

Fukushima Daiichi Nuclear Power Station Unit 2 Primary Containment Vessel Internal Investigation Results

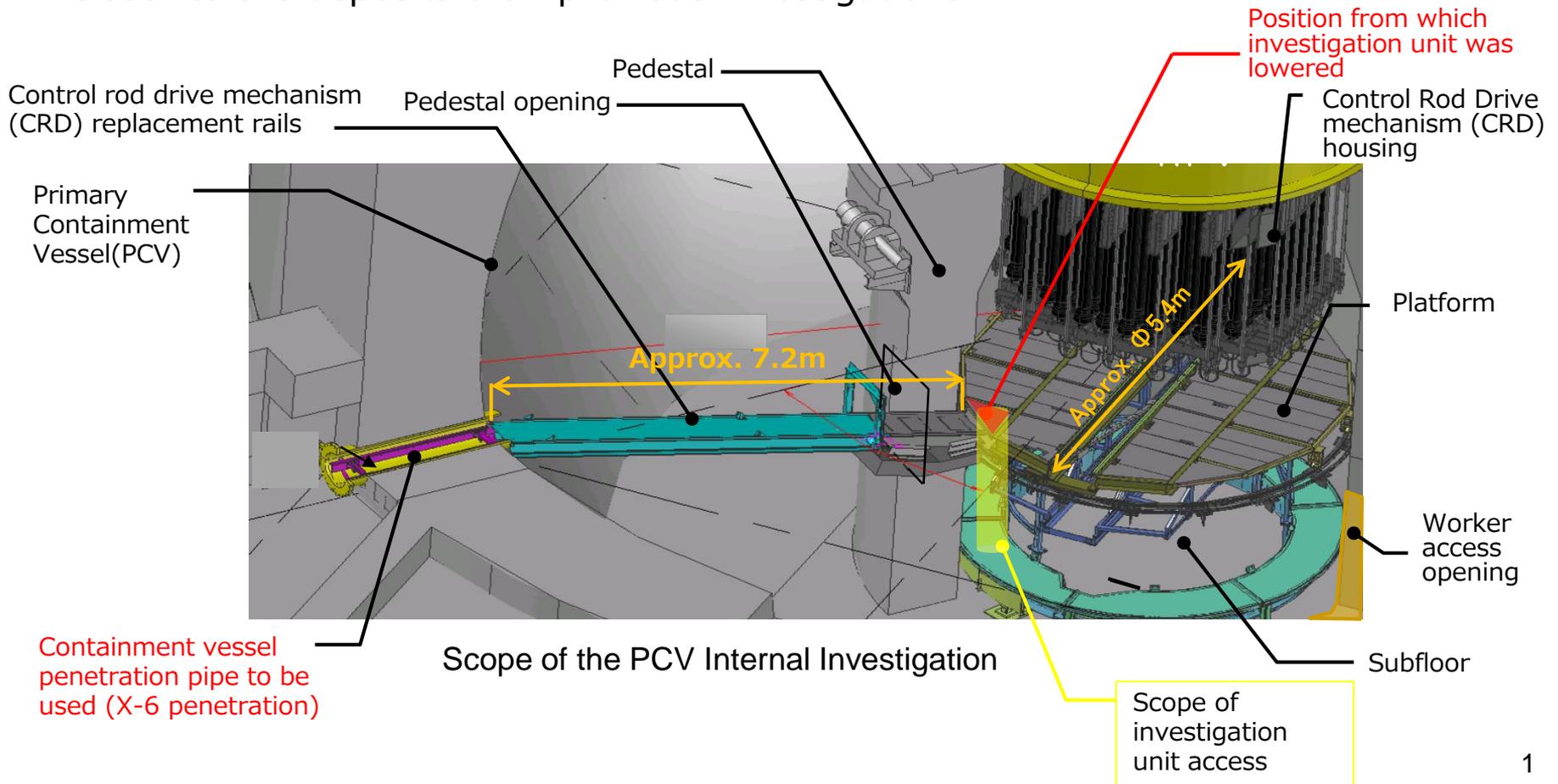
February 28, 2019



Tokyo Electric Power Company Holdings, Inc.

1. Primary containment vessel internal investigation overview **TEPCO**

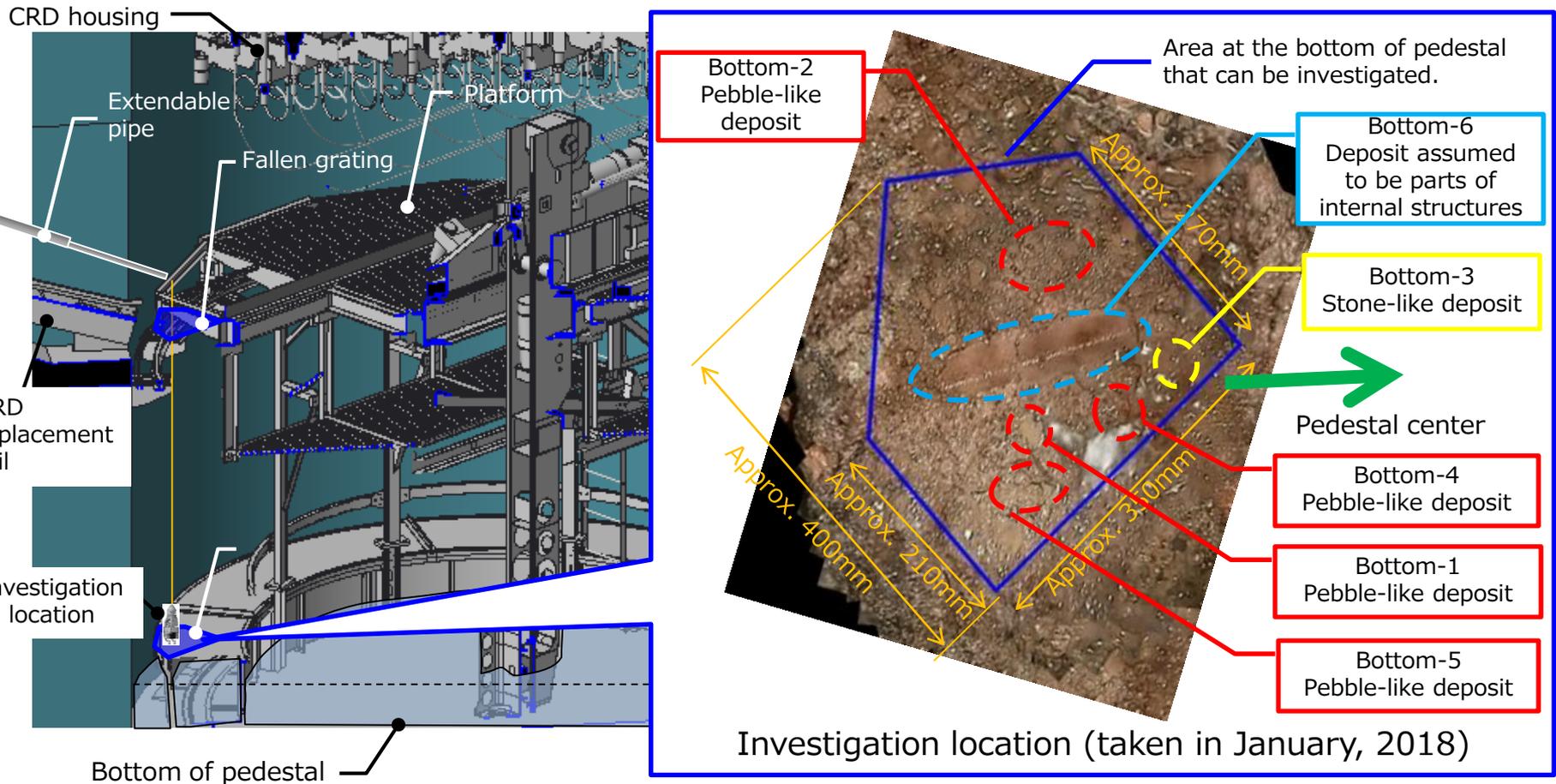
- The investigation unit was lowered from the same location as the previous investigation (January 2018) to investigate the primary containment vessel (PCV).
- During this investigation we purposely let the investigation unit come in contact with the deposits at the bottom to observe the behavior of said deposits. Video images, and dose and temperature readings were also obtained from locations closer to the deposits than previous investigations.



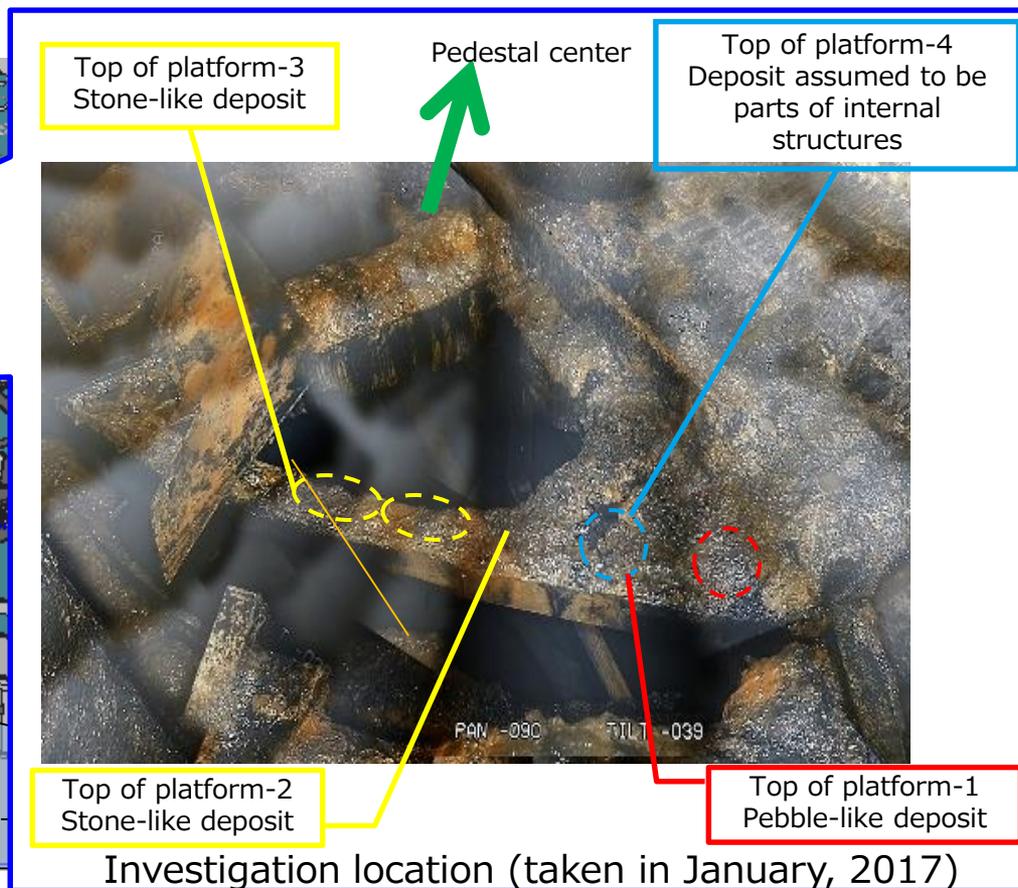
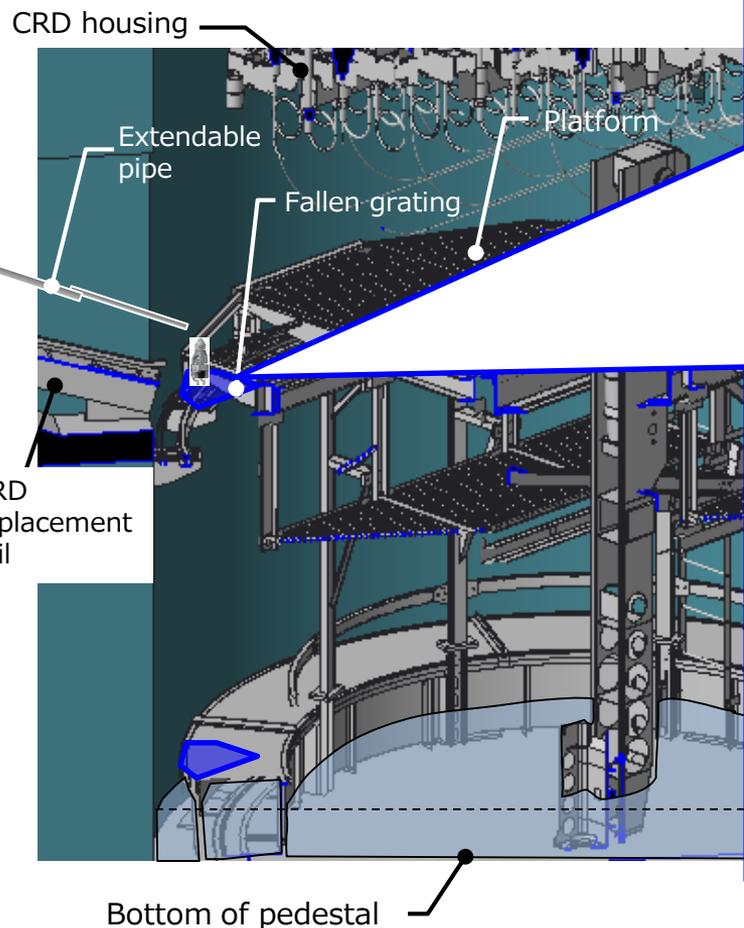
2. Contact locations during the investigation (1/2)

- We classified deposits touched during this investigation into the following three groups to summarize the results: ①Pebble-like^{※1} deposits ②Stone-like^{※1} deposits ③Deposits assumed to be parts of internal structures

※1 We defined "pebble-like" as having apparently a clear shape and "stone-like" as not having such a shape.

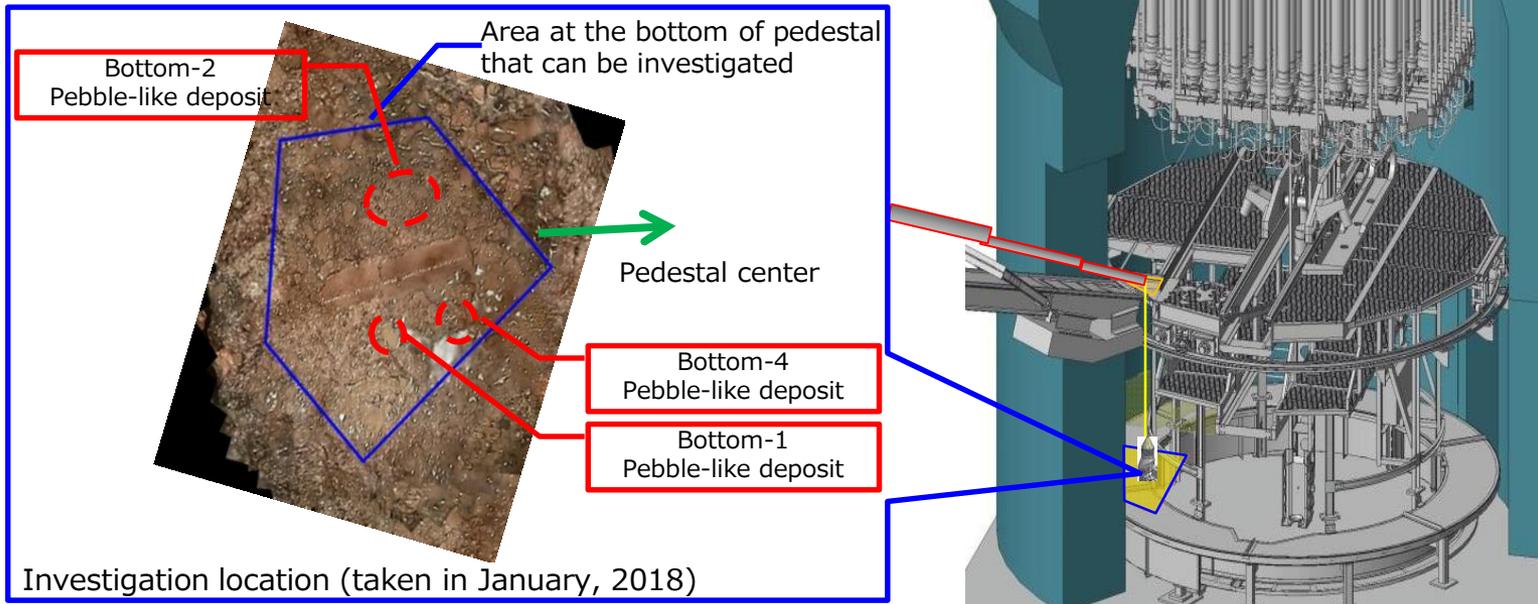


2. Contact locations during the investigation (2/2)



3. Investigation results (Bottom of pedestal) (1/3)

- It was found that pebble-like deposits can be moved.



Conditions at the bottom-1



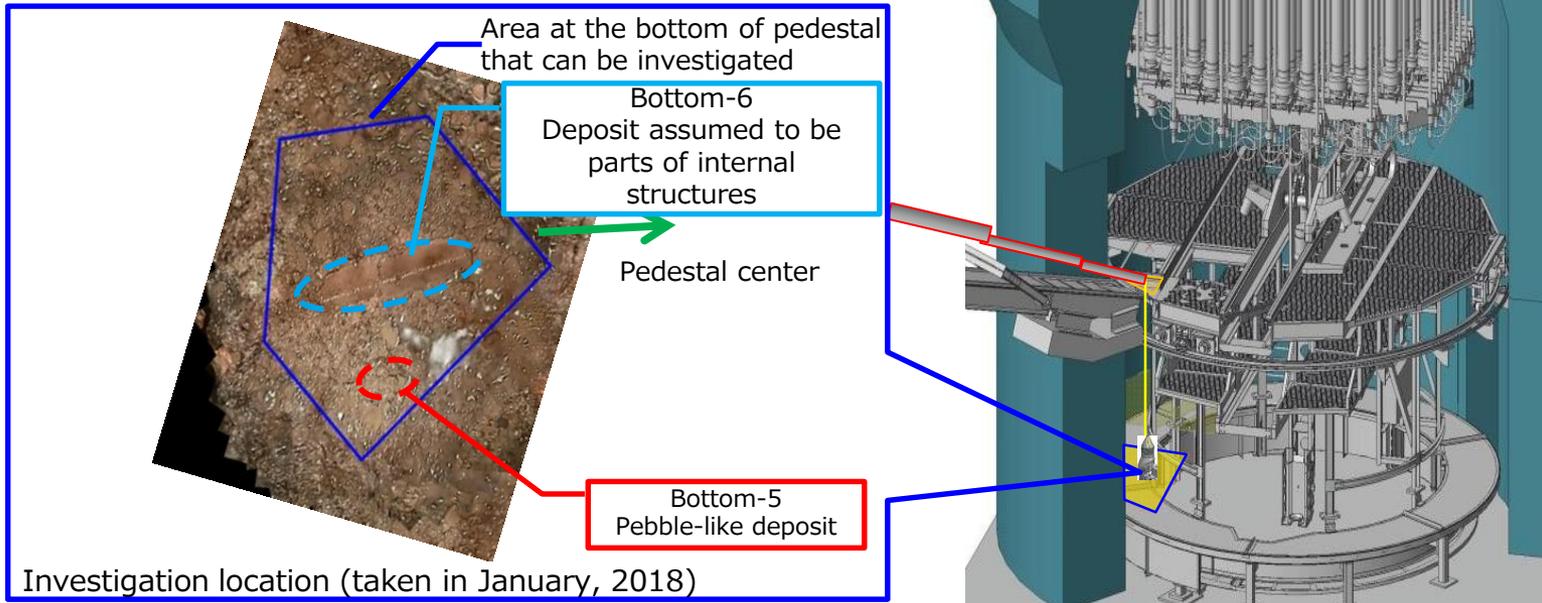
Conditions at the bottom-2



Conditions at the bottom-4

3. Investigation results (Bottom of pedestal) (2/3)

- It was found that pebble-like and structure-shaped deposits can be moved.



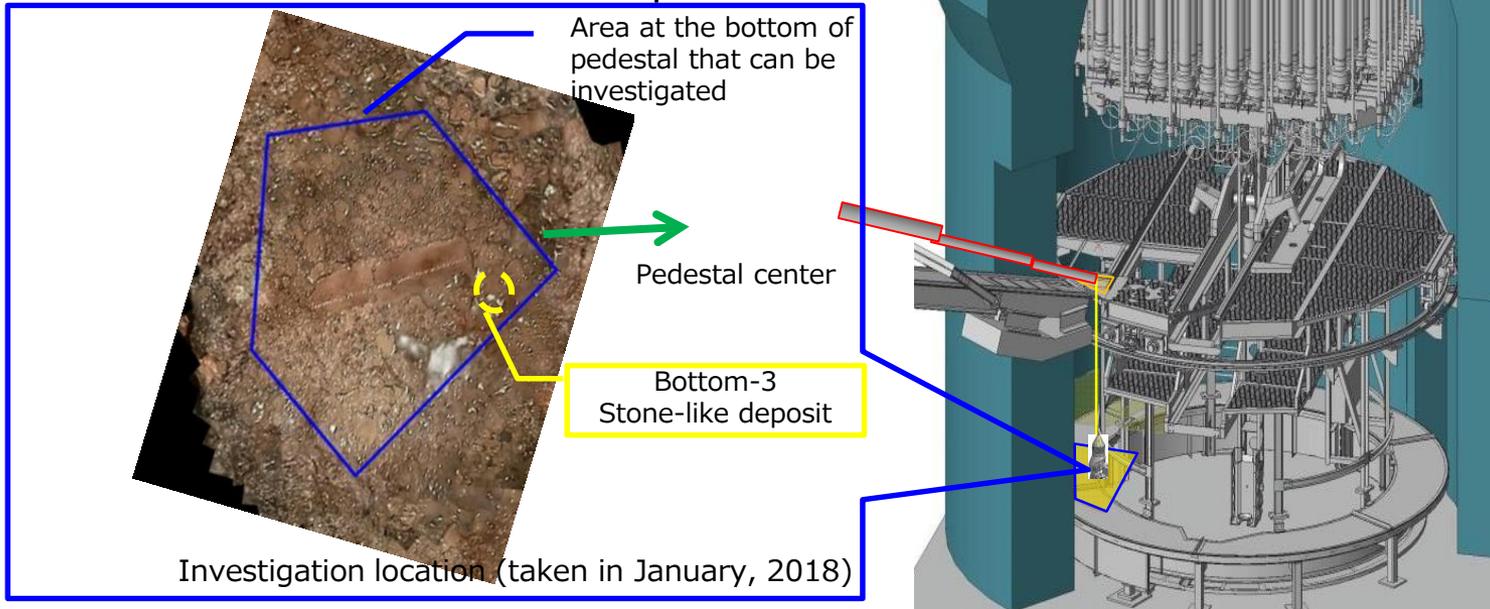
Conditions at the bottom-5



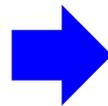
Conditions at the bottom-6

3. Investigation results (Bottom of pedestal) (3/3)

- It was found that the stone-like deposit did not move. And, the video showed no contact marks left on the deposit.



While grasping deposit

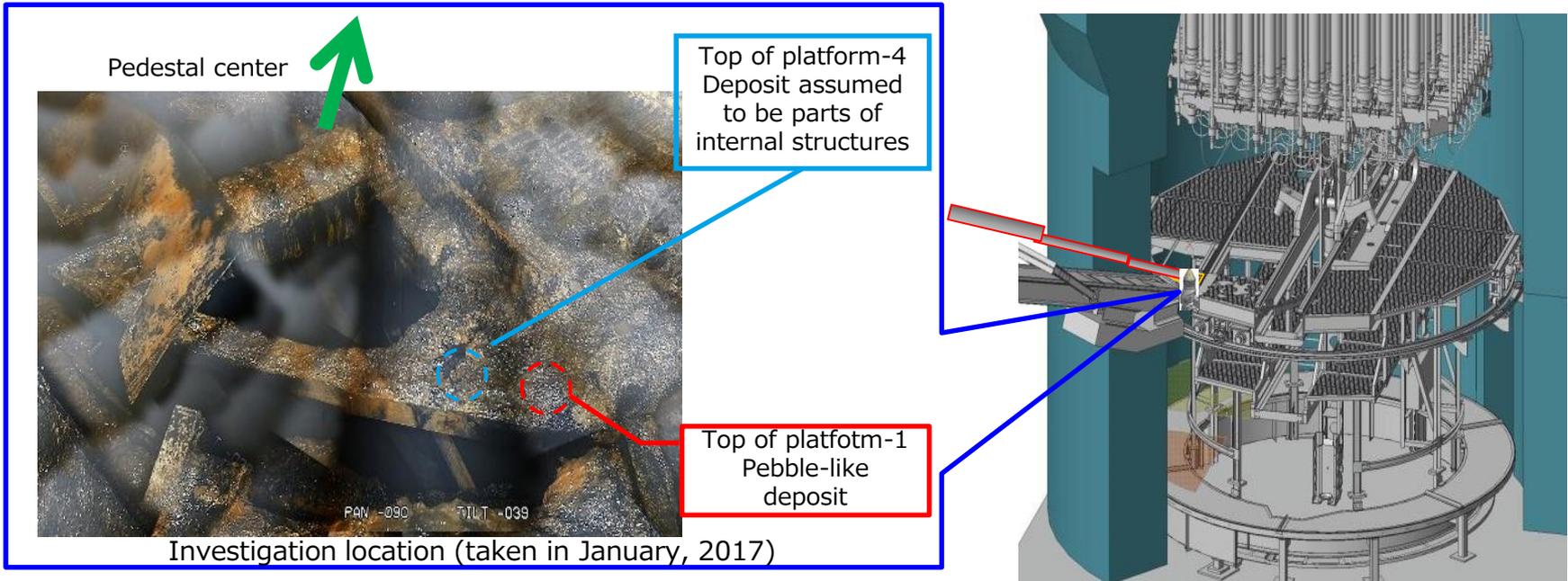


After grasping deposit

- ✓ Grasping with finger (left)
- ✓ Investigation unit was hoisted while it grasped the deposit, but it did not move (right).

3. Investigation results (Top of platform) (1/3)

- It was found that pebble-like and structure-shaped deposits can be moved.



Conditions at the top of platform-1

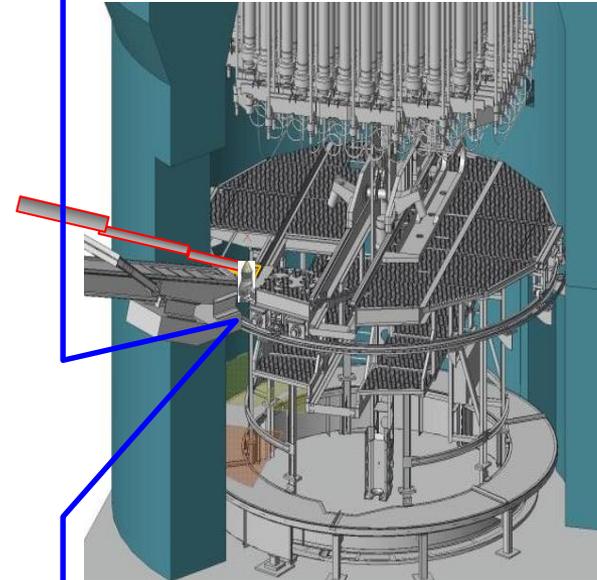
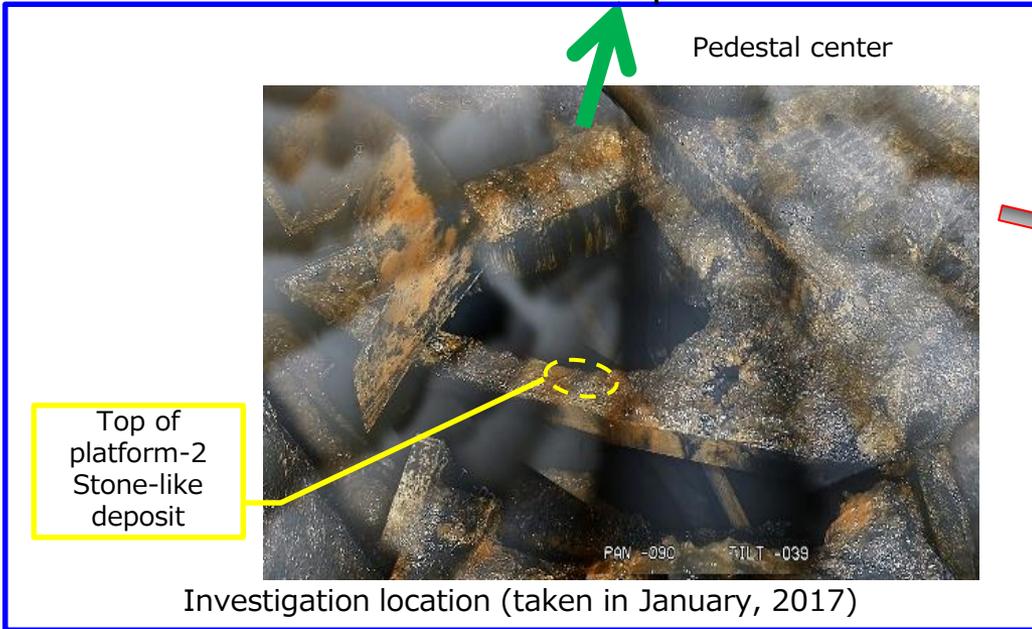


Conditions at the top of platform-4

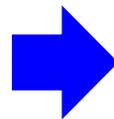
Investigated on February 13, 2019

3. Investigation results (Top of platform) (2/3)

- It was found that the stone-like deposit did not move. And, the video showed no contact marks left on the deposit.



While grasping deposit

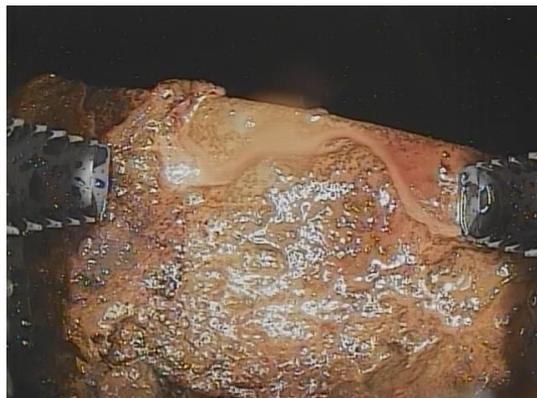
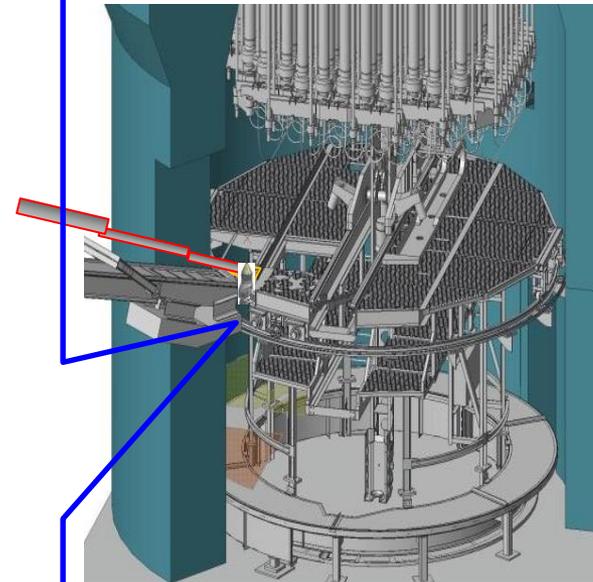
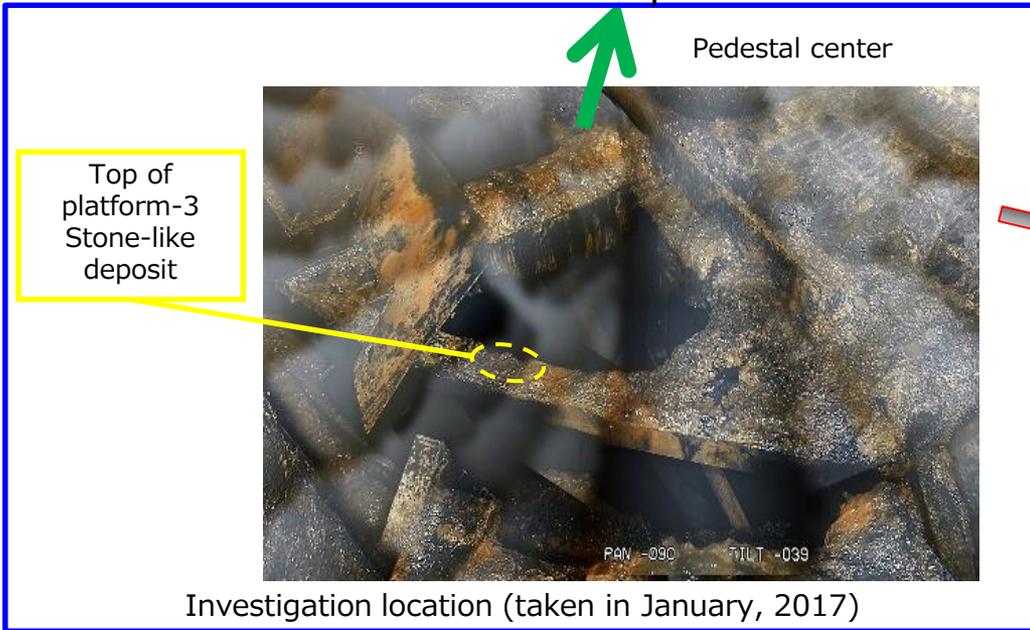


After grasping deposit

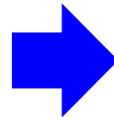
- ✓ Grasping with finger (left)
- ✓ Investigation unit was hoisted while it grasped the deposit, but it did not move (right).

3. Investigation results (Top of platform) (3/3)

- It was found that stone-like deposit did not move. And, the video showed no contact marks left on the deposit.



While grasping deposit

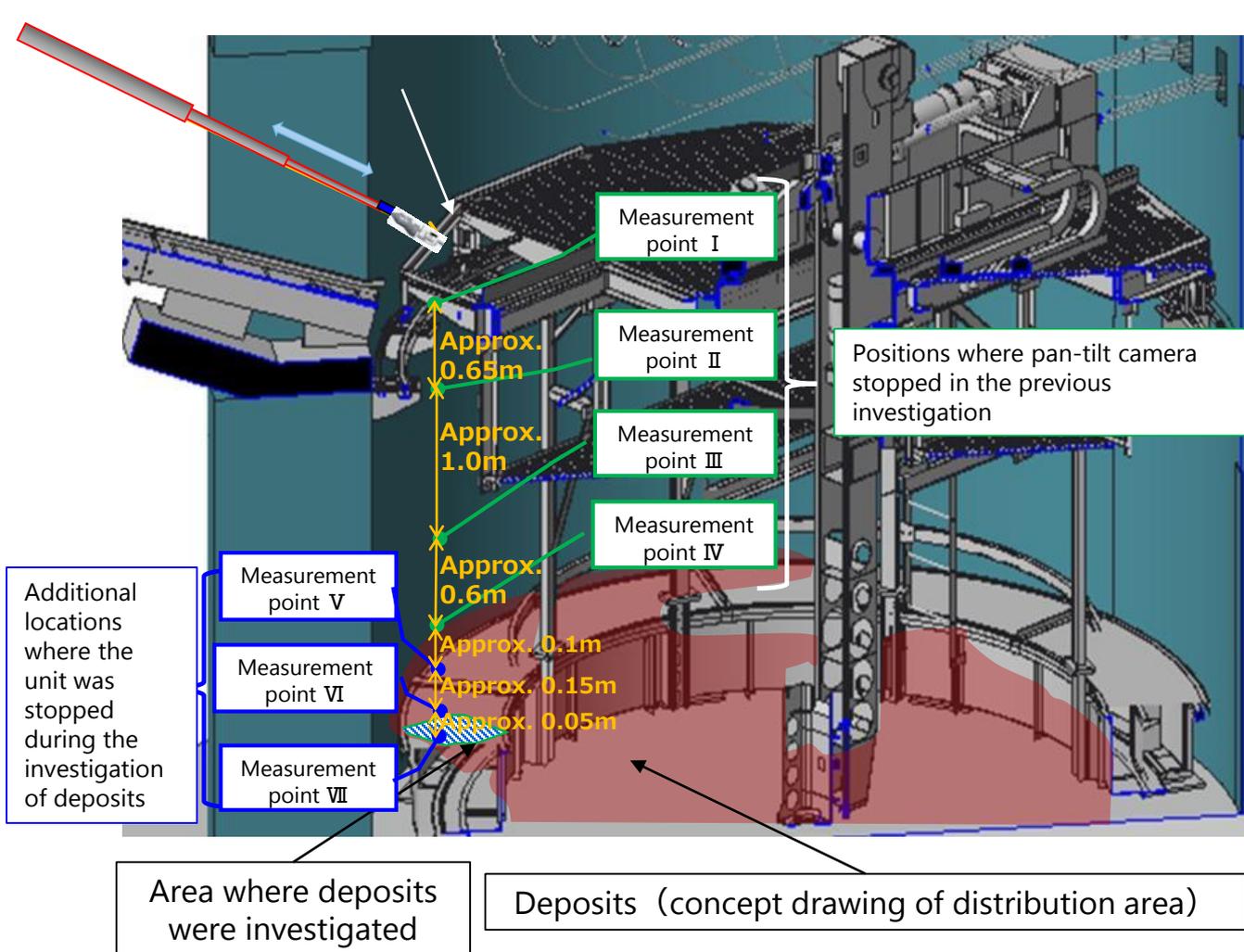


After grasping deposit

- ✓ Grasping with finger (left)
- ✓ Investigation unit was hoisted while it grasped the deposit, but it did not move (right).

4. Measured dose and temperature

- Temperature was approximately constant regardless of measurement height.
- Dose inside the pedestal tended to increase as we approached the bottom of pedestal.



Measurement point	Dose rate ^{※1,2} [Gy/h]	Temp. ^{※2} [°C]
I	6.4	23.2
II	6.8	23.1
III	6.5	23.1
IV	7.0	22.9
V	7.2	22.8
VI	7.5	22.9
VII	7.6	22.9

【Reference : Outside the pedestal^{※3}】
 Dose rate : Max. 43[Gy/h]
 Temp. : Max. 23.7[°C]

※1 : Calibrated with Cs-137 radiation source
 ※2 : Error : Dosimeter: ±7%
 Temp. Gauge: ±0.5°C

※3 : Reference value because measurement equipment is housed inside the investigation unit

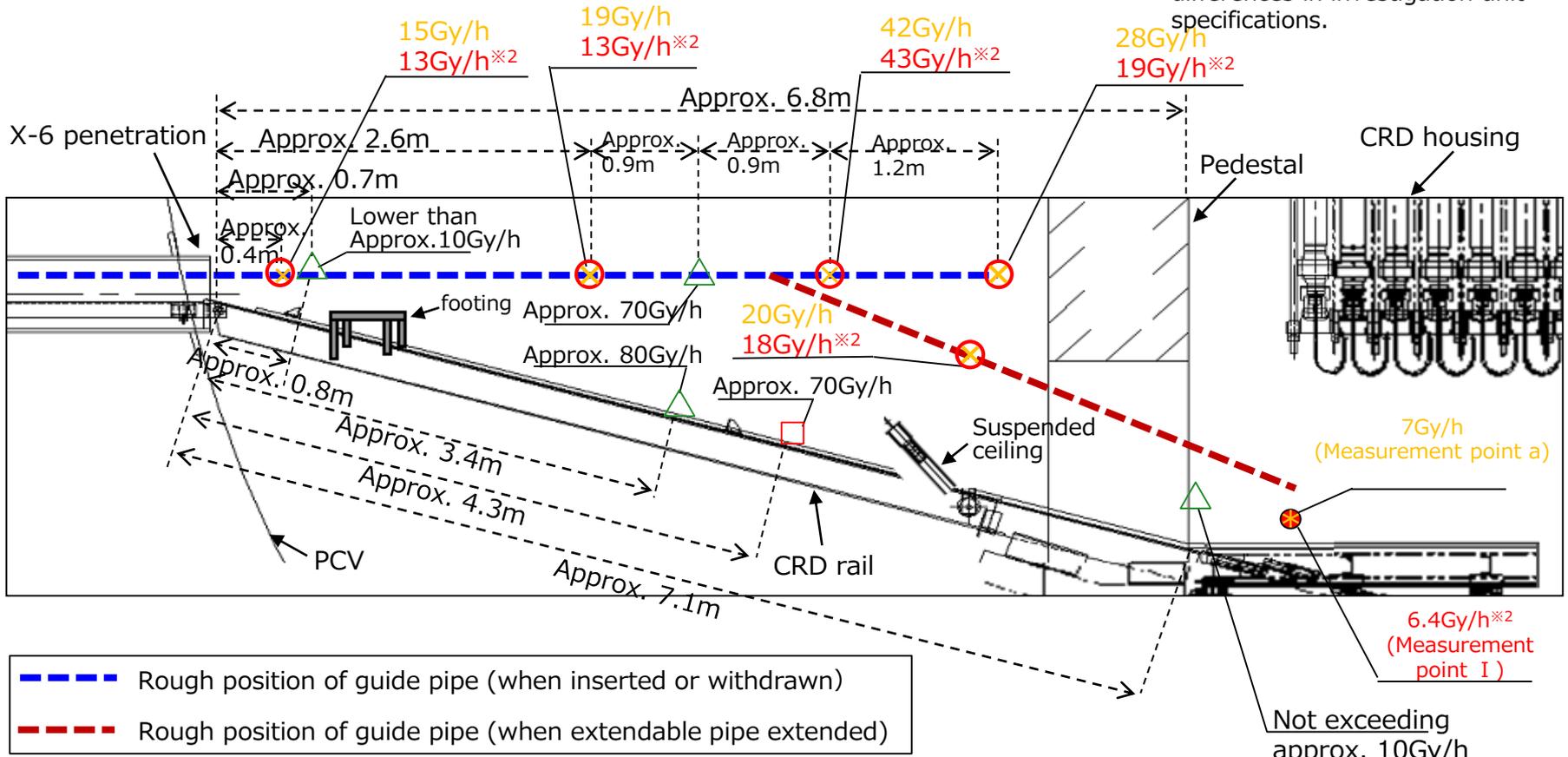
5. Summary

- In preparation to remove fuel debris we have made attempts to ascertain conditions inside the reactor through internal investigations, researched and developed grasping and cutting mechanisms, and deliberated the practical application of R&D achievements in the field.
- The following information was obtained from this contact investigation:
 - 1) Characteristics of fuel debris
 - ✓ We have tried to deduce the characteristics of fuel debris in the course of deliberating methods for grasping pebble-like fuel debris and methods for removing stone-like fuel debris that entail cutting the debris.
 - ✓ During the contact investigation we found out that it is possible to grasp and move pebble-like deposits and structure-shaped deposits, but also that there are hard stone-like deposits that cannot be grasped.
 - ✓ By moving the camera closer to the deposits than ever before we obtained images that will help us estimate the shape and size of deposits.
 - 2) Information about the environment inside the Primary Containment Vessel
 - ✓ We confirmed for the first time that dose levels tend to increase as we approached the bottom of the PCV inside the pedestal. And, as observed during the previous investigation, it was confirmed that dose levels inside the pedestal tend to be lower than outside the pedestal, and that temperature is approximately constant regardless of measurement height.
- We will leverage this information to deliberate future internal investigations and fuel debris removal methods (such as locations for removal, device design, etc.).

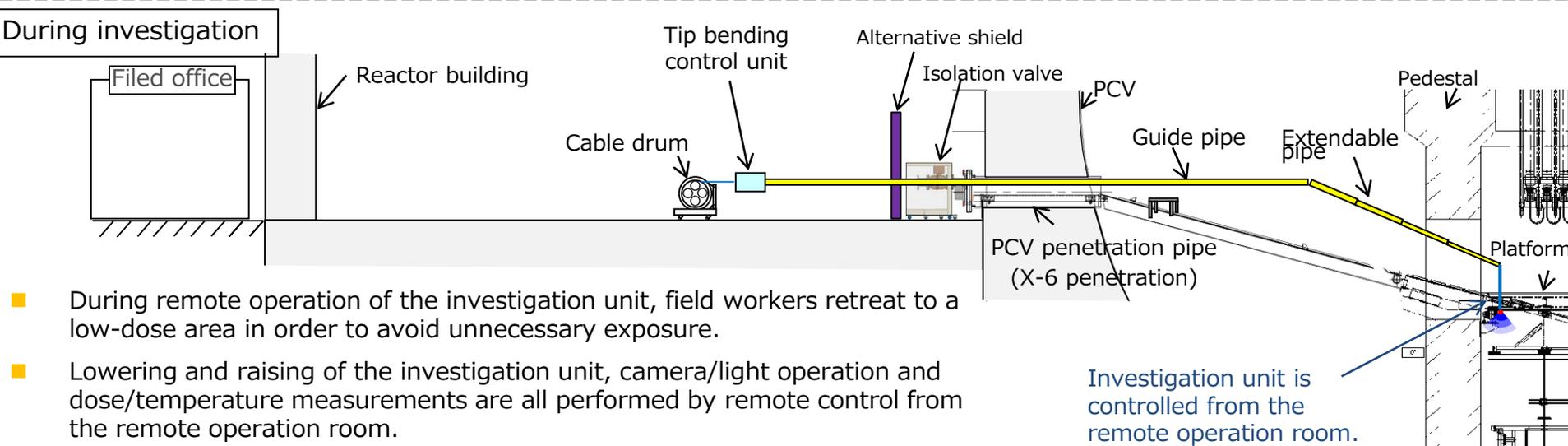
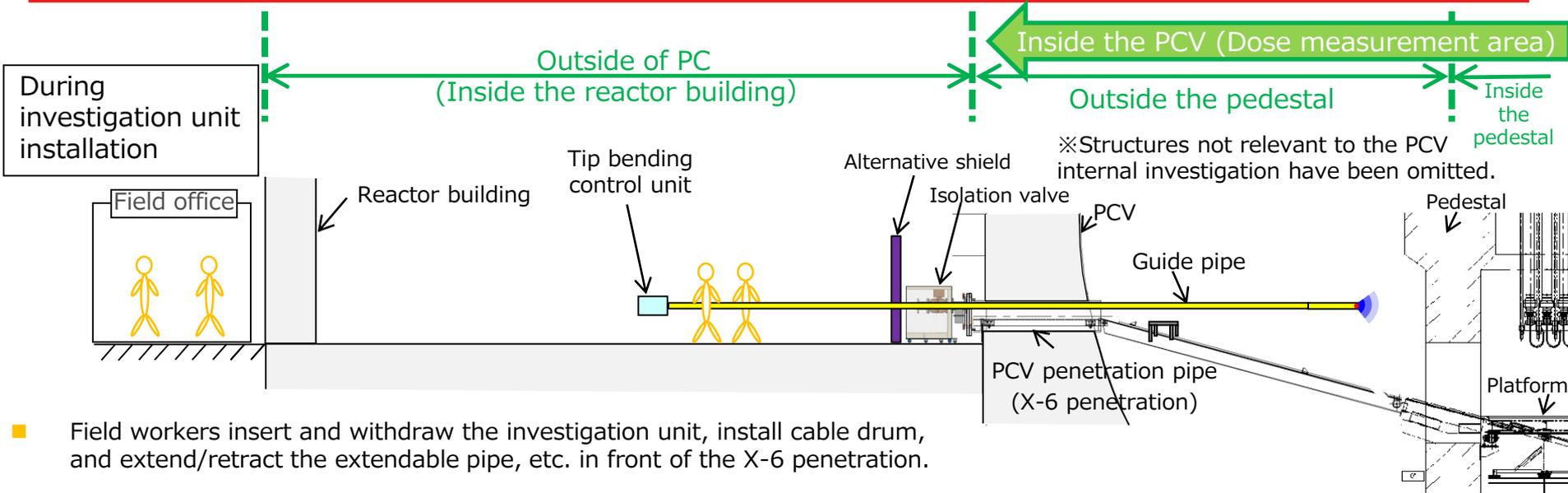
Reference: Measurement points of reference dose rate

- Measured during this investigation
- Measured for reference during this investigation^{※1}
- * Measured in January, 2018 ✕ Measured for reference in January, 2018^{※1}
- △ Measured in 2017 (estimated from noise of camera image)
- Measured in 2017 (calculated by integral dosimeter)

※1 : Reference value because measurement equipment is housed inside the investigation unit
 ※2 : Measurement points used during this investigation are not all the same as the previous investigation because of the differences in investigation unit specifications.

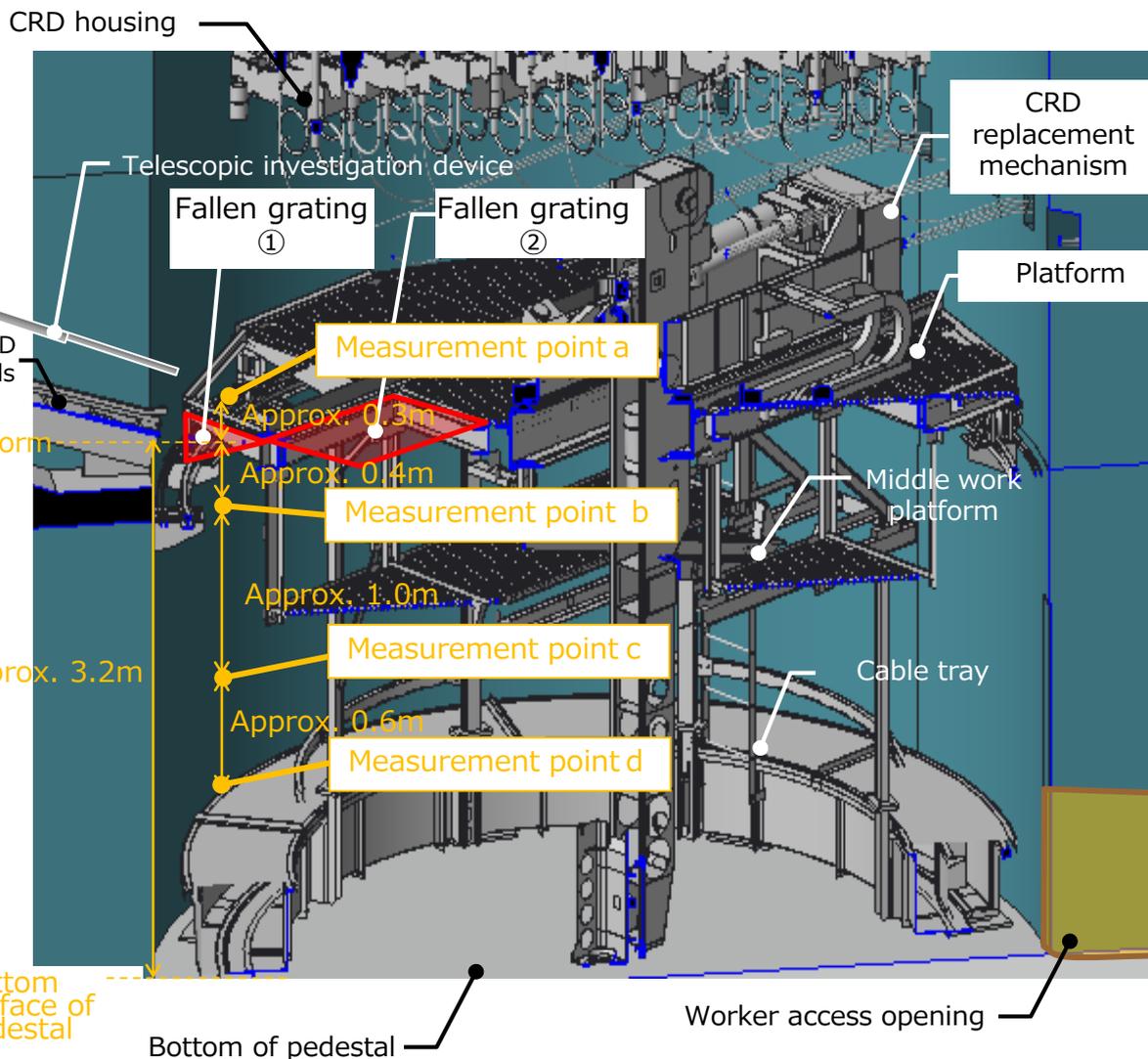


Reference: Positional relationship between work area and dose measurement area



• Exposure dose on February 13, 2019 (Investigation date)
 Planned : 3.00[mSv/day] Actual : Avg. 0.26[mSv/person] Max. 0.68[mSv]

Reference: Previous investigation results (January, 2018)



Measurement point	Dose rate ^{※1,2} [Gy/h]	Temp. ^{※2} [°C]
a	7	21.0
b	8	21.0
c	8	21.0
d	8	21.0

【Reference : Outside the pedestal^{※3}】
 Dose rate : Max. 42[Gy/h]
 Temp. : Max. 21.1[°C]

- ※1 : Calibrated with Cs-137 radiation source
- ※2 : Error : Dosimeter: ±7%
Temp. gauge: ±0.5°C
- ※3 : Reference value because measurement equipment is housed inside the investigation unit

Reference: Environmental impact (1/2)

- **There was no impact on the surrounding environment from radiation** during the internal investigation of the Unit 2 primary containment vessel conducted on February 13.
- **During the investigation a boundary was formed to prevent the gases inside the containment vessel from leaking into the external environment.**
- **No significant fluctuation in data from monitoring posts and dust monitors were seen neither prior to, nor after, the investigation.**
- **Data from monitoring posts and dust monitors near site boundaries can be found on our website.**

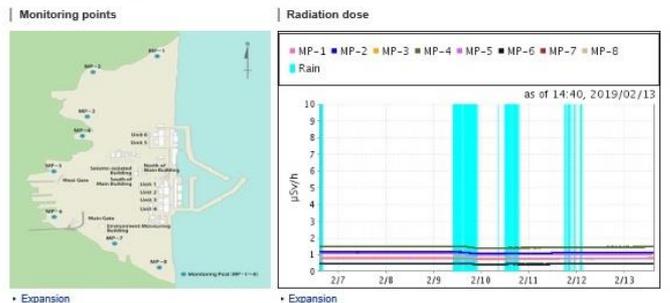
URL : <https://www4.tepco.co.jp/en/nu/fukushima-np/f1/index-e.html>
<https://www4.tepco.co.jp/en/nu/fukushima-np/f1/dustmonitor/index-e.html>

(Reference) Website Excerpt

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), portable monitoring posts and monitoring cars on the premises of Fukushima Daiichi Nuclear Power Station.

Monitoring post (MP1 - MP8)

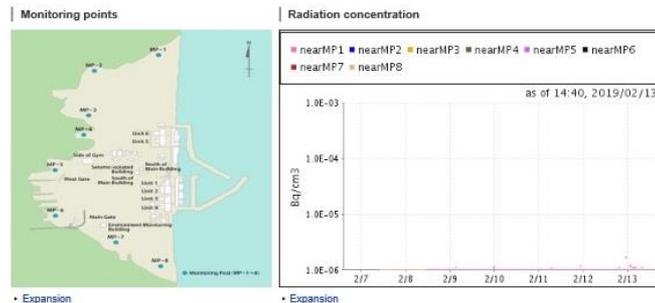


Measurement value (2019/02/13 14:40)

MP-1	MP-2	MP-3	MP-4	MP-5	MP-6	MP-7	MP-8	Wind Direction	Wind Velocity	Rain
0.774	1.138	0.791	1.490	1.055	0.441	0.788	0.746	west	11.3	No

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.



Measurement value (2019/02/13 14:40)

nearMP1	nearMP2	nearMP3	nearMP4	nearMP5	nearMP6	nearMP7	nearMP8	Wind Direction	Wind Velocity
1.0E-06	1.0E-06	-	-	-	-	-	1.0E-06	west-northwest	3.6

- Radiation levels include contributions from radiation sources other than those inside the primary containment vessel.

Reference: Environmental impact (2/2)

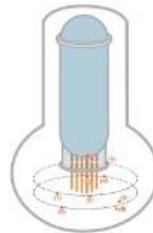
- During the internal investigation of the Unit 2 primary containment vessel conducted on February 13 plant parameters were continuously monitored and **no significant fluctuations were seen in the temperature of the primary containment vessel neither prior to, nor after, the investigation. There were also no changes in the cold shut down status of the reactor.**
- Primary containment vessel internal temperature data can be viewed on our website.
URL : https://www4.tepco.co.jp/en/nu/fukushima-np/f1/plantdata/unit2/rpv_index-e.html

(Reference) Website Excerpt

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

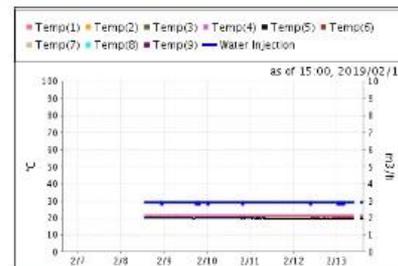
Here are the measurement results of temperatures inside the Unit 2 Primary Containment Vessel at Fukushima Daiichi Nuclear Power Station.

Monitoring points



▶ Expansion

Temperature



▶ Expansion

◦Measurement value (2019/02/13 15:00)

Temperature Unit:°C, Water Injection Unit:m³/h

Temp(1)	Temp(2)	Temp(3)	Temp(4)	Temp(5)	Temp(6)	Temp(7)	Temp(8)	Temp(9)	Water Injection
21.5	21.6	21.2	21.0	19.7	20.7	20.5	21.3	21.4	2.9