Implementation Status of the Fukushima Daiichi Nuclear Power Station Unit 1 Primary Containment Vessel Internal Investigation (ROV-A2) (work conducted on May 17 and 18)

< Reference Material >
May 19, 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 to obtain information, such as the amount and origins of such deposits. Going forward, 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 outside of the pedestal※1, measure the thickness of deposits, detect deposit debris, sample debris, and create 3-D maps of the deposits. In preparation for these investigations, we used submersible ROV-A to install guide rings ※2 inside the PCV between February 8~10.

<Announced by February 10>

- The submersible ROV-A2 was used to perform a detailed visual investigation of the outside of the pedestal starting on March 14, however in light of the turbidity of the water inside the PCV, and the gradual decrease in PCV water level, which are assumed to have been caused by the earthquake that occurred off the coast of Fukushima Prefecture on March 16, the investigation was temporarily suspended. Furthermore, as of March 29, three of the cameras mounted on submersible ROV-A2 were exhibiting imaging problems, so the investigation was suspended.

< Announced by March 31 >

- Before recommencing the investigation using submersible ROV-A2, we implemented countermeasures to prevent recurrence of camera imaging problems (water intrusion), and ensured that the water level inside the PCV is at the height necessary for the investigation by injecting additional cooling water into the reactor. Additionally, power was turned on to each piece of equipment under the same conditions, and in the same order, as the actual investigation, upon which submersible ROV-A2 was inserted into the PCV from the X-2 penetration ※3, and we have confirmed that equipment is functioning normally.

< Announced by May 16 >

- Now that these advanced preparations have been completed, the detailed visual investigation of the outside perimeter of the pedestal using submersible ROV-A2 was recommenced at 9:55AM on May 17. Furthermore, prior to the detailed investigation, the cameras mounted on submersible ROV-A2 were used to check the turbidity of the water inside the PCV as well as the water level, and we have confirmed that conditions have returned to what they were prior to the earthquake that occurred off the coast of Fukushima Prefecture on March 16, and that there will be no impact on the investigation.

- On May 17th and 18th, we examined the condition of existing structures and also the dispersion of deposits in the area on slide 4 indicated with the blue box and confirmed the following.

  ① No large damage to the pipes/valves of the reactor auxiliary cooling water system (hereinafter referred to as, "RCW") or the pipes (A) for the primary loop recirculation system (hereinafter referred to as, "PLR") was visible (Refer to photo 1 on slide 5, and photo 1 on slide 9).

  ② Deposits were found near the equipment drain sump pump (Refer to photo 1 on slide 5).

  ③ Deposits form a top and bottom layer near the equipment drain sump pump shielding, and the inside is hollow (Refer to photos 2 and 3 on slide 5).

  ④ No large damage was seen from the top of the deposits to the top of the pedestal foundation. Objects that are thought to be rebar were also found below the top layer of the deposits (Refer to photos 1 and 2 on slide 6, and photo 2 on slide 9).

  ⑤ No significant changes have been seen in the condition of deposits near jet deflector※4 (F) compared to prior to the earthquake on March 16 (Refer to slide 7).

  ⑥ Clumped deposits were found on the bottom surface and at the back (pressure suppression chamber side) of jet deflector (E) (Refer to slide 8).

- The conditions observed will be assessed going forward, and additional investigations will be conducted as necessary using submersible ROV-B, C, D and E.

- Today (May 19), we continued to use submersible ROV-A2 to investigate the condition of existing structures and the status of deposit dispersion around the pedestal near jet deflector (D) and the pedestal opening (photo 3, slide 9).

- Furthermore, on May 20 and 21, we plan to measure neutron flux in order to narrow down the scope of the investigation to detect deposited fuel debris (nuclide analysis/neutron flux management) that will be implemented in the future using submersible ROV-D.

- This investigation was performed after constructing boundaries※5 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.

- Furthermore, at current time we have not experienced any malfunctions with the cameras mounted on submersible ROV-A2. 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 X-2 penetration: Hole used by workers to enter the PCV
※4 Jet deflector: Disk-shaped steel material installed on the PCV side of pipes connecting the PCV and the pressure suppression chamber.
※5 Boundary: PCV containment function

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

＜ Main targets of the investigation ＞

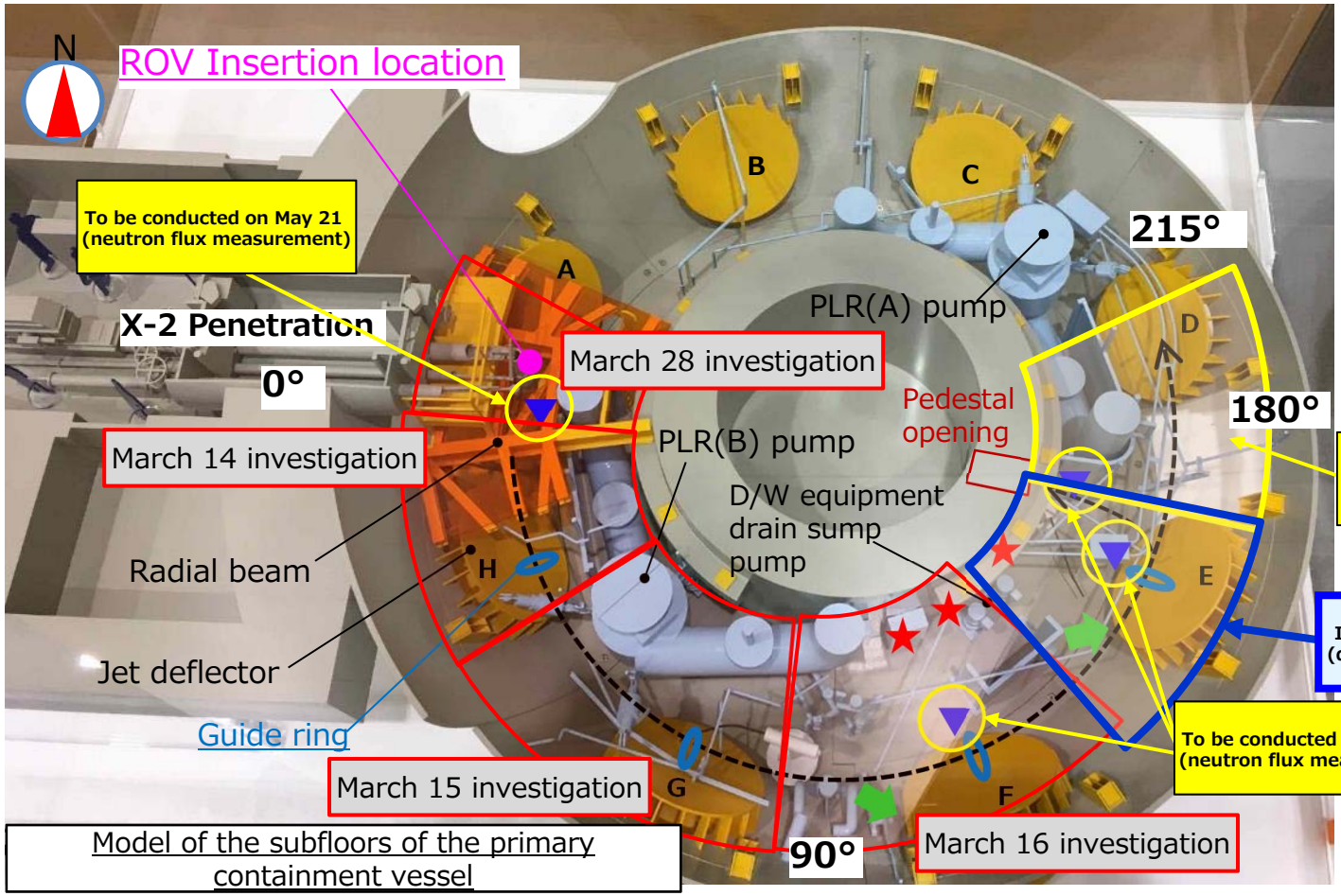
■Examine the condition of existing structures

■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

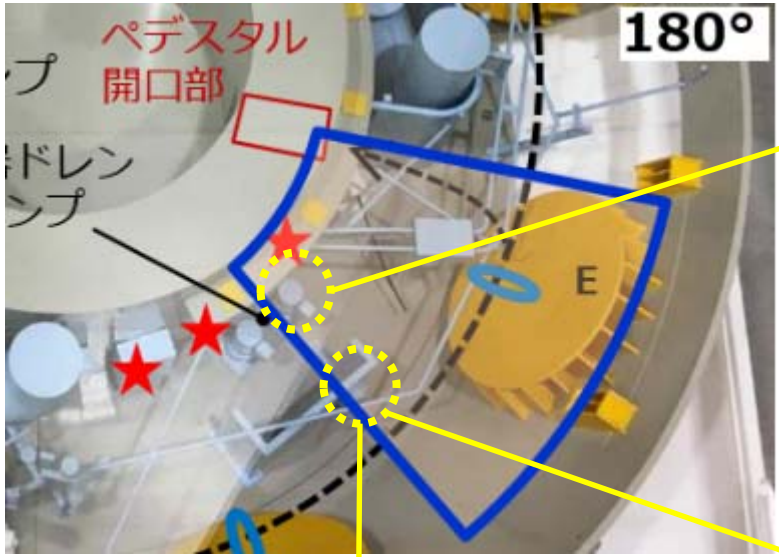
※
The investigation schedule may be altered in accordance with investigation progress

※
May 22 is a spare investigation day

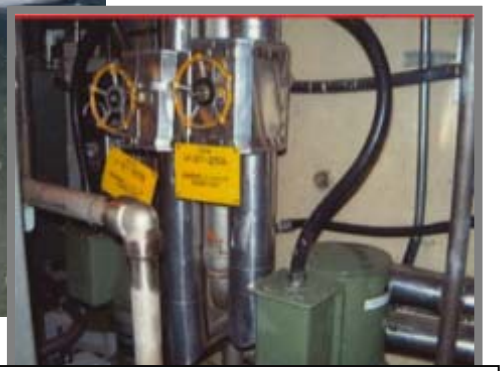
※
Investigation to conclude on May 23 (ROV extraction)

Source : International Research Institute for Nuclear Decommissioning (IRID)

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



ROV frame got caught in photo

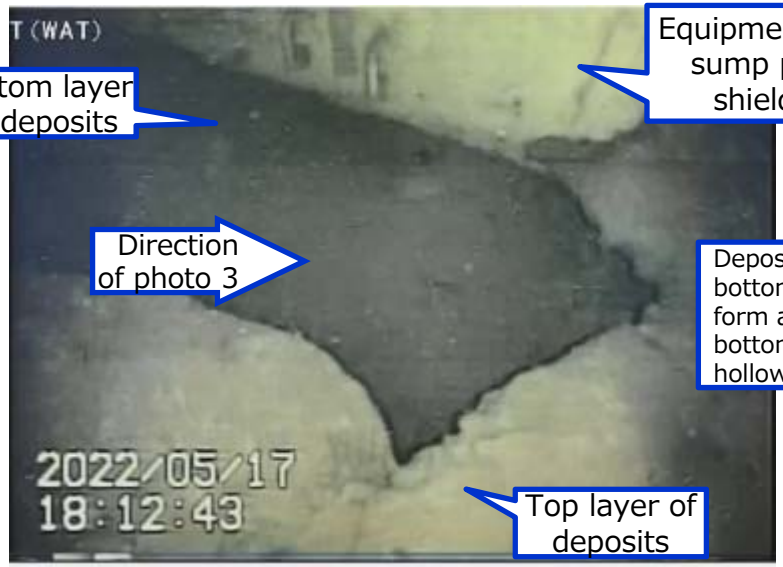


RCW pipe/valve

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

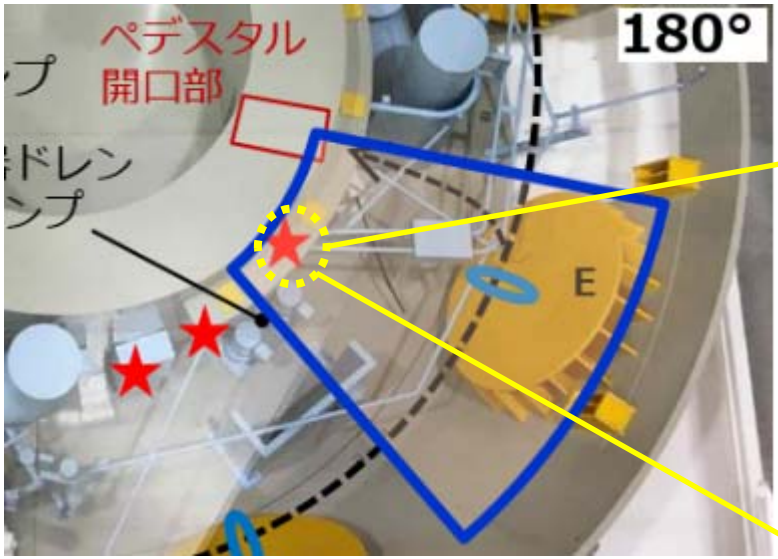
Photo 2. Deposits at the bottom of the PCV

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)

Conditions around the pedestal (from investigation on May 17 ②)



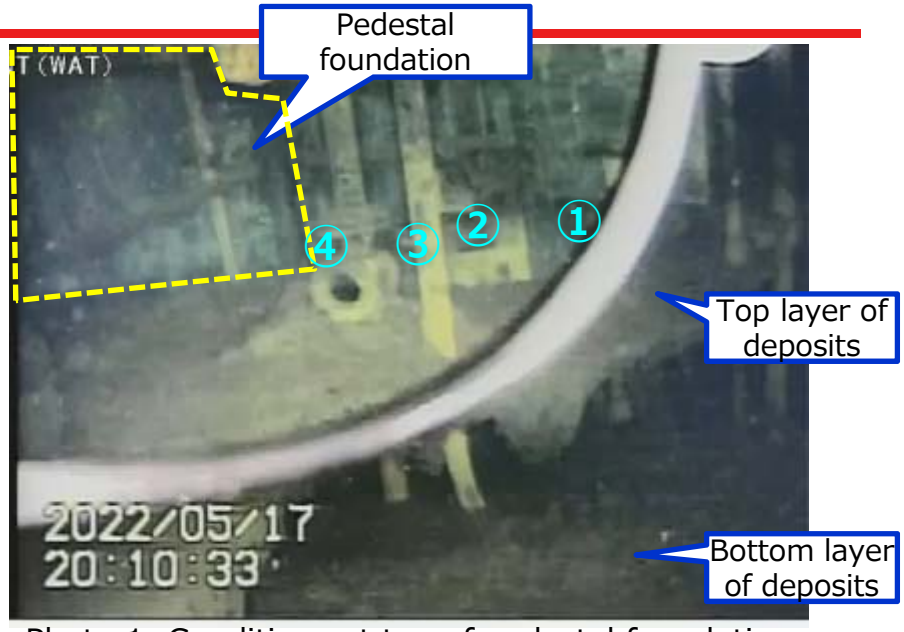


Photo 1. Conditions at top of pedestal foundation

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

(Reference photo) conditions prior to the accident in 2011

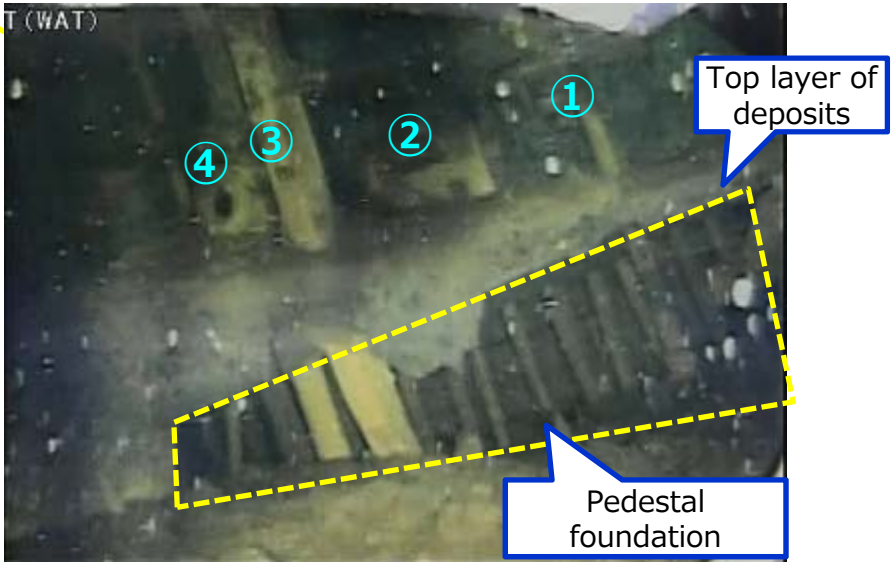


Photo 2. Conditions at bottom of pedestal foundation

Source: International Research Institute for Nuclear Decommissioning (IRID)

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

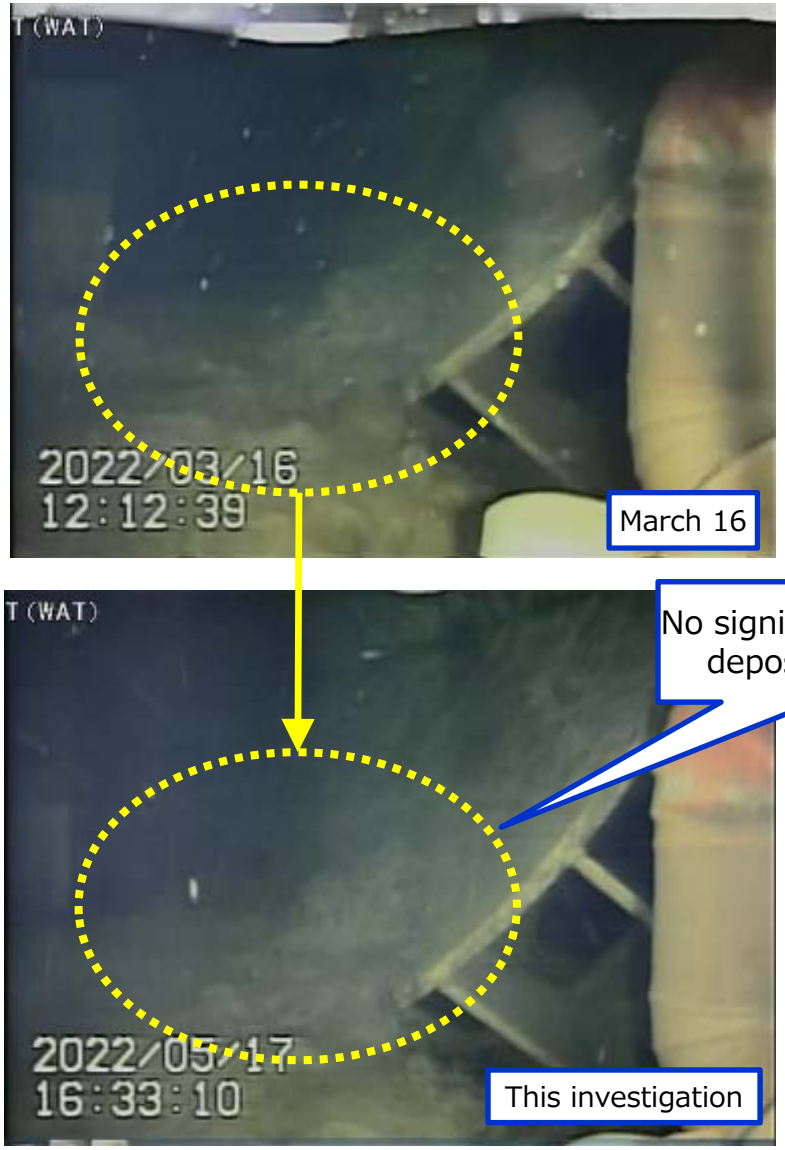


Photo 1. Looking down on jet deflector (F)

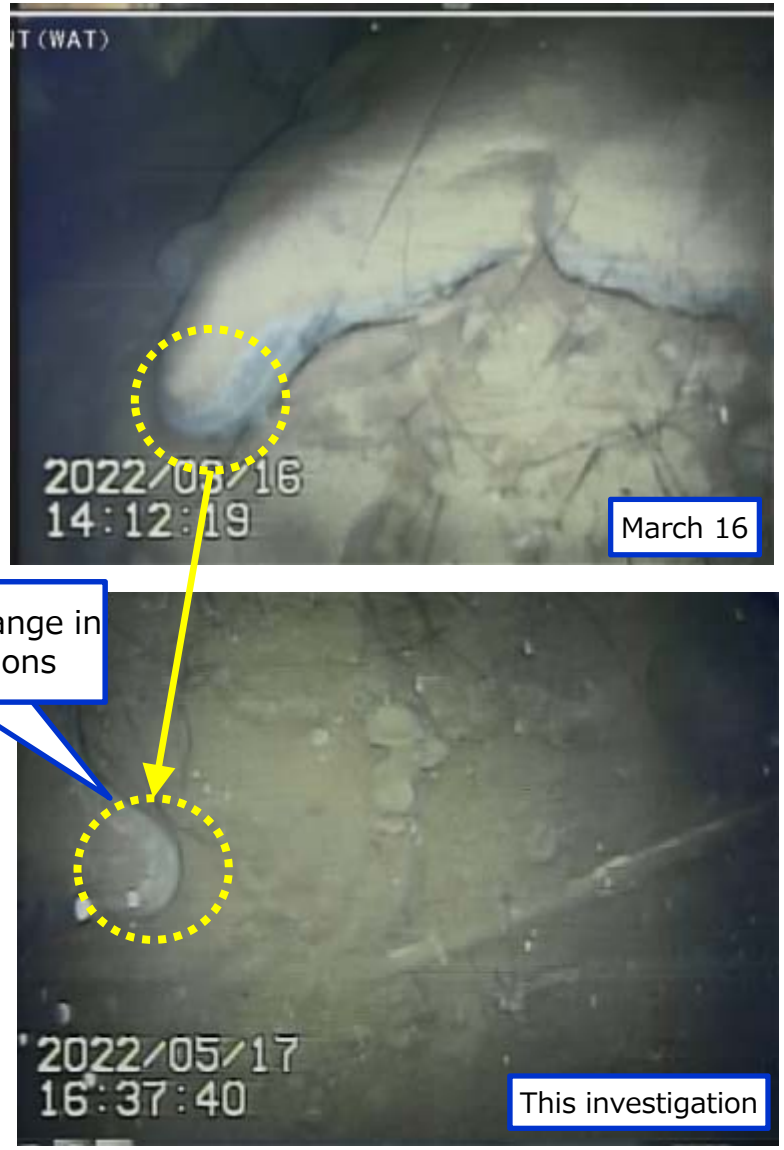


Photo 2. Conditions around jet deflector (F)

No significant change in deposit conditions

Source: International Research Institute for Nuclear Decommissioning (IRID)

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

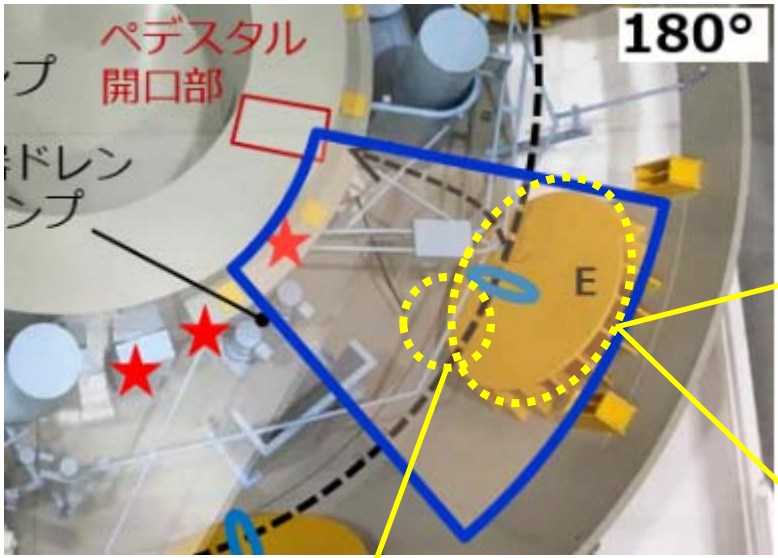


Photo 1. Looking down on jet deflector (E)

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

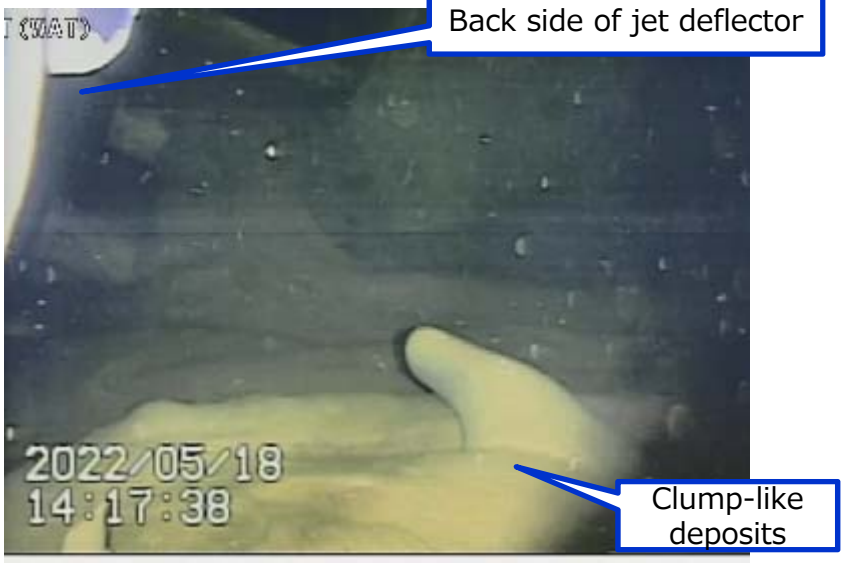


Photo 3. Conditions at the back of jet deflector (E)

Source: International Research Institute for Nuclear Decommissioning (IRID)

Conditions around the PLR (A) pipe and pedestal (from May 18 investigation②)

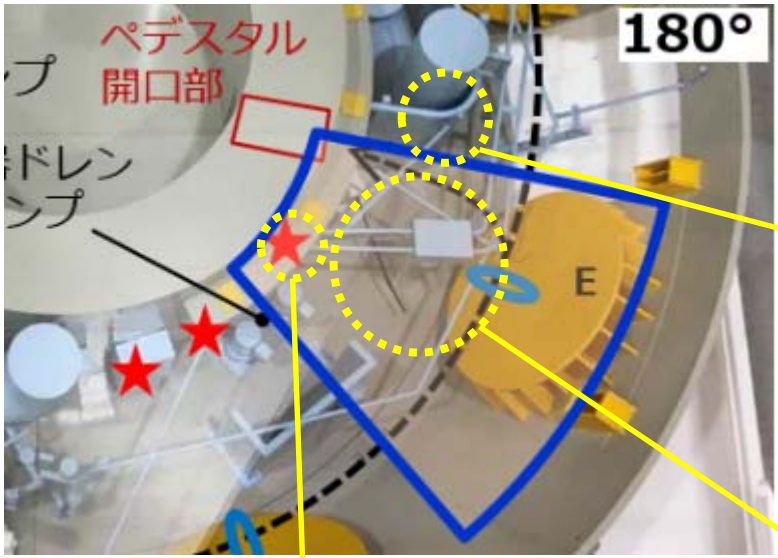


Photo 1. PLR (A) pipe conditions

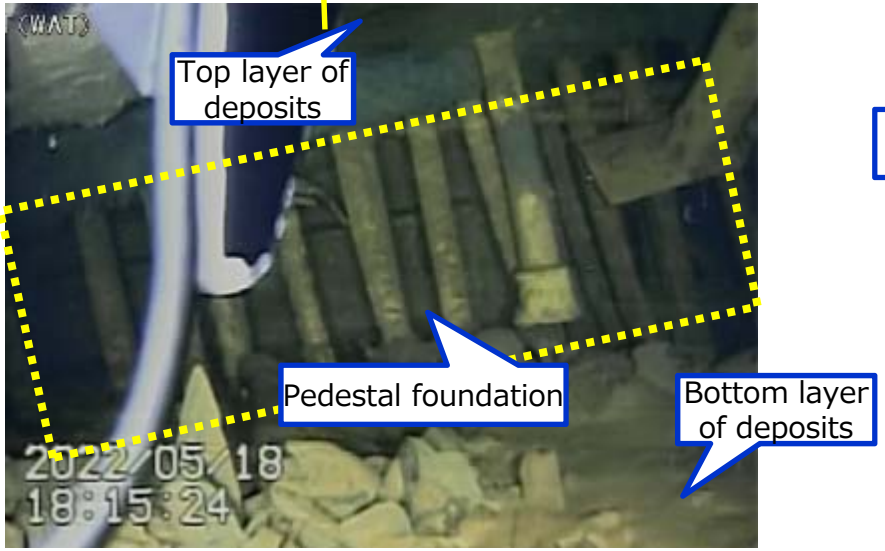


Photo 2. Conditions around the pedestal foundation

Photo 3. Deposits in front of the pedestal opening

Source: International Research Institute for Nuclear Decommissioning (IRID)

Sequence of events (May 17 and 18)

【May 17】

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 by submersible ROV-A2 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 by submersible ROV-A2 conducted

Work structure/ Equipment/ Dose (May 17 and 18)

【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)

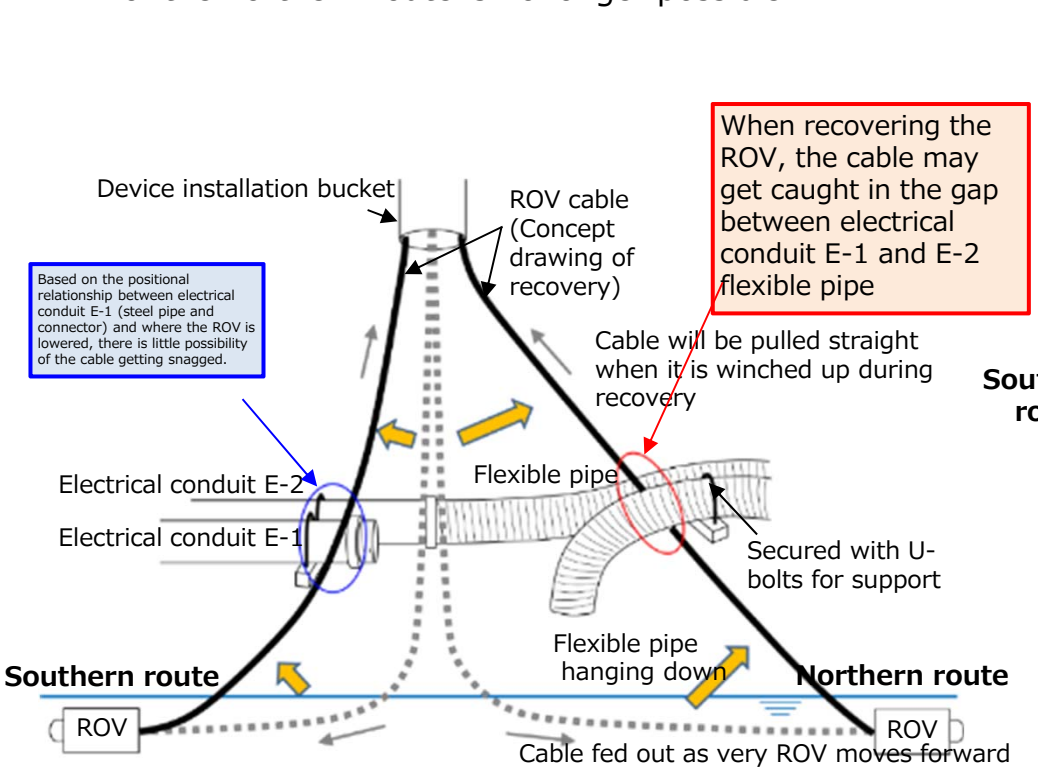
【Reference】Foreseen risks and countermeasures（1/5）

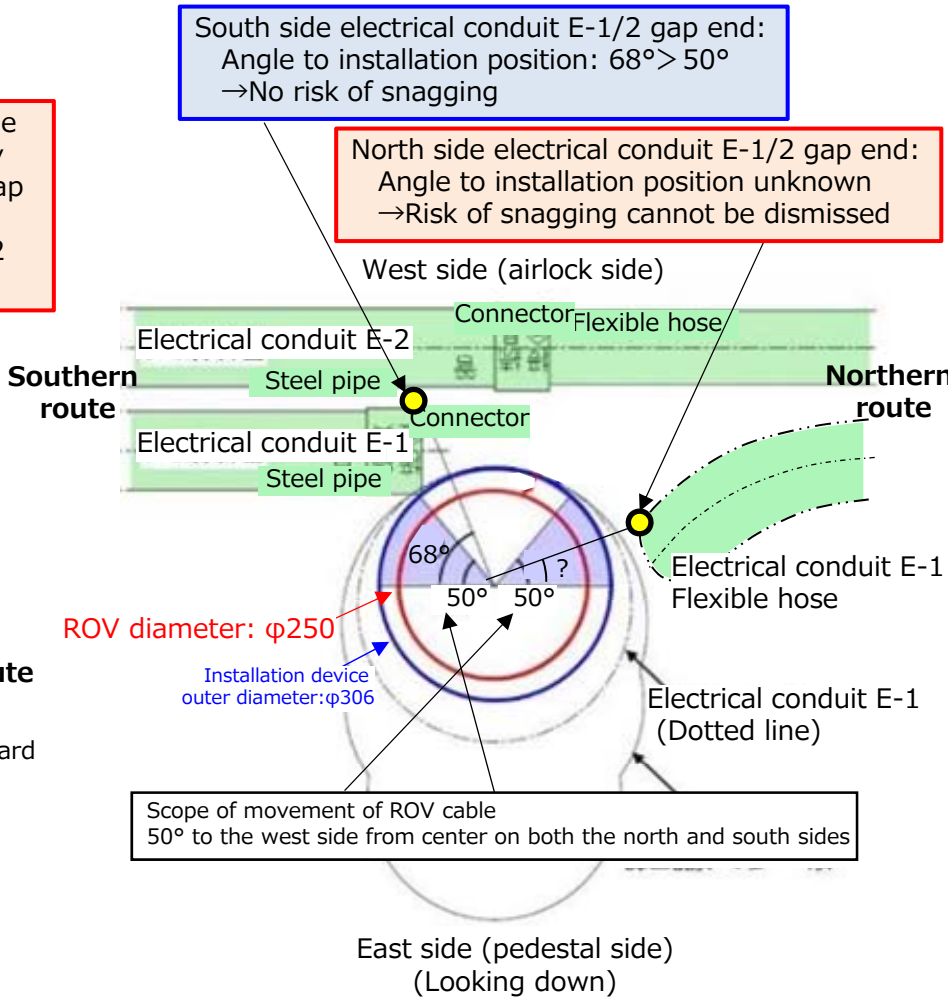
Issue	Risk	Countermeasures
PCV temperature rise	Change in cooling status of fuel debris in conjunction with the swimming movement of the submersible ROV	The investigation will be immediately terminated if overall temperatures inside the PCV start to rise
Drop in PCV pressure	When the isolation valve is opened, an abnormality with the boundary outside the isolation valve may allow gasses inside the PCV to escape into the building.	The investigation will be immediately terminated if a significant decrease in PCV pressure is seen※
Dust concentration increase	Dust concentrations may increase due to changes in the behavior of dust inside the PCV caused by the swimming motion of the submersible ROV	The investigation will be immediately terminated if significant increases in dust concentrations inside the PCV are seen
Snagging of the submersible ROV	Refer to Foreseen risks and countermeasures（2/5~5/5）	

※ When the isolation valve is open, personnel are always on standby ready to immediately close the isolation valve and quickly recover the ROV in the event of an emergency

【Reference】Foreseen risks and countermeasures（2/5）

- During preparations to insert PCV internal investigation equipment, an electrical conduit that is obstructing the path was seen, and there is the risk that the submersible ROV cable will get snagged when investigating the northern route.
- If the ROV cable gets snagged, it will be impossible to recover the ROV and insert other ROV's, so investigation of the northern route is no longer possible.

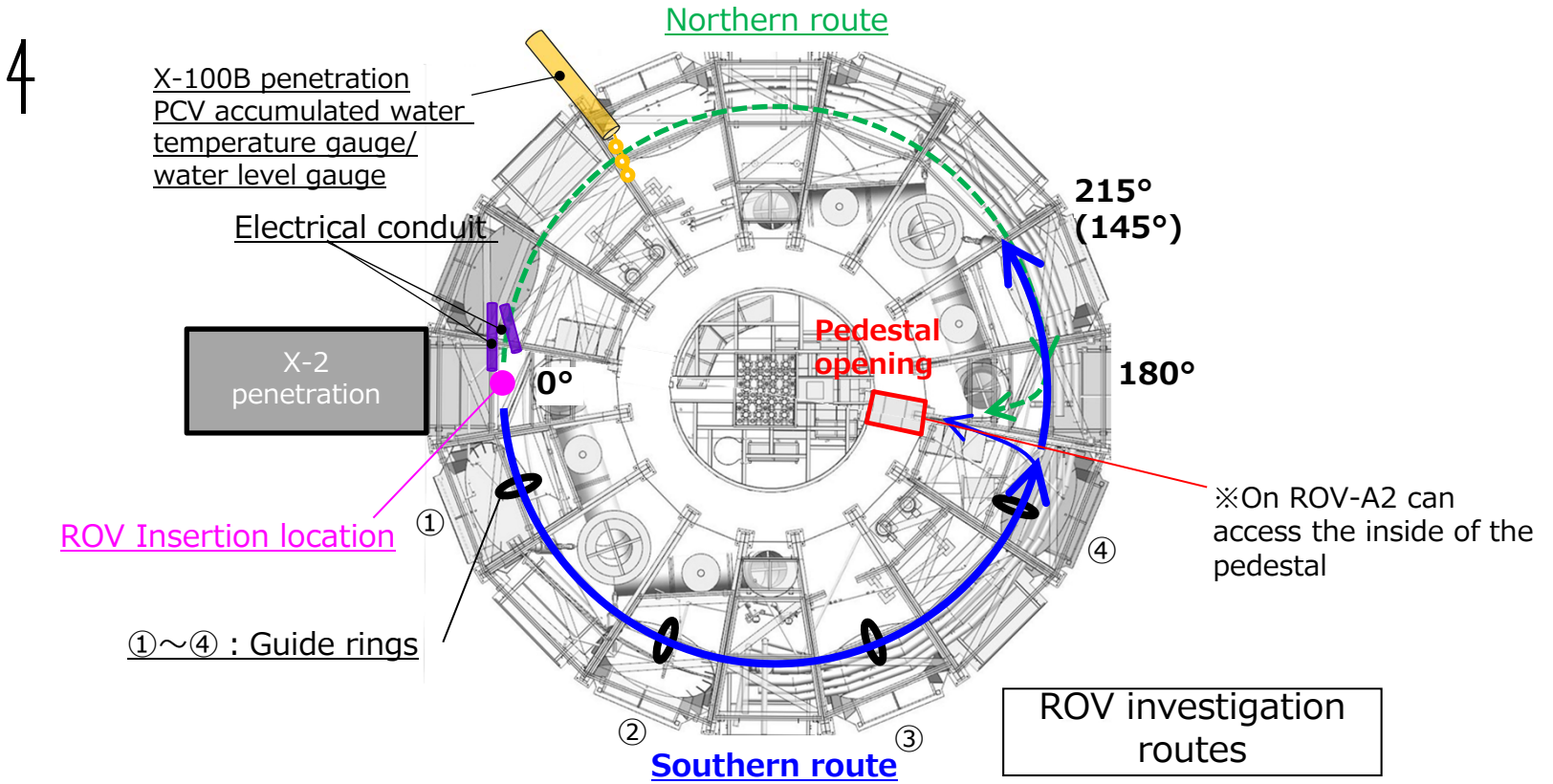




Source: International Research Institute for Nuclear Decommissioning（IRID）

【Reference】Foreseen risks and countermeasures（3/5）

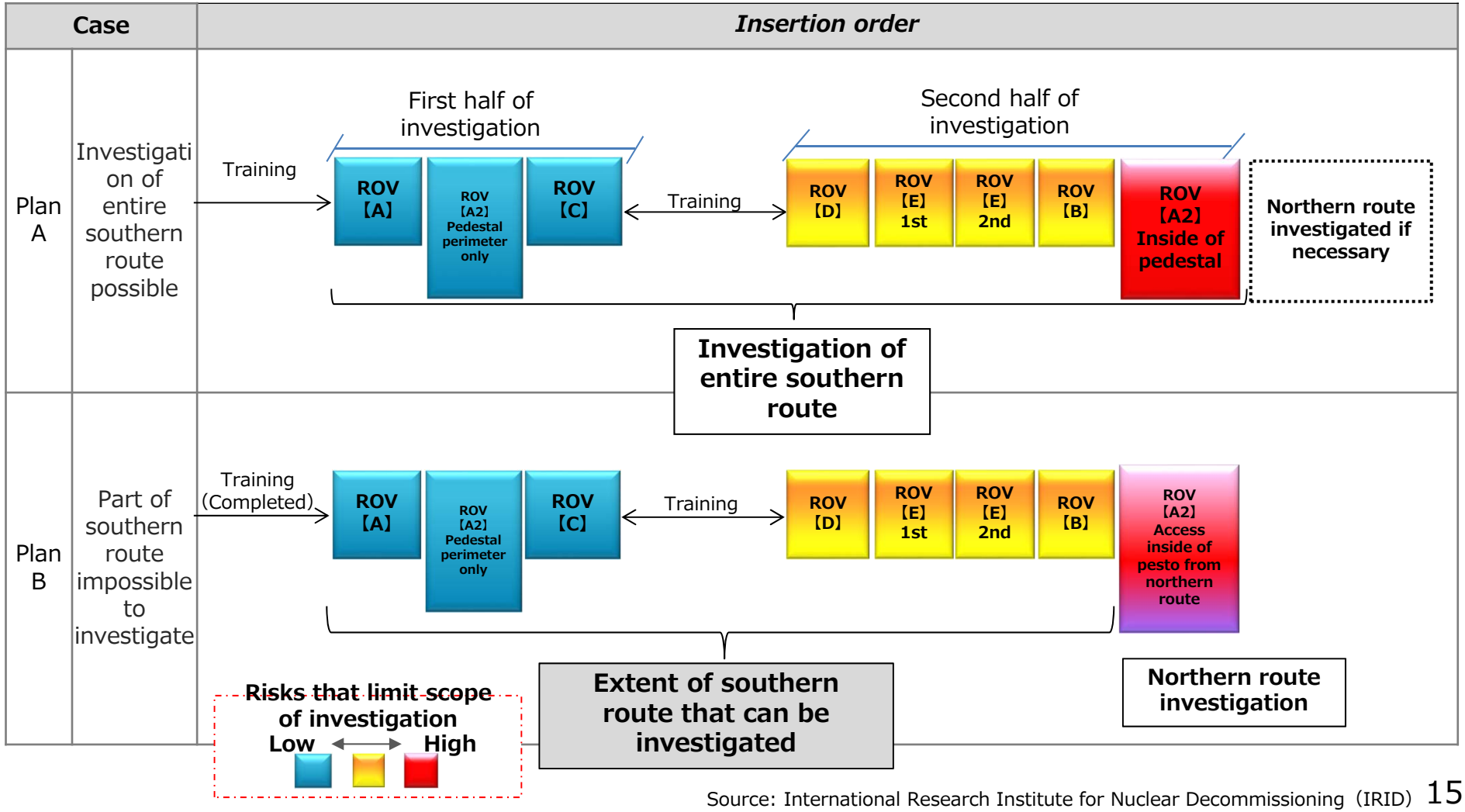
- The investigation will be performed along the southern route in order to avoid the risk of getting the ROV cable snagged on the northern route.
- The scope of the southern route investigation will be approximately 0°~215°, so if all information can be obtained, it should be analogous to the northern route.
- If the pedestal cannot be accessed from the southern route, an investigation of the inside of the pedestal (ROV-A2) will be conducted from the northern route.
- The feasibility of an investigation from the northern route shall be quickly determined as the southern route investigation is performed.



Source: International Research Institute for Nuclear Decommissioning（IRID）

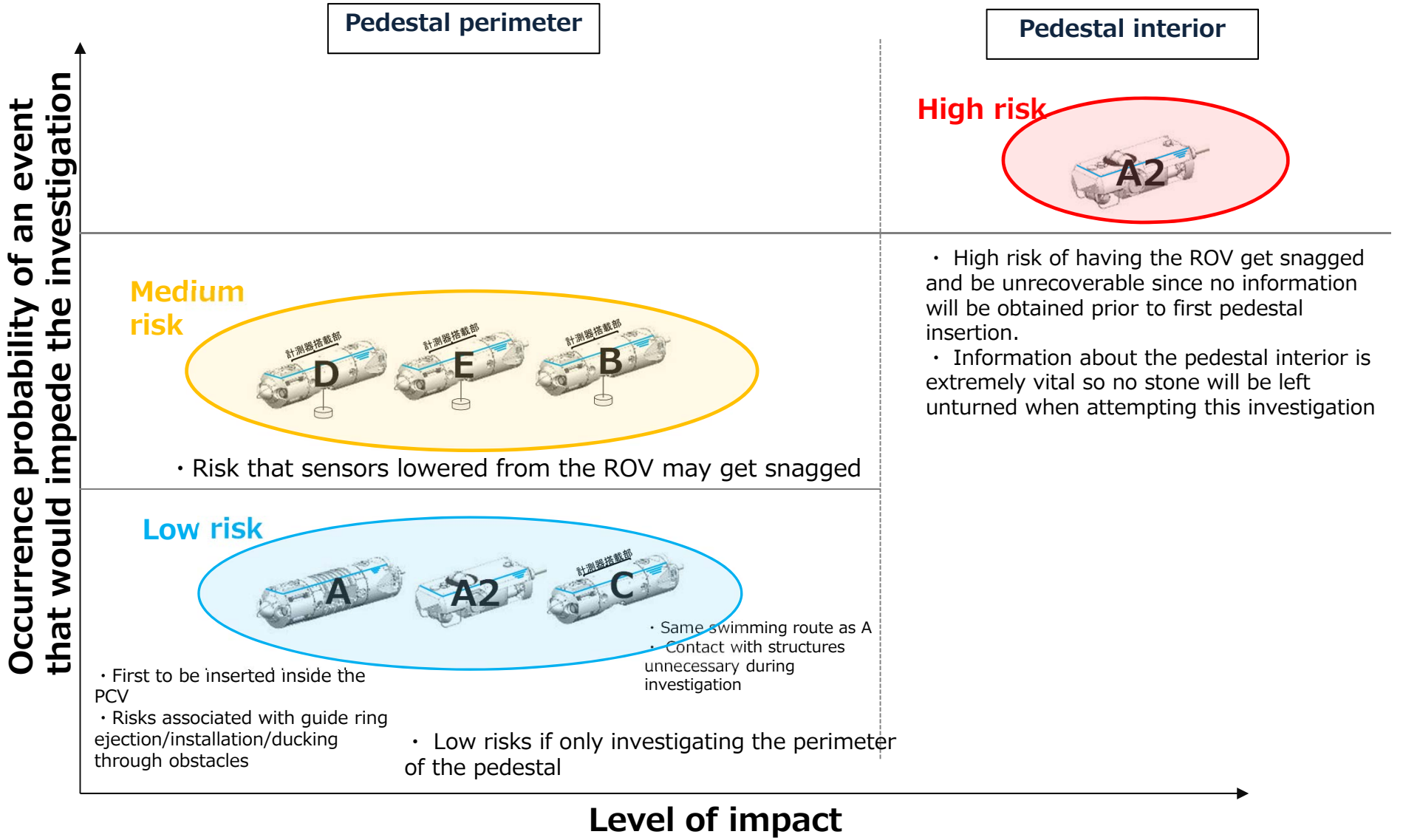
【Reference】Foreseen risks and countermeasures（4/5）

- 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）

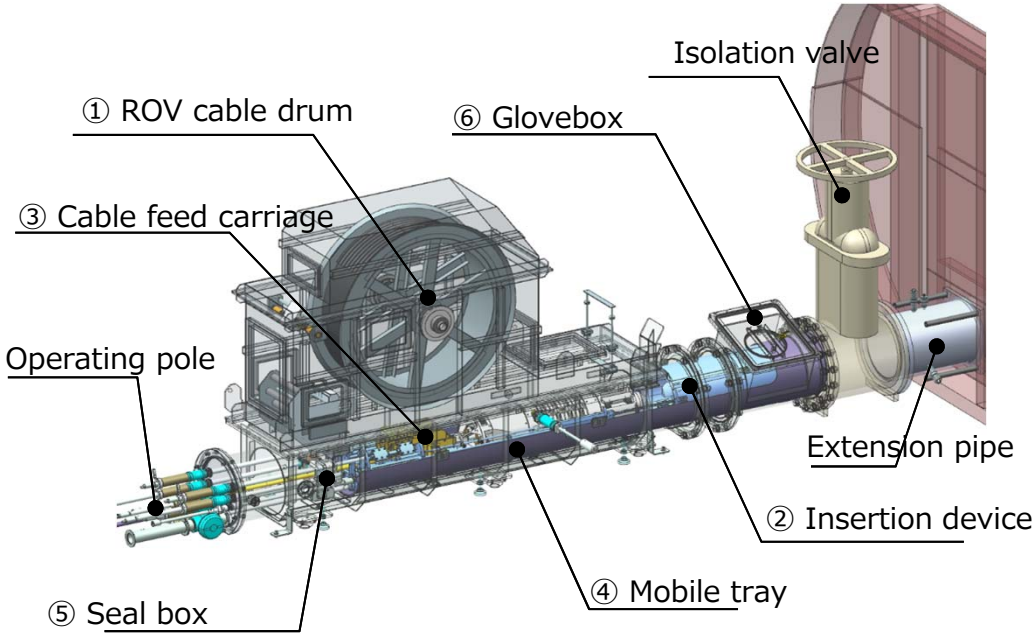
【Reference】Foreseen risks and countermeasures（5/5）

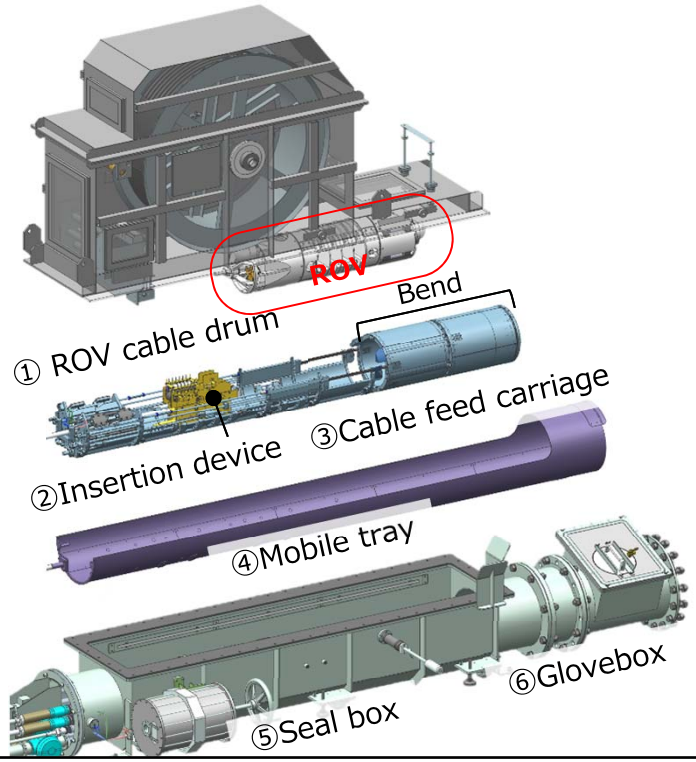


Source: International Research Institute for Nuclear Decommissioning（IRID）

【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.



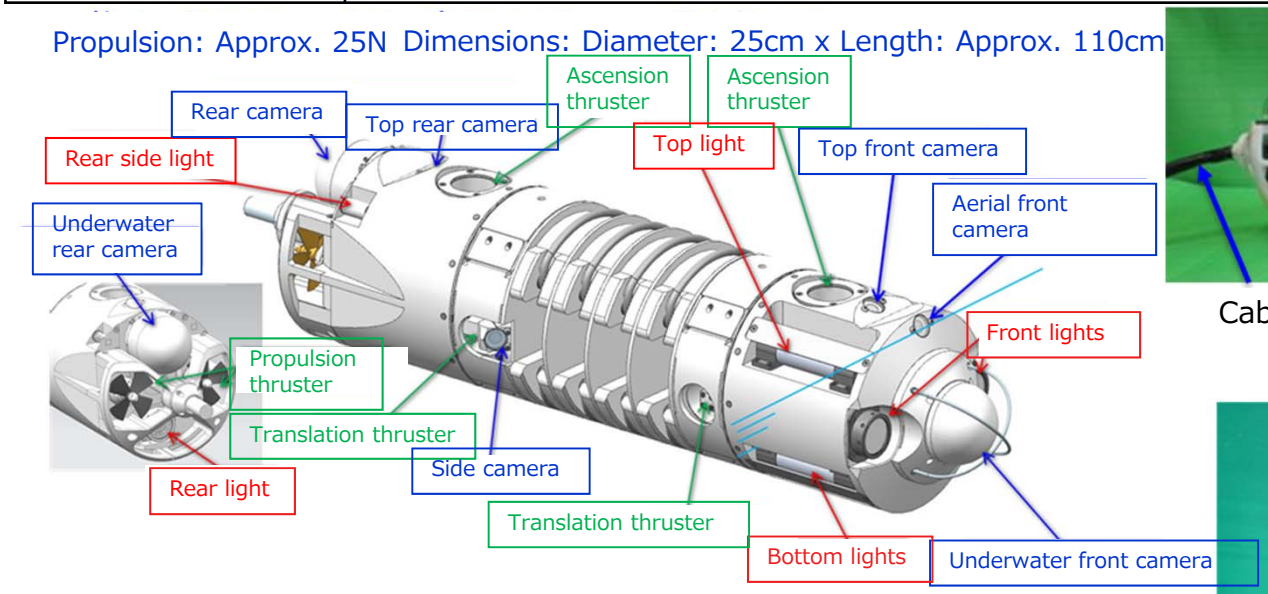


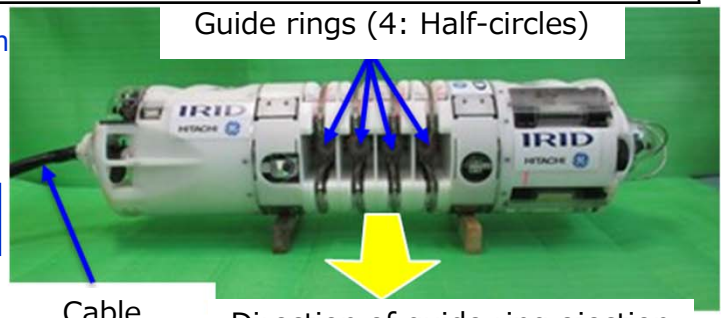
Name of component		Role
①	ROV Cable drum	Part of the ROV that feeds and retracts the ROV cable.
②	Insertion device	Inserts the ROV into the PCV via guide rings and bends to stand the ROV vertically once inside.
③	Cable feed carriage	Works in tandem with the cable drum to assist with the cable.
④	Mobile 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.

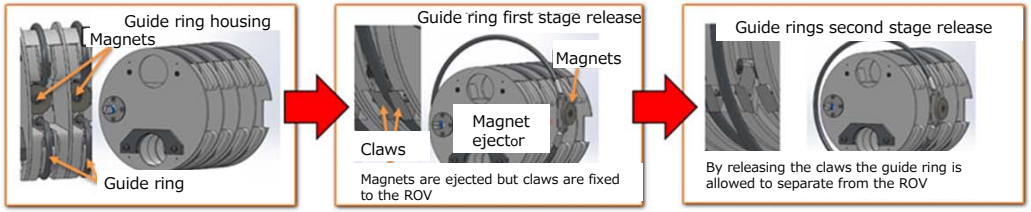
Source: International Research Institute for Nuclear Decommissioning (IRID)

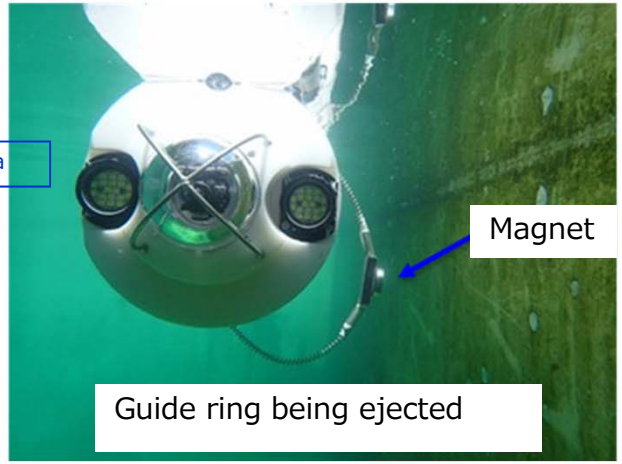
【Reference】 Investigation device details
ROV-A guide ring installation device

Investigation device	Instruments	Details
ROV-A Guide ring installation	ROV protection （Fiber-optic γ-ray dosimeter※） ※ : 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	







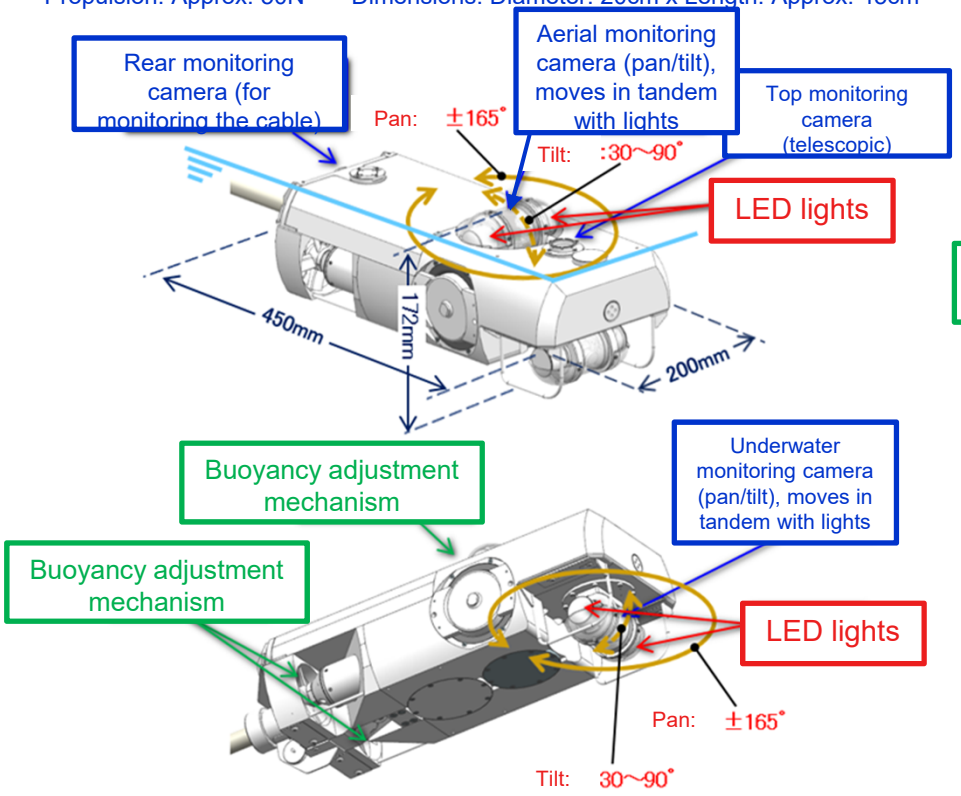


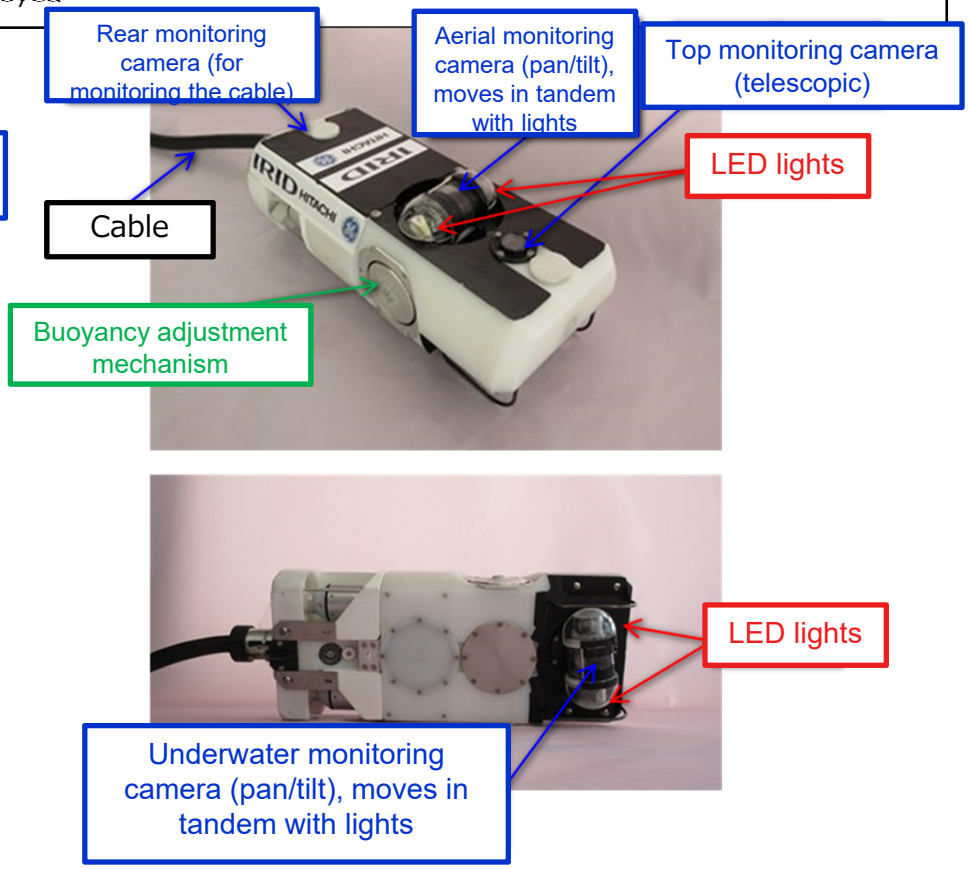
Source: International Research Institute for Nuclear Decommissioning (IRID)

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

Investigation device	Instruments	Details
ROV-A2 Detailed visual investigation	ROV protection (Fiber-optic γ-ray dosimeter※, Improved mini B10 detector) ※ : 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 (※) (※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

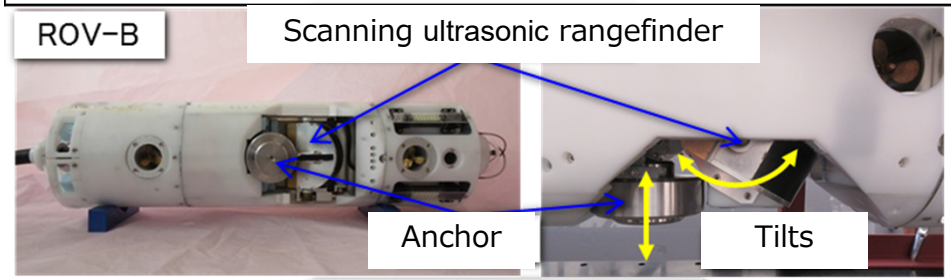


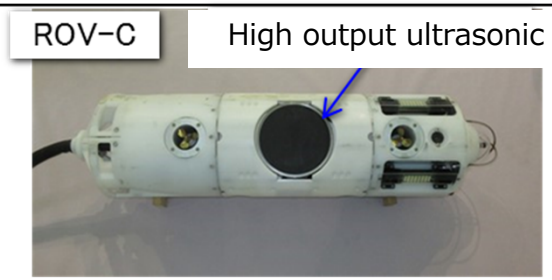


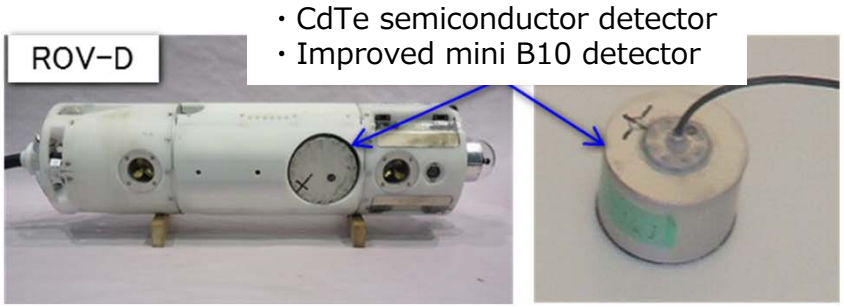
Source: International Research Institute for Nuclear Decommissioning (IRID)

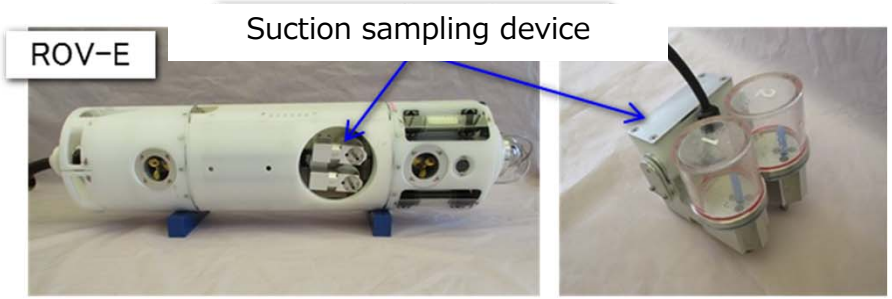
【Reference】 Investigation device details
ROV-B~E for different investigations

Investigation device	Instruments	Details
ROV-B 3-D mapping of deposits	・Scanning ultrasonic rangefinder ・Water temperature gauge	Scanning ultrasonic rangefinder used to examine the height distribution of deposits.
ROV-C Deposit thickness measurements	・High output ultrasonic sensor ・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 Deposit debris detection	・CdTe semiconductor detector ・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 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)