Handling of the PCV Water Level Drops at Units 1 and 3

March 25, 2021

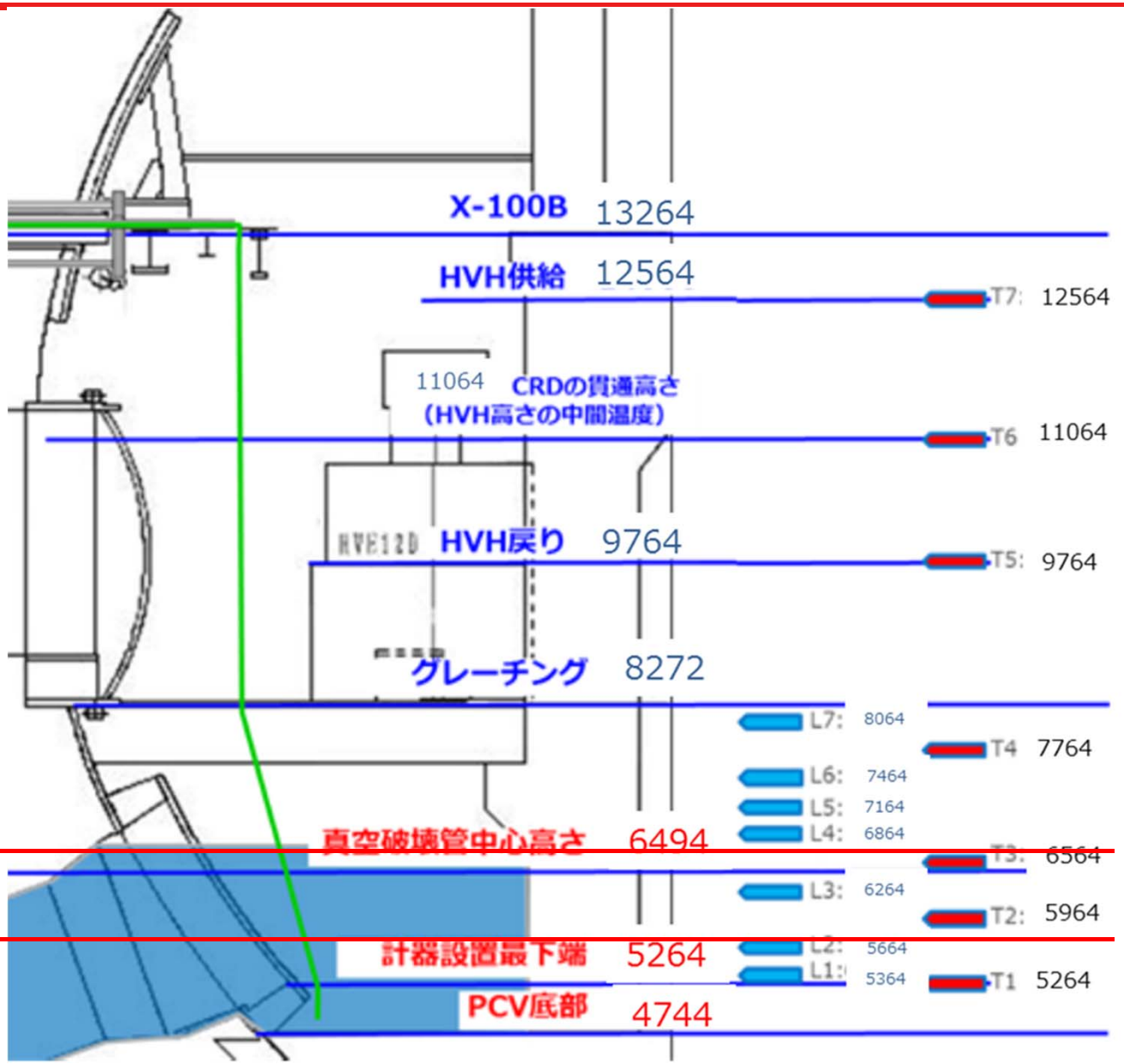
Tokyo Electric Power Company Holdings, Inc.

1. Event history

- When plant parameters were checked on February 18, 2021, the Unit 1 PCV water level gauge was showing a drop in water level.
- Confirmation/assessment of other parameters thereafter revealed that some of the newly installed PCV temperature gauges were showing dropping trends, so it was determined on February 19 that the PCV water levels at Units 1 and 3 were dropping.
- In response to this, plant parameters for Units 1 ~3 (including Unit 2) are being watched more carefully in consideration of the possible impact of the earthquake. However, we have seen no significant fluctuation in cooling water injection amounts, plant parameters, monitoring posts at site boundaries, dust monitors, on-site dust monitors, or reactor building water levels, so at current time we have determined that there is no danger to nuclear safety.
- In regards to the cause of the PCV water level drops, it is assumed that a primary factor is the earthquake that occurred at 11:08 PM on February 13 that resulted in a change of status of known damaged portions of the PCV, thereby increasing leakage amounts.
- At current time, water levels in the Units 1 and 3 PCVs are dropping slowly, and we have determined that the water level in Unit 3 has almost stabilized. Furthermore, we have confirmed that water levels in both Units 1 and 3 exceed the PCV water levels we experienced during cooling water injection shutdown tests, but we will continue to monitor parameters carefully.
- At Unit 1, the PCV water level fell below water level gauge L2※ at 8:24 PM on March 22, so at 10:42 PM on the same day the amount of cooling water injection was increased（Approx. 3.0m^3/h→Approx.4.0m^3/h). As a result, the water level rose above L2 at 3:57 AM on the next day (March 23).
- At Unit 3, cooling water injection volume will be increased when the water level falls below the PCV water level gauge L2 ※ （+1.0m^3/h) so that PCV water level is kept at a height that can be continually confirmed.

※ Set at the level of the gauge above the lowermost gauge in order to monitor PCV water level in a stable manner

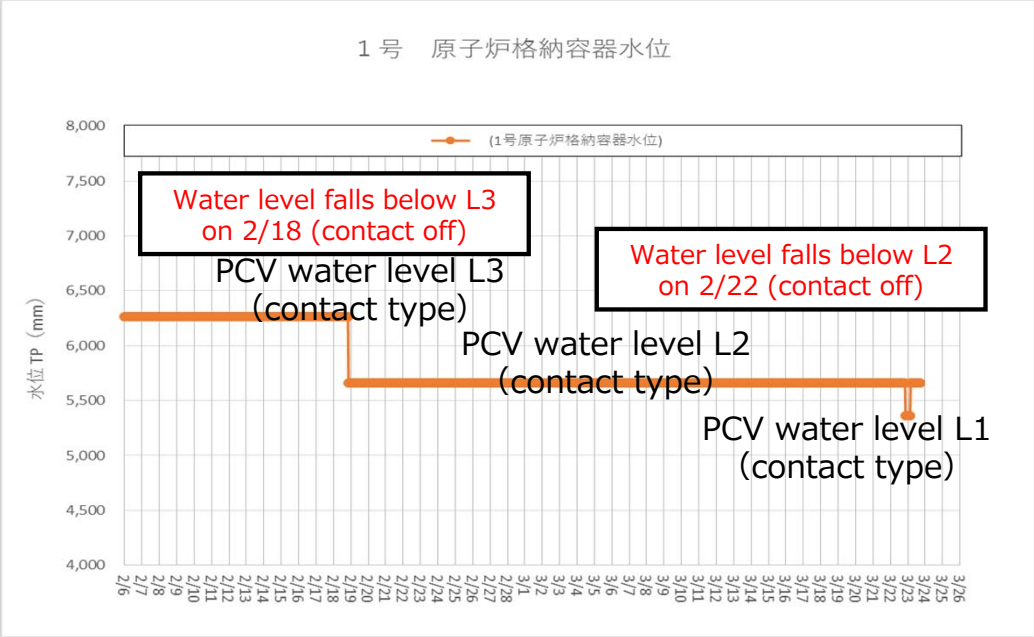
2-1. Trends in parameters related to the Unit 1 PCV water level drop

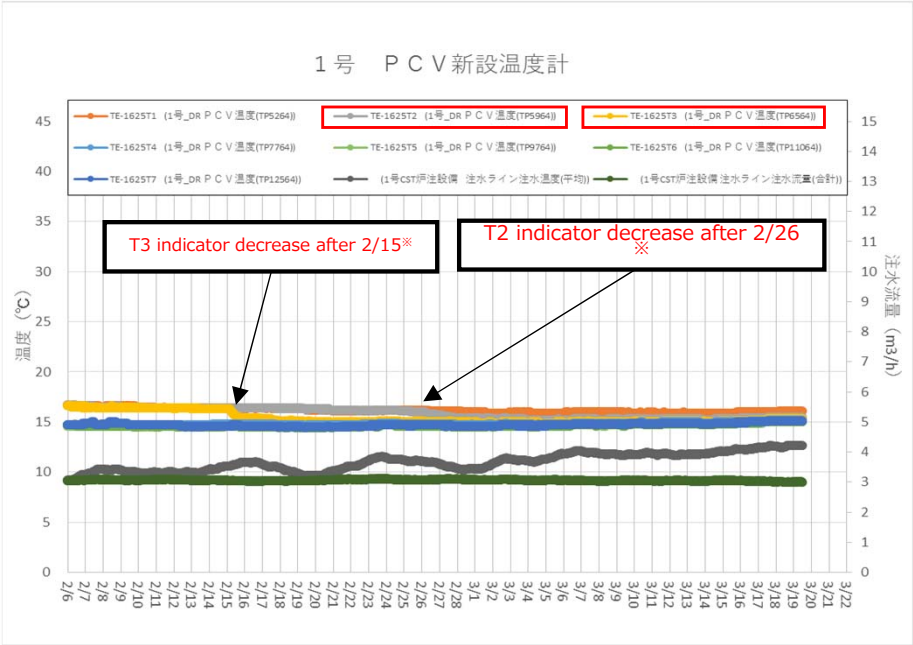


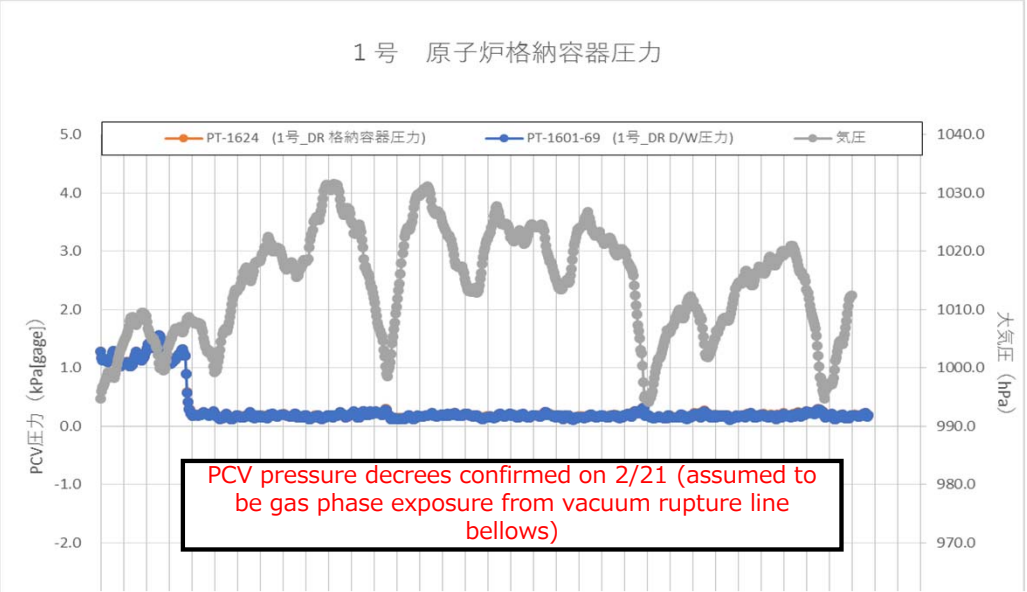
Water level on February 13 prior to the earthquake

Current water level (March 23) (estimated)

2-1. Trends in parameters related to the Unit 1 PCV water level drop



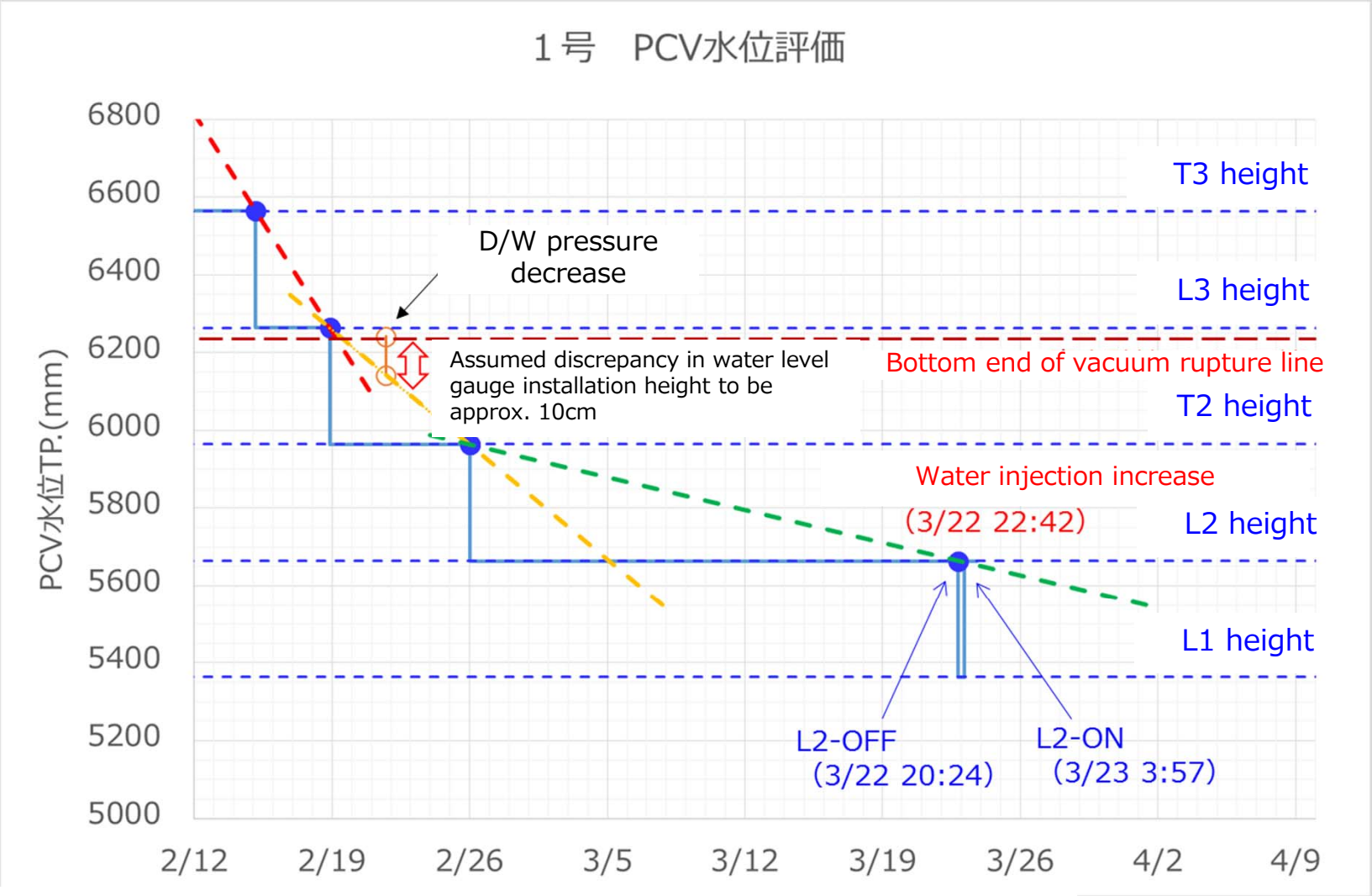




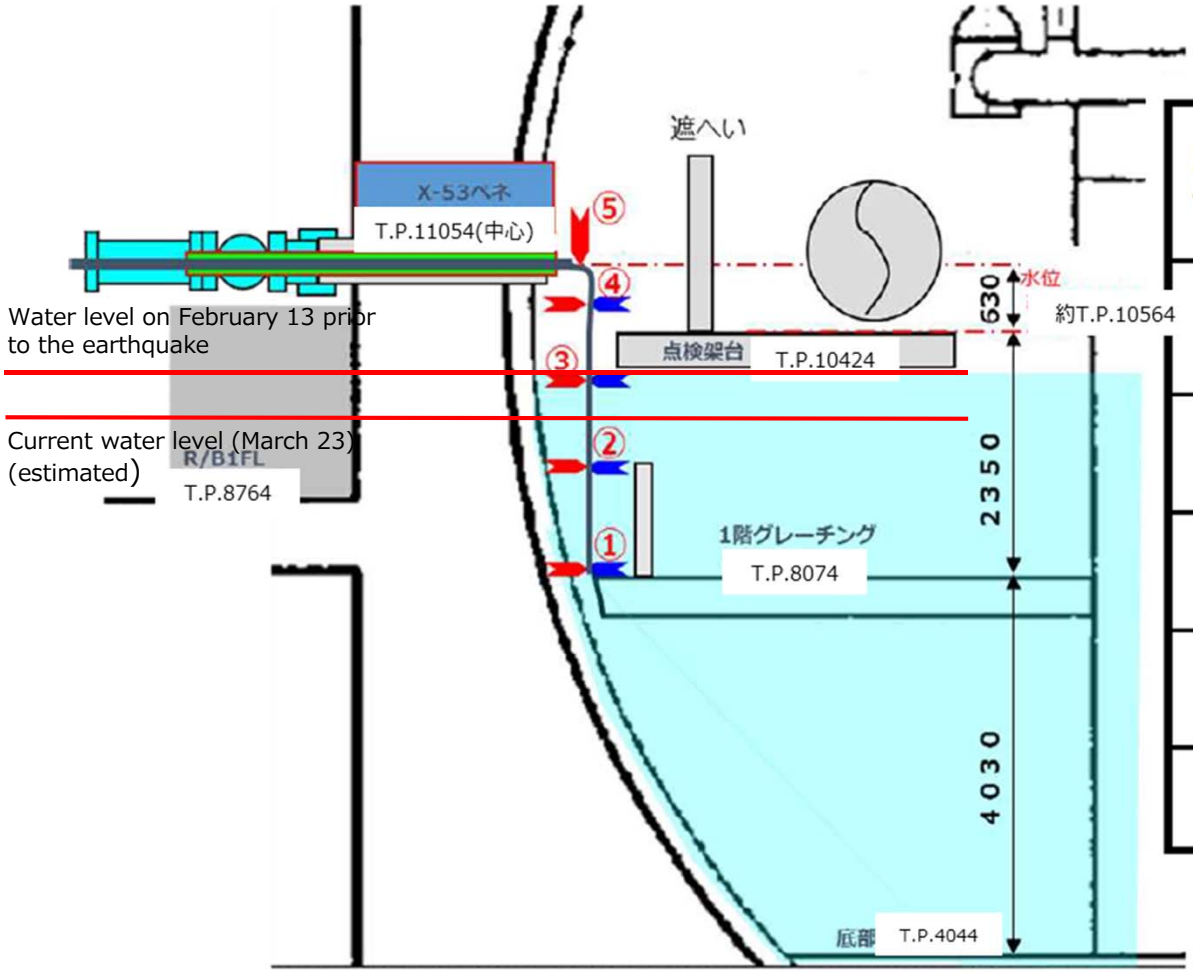
※ From past data we know that temperature gauges inside the PCV read a few degrees Celsius higher amidst gases (exposed) then when submerged in liquids, so we assume that the temperature gauge is exposed.

2-1. Trends in parameters related to the Unit 1 PCV water level drop

- On March 22 the PCV water level fell below water level gauge L2 so the amount of cooling water injection was increased (Approx. 3.0m³/h→Approx.4.0m³/h). As a result, the water level rose above L2 on March 23.

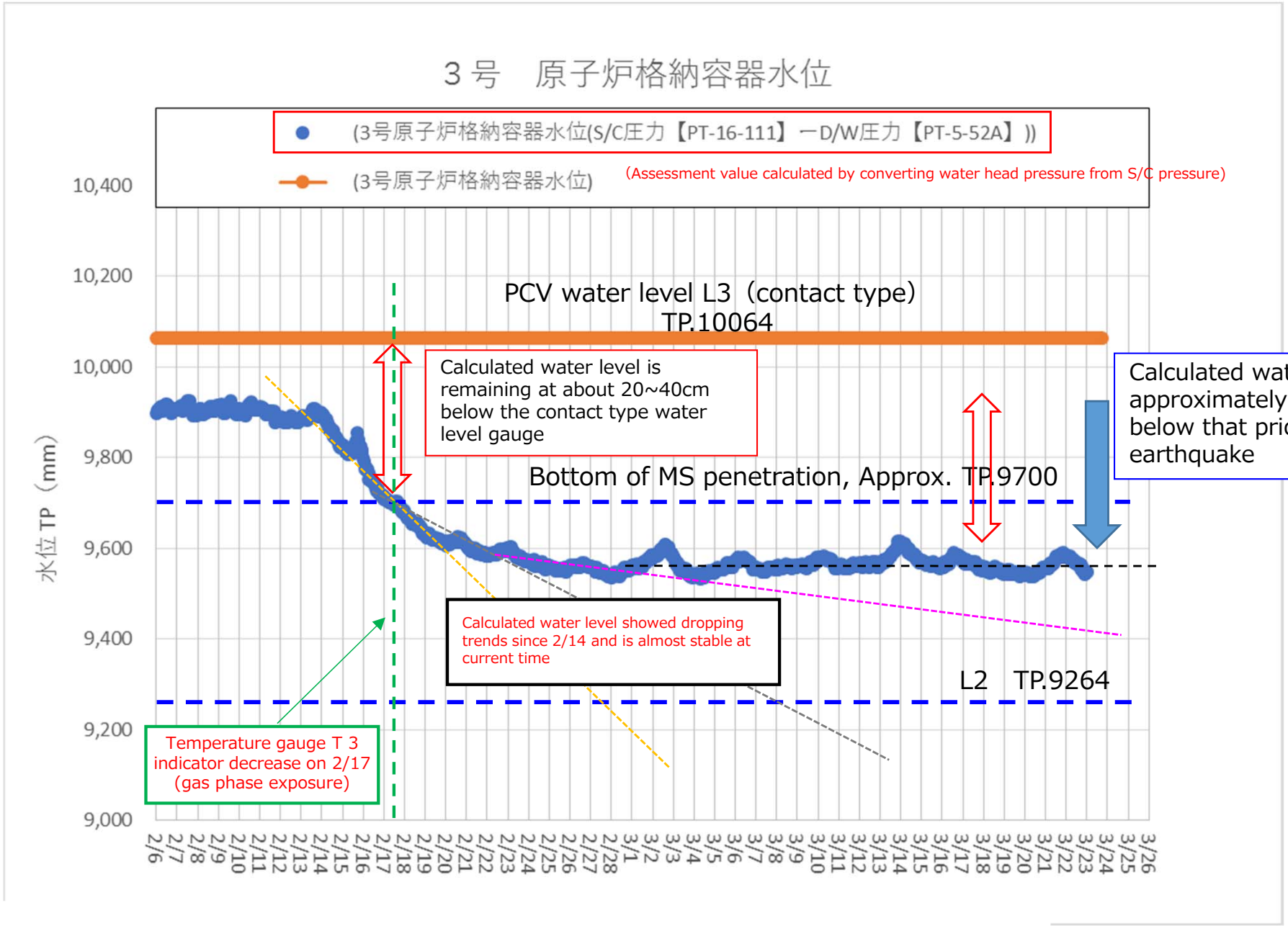


2-2. Trends in parameters related to the Unit 3 PCV water level drop

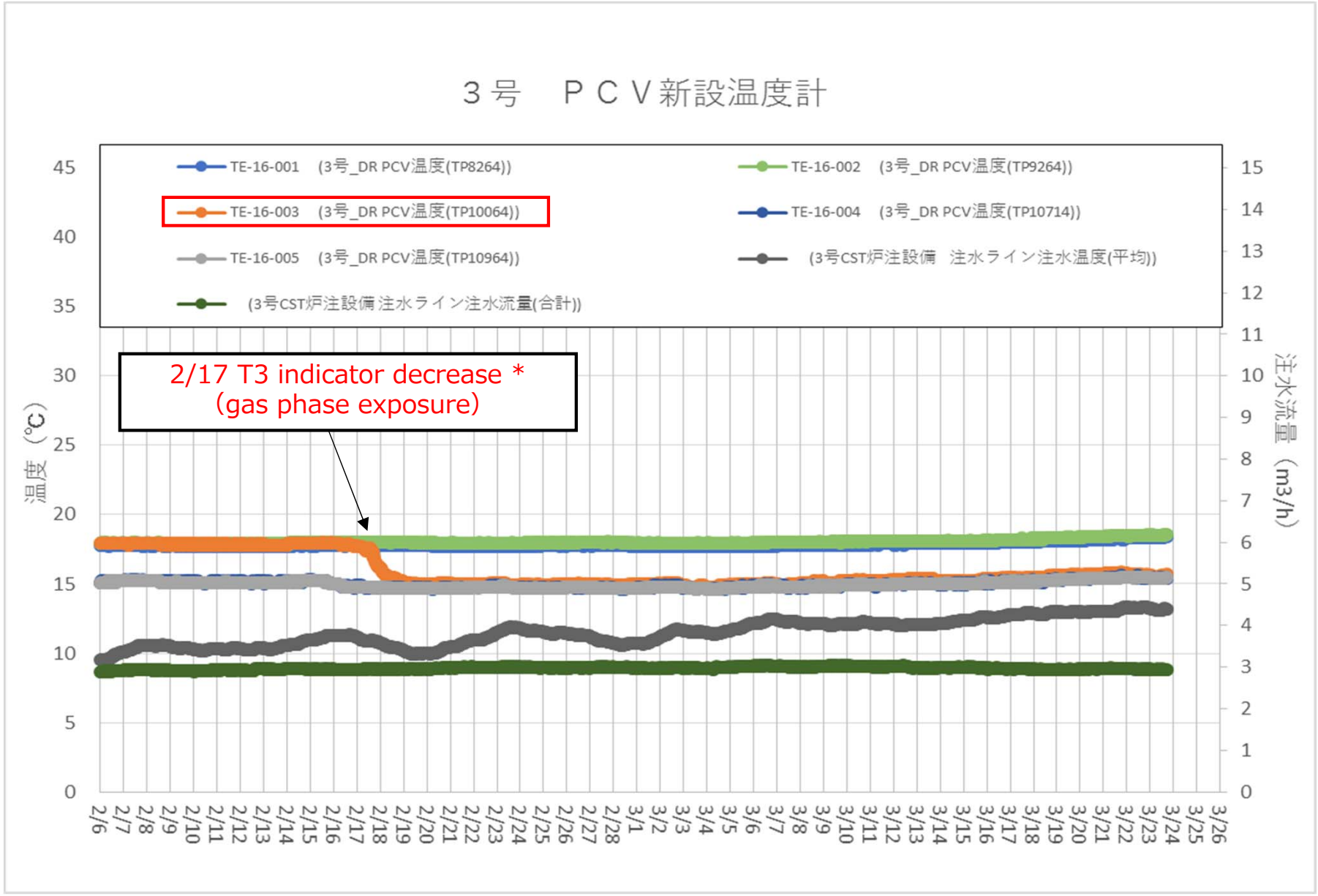


計器位置	設置計器		設置位置 (T.P)
	温度計	水位計	
⑤	TE-16-005	—	約10964
④	TE-16-004	LS-16-004	約10714
③	TE-16-003	LS-16-003	約10064
②	TE-16-002	LS-16-002	約9264
①	TE-16-001	LS-16-001	約8264

2-2. Trends in parameters related to the Unit 3 PCV water level drop



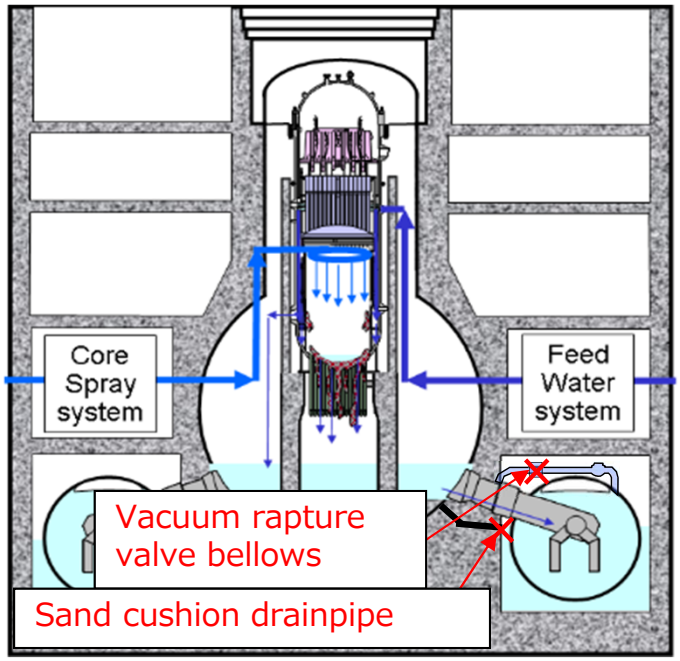
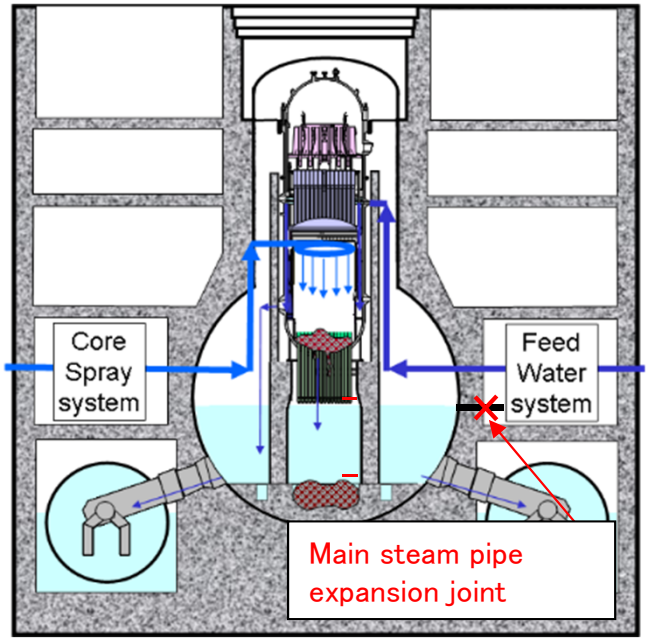
2-2. Trends in parameters related to the Unit 3 PCV water level drop



*From past data we know that temperature gauges inside the PCV read a few degrees Celsius higher amidst gases (exposed) then when submerged in liquids, so we assume that the temperature gauge is exposed.

3. Presumed cause of the PCV water level drops

- We have found leaks at the following locations at Units 1 and 3

	Unit 1	Unit 3
Concept diagram		

The Unit 3 PCV water level drop has stabilized around the main steam pipe expansion joints. At Unit 1, water level is slowly dropping around the vacuum rupture valve bellows, and the PCV water level drop continues.

Whereas we cannot deny the possibility that a new leak was caused below the PCV water level, it is more probable that the earthquake caused changes to the status of existing leaks.

- Going forward we aim to obtain more information by monitoring changes in parameters, such as water level, through cooling water injection shut off tests.

4-1. Monitor parameters, impact assessments

In light of the PCV water level drops the following measures are being implemented in order to enhance monitoring and obtain more information on this event and the impact it is having

<Enhanced monitoring>

- Unit 1~3 Plant parameters: Checked every hour or every six hours

  PCV water level (Units 1 and 3 only), RPV temperature, PCV temperature, cooling water injection volume, PCV gas management system dust monitors, PCV gas management system noble gas monitors, PCV pressure (Unit 1 only)

- Video footage from the area around the Unit 3 MSIV entrance door: Every six hours

  (To check reactor cooling water injection pipe integrity and to see if there are any additional leaks from the main steam isolation valve room)

<Obtaining more information: Same measures for Units 1~3> (Monitoring enhancement and systems that have been isolated to check for impact)

- PCV gas management system filter entrance dust/drain sampling: Successively implemented (Normally done during cooling water injection shut off tests)

  (To assess the impact that the earthquake had on the inside of the PCV)

<Detailed post-earthquake inspections: Same measures for Units 1~3 >

(Monitoring enhancement and systems that have been isolated to check for impact)

- R/B accumulated water sampling: Every week for the time being (normally once a month)

  (To assess the impact of the PCV water level drop on water leaks)

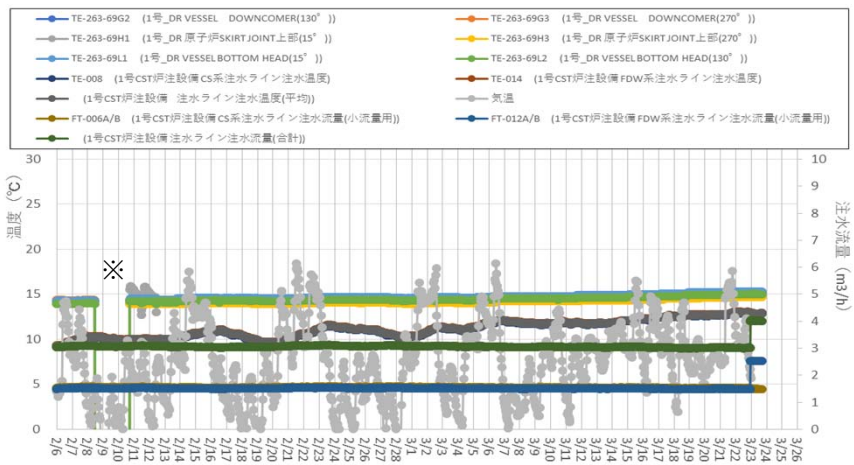
- Sampling from subdrains in the vicinity of the R/B: Every week for the time being (normally once every 1 to 2 weeks)

  (To assess the impact that the earthquake had on accumulated water outside the building)

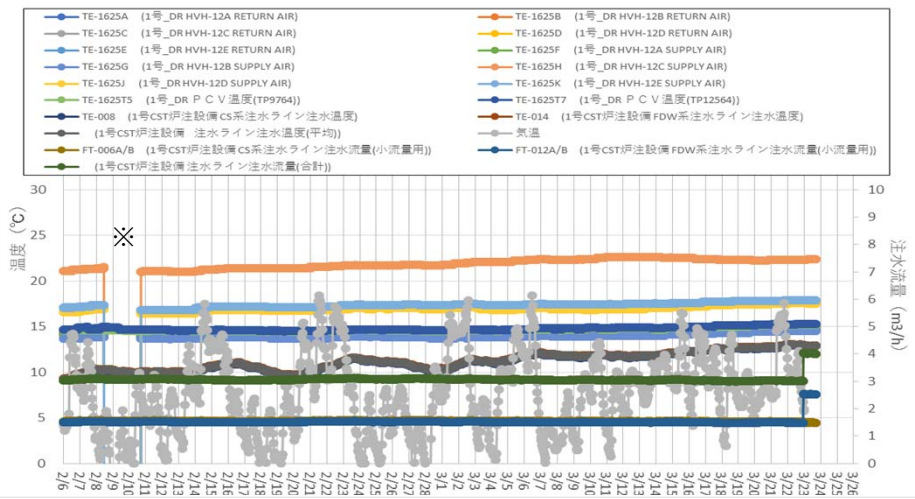
4-2. Unit 1 plant parameter trends

- A check of various parameters has shown no significant impact on anything other than the PCV water level drop

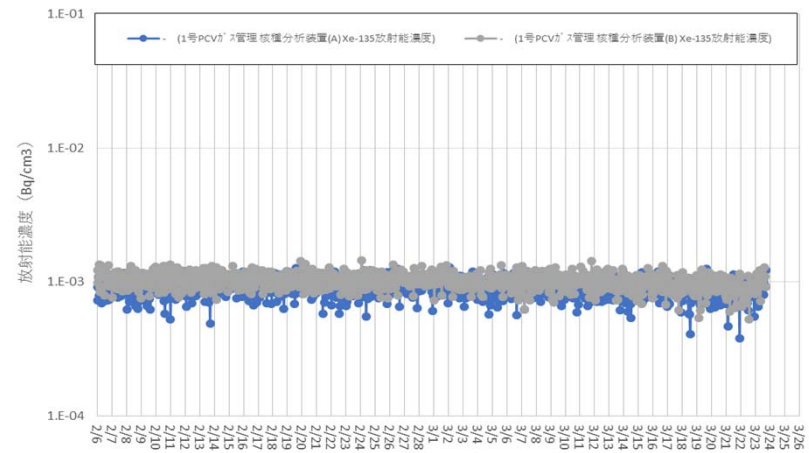
RPV bottom temperature



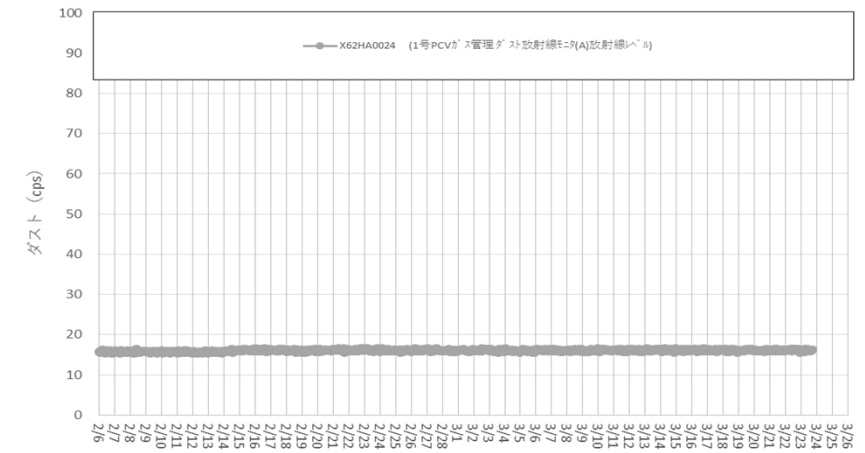
PCV temperature



Xe-135 concentration



PCV Gas management system dust monitors

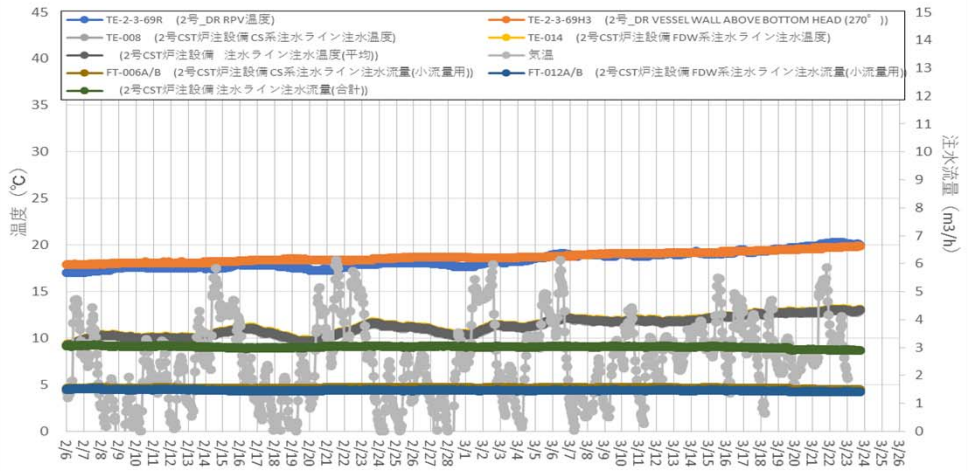


* No measurements due to ongoing work, temperature assessment implemented

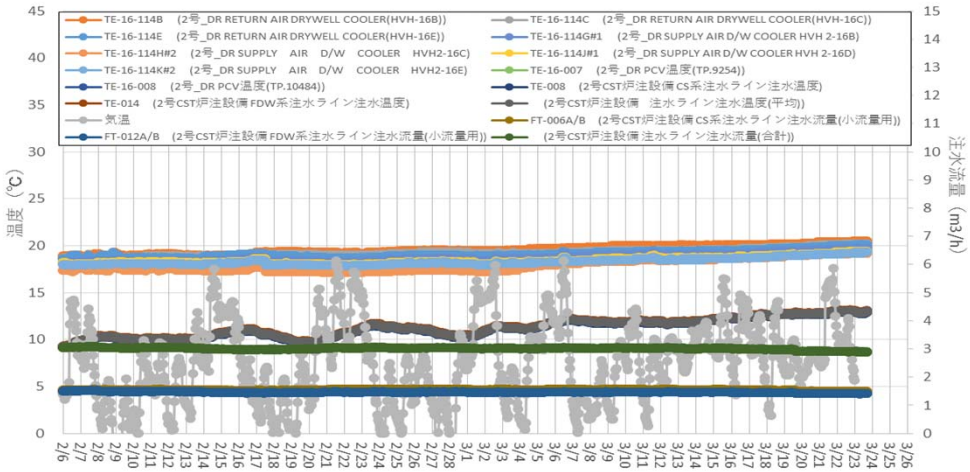
4-2. Unit 2 plant parameter trends

- A check of various parameters has shown no significant impact on anything other than the PCV water level drop

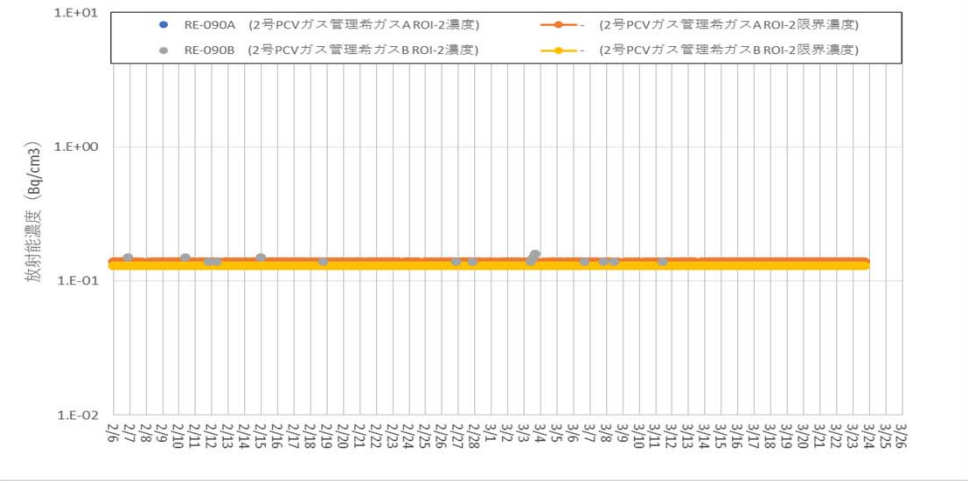
RPV bottom temperature



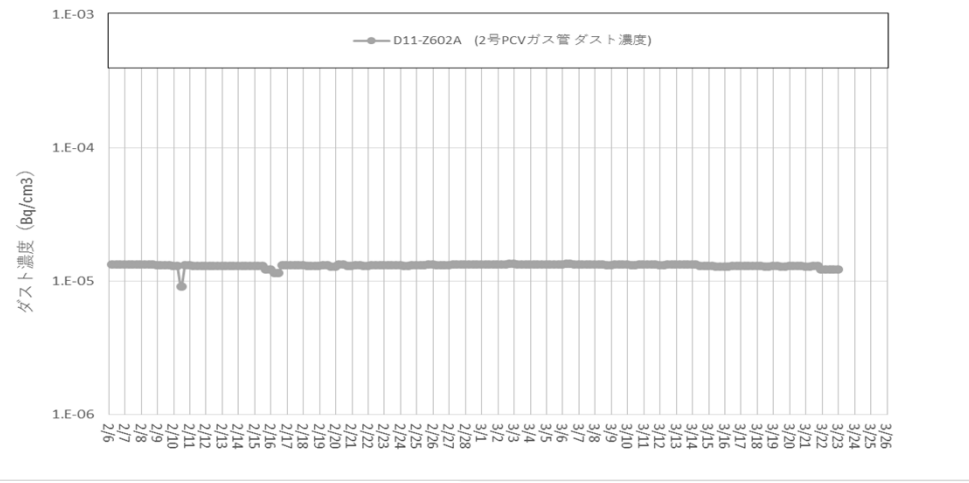
PCV temperature



Xe-135 concentration



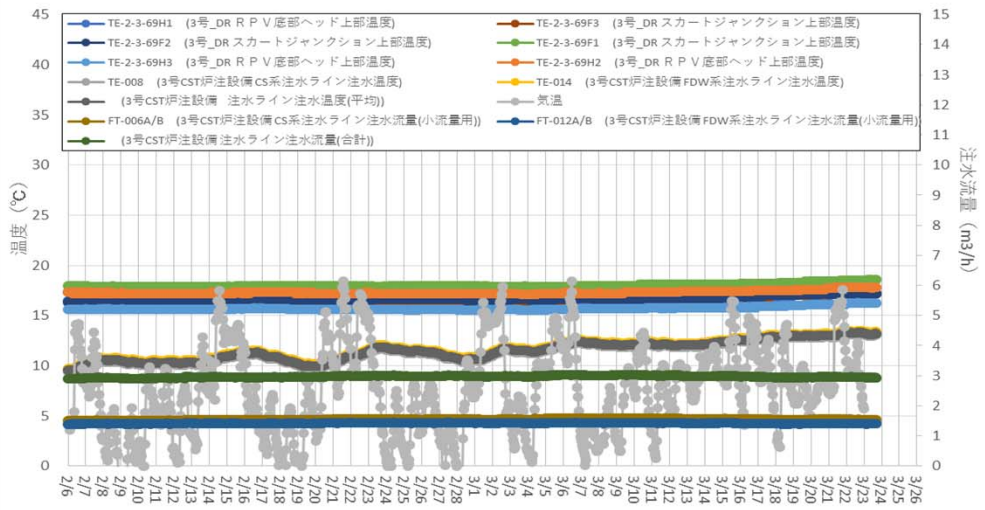
PCV Gas management system dust monitors



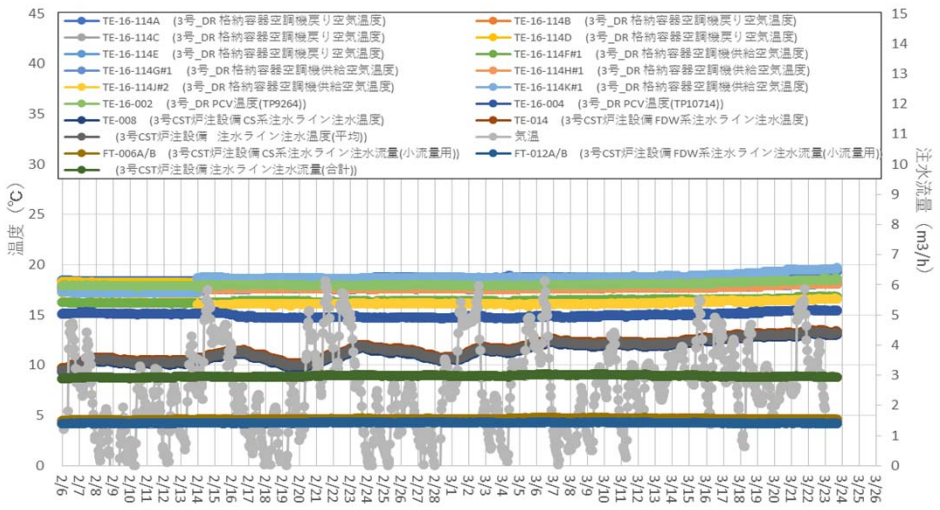
4-2. Unit 3 plant parameter trends

- A check of various parameters has shown no significant impact on anything other than the PCV water level drop

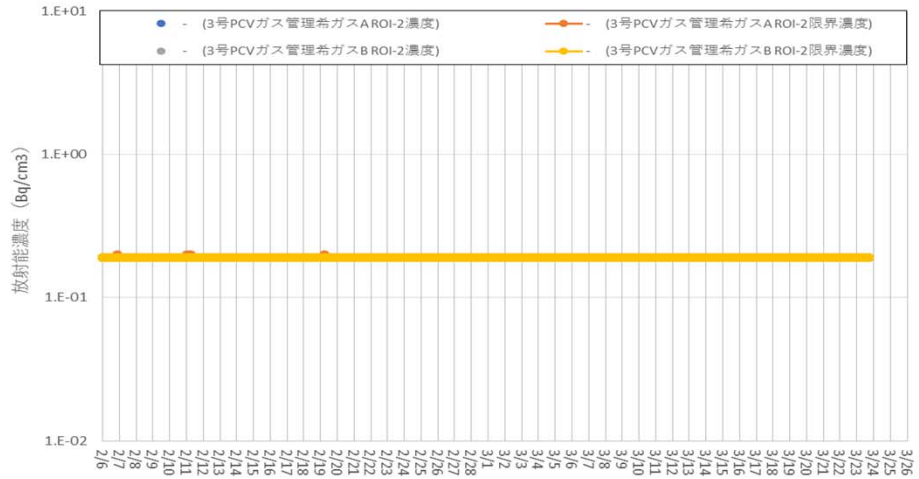
RPV bottom temperature



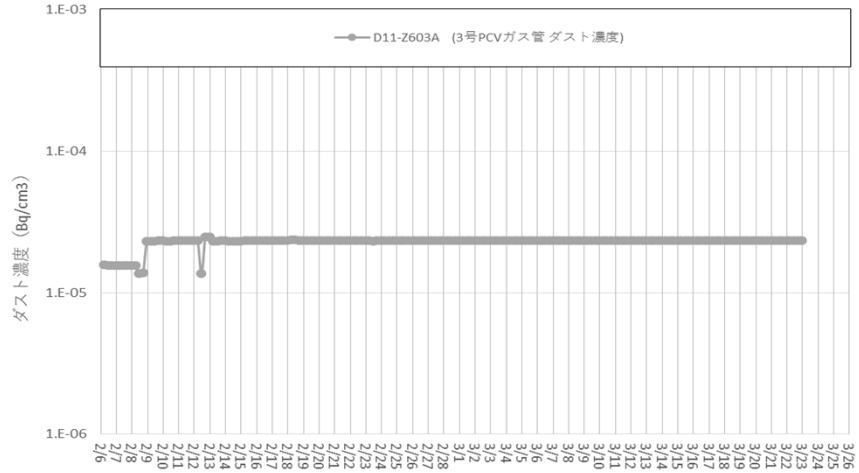
PCV temperature



Xe-135 concentration



PCV Gas management system dust monitors



4-2. Results of Units 1~3 fuel debris cooling status check

<Results of Units 1~3 fuel debris cooling status check>

- Cooling water injection into the reactors continued through the earthquake and no significant fluctuation has been seen with plant parameters (RPV bottom temperature, PCV temperature, PCV gas management system dust monitors, etc.), so it has been determined that there are no problems with fuel debris cooling and no immediate impact on nuclear safety.

  (Reference) During cooling water injection shut off tests plant parameters remained stable for approximately one week after system shutdown

< Approach to the stable cooling of fuel debris >

- The determination that there is no problem with cooling status was based not only on PCV water level, but also mainly cooling water injection volume, RPV bottom temperature, and PCV temperature.
- Ultimately, PCV gas management system dust concentrations were also checked and there have been no significant increases, so it was determined that there are no abnormalities.
- At current time it is unclear how much of the fuel debris inside the PCV is submerged, so this needs to be checked during future internal investigations.

4-3. The impact on Units 1~3 R/B accumulated water and surrounding subdrains

Since water leaking from the PCV becomes accumulated water in the R/B, we have checked the status of R/B accumulated water and subdrains in the vicinity. Results have shown no significant impact current time.

- Units 1~3 R/B accumulated water radioactivity concentration

  No significant fluctuations were seen around the time of the earthquake

- Impact on Units 1~3 R/B accumulated water levels

  The amount of water leaking from the PCV is limited compared to fluctuations in the influx of groundwater and rainwater, and are included in the scope of the aforementioned fluctuations, so no significant impact has been seen.

  Furthermore, a rise in water levels in the northeast triangular corner of the bottom floor of the Unit 3 R/B was seen on March 9 and after, but this was found to be caused by a clogged floor funnel which is where water leaking from the main steam line bellows (pre-existing leak) flows to, and a field investigation has confirmed that the rise in water level happened due to changes in the direction of water flow.

- Water level differences between the Units 1~3 R/B accumulated water and surrounding subdrains

  A sufficient water level difference has been maintained since the earthquake, and no water leaking from the PCV has leaked out of the building.

- Radioactivity concentration of water from subdrains in the vicinity of the Units 1~3 R/B

  Significant fluctuations indicating a leak of accumulated water from the buildings were not seen around the time of the earthquake.

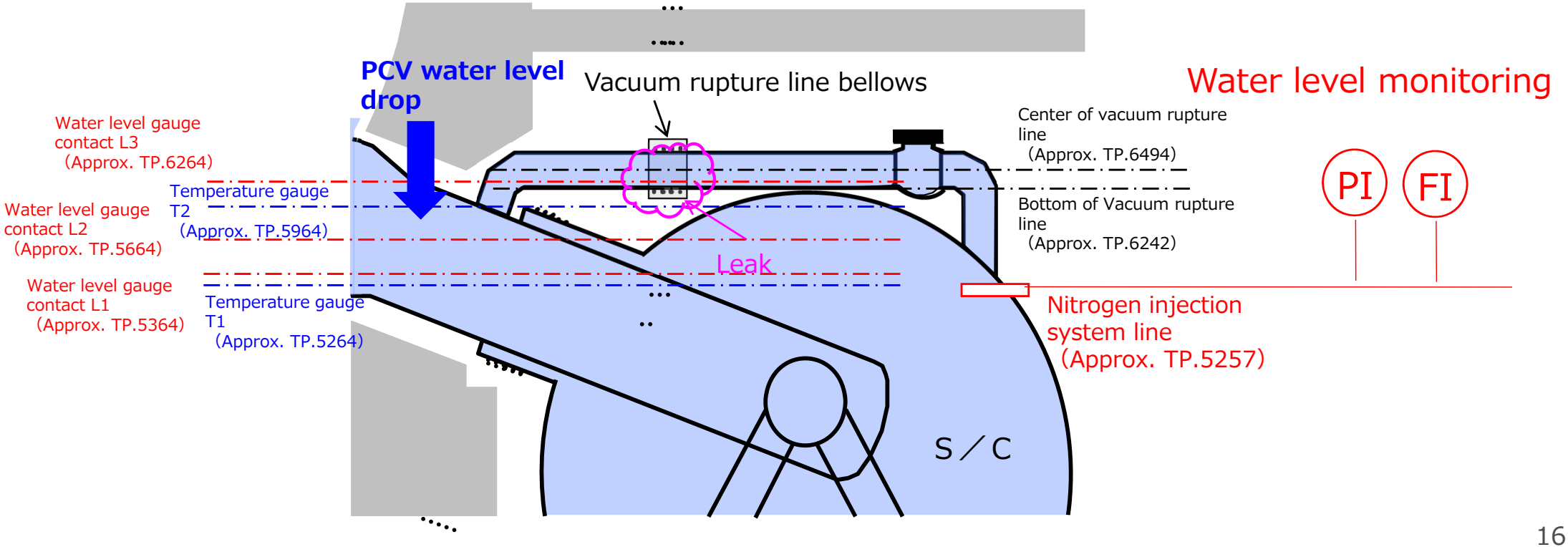
5. Current countermeasures

	Current countermeasures
Common to Units 1~3	■ Units 1~3 parameters are stable, and the PCV water levels in Units 1 and 3 are also stable. However, just to be safe, for the time being (until the end of March) enhanced monitoring will continue and plant parameters will be assessed.
Unit 1	The following will be implemented in order to stably monitor PCV water levels and confirm that water levels can be controlled: ■ For the time being the amount of cooling water injected shall be increased as necessary since the water level has fallen below L2, and we shall monitor PCV water level changes between L2 and T2. Furthermore, we shall examine how to address future drops in PCV water level. ■ We shall deliberate methods for continuously monitoring water levels (additional installation of pressure gauge on S/C nitrogen injection line)
Unit 3	■ More data will be obtained by forcing changes in PCV water level through cooling water injection shutoff tests

【Reference】 Enhancing Unit 1 water level monitoring instruments

- It will take time to install new monitoring instruments, so for the time being we will examine how to strengthen monitoring methods including the potential of utilizing existing pipes.
- We are examining the possibility of assessing system pressure to confirm water level trends by additionally installing pressure gauges on the nitrogen injection lines to the S/C. The following action will be needed to achieve this.

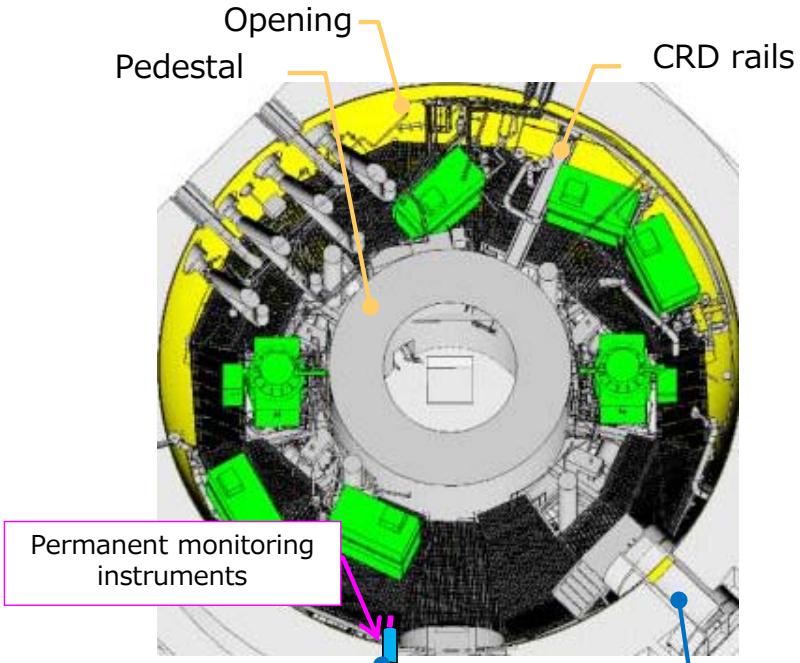
- Current flow needs to be reduced in order to improve the accuracy of water level assessment because existing S/C nitrogen injection line outlet pressure results in large system pressure loss.
- Conventional flowmeters/output pressure gauges cannot easily be disassembled, and the measurement ranges need to be changed (low range measurements are required).
- Water level assessment feasibility needs to be confirmed after installation of instruments and changes made to the nitrogen injection flow.
- Transmission equipment for continually monitoring the water levels also needs to be renovated.

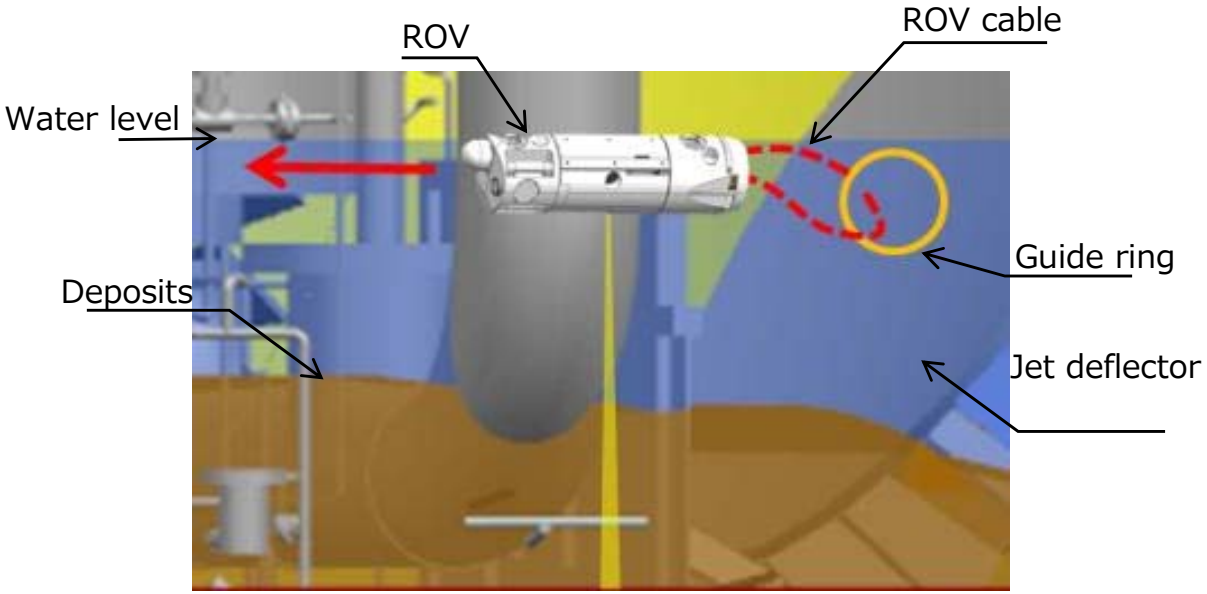


【Reference】Impact on the internal investigation of the Unit 1 PCV

The drop in PCV water level may have the following impact on the PCV internal investigation (under examination)

- If the guide ring that keeps the ROV cable from getting hung up on obstructions cannot be attached to the jet deflector due to the drop in water level, the risk that obstructions may interfere with the ROV cable will increase.
- If the PCV temperature gauges/water level gauges cannot be removed to avoid obstructions on the investigation route then the scope of the investigation will have to be narrowed.
- The risk of interference by PCV internal structures and deposits will increase if the vertical range of ROV movement is restricted.





Concept drawing of investigation to measure deposit thickness

【Reference】Initiatives to address the PCV water level drops (cooling water injection shut off test)

- Cooling water injection shut off test: To be implemented in the future in order to control the amount of accumulated water. In light of the recent water level drops, the plans for cooling water injection shut off tests at Units 1 and 3 are as shown in the chart below.

	Unit 3	Unit 1
Prior objective (test period)	To confirm whether water level falls to the lowermost point of the main steam pipe expansion joint (seven days)	To check whether or not water levels fall below T1 at the lowermost part of the PCV seen during cooling water injection shut off tests implemented in November (five days)
Current conditions	Water level has dropped and is remaining stable around the main steam pipe expansion joint	Water level drop trends are being monitored to assess whether or not water level has fallen below T2
Objectives in light of the PCV water level drops	In addition to the previous objectives, we will check to see if water levels stabilizes even if it falls below the lowermost point • We will learn if there are large leaks lower than the main steam pipe expansion joint • This may lead to cooling water injection reductions or even longer cooling water injection shut off tests • If the water level drops further, we will know that there is a leak below the main steam pipe penetration.	Test priority is low • The previous test showed that water level drops to around T1 • Even longer shut off tests will be considered in light of the increase in water level trend data
Other	• The tests are being planned for April • In conjunction with the tests, we are examining the possibility of using a camera to check the conditions inside the MSIV room	• Water level may have to be maintained at a certain height in order to conduct the internal investigation using an ROV

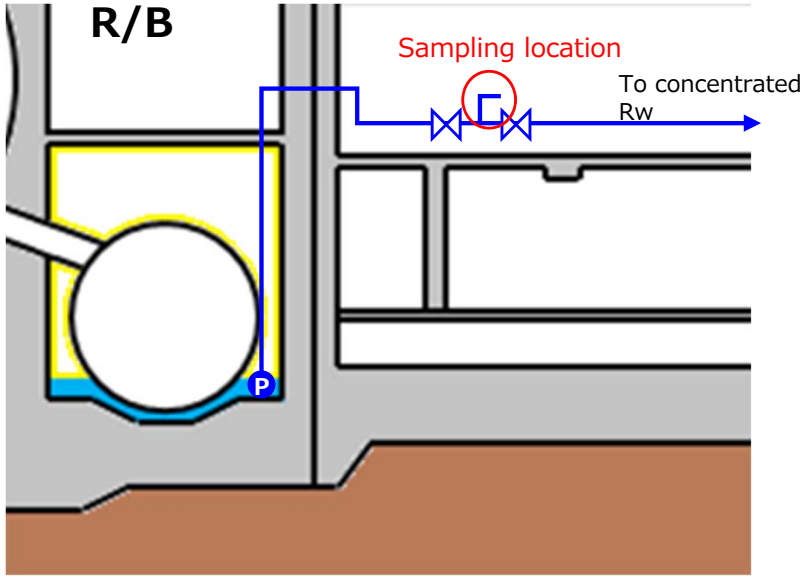
【Reference】 Units 1~3 R/B accumulated water quality analysis results

- It is assumed that water leaking from the PCV flowed into the accumulated water in the R/B, so the radioactivity concentration※1 of accumulated water in the R/B prior to the earthquake shall be compared with that after the earthquake
- Fluctuations are within the scope of past fluctuations seen at each unit, and no significant fluctuations have been seen, however analysis results trends will be continuously monitored

※1 Accumulated water from each R/B shall be sampled from the accumulated water transfer equipment (pipes)

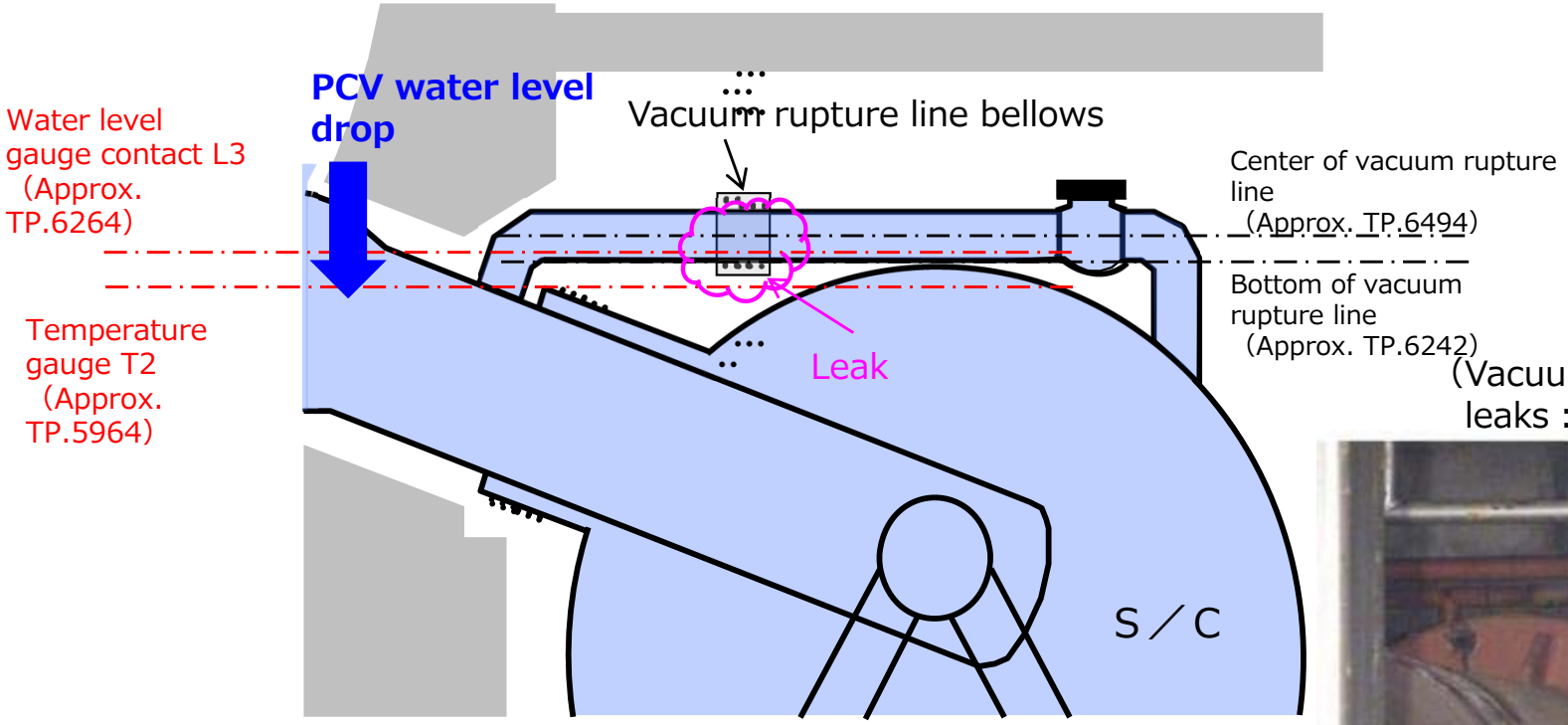
Radioactivity concentration of accumulated water in each R/B

Building	Sampling date		Cs-134 (Bq/L)	Cs-137 (Bq/L)	Sr-90 (Bq/L)	Gross α (Bq/L)
Unit 1 R/B	Before earthquake	2021/1/21	1.24E6	3.01E7	7.18E6	2.77E3
	After earthquake	2021/2/25	1.16E6	2.88E7	7.24E6	1.98E3
		2021/3/3	1.10E6	2.60E7	6.33E6	3.09E2
		2021/3/10	1.07E6	2.69E7	7.49E6	1.48E2
Unit 2 R/B	Before earthquake	2021/1/22	1.14E6	2.16E7	2.03E7	2.81E2
	After earthquake	2021/2/25	1.09E6	2.24E7	2.39E7	1.32E2
		2021/3/3	1.13E6	2.29E7	2.13E7	3.83E2
		2021/3/10	1.58E6	3.33E7	2.58E7	3.69E1
Unit 3 R/B	Before earthquake	2021/1/25	3.54E5	7.56E6	6.88E6	1.22E3
	After earthquake	2021/2/25	4.50E5	8.98E6	8.71E6	6.81E3
		2021/3/3	4.64E5	1.01E7	8.89E6	6.28E3
		2021/3/10	4.69E5	1.05E7	1.08E7	1.20E3

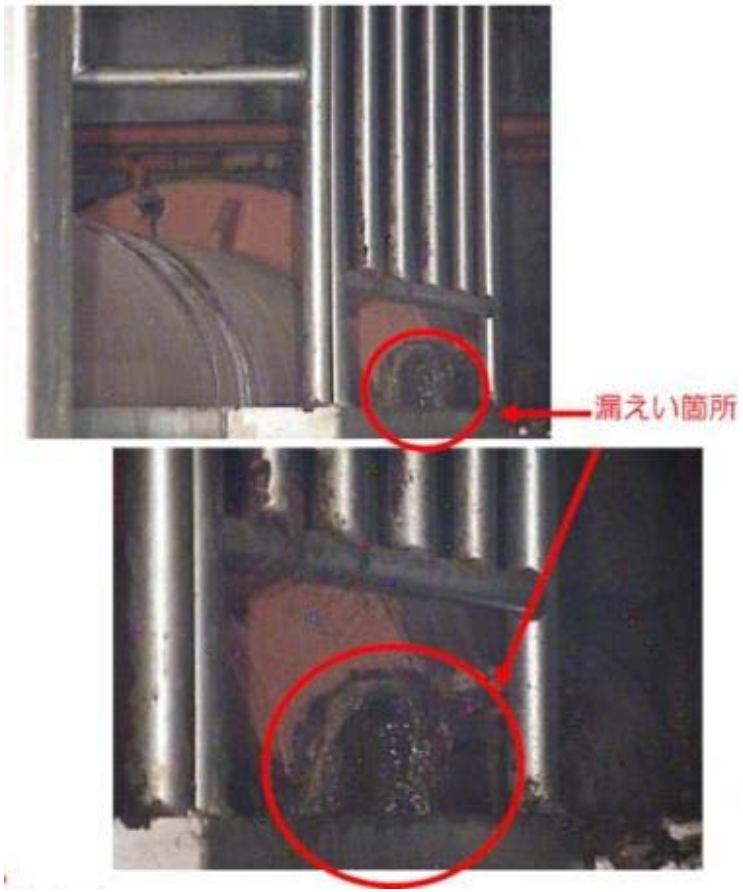


Sampling location

【Reference】Estimated location of existing Unit 1 PCV leaks（1/2）

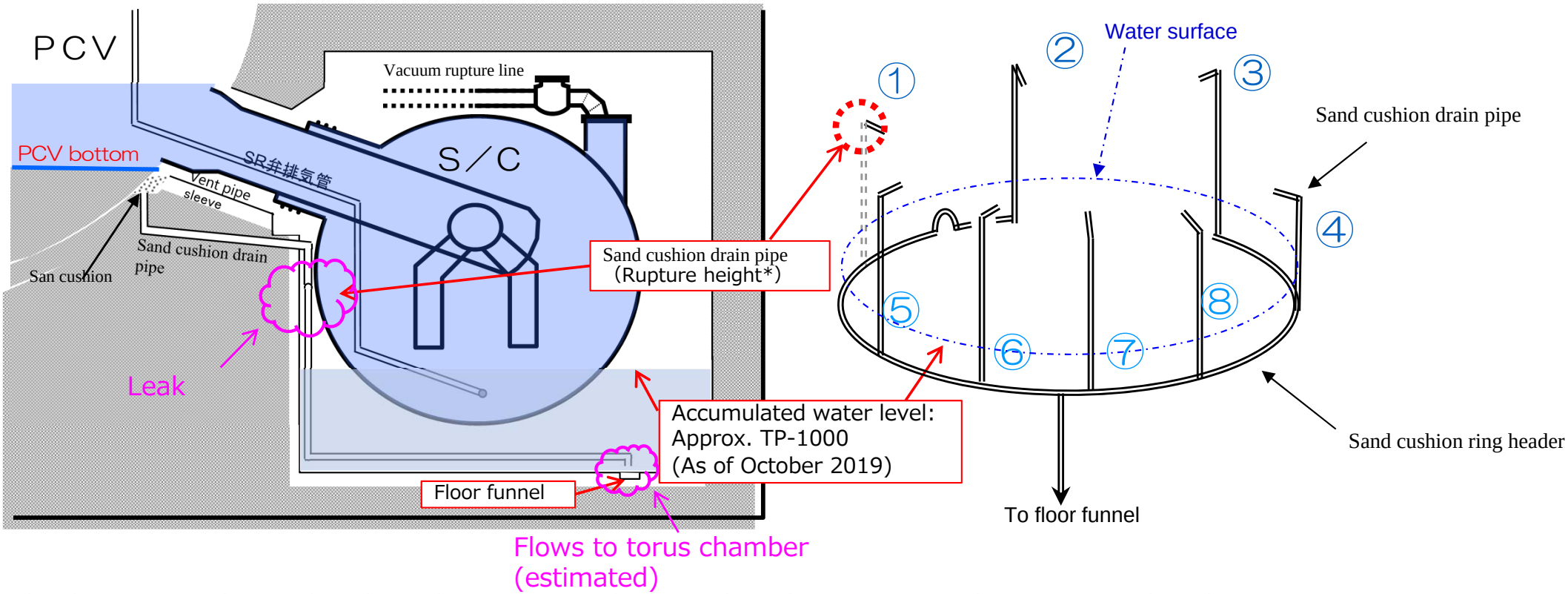


(Vacuum rupture line bellows leaks : As of 2014 investigation)



- Prior investigations of Unit 1 have found leaks from the vacuum rupture line bellows and from ruptured sand cushion drain pipes.
- The height of vacuum rupture line bellows installation approximately matches the height of leaks that are assumed to exist based upon D/W pressure behavior during reactor cooling water injection was shut off tests

【Reference】Estimated location of existing Unit 1 PCV leaks (2/2)

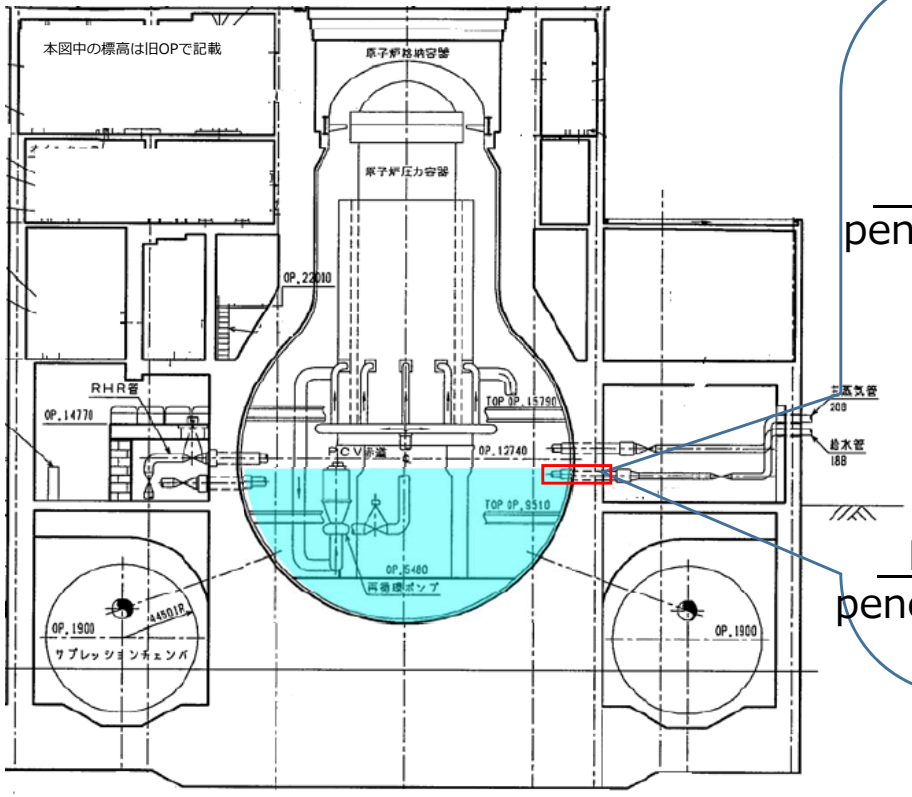


* There are eight sand cushion drainpipes, and one of them has a rupture that is exposed to the air

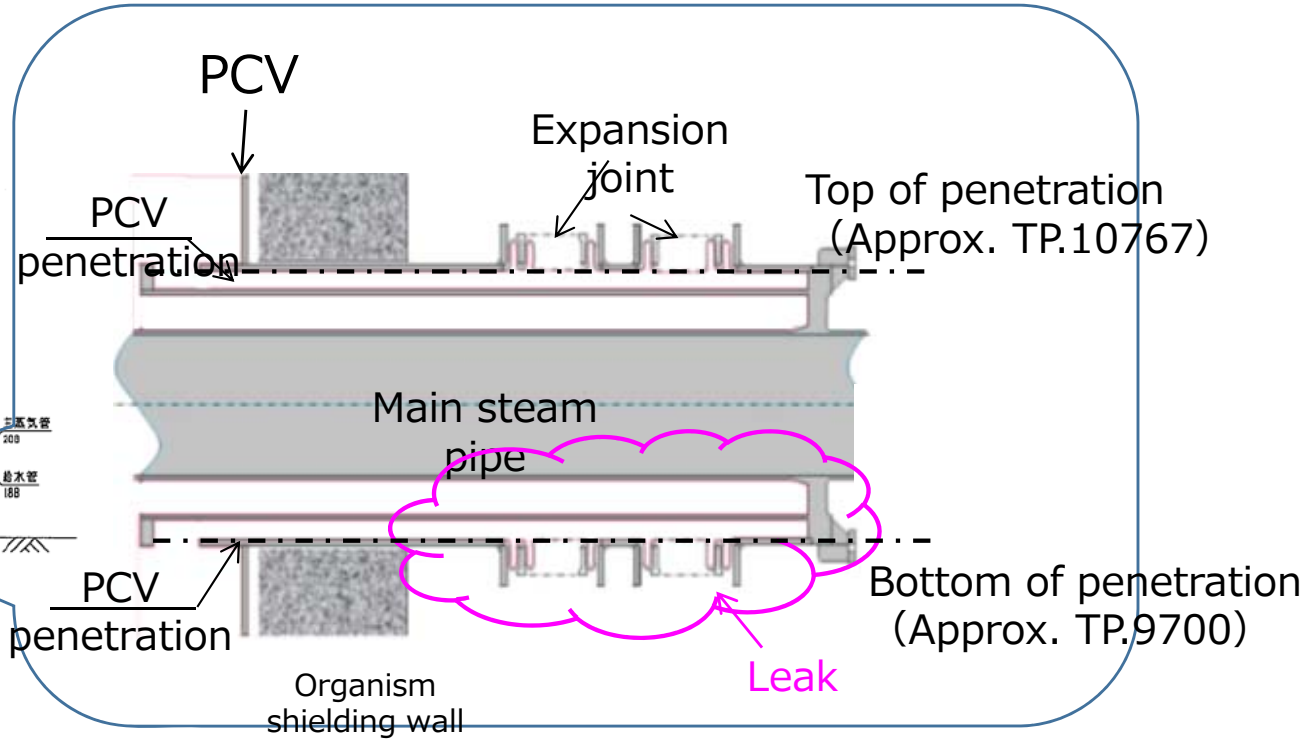
- Out of the leaks found from the sand cushion drain pipes, only one is exposed to the air, and the other seven locations of PCV water leaks are submerged (for example, near the floor funnel)

【Reference】Estimated location of existing Unit 3 PCV leaks

- Prior investigations of Unit 3 have found leaks from the main steam pipe expansion joint



Cross-section of Unit 3 reactor building



Enlarged view of main steam pipe penetration