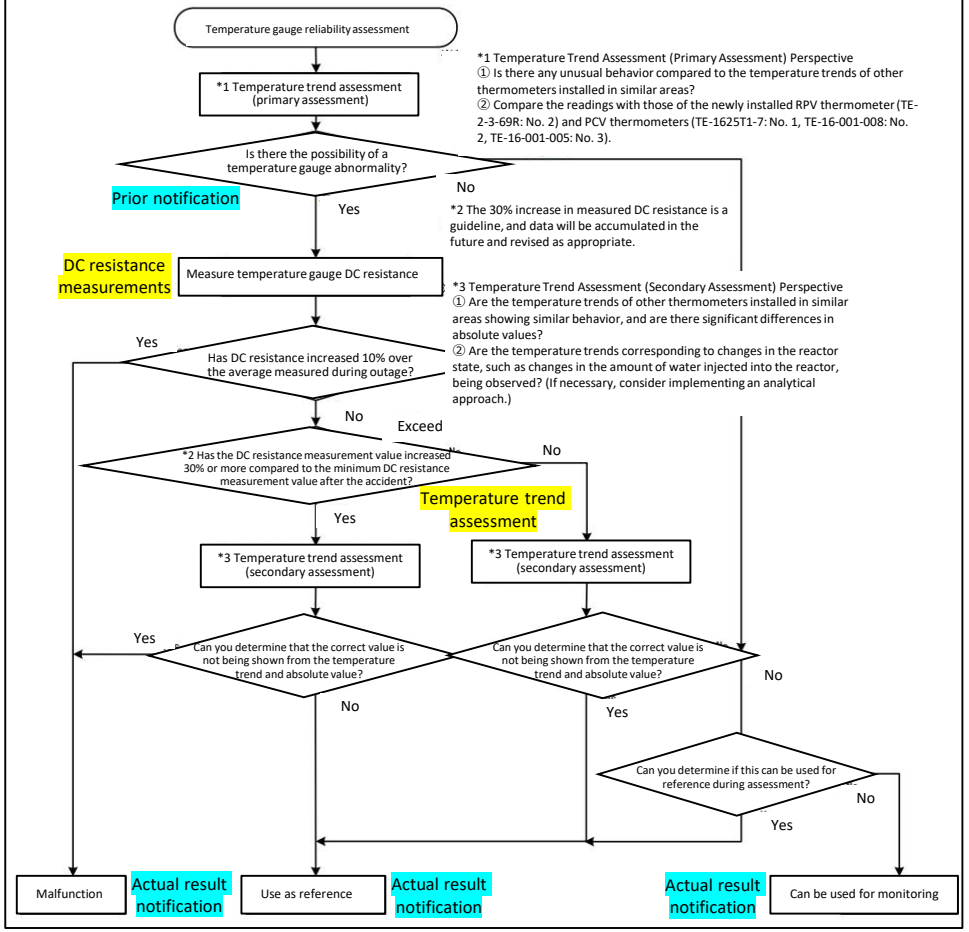
Height relationship of Unit 3 PCV water level gauges

[Reference] Responding to changes in the readings on existing temperature gauges

- A method for assessing the reliability of temperature gauges has been stipulated based on the instructions※ received from the Nuclear Regulatory Agency in 2012 after an abnormal increase in the temperature of Unit 2, and the results of these assessments are reported monthly to the Nuclear Regulatory Agency.
- Temperature gauge reliability assessments are conducted if the permanent temperature gauges noted in the implementation plan deviate approximately 10°C (internal operability value).
- Prior notification is given before taking DC resistance measurements and results are notified after the assessment is completed in the form of actual result notification.

※ Handling Procedure in the Wake of the Temperature Increase at the Bottom of the TEPCO Fukushima Daiichi Nuclear Power Station Unit 2 Reactor Pressure Vessel (Instructions)

Temperature Gauge Reliability Assessment Flow and Temperature Gauge Status Classifications

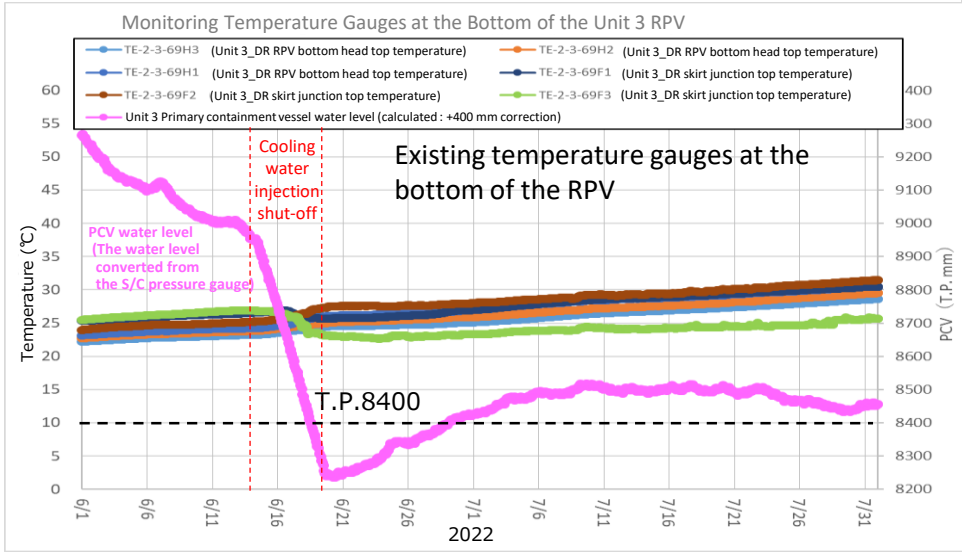


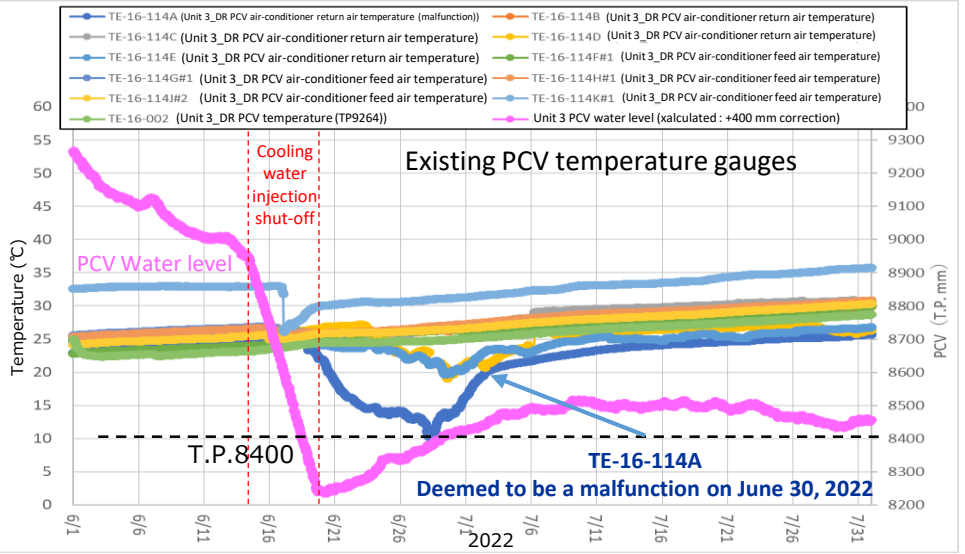
Status classification	Assessment method	Assessment method
Malfunction (When the outcome is (1) or (2))		(1) DC resistance has increased 10% over the average measured during outage
		(2) "DC resistance measurement value increased 30% or more compared to the minimum DC resistance measurement value after the accident(*)" and "It can be determined on an engineering-basis that the correct value is not being shown from temperature trends"
Use as reference (When the outcome is (1) or (2))		(1) "DC resistance measurement value increased 30% or more compared to the minimum DC resistance measurement value after the accident(*)" and "It can be determined on an engineering-basis that the correct value is not being shown from temperature trends"
		(2) "DC resistance measurement value increased less than 30% compared to the minimum DC resistance measurement value after the accident(*)" and "It can be determined on an engineering-basis that the correct value is not being shown from temperature trends"
Can be used for monitoring (Resistance decrease or normal)		Anything other than what's mentioned above

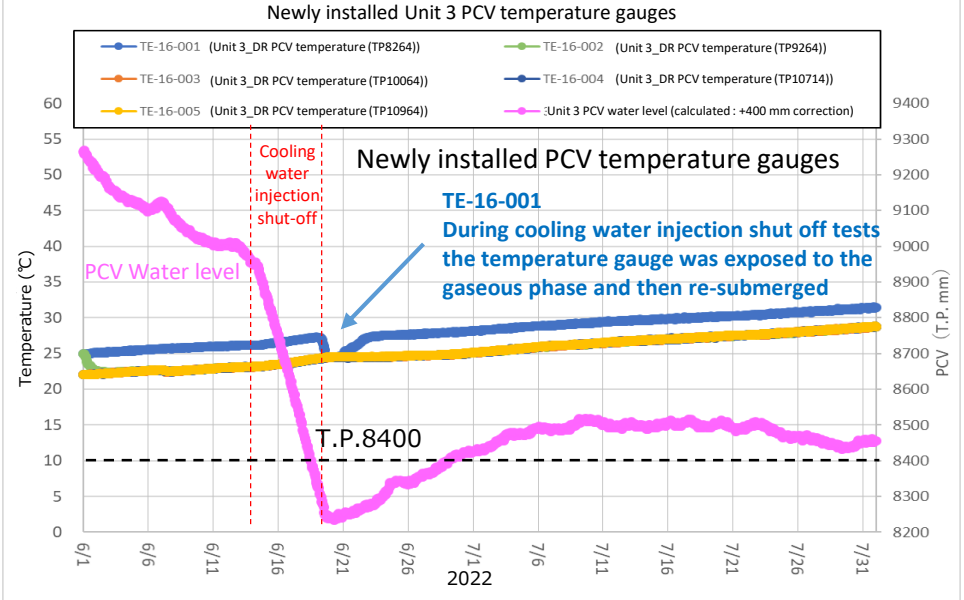
*30% (DC resistance measurement value/minimum DC resistance after the accident) is a benchmark that will be revised as necessary as data is accumulated

[Reference] Existing temperature gauge reading fluctuations (during 2022 Unit 3 reactor cooling water injection shut-off tests)

- In the past, fluctuations in the readings of some existing temperature gauges (including temperature gauges noted in the implementation plan) have been seen when the PCV water level fell below approximately T.P.8400. This might have been caused by partial gaseous phase exposure of the terminal board. (There were no reading fluctuations in newly installed PCV temperature gauges.







※Installation height of existing temperature gauge terminal board Approx. T.P. 8150 ~ 9150