**Fukushima Daiichi Nuclear Power Station**
**Unit 1 Primary Containment Vessel Internal Investigation**

# Completion of the detailed visual investigation of the perimeter of the pedestal using submersible ROV-A2

< Reference Material >
May 23, 2022
Tokyo Electric Power Company Holdings, Inc.
Fukushima Daiichi D&D Engineering Company

- In order to deliberate equipment and methods for recovering deposits from inside the primary containment vessel (hereinafter referred to as, “PCV”), internal investigations of the PCV shall be conducted.

- In this investigation, separately developed remotely operated vehicles (hereinafter referred to as, “submersible ROV”) will be used to perform a detailed visual investigation of the inside and the perimeter of the pedestal※1, measure the thickness of deposits to obtain information, such as the amount and origins of such deposits.

- In preparation for these investigations, we used submersible ROV-A to install guide rings ※2 inside the PCV between February 8~10.

- The detailed visual investigation of the perimeter of the pedestal using submersible ROV-A2 was commenced on March 14. After a short suspension the investigation was recommenced on May 17, and on May 17 and 18 the condition of existing structures and the degree of dispersion of deposits around the pedestal foundation and jet deflector ※3 (E) (indicated in the blue box on slide 3) were investigated. <Announced by May 19>

- On May 19, the condition of existing structures and the degree of dispersion of deposits around the pedestal opening and jet deflectors (C, D) (indicated in the green box on slide 3) were investigated. (Refer to slides 4~7)

- On May 20 and 21, neutron flux was measured around the pedestal opening and jet deflectors (E, F, H) (indicated in the yellow box on slide 3). We are currently analyzing and assessing the data that was obtained, and will announce the results of this neutron flux measurement after such analysis/assessment has been completed.

- Today (May 23) at 11:00 AM, we began extracting submersible ROV-A 2, and completed the extraction at 3:23 PM. This marks the conclusion of the detailed visual investigation of the perimeter of the pedestal. Furthermore, since the investigation was recommenced on May 17, there have been no significant changes in PCV water level or water turbidity, and these conditions had no impact on the investigation. The cameras mounted on submersible ROV-A2 were also functioning normally.

- Going forward, we shall assess the conditions observed through the detailed visual investigation, and conduct further investigations with submersible ROV's A2, B, C, D, and E as necessary. Furthermore, the neutron flux measurements obtained will be used to narrow down the scope of the investigation using submersible ROV-D that will focus on deposit debris detection (nuclide analysis/neutron flux measurements).

- This investigation was performed after constructing boundaries※4 to prevent gases inside the PCV from leaking to the outside, and there have been no significant fluctuations in data from monitoring post or dust monitors, or with plant parameters from before the investigation to the present, so there have been no radiological impact on the surrounding environment. We will continue to prioritize safety while carefully implementing these investigations.

※1 Pedestal: Work space and platform below the primary containment vessel
※2 Guide ring: Ring installed to prevent the cables attached to the submersible ROV from getting twisted.
※3 Jet deflector: Disk-shaped steel material installed on the PCV side of pipes connecting the PCV and the pressure suppression chamber.
※4 Boundary: PCV containment function

# Location of the detailed visual inspection of the perimeter of the pedestal and inspection schedule

**＜ Main targets of the investigation ＞**

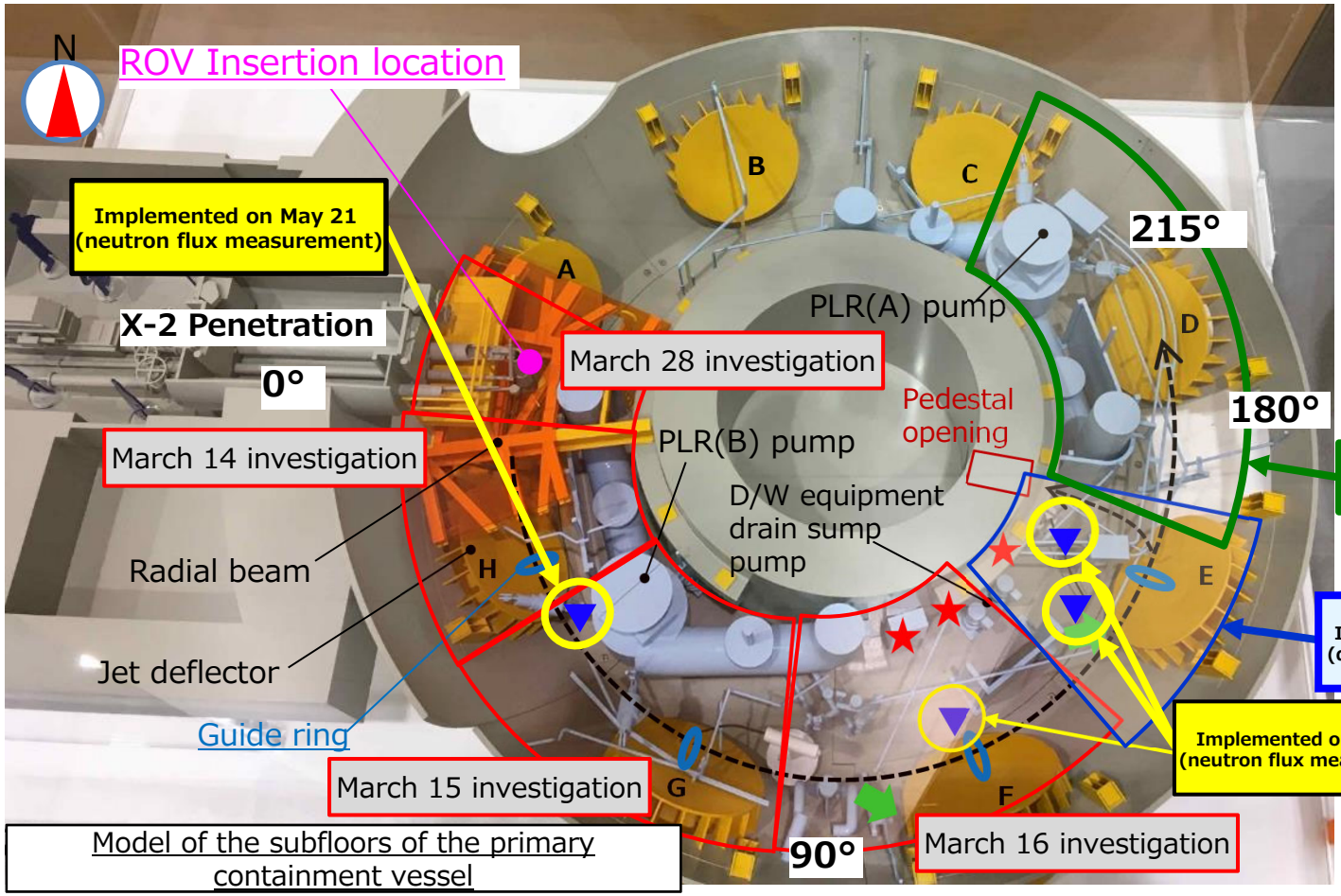
■Examine the condition of existing structures

■Examine the extent of dispersal of debris, debris height, and slope

■Examine the conditions around the pedestal opening and also the condition of the concrete wall near the pedestal opening（★Location）

■Condition of deposits around the jet deflectors（Location）

■Measure neutron flux above deposits（▼ Location）




Model of the subfloors of the primary containment vessel

※ Originally measurements were to be taken near the ROV insertion point, but tension in the ROV cable prevented stable hovering of the ROV at this location and required that a change be made to the measurement point.

Source : International Research Institute for Nuclear Decommissioning (IRID)

# Conditions around the pedestal opening (foundation) (from investigation on May 19 ①)

✓ Close up photos of the rebar-like objects were compared with photos taken at the time of construction and it was determined that the objects are indeed rebar from the pedestal. The inner skirt ※ was also observed

※Inner skirt: Steel cylinder located inside the pedestal (on the inside of the rebar) that transfers the load of the pedestal to the bottom of the PCV (foundation mat)

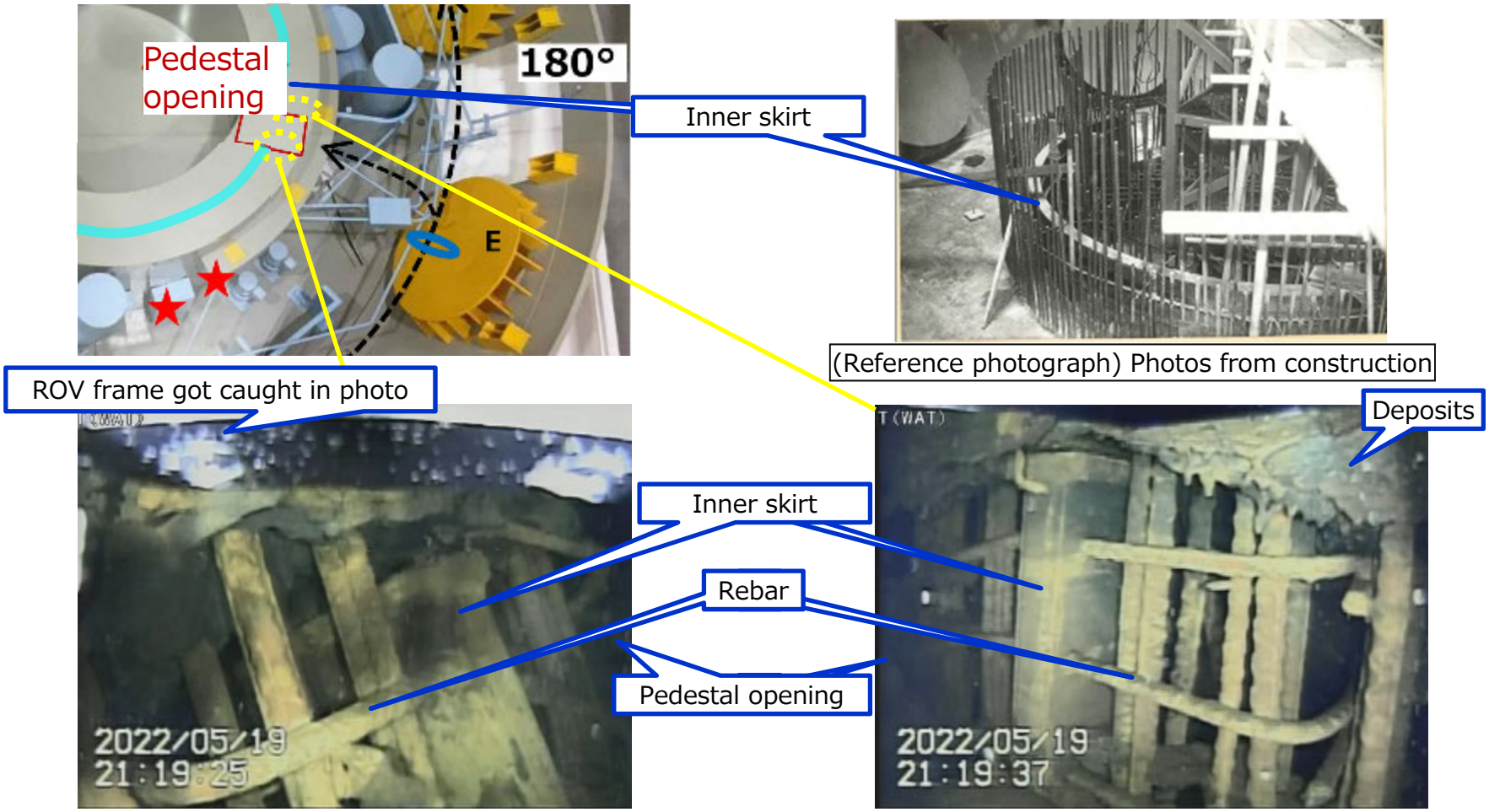


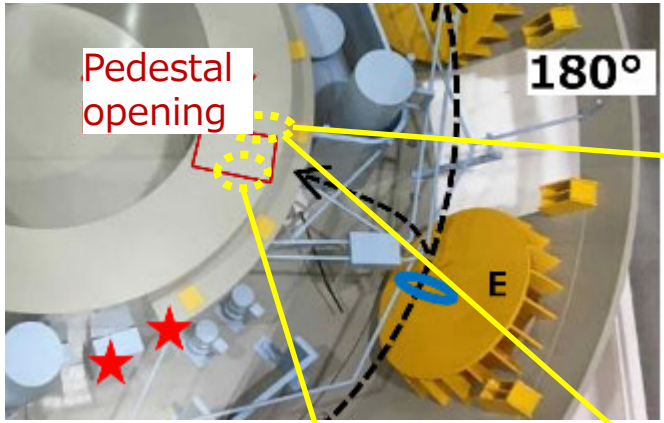

Photo 1. Conditions at the pedestal opening (left side foundation)

Photo 2. Conditions at the pedestal opening (right side foundation)

Source: International Research Institute for Nuclear Decommissioning (IRID)

# Conditions around the pedestal opening (foundation) (from investigation on May 19 ②)

- ✓ Pedestal rebar was found at the bottom the deposits
- ✓ At the top of the deposits we found the pedestal foundation intact



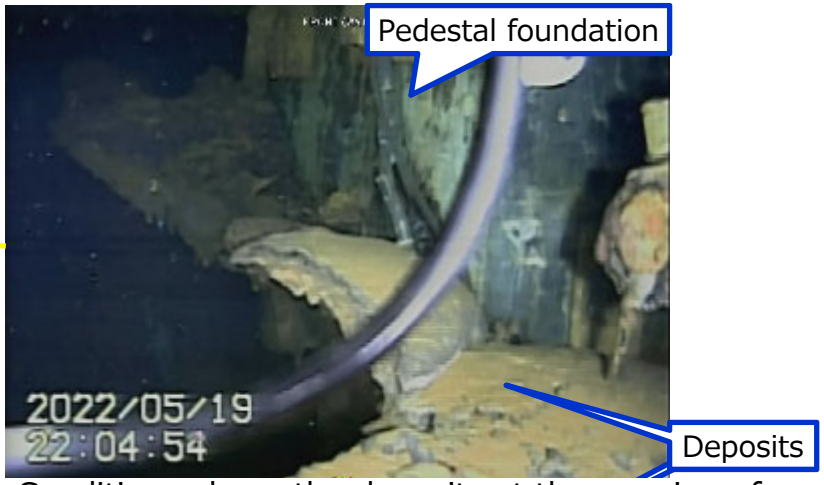




Photo 1. Conditions above the deposits at the opening of the pedestal (right side foundation)


Photo 2. Conditions above and below the deposits at the pedestal opening (left side foundation)

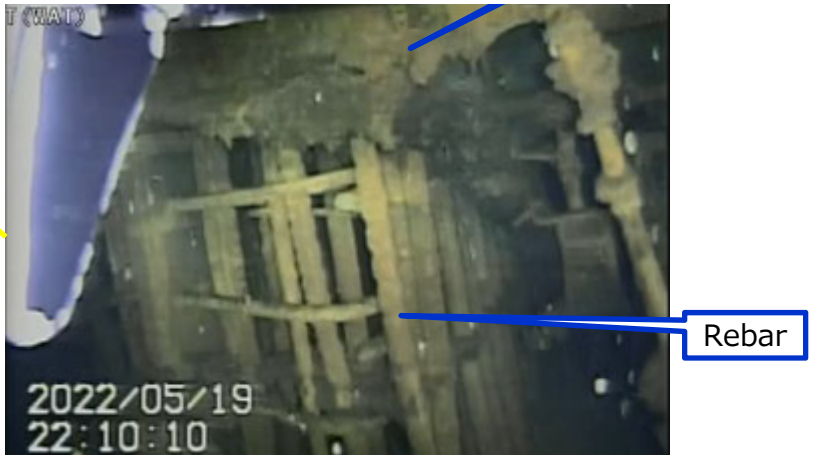
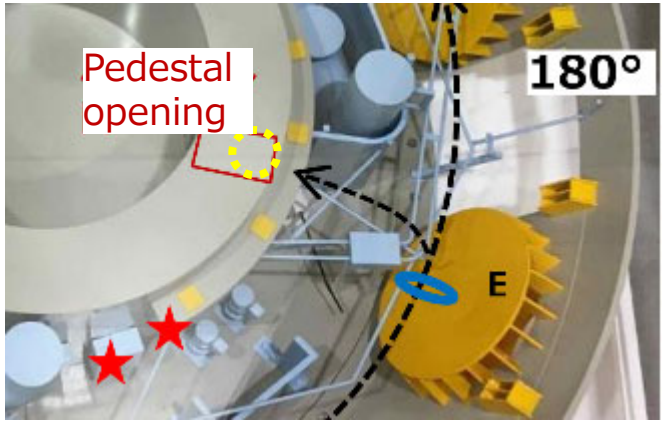



Photo 3. Conditions at the bottom of the deposits at the pedestal opening (right side foundation)

Source: International Research Institute for Nuclear Decommissioning (IRID)

# Pedestal opening (inside nearest to the ROV) conditions (from investigation on May 19③)

✓ Several clump-like deposits were found



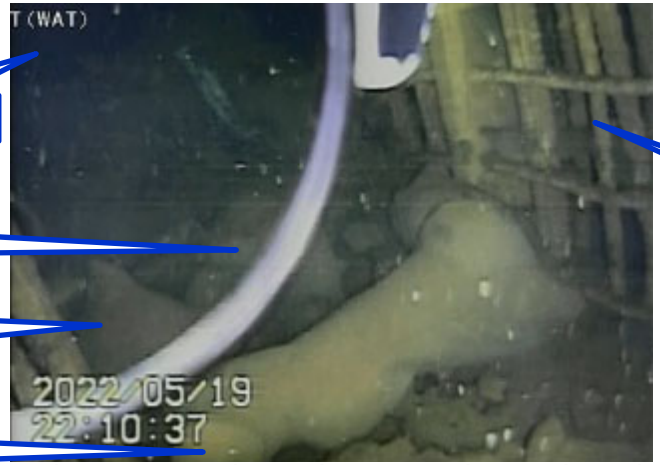




Photo 1. Looking down on the pedestal opening (inside nearest to the ROV)


Photo 2. Conditions at the pedestal opening (inside nearest to the ROV)

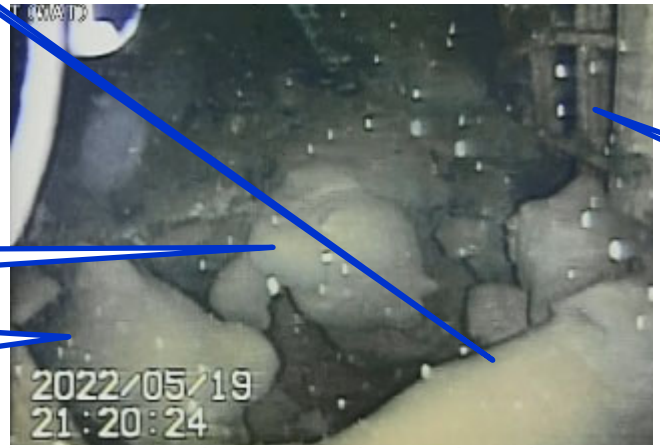
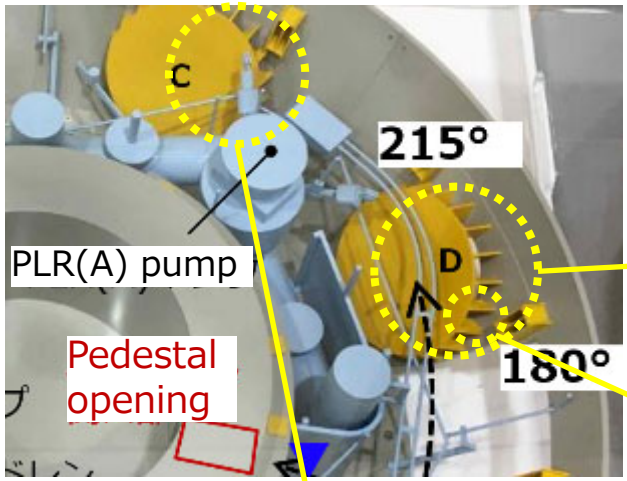



Photo 3. Conditions at the pedestal opening (inside nearest to the ROV)

Source: International Research Institute for Nuclear Decommissioning (IRID)

# Conditions around jet deflector (C and D) (from investigation on May 19 ④)

- ✓ Deposits were found around Jets deflector (D) and behind it (pressure suppression chamber side)
- ✓ Deposits were found around Jets deflector (C)



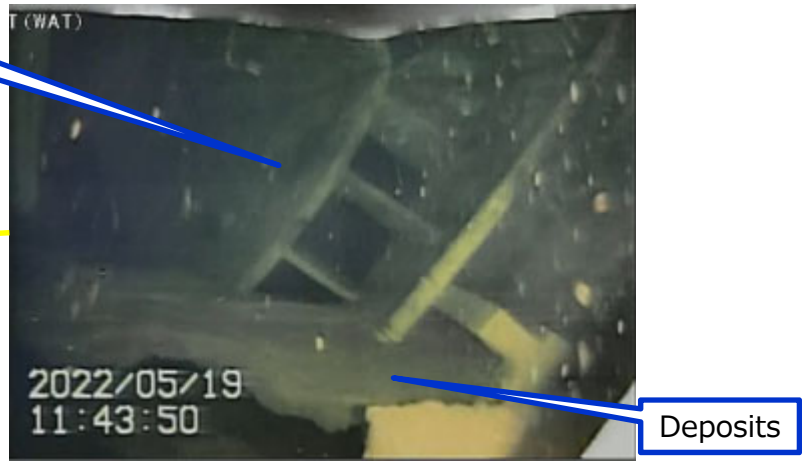




Photo 1. Looking down on jet deflector (D)

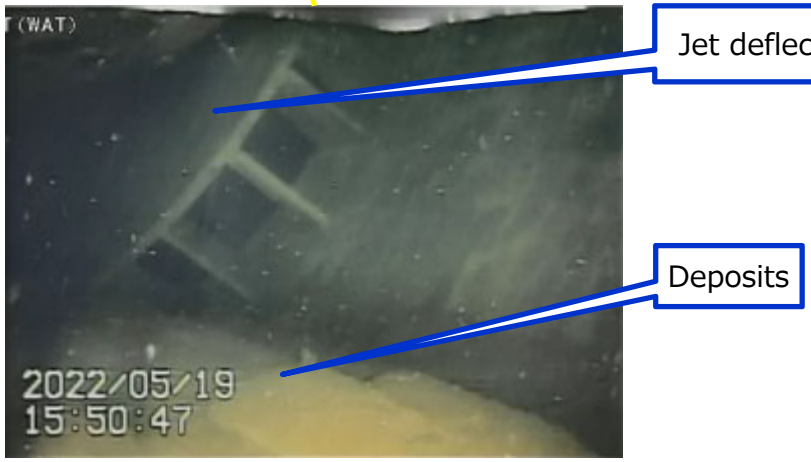



Photo 2. Looking down on jet deflector (C)


Photo 3. Conditions at the back of jet deflector (D)

Source: International Research Institute for Nuclear Decommissioning (IRID)

# Sequence of events

**【May 17】** ※ X-2 penetration: Hole used by workers to enter the PCV

09:55 AM **PCV internal investigation (ROV-A2) recommences** (Power is turned on for each piece of equipment)
10:55 AM It is confirmed that dose data built-in to the submersible ROV-A2 and the timestamp on submersible ROV camera monitors are displaying correctly
2:04 PM Submersible ROV-A2 arrives at the surface of the water inside the PCV
3:55 PM - 4:15 PM Operations check of submersible ROV-A2 conducted (No abnormalities)
4:43 PM - 10:00 PM Detailed visual investigation conducted

**【May 18】**

9:49 AM PCV internal investigation preparations begin (Power is turned on for each piece of equipment)
10:54 AM – 11:38 AM Operations check of submersible ROV-A2 conducted (No abnormalities)
11:55 AM - 9:25 PM Detailed visual investigation conducted

**【May 19】**

9:52 AM PCV internal investigation preparations begin (Power is turned on for each piece of equipment)
10:50 AM - 11:12 AM Operations check of submersible ROV-A2 conducted (No abnormalities)
11:12 AM - 10:43 PM Detailed visual investigation conducted

**【May 20】**

9:56 AM PCV internal investigation preparations begin (Power is turned on for each piece of equipment)
10:49 AM - 11:17 AM Operations check of submersible ROV-A2 conducted (No abnormalities)
0:30 PM - 1:30 PM Neutron flux measurement (around the perimeter of the pedestal opening)
3:53 PM - 4:53 PM Neutron flux measurement (around jet deflector E)
6:30 PM - 7:30 PM Neutron flux measurement (around jet deflector F)

**【May 21】**

9:57 AM PCV internal investigation preparations begin (Power is turned on for each piece of equipment)
11:03 AM - 11:32 AM Operations check of submersible ROV-A2 conducted (No abnormalities)
2:12 PM - 3:12 PM Neutron flux measurement (around jet deflector H)

**【May 23】**

9:30 AM PCV internal investigation preparations begin (Power is turned on for each piece of equipment)
10:32 AM - 10:44 AM Operations check of submersible ROV-A2 conducted (No abnormalities)
11 AM Commencement of submersible ROV-A2 extraction
3:23 PM **Conclusion of PCV internal investigation (submersible ROV-A2)** (isolation valve connected to X-2 penetration ※ closed)

## Work structure/ Equipment/ Dose

【Work structure】

Area in front of the outside of the PCV (X-2 penetration): 6 teams each comprised of 8 people

Field headquarters: approx. 10 people mainly supervisors

Remote control room: 4 teams comprised of 4 operators each (1 team leader, 3 member operators) + approx. 18 supervisors

【 Equipment】

Area in front of the outside of the PCV (X-2 penetration): R gear (i.e., Anorak, coveralls, full face mask, helmet, cotton gloves, 3 sets of rubber gloves, 3 pairs of socks, shoe covers, R shoes)

Field headquarters: Y gear (i.e., coveralls, full face mask, helmet, cotton gloves, 2 sets of rubber gloves, 2 pairs of socks, Y shoes)

【 Dose】

Planned dose ：3mSv/day per person

APD set value ：1.5mSv

Actual dose (maximum value for an individual) :

May 17: Gamma: 0.56mSv (Beta: 0mSv for the worker concerned)

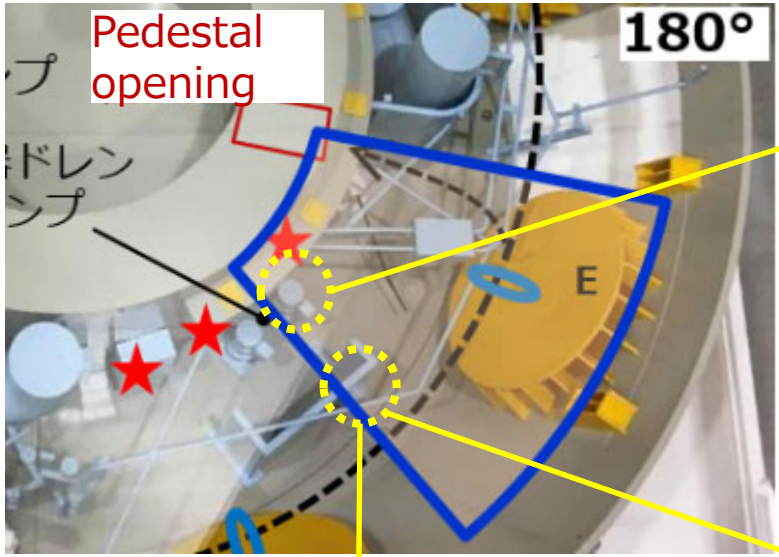
May 18: Gamma: 0.19mSv (Beta: 0mSv for the worker concerned)

May 19: Gamma: 0.12mSv (Beta: 0mSv for the worker concerned)

May 20: Gamma: 0.13mSv (Beta: 0mSv for the worker concerned)

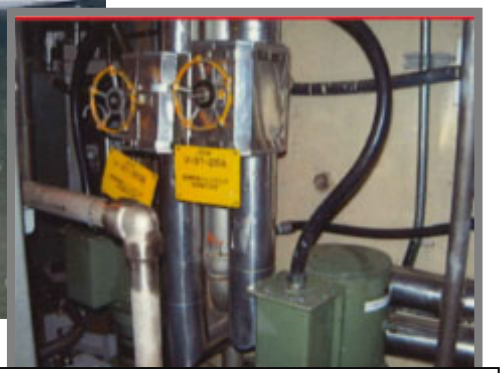
May 21: Gamma: 0.21mSv (Beta: 0mSv for the worker concerned)

# 【Reference】 Conditions near the equipment drain sump pump and bottom of the PCV (from investigation on May 17 ①)





ROV frame got caught in photo

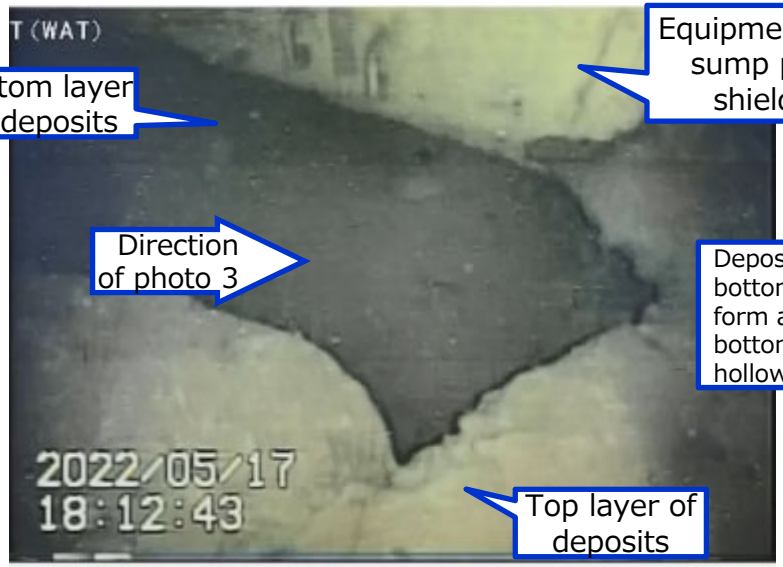


RCW pipe/valve

Top layer of deposits

(Reference photo) conditions prior to the accident in 2011

Photo 1. Conditions near the equipment drain sump pump




Bottom layer of deposits

Equipment drain sump pump shielding

Direction of photo 3

Top layer of deposits

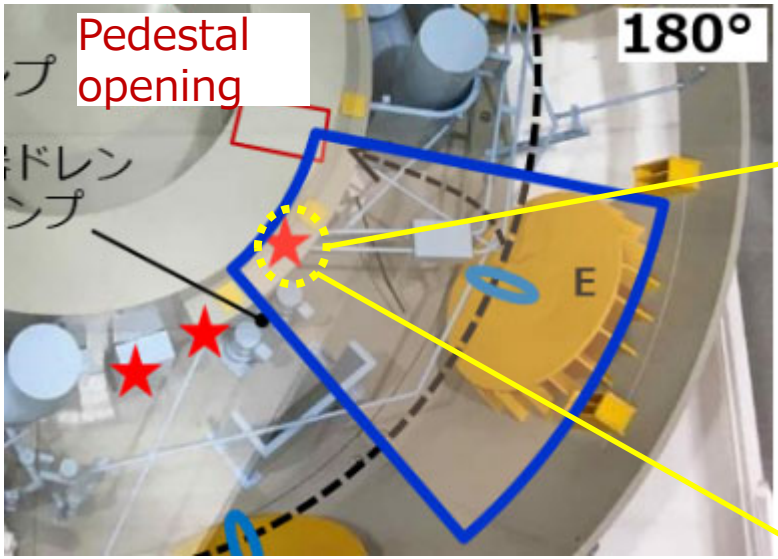
Photo 2. Deposits at the bottom of the PCV


Deposits at the bottom of the PCV form a top and bottom layer with a hollow center

Photo 3. Deposits at the bottom of the PCV (hollow area)

Source: International Research Institute for Nuclear Decommissioning (IRID)

# 【Reference】 Conditions around the pedestal (from investigation on May 17 ②)



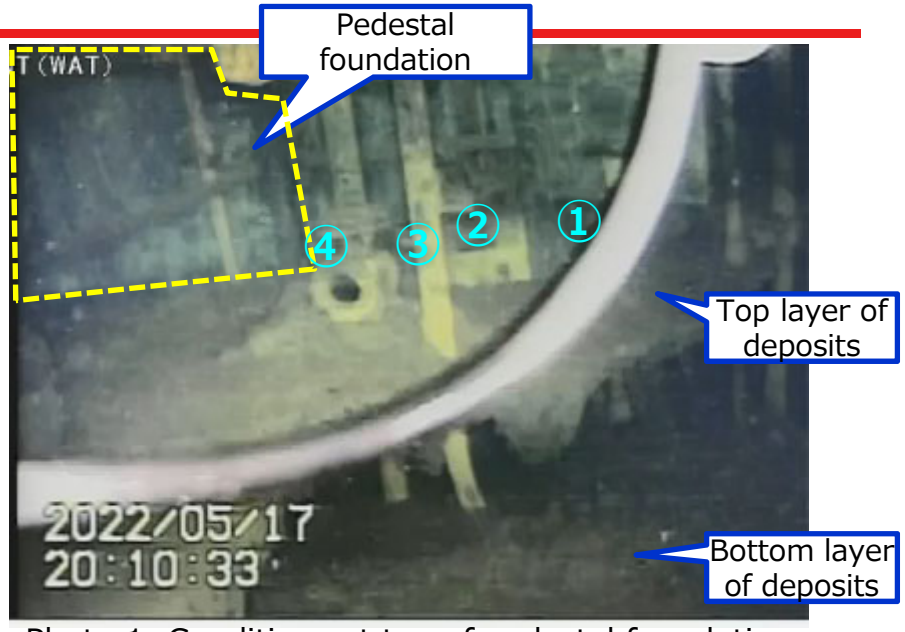
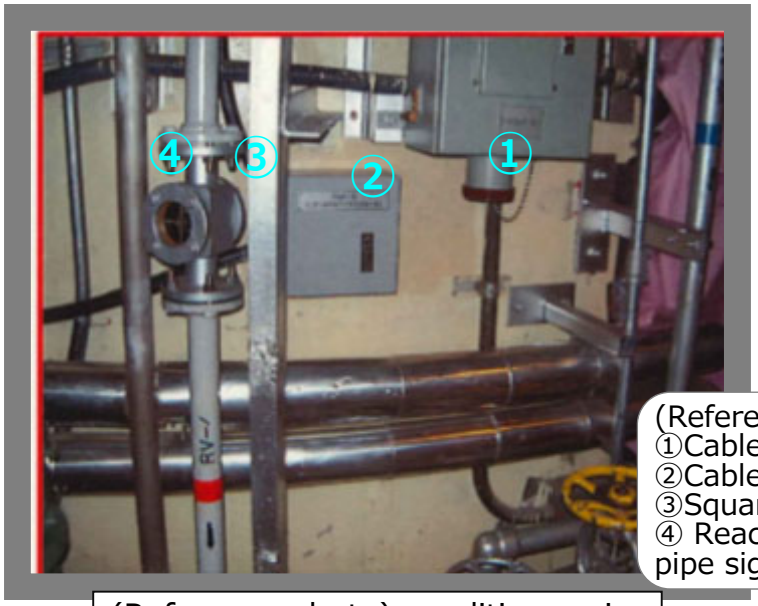




Photo 1. Conditions at top of pedestal foundation




(Reference photo) conditions prior to the accident in 2011

(Reference)
①Cable relay box (A)
②Cable relay box (B)
③Square support box
④ Reactor venting pipe sight glass

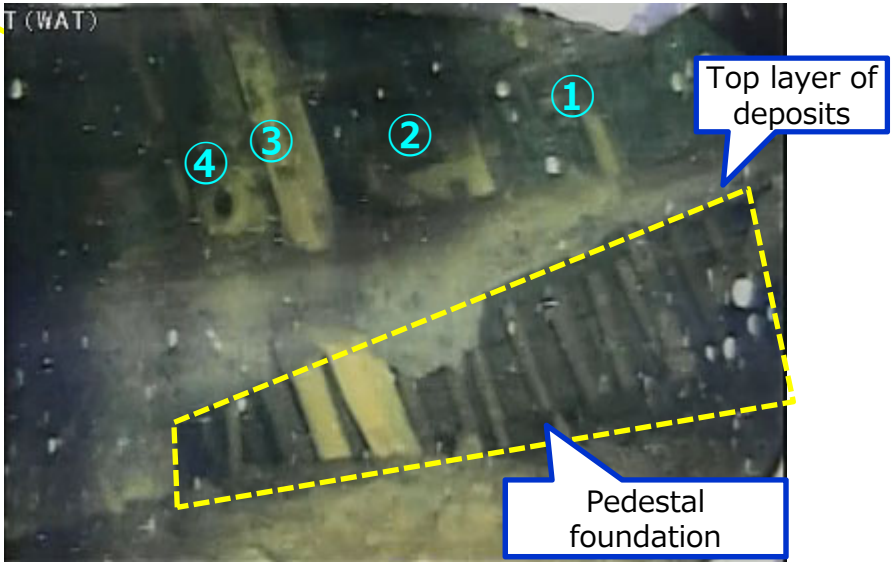



Photo 2. Conditions at bottom of pedestal foundation

Source: International Research Institute for Nuclear Decommissioning (IRID)

【Reference】 Comparison with conditions prior to the March 16 earthquake around jet deflector F (from investigation on May 17 ③)

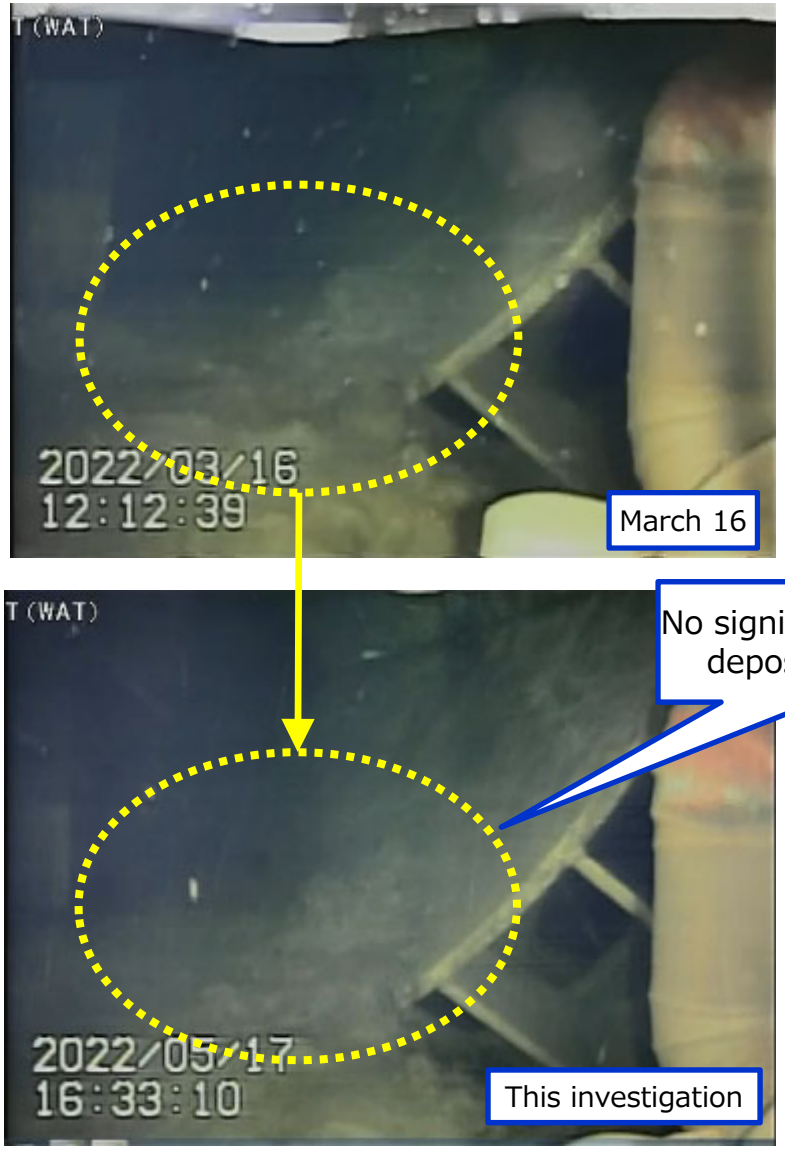



Photo 1. Looking down on jet deflector (F)

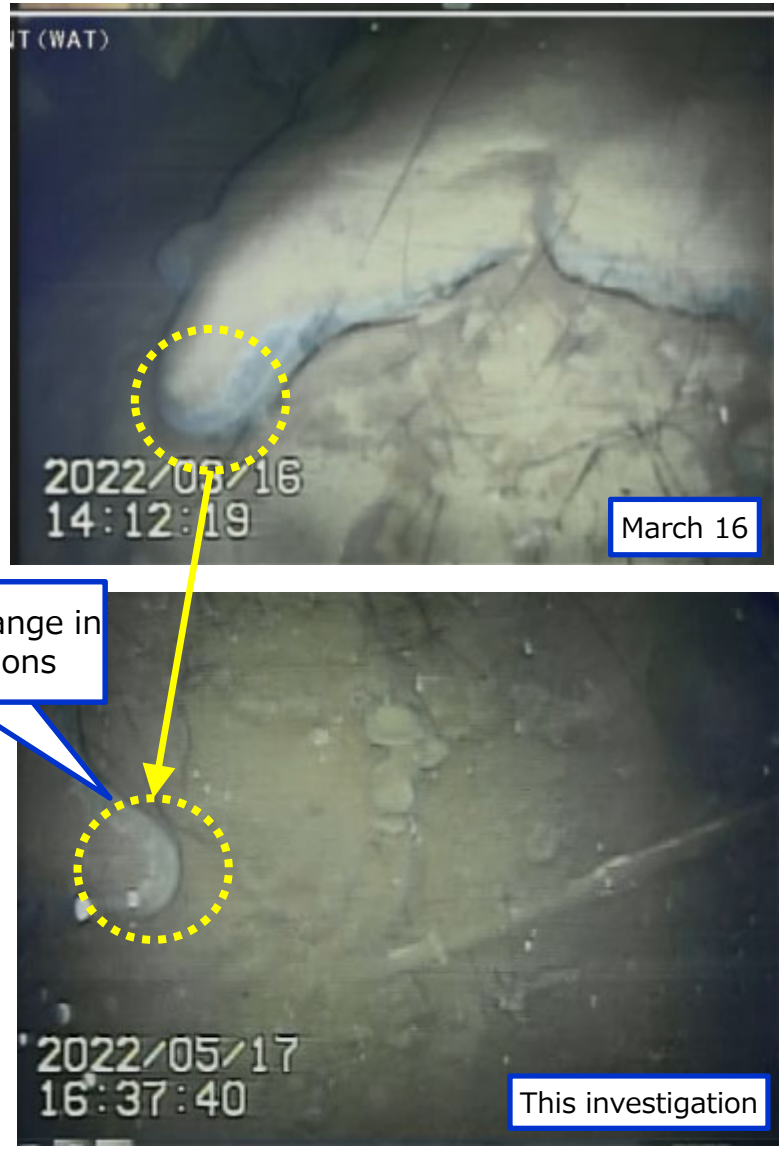
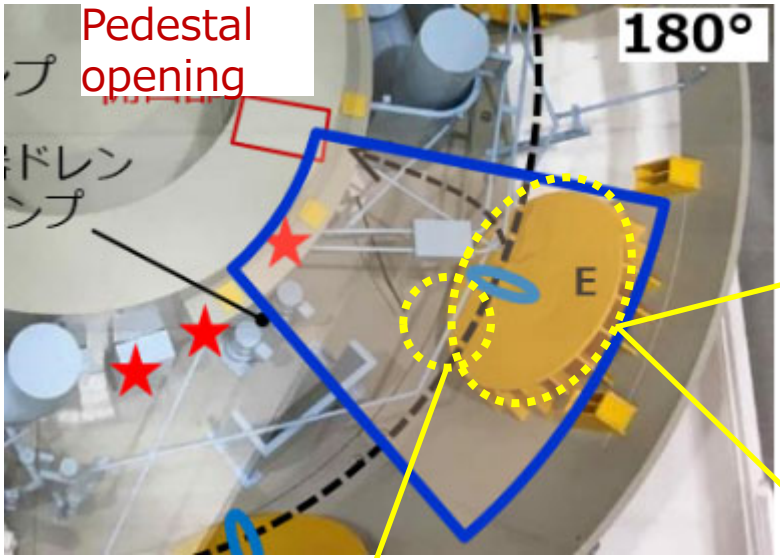



Photo 2. Conditions around jet deflector (F)

Source: International Research Institute for Nuclear Decommissioning (IRID)

# 【Reference】 Conditions around jet deflector (E)
(from investigation on May 17 ④ and May 18 ①)



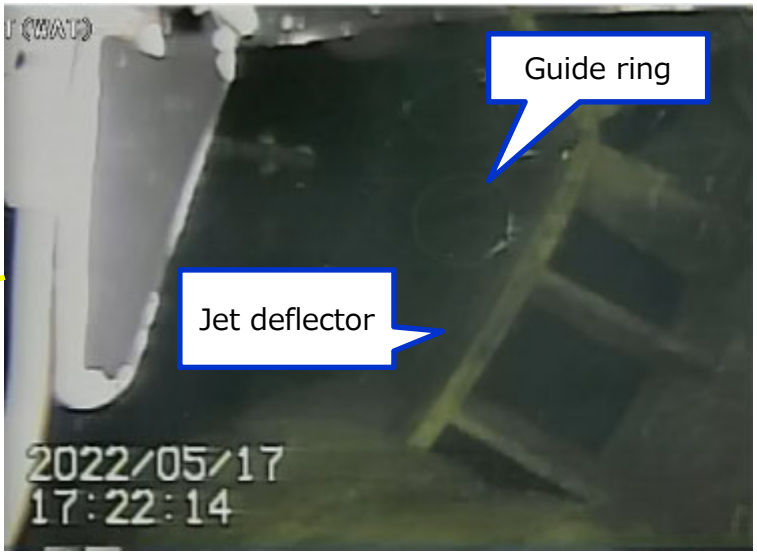




Photo 1. Looking down on jet deflector (E)


Photo 2. Conditions at the bottom front of jet deflector (E)

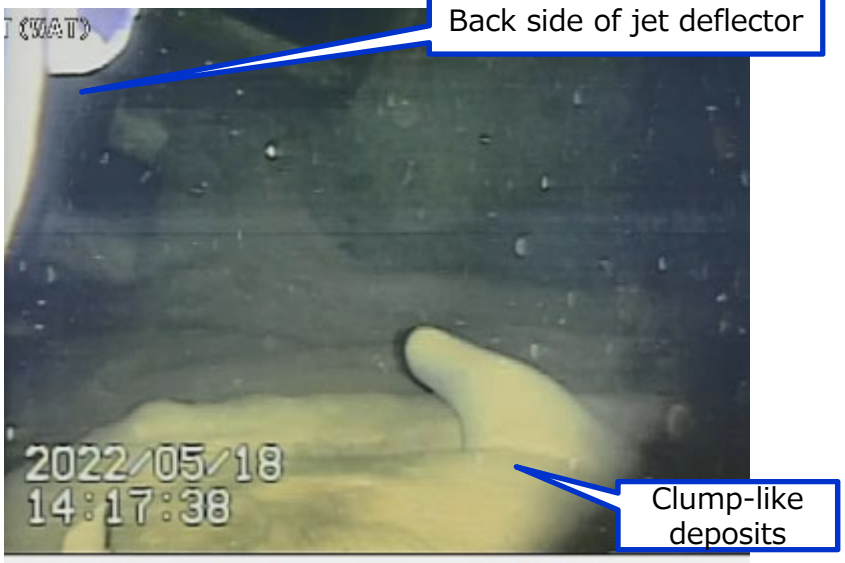



Photo 3. Conditions at the back of jet deflector (E)

Source: International Research Institute for Nuclear Decommissioning (IRID)

# 【Reference】 Conditions around the PLR (A) pipe and pedestal (from May 18 investigation②)

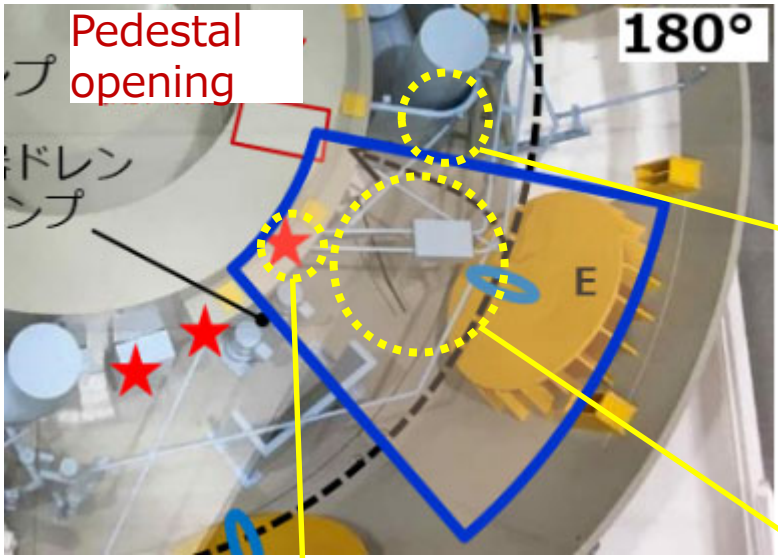




Photo 1. PLR (A) pipe conditions

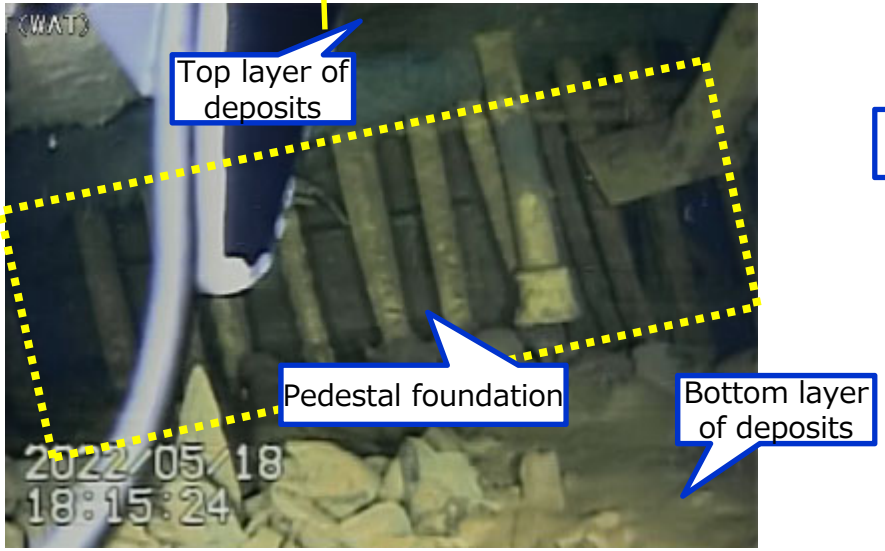


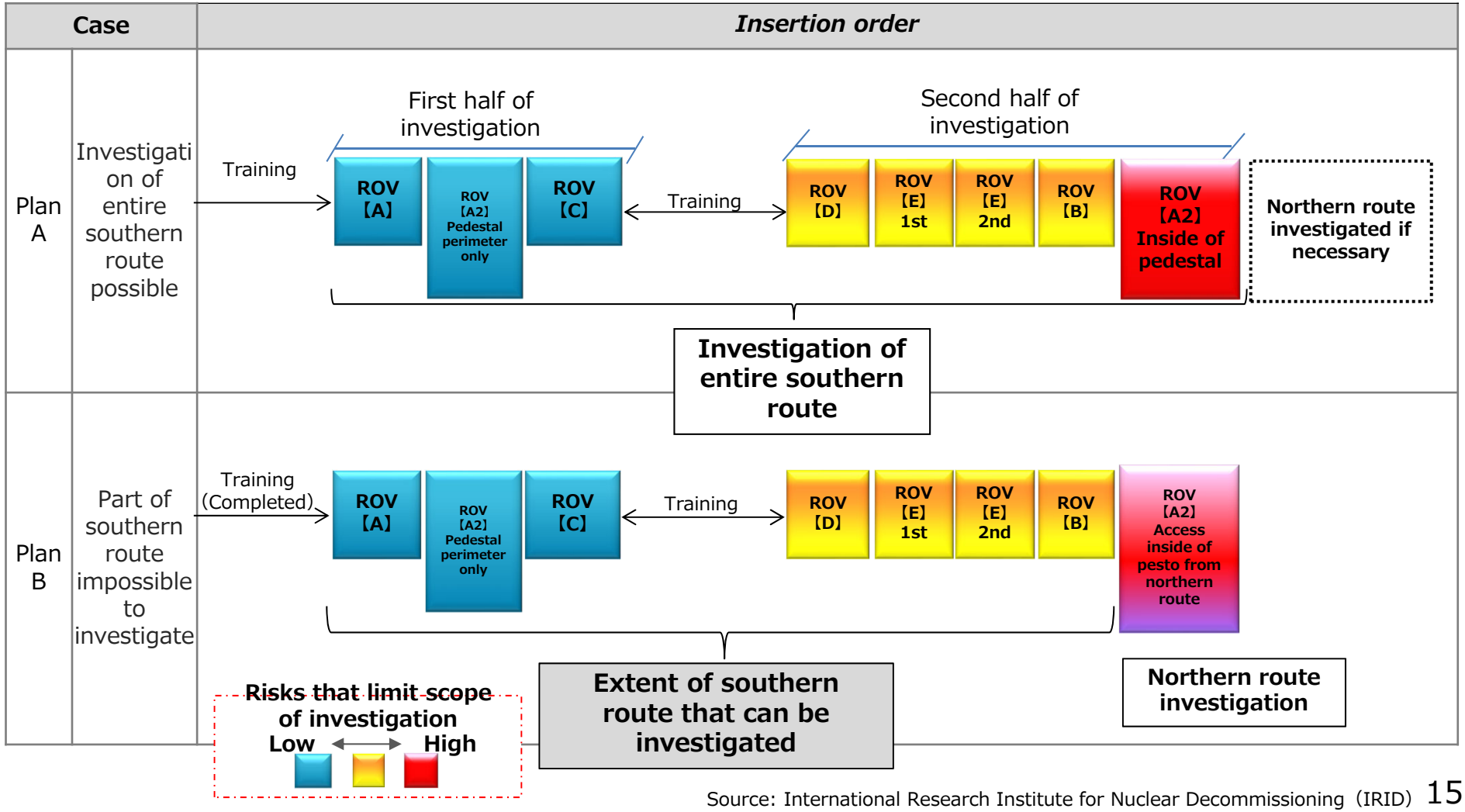

Photo 2. Conditions around the pedestal foundation


Photo 3. Deposits in front of the pedestal opening

Source: International Research Institute for Nuclear Decommissioning (IRID)

# 【Reference】 Insertion order of the submersible ROV

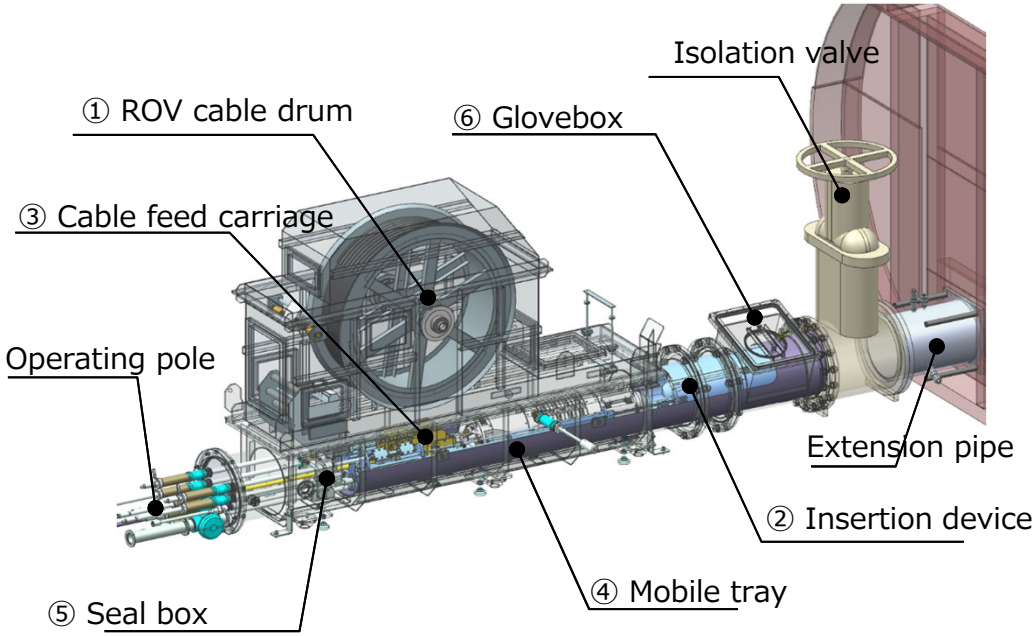
- The PCV internal investigation shall be twofold, and prior to inserting the ROV's during the first half and second half of the investigation, effective training shall be conducted in order to prevent ROV operating errors.
- Low-risk investigation equipment with limited scopes of investigation shall be inserted first in order to prioritize the acquisition of as much information as possible. (The investigation of the inside of the pedestal shall be performed last since it is the most risky)

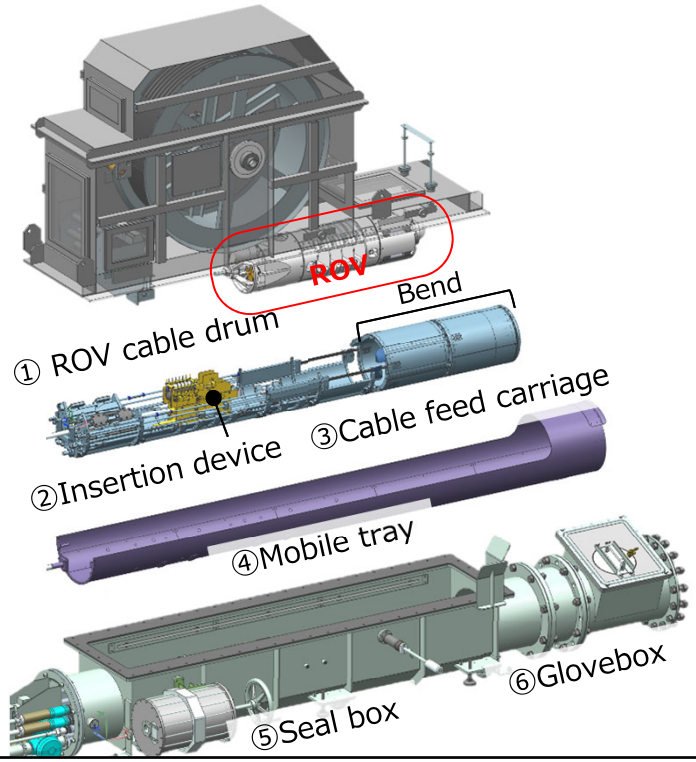



Source: International Research Institute for Nuclear Decommissioning (IRID)

# 【Reference】 Investigation device details - Seal box and other equipment

Inserts/extracts the ROV into/from the PCV.
Creates a PCV boundary along with the ROV cable drum.



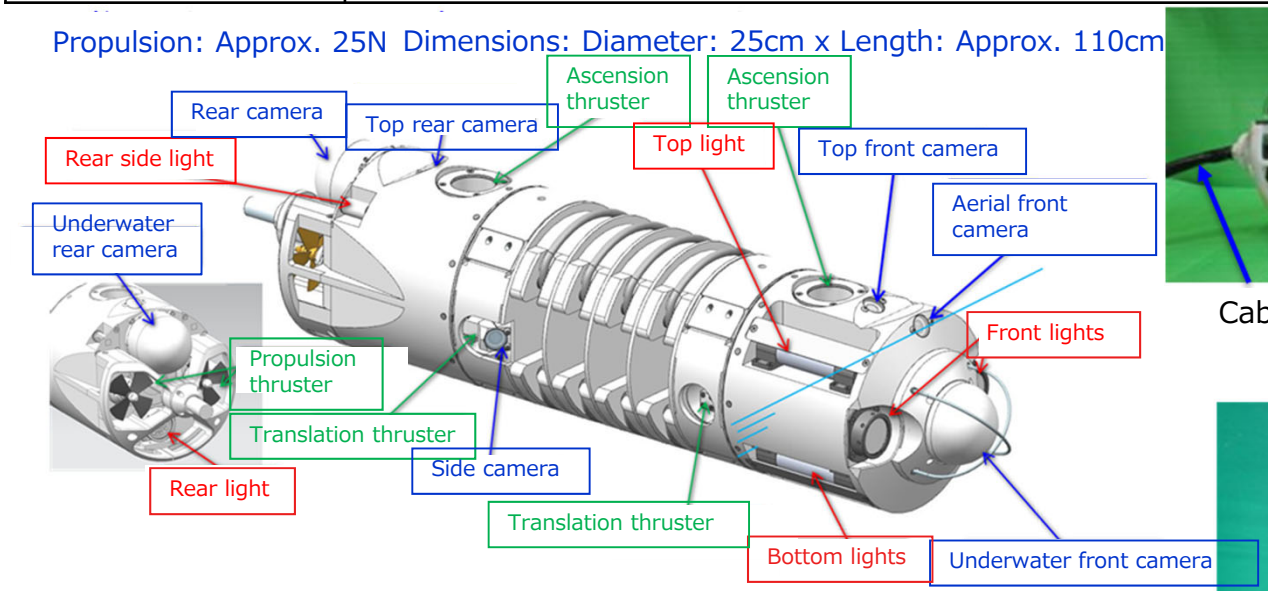



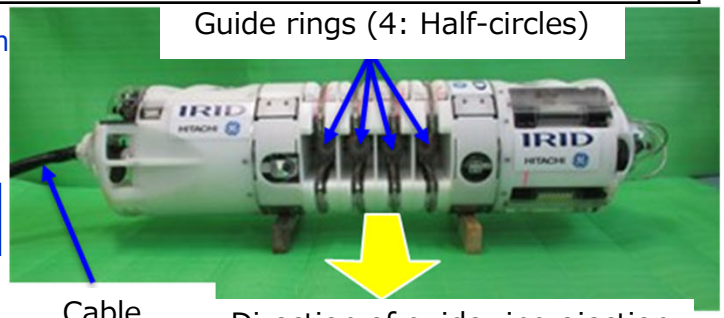

| Name of component | | Role |
|---|---|---|
| ① | ROV Cable drum | Part of the ROV that feeds and retracts the ROV cable. |
| ② | Insertion device | Inserts the ROV into the PCV via guide rings and bends to stand the ROV vertically once inside. |
| ③ | Cable feed carriage | Works in tandem with the cable drum to assist with the cable. |
| ④ | Mobile tray | Device for carrying the insertion device up to the guide pipe. |
| ⑤ | Seal box | Houses the ROV cable drum and constitutes a boundary. |
| ⑥ | Glovebox | Used to set the cable fee carriage and to cut the cable in the event of an emergency. |

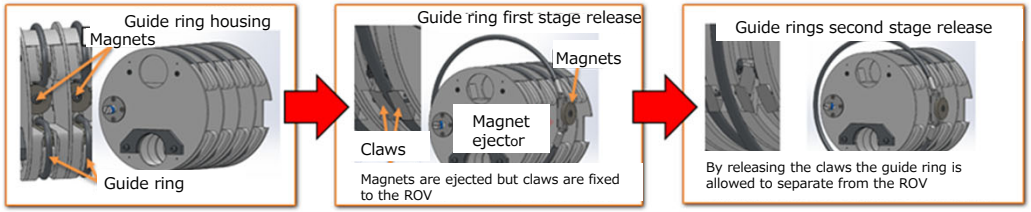
Source: International Research Institute for Nuclear Decommissioning (IRID)

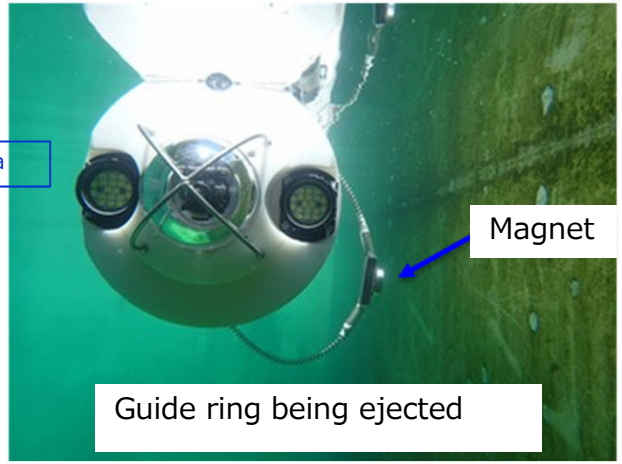
# 【Reference】 Investigation device details - ROV-A guide ring installation device

| Investigation device | Instruments | Details |
|---|---|---|
| **ROV-A**<br>Guide ring installation | ROV protection （Fiber-optic γ-ray dosimeter※）<br>※ : Same as that used for the external investigation of the pedestal | Guide rings (internal diameter: 300mm (design value)) are attached to the jet deflectors to prevent structures from interfering with the cable |
| | Quantity: 1 for the north and 1 for the south; Cruising time: Approx. 80 hours/unit Since this is the first ROV to be inserted, low-friction and relatively hard polyethylene cables (φ24mm) will be employed | |



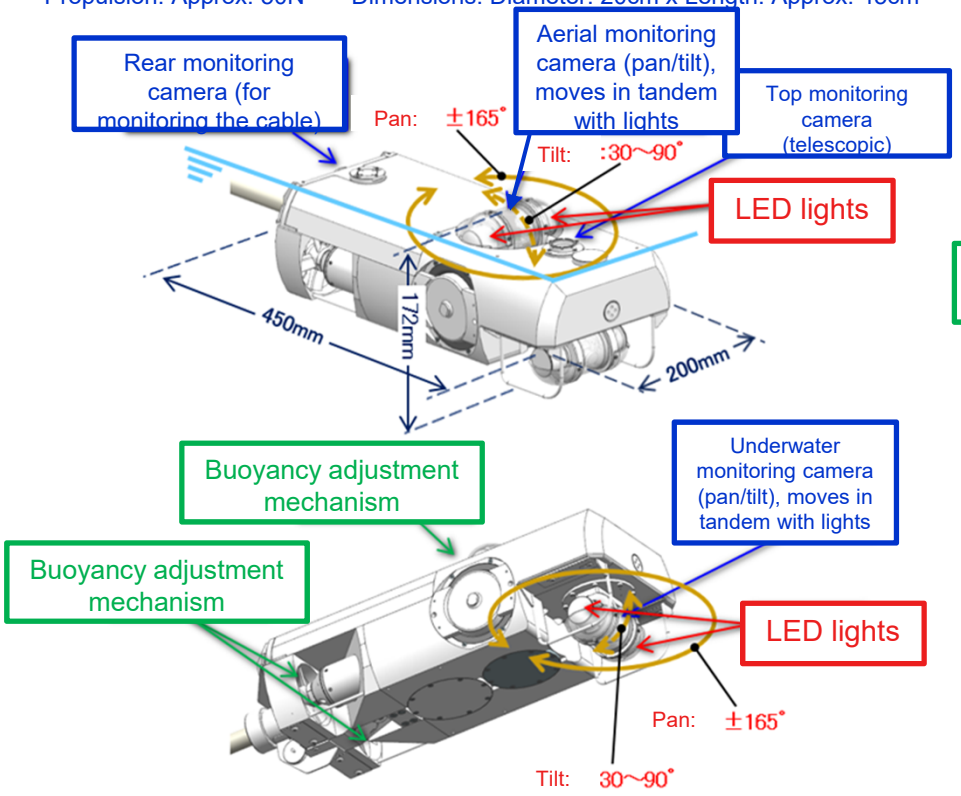



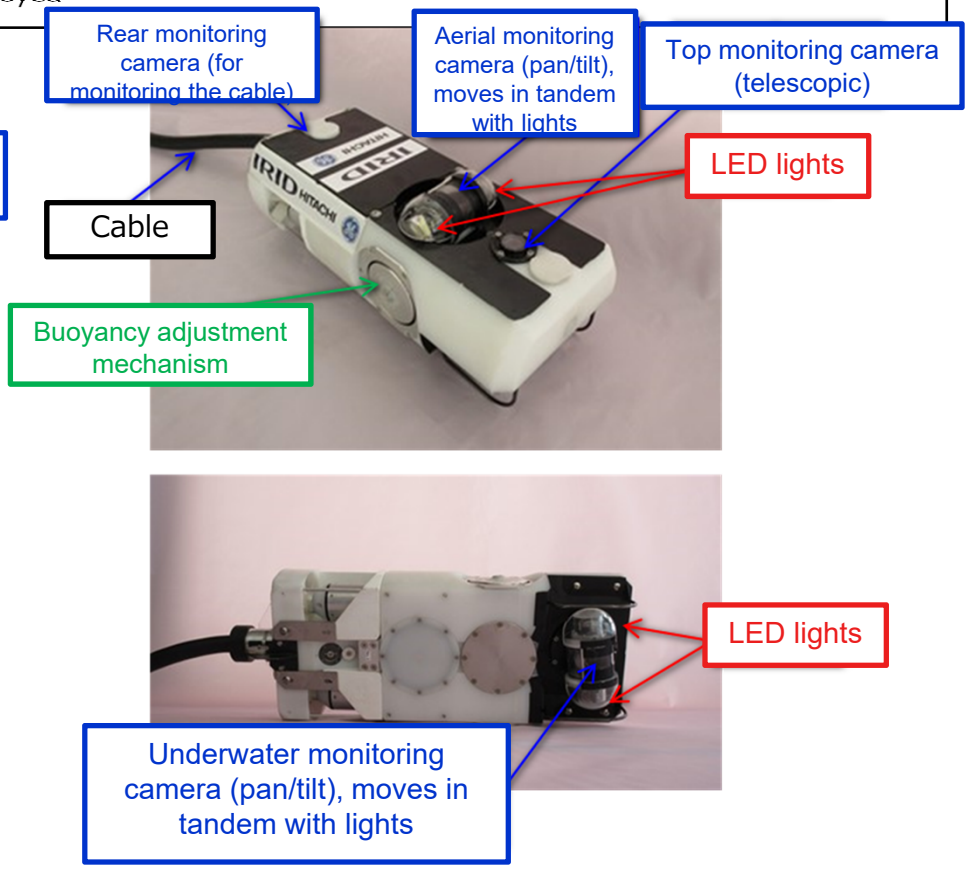

Source: International Research Institute for Nuclear Decommissioning (IRID)

# 【Reference】 Investigation device details - ROV-A2 For detailed visual investigation

| Investigation device | Instruments | Details |
|---|---|---|
| **ROV-A2**<br>Detailed visual investigation | ROV protection (Fiber-optic γ-ray dosimeter※, Improved mini B10 detector)<br>※ : Same as that used for the external investigation of the pedestal | Uses cameras to perform a visual investigation of the extensive basement area and of the status of the detached CRD housing inside the pedestal (※)<br>(※If it can be accessed) |
| | Quantity: 2 units; Cruising time: Approx. 80 hours/unit Since the units need to be agile for the investigation flexible PVC cables (φ23mm) will be employed | |

Propulsion: Approx. 50N Dimensions: Diameter: 20cm x Length: Approx. 45cm

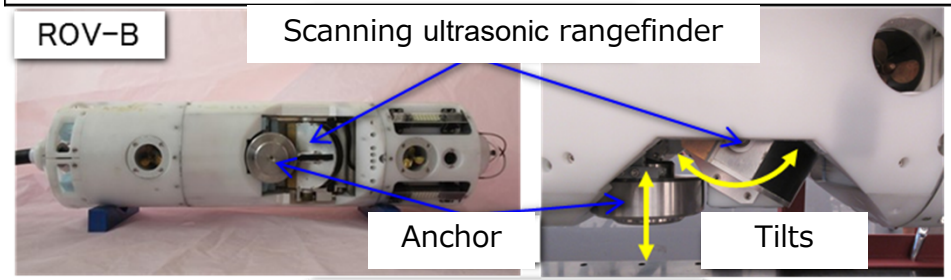


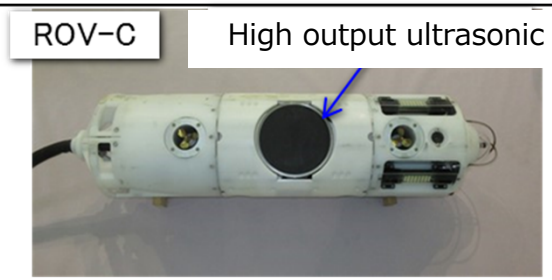



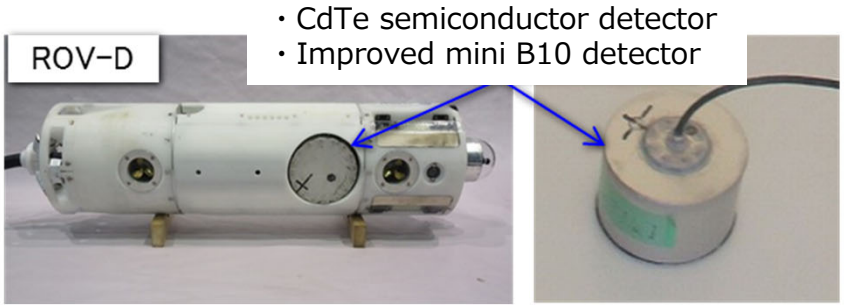

Source: International Research Institute for Nuclear Decommissioning (IRID)

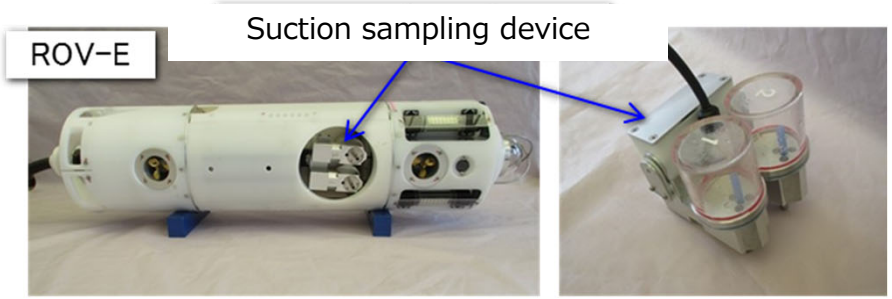
# 【Reference】 Investigation device details - ROV-B~E for different investigations

| Investigation device | Instruments | Details |
|---|---|---|
| **ROV-B**<br>3-D mapping of deposits | ・Scanning ultrasonic rangefinder<br>・Water temperature gauge | Scanning ultrasonic rangefinder used to examine the height distribution of deposits. |
| **ROV-C**<br>Deposit thickness measurements | ・High output ultrasonic sensor<br>・Water temperature gauge | High output ultrasonic sensor used to measure the height of deposits and examine objects underneath them in order to estimate debris height and distribution. |
| **ROV-D**<br>Deposit debris detection | ・CdTe semiconductor detector<br>・Improved mini B10 detector | Debris detection sensors will be dropped on the surface of the deposits to analyze nuclides and measure neutron flux in order to examine if debris exists inside the deposits. |
| **ROV-E**<br>Deposit sampling | ・Suction sampling device | The deposit sampling device will be dropped on the surface of the deposits to take samples from the surface of the deposits. |
| Quantity: 2 each; Cruising time: Approx. 80 hours/unit Since the units need to be agile for the investigations flexible PVC cables (ROV-B : φ33mm、ROV-C : φ30mm、ROV-D : φ30mm、ROV-E : φ30mm) will be employed | | |




Source: International Research Institute for Nuclear Decommissioning (IRID)