IRID In-house Project

Development of Technology for Detailed Investigation inside Primary Containment Vessel (PCV) (On-site Demonstration of Technology for Detailed Investigation Considering Deposit Measures)

FY2021 Accomplishment Report

August, 2022

International Research Institute for Nuclear Decommissioning (IRID)

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[Background]

In order to ascertain the distribution and form of fuel debris inside and outside the pedestal in the Primary Containment Vessel (PCV), the situation of structures in the PCV, etc. with higher accuracy for finalizing the fuel debris retrieval method, the size of the access and investigation equipment needs to be increased, and the investigation technology used in those equipment need to be further advanced.

[Purpose of this project]

There are large amount of deposits in Unit 1 and since the Control Rod Drive (CRD) housing or the reactor internals are assumed to have fallen off (refer to Figure 1.1-1), the deposits need to be retrieved and the fallen objects need to be removed during fuel debris retrieval (or before then). The purpose of this project is to enter inside the PCV by creating an opening (approximately 350mm) larger than those created for internal investigations in the past and ascertaining the situation of inside the PCV such as the distribution of deposits, distribution of fuel debris in the deposits, situation of the reactor internals, etc.

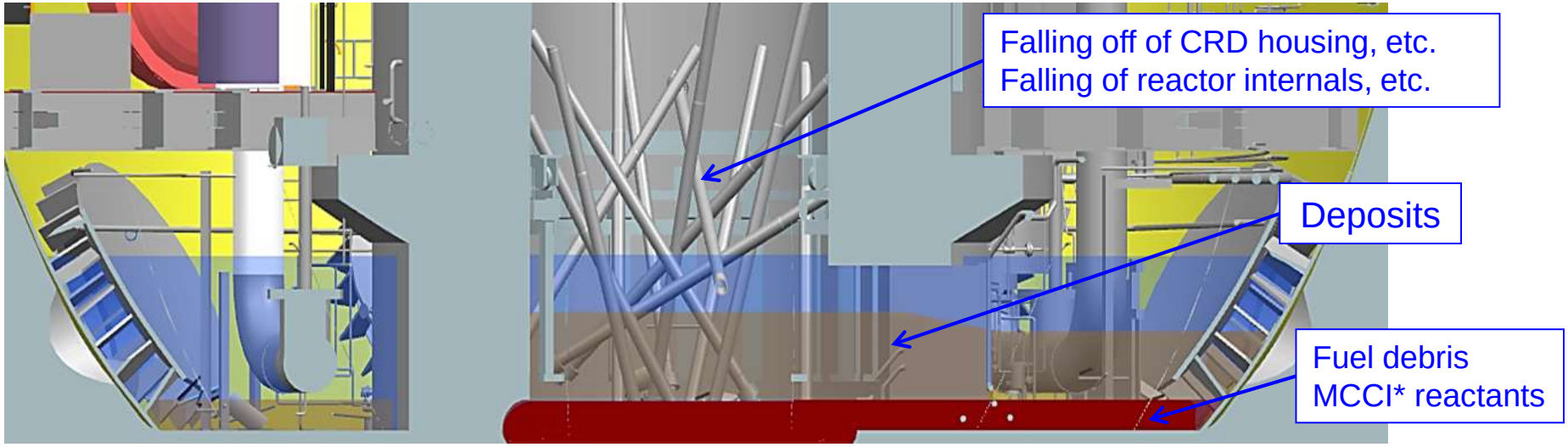


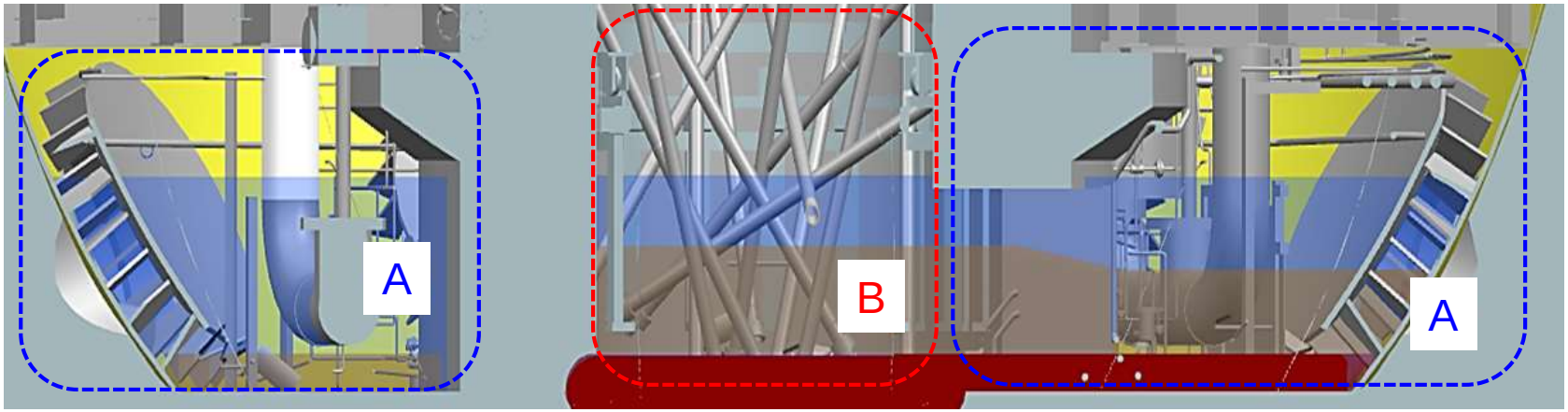
Figure 1.1-1 Estimated status of inside Unit 1 PCV

*MCCI: Molten Core Concrete Interaction

1. Research Background and Purposes

1.1 Reasons for this research (2/2) - Overview of detailed investigation inside Unit 1 PCV -

The purpose of this project is to study means and equipment for retrieving deposits, and to collect information such as information pertaining to the work plan for deposit retrieval, dismantlement and removal of fallen objects, etc., by investigating the extensive area outside and the inside of the pedestal, by introducing Remotely Operated Vehicles (ROVs) in the basement inside the PCV through the X-2 penetration, during on-site demonstration of the detailed investigation inside Unit 1 PCV.



	Information to be acquired	Method of investigation
Outside the pedestal to the worker access port (A in the figure)	・ Information concerning the study of deposit retrieval means and equipment (Amount, source, etc. of deposits) ・ Information concerning the plan for deposit retrieval, breaking up and removal of fallen objects, etc. (Status under the deposits, spread of fuel debris, etc.)	・ Measurement* ・ Deposit sampling ・ Visual inspection
Inside the pedestal (B in the figure)	・ Information concerning the plan for deposit retrieval, breaking up and removal of fallen objects, etc.(Information concerning the work space inside the pedestal, and status of falling off of CRD housing)	・ Visual inspection

*: Three dimensional mapping of the surface of deposits, measurement of the thickness of the deposits, detection of fuel debris inside or under the deposits.

1. Research Background and Purposes
1.2 Reflection of results and contribution thereof

FY2016 to FY2017　Development of Technology for Investigation inside PCV

↓

FY2017 to FY2018　Development of Technology for Detailed Investigation inside PCV

↓

FY2018 to FY2019　Development of Technology for Detailed Investigation inside PCV
(On-site Demonstration of Technology for Detailed Investigation Considering Deposit Measures)

- Development of investigation plan and development plan
- Part of the on-site demonstration of the access and investigation equipment and investigation technology

↓

FY2020　Development of Technology for Detailed Investigation inside PCV
(Part of “On-site demonstration of access route establishment” and part of “On-site Demonstration of Detailed Investigation inside PCV” during the “On-site Demonstration of Technology for Detailed Investigation Considering Deposit Measures”)

↓

This project

FY2021 to FY2022　IRID In-house Project　Development of Technology for Detailed Investigation inside PCV
(On-site Demonstration of Technology for Detailed Investigation Considering Deposit Measures)

↓

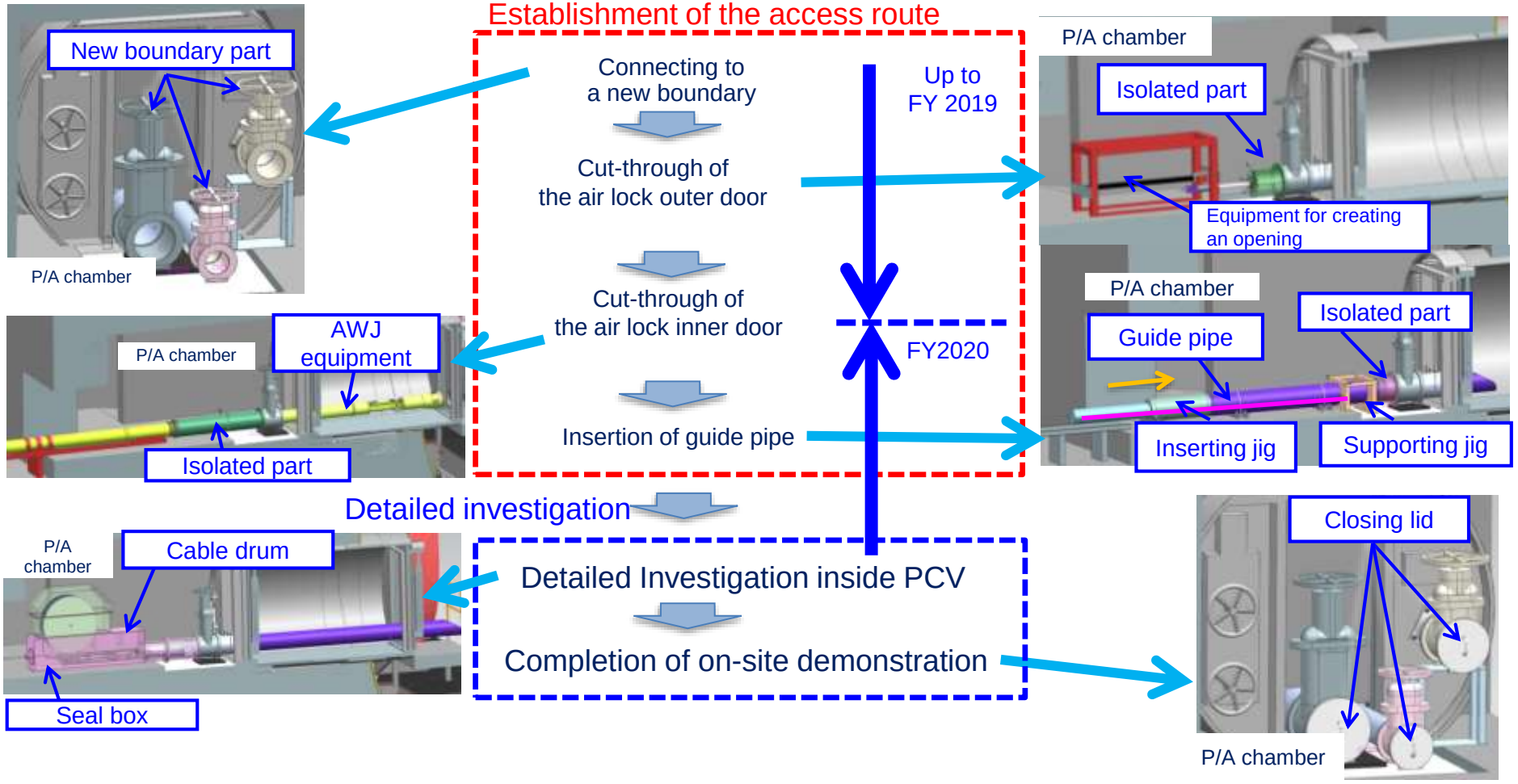
- Research projects concerning detailed design of the fuel debris retrieval methods and equipment, etc. (fuel debris retrieval, earthquake resistance measures, repairs, criticality control, etc.)
  - Information for “Determination of fuel debris retrieval methods” and “Detailed design of the fuel debris retrieval equipment”, etc.
- Research concerning the technology for gradually increasing the scale of fuel debris retrieval
  - Information required for gradually increasing the scale of fuel debris retrieval, etc.

1. Research Background and Purposes

1.3 Overview of on-site demonstration (1/2)

On-site demonstration is carried out using equipment related to the establishment of the access route developed during the "Development of Technology for Detailed Investigation inside PCV", the technology related to the detailed investigation inside PCV and the prototype of the access and investigation equipment.

P/A chamber: Personnel air lock chamber



1. Research Background and Purposes

1.3 Overview of on-site demonstration (2/2)

Setting up of installation equipment and the isolation part

Guide ring installation (γ dosimeter)

Detailed visual inspection (γ dosimeter, B10 detector)

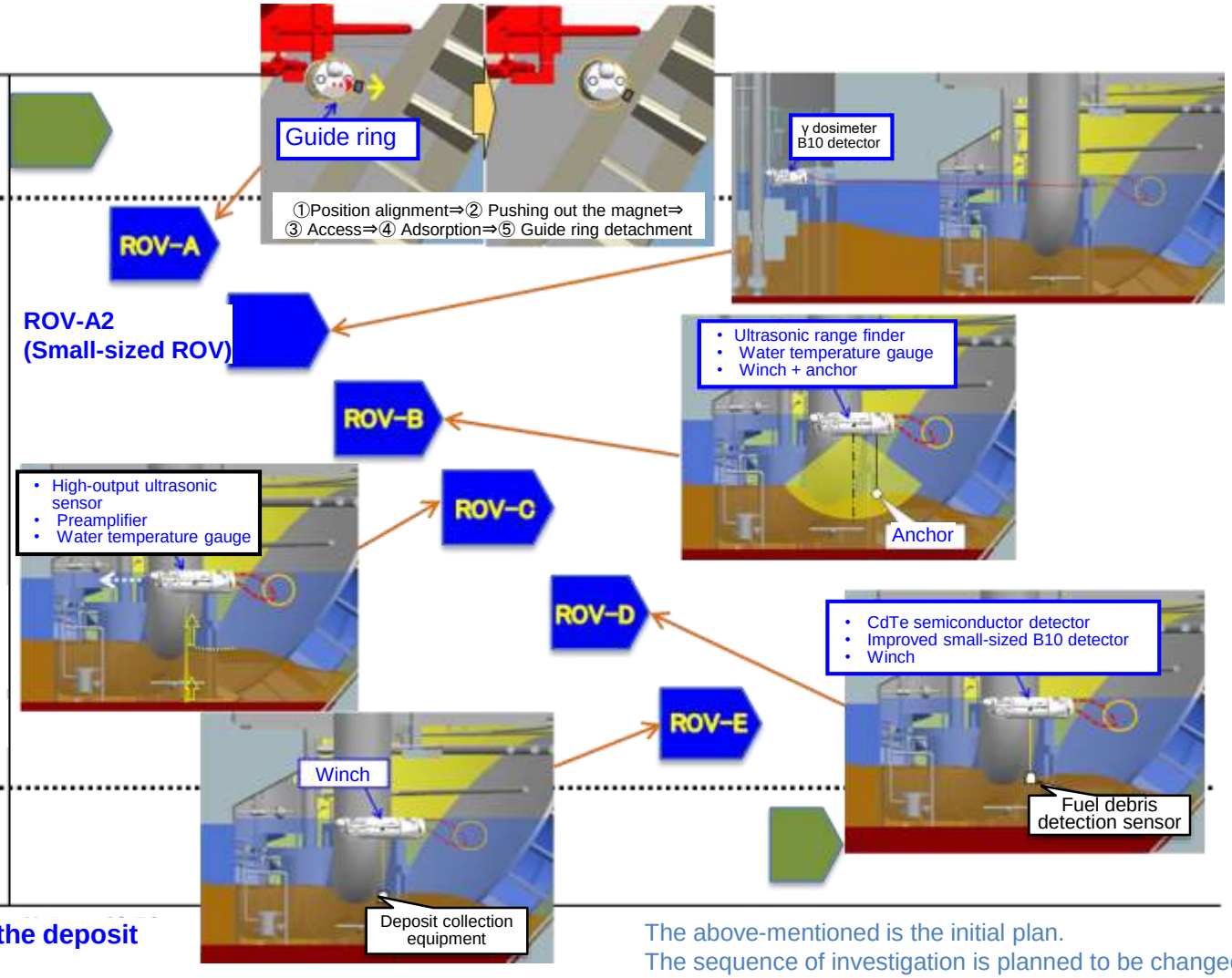
Deposit 3D mapping (Water temperature gauge, high-output ultrasonic sensor)

Deposit thickness measurement (Water temperature gauge, ultrasonic range finder)

Fuel debris detection (CdTe semiconductor detector, B10 detector)

Deposit sampling*

Removal of installation equipment and isolation equipment



***Transportation and analysis of the deposit will be studied as part of other collaborating PJs.**

PJ: Project

The above-mentioned is the initial plan.
The sequence of investigation is planned to be changed depending on the site situation.

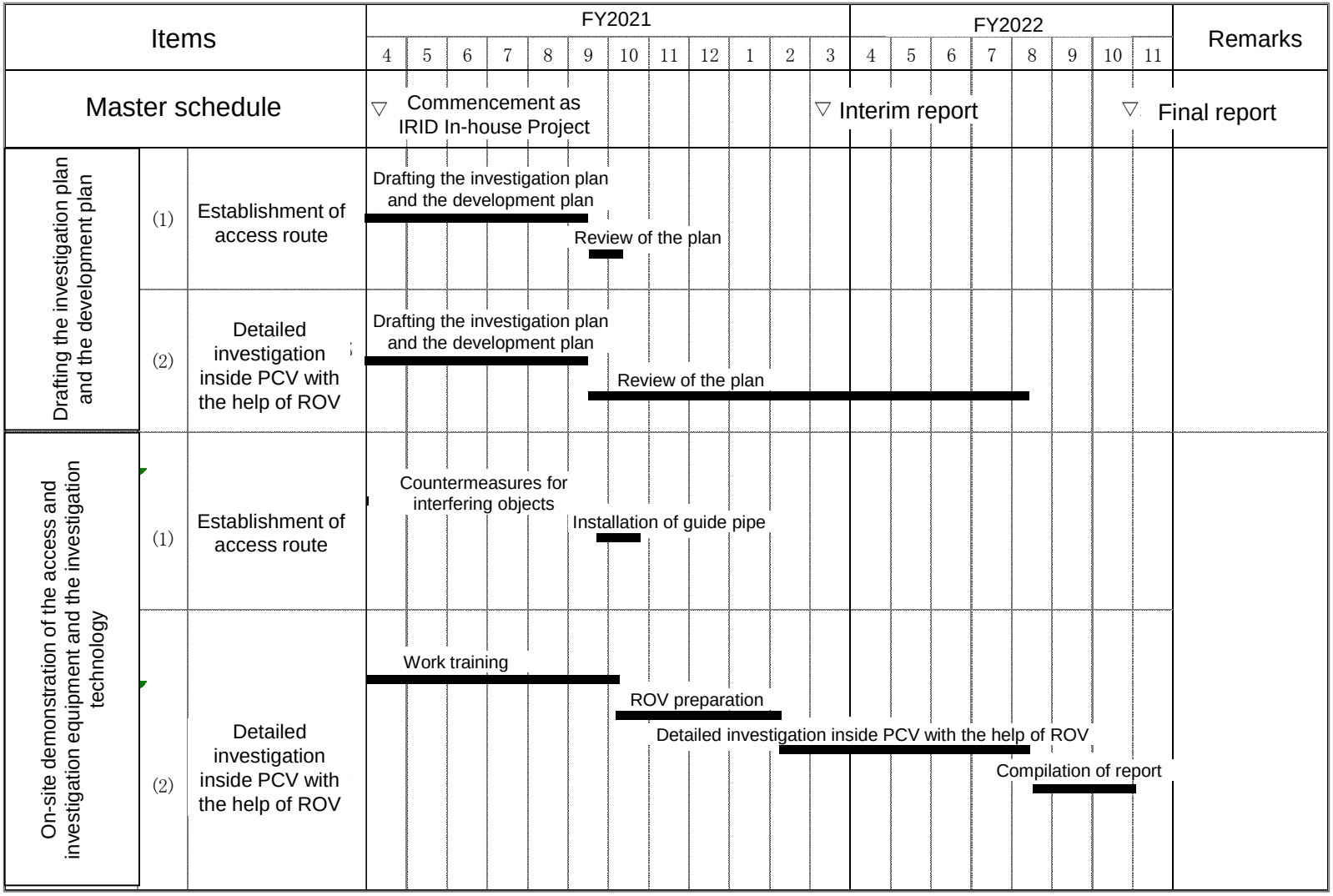
2. Implementation Items and Goals

Implementation items			Goal achievement indicators (FY2021)	Explanation
Detailed planning for establishment of access route	Study of ROV insertion route		Drafting the cutting plan (Not included in the scope of the goal achievement indicators)	4.1.1(1)
	Study of cutting plan			4.1.1(2)
	Cutting plan			4.1.1(3)
On-site demonstration of access route establishment	Counter-measures for Interfering objects	Implementation of detailed investigation of interfering objects	Completion of detailed investigation of interfering objects (Target TRL at completion: Level 6)	4.1.2(1)(i)
		Removal of lead wool mat and cutting of grating	Completion of cutting (Target TRL at completion: Level 6)	4.1.2(1)(ii)
		Cutting of T type beam and middle crosspiece of handrail		4.1.2(1)(iii)
		Cutting of conduits		4.1.2(1)(iv)
	Installation of guide pipe		Completion of installation of guide pipe (Target TRL at completion: Level 6)	4.1.2(2)
Detailed planning for detailed investigation inside PCV	Study on impact of interfering objects		Drafting of the cutting plan (Not included in the scope of the goal achievement indicators)	4.2.1(1)
	Study on impact of reduced water level inside PCV due to the earthquake off-shore of Fukushima Prefecture			4.2.1(2)
On-site demonstration of detailed investigation inside PCV	Guide ring installation (ROV-A)		Completion of guide ring installation (Target TRL at completion: Level 6)	4.2.2

TRL: Technology Readiness Level

3. Implementation Schedule and Project Organization

3.1 Implementation schedule



The above-mentioned is the initial plan. The schedule is planned to be revised as needed depending on the situation of investigation, etc.

3. Implementation Schedule and Project Organization
3.2 Project Organization

International Research Institute for Nuclear Decommissioning(IRID) (Headquarters)
○ Development of overall plan and technology management ○ Summary of technology management such as progress of technological development, etc.
Hitachi-GE Nuclear Energy, Ltd.
Part of “On-site Demonstration of Access Route Establishment” and part of “On-site Demonstration of Detailed Investigation inside PCV” during the “On-site Demonstration of Technology for Detailed Investigation Considering Deposit Measures”

⇔ Cooperation

Project teams to cooperate for technological development

- Development of Technology for Detailed Investigation inside PCV
  (Onsite demonstration of the technology for detailed internal investigation using X-6 penetration)
- Development of Technology for Retrieval of Fuel Debris and Reactor Internal structures
- Development of Sampling Technology for Retrieval of Fuel Debris and Reactor Internal Structures
- Development of Technology for Increasing the Scale of Fuel Debris Retrieval in Stages
- Development of Technology for Collection, Transfer and Storage of Fuel Debris
- Development of Analysis and Estimation Technology for Characterization of Fuel Debris
- Development of Technology for Investigation inside RPV
- Research and Development for Treatment and Disposal of Solid Radioactive Waste

4. Implementation Details

4.1 On-site demonstration of access route establishment
- 4.1.1 Detailed planning for establishment of access route
  - (1) Study of ROV insertion route
  - (2) Study of cutting plan
  - (3) Cutting plan
- 4.1.2 On-site demonstration of access route establishment
  - (1) Countermeasures for interfering objects
    - (i) Implementation of detailed investigation of interfering objects
    - (ii) Removal of lead wool mat and cutting of grating
    - (iii) Cutting of T type beam and middle crosspiece of handrail
    - (iv) Cutting of conduits
  - (2) Installation of guide pipe

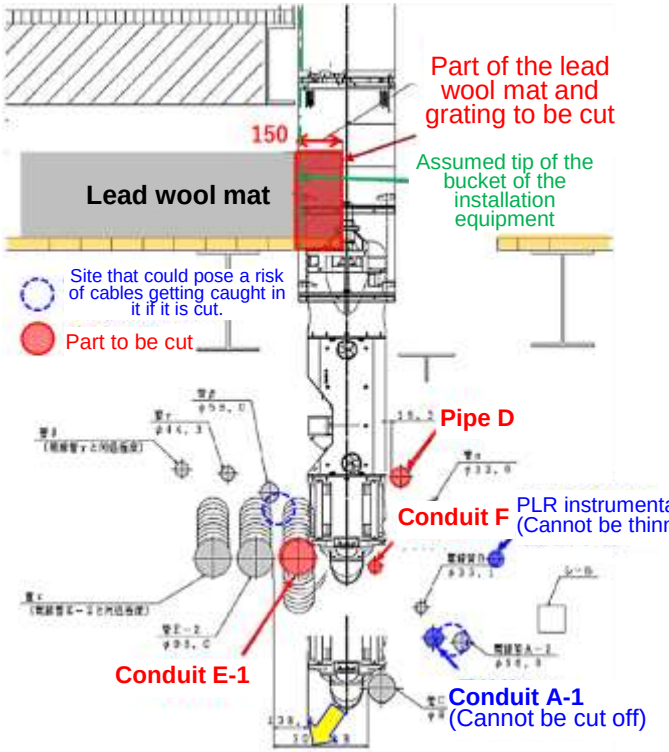
4.2 On-site demonstration of detailed investigation inside PCV
- 4.2.1 Detailed planning for detailed investigation inside PCV
  - (1) Study on impact of interfering objects
  - (2) Study on impact of reduced water level inside PCV due to the earthquake off-shore of Fukushima Prefecture
- 4.2.2 On-site demonstration of detailed investigation inside PCV

4.1 On-site demonstration of access route establishment

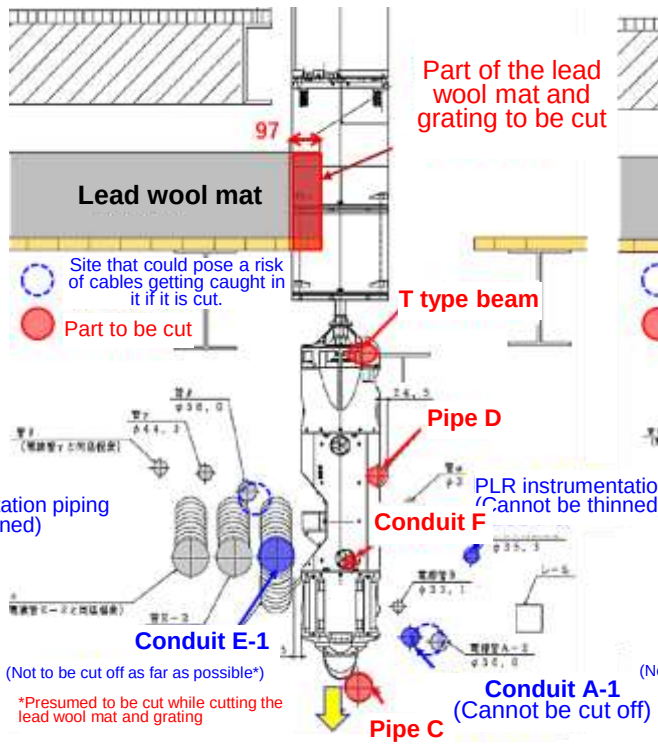
4.1.1 Detailed planning for establishment of access route (1) Study of ROV insertion route (1/2)

- If conduit E-1 or A-1 is cut, there will be a risk of ROV cables getting caught in it, therefore, Plan 1, Plan 2-1 and Plan 3 were selected as prospective ROV insertion routes based on the results of the interfering objects investigation.
- The ROV insertion route was narrowed down based on the concept of making sure to avoid impact of cutting on the PLR instrumentation piping, that the conduit A-1 is not cut off (thinning or partial cutting is permitted), and that conduit E-1 is not cut, if it has remained while cutting the lead wool mat and the grating.

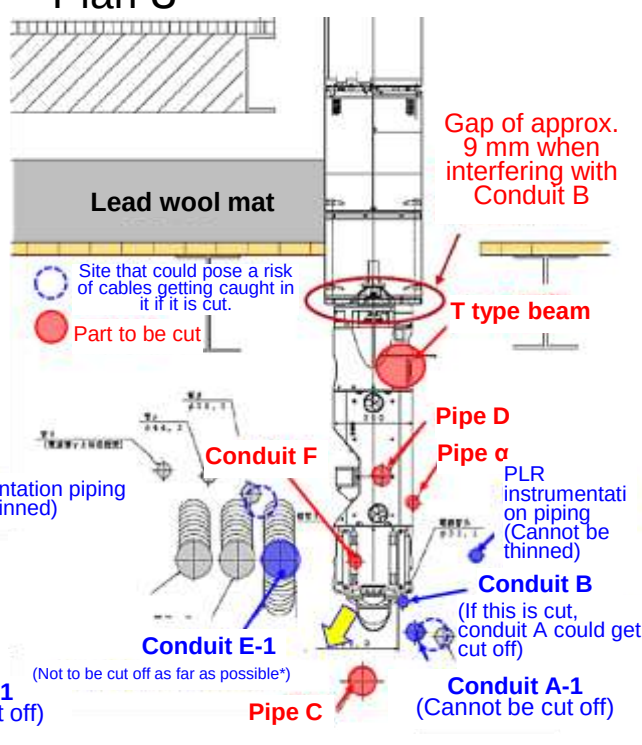
Plan 1



Plan 2-1



Plan 3

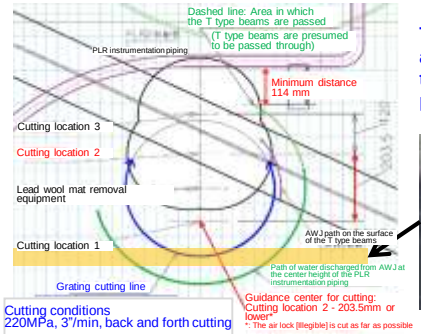


4.1 On-site demonstration of access route establishment
4.1.1 Detailed planning for establishment of access route (1) Study of ROV insertion route (2/2)

In the case of Plan 1 or Plan 2-1

- It was verified that the impact of cutting on the PLR instrumentation piping can be avoided.
- It is presumed that water discharged from AWJ while cutting lead wool mat, etc. hits Conduit E-1 and it is cut.

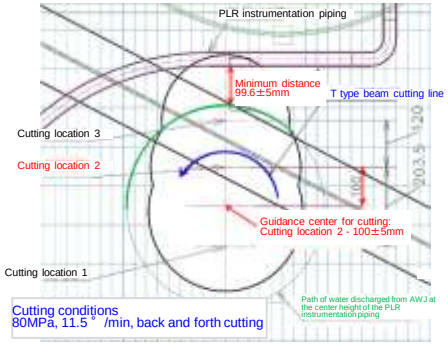
While cutting the lead wool mat and grating

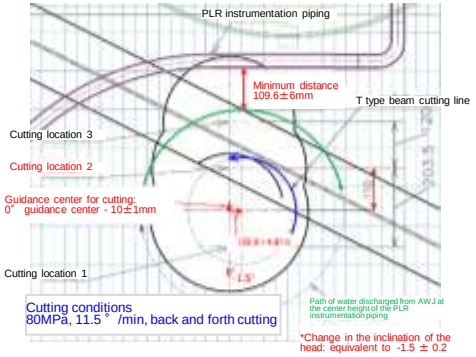


The distance from the nozzle to Conduit E-1 is approx. 1.1m, and hence it is presumed that a part of the conduit would get be cut and cut off due to passage of the water discharged from AWJ.

External appearance of Conduit E-1

While cutting T type beam

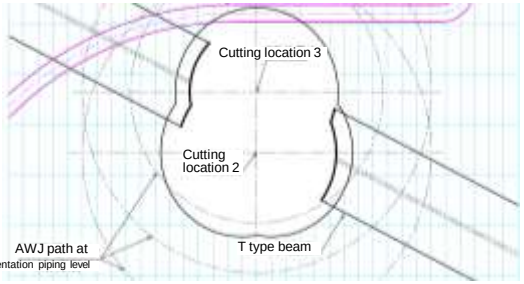


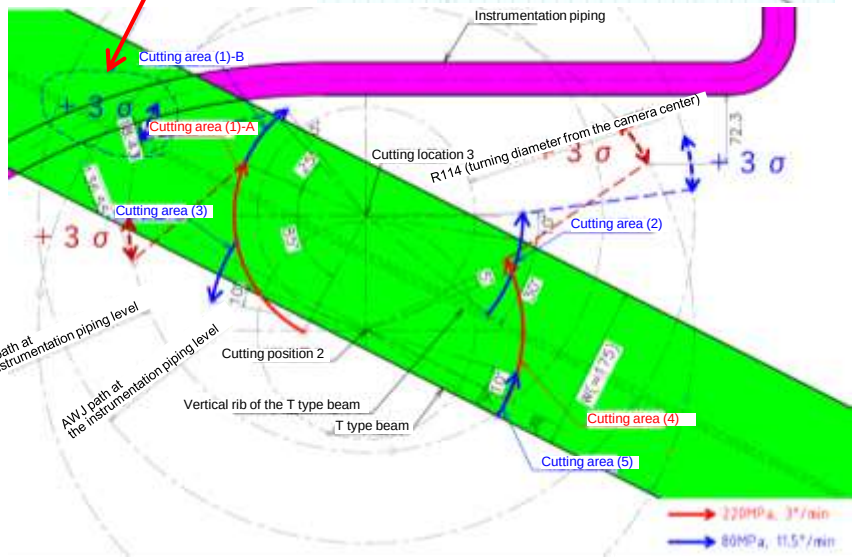


In the case of Plan 3

- It was verified that the water discharged from AWJ while cutting the T type beam is likely to pass through the PLR instrumentation piping.
- The impact can be reduced (minor thinning) by using a discharge pressure of 80MPa.

If the swivel accuracy (3σ) of the nozzle is considered, the water discharged from AWJ passes through the PLR instrumentation piping





- Avoiding any impact of cutting on the PLR instrumentation piping was given priority and the ROV insertion route was narrowed down to Plan 1 and Plan 2-1.

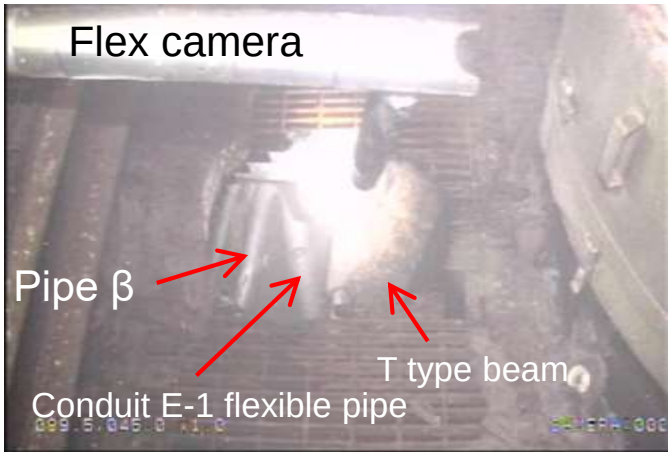
AWJ: Abrasive Water Jet

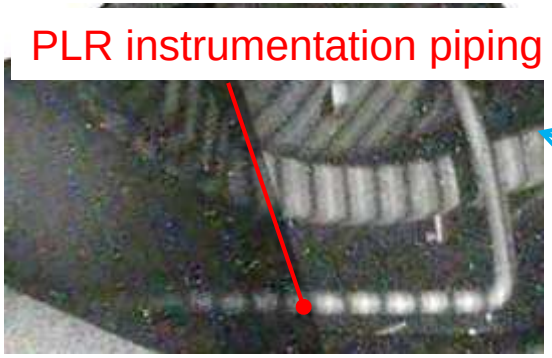
4.1 On-site demonstration of access route establishment

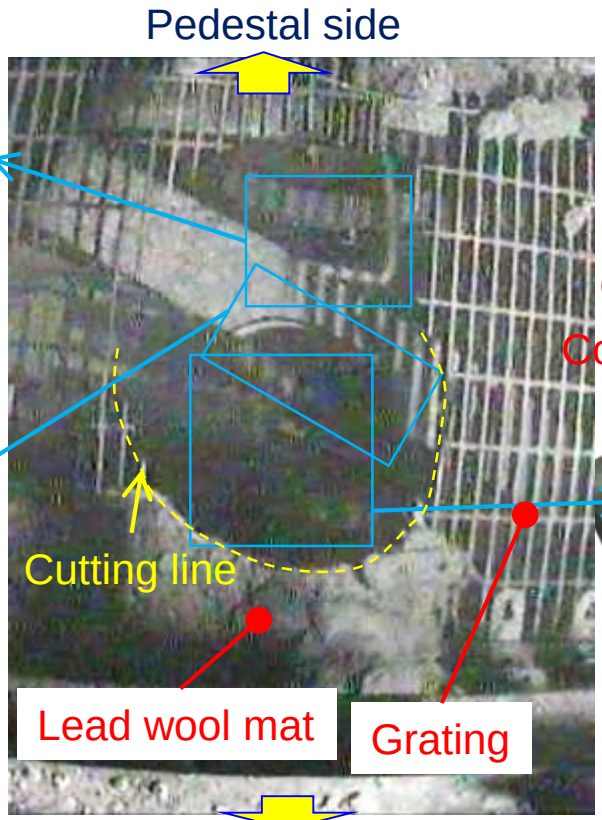
4.1.1 Detailed planning for establishment of access route (2) Study of cutting plan (1/2)

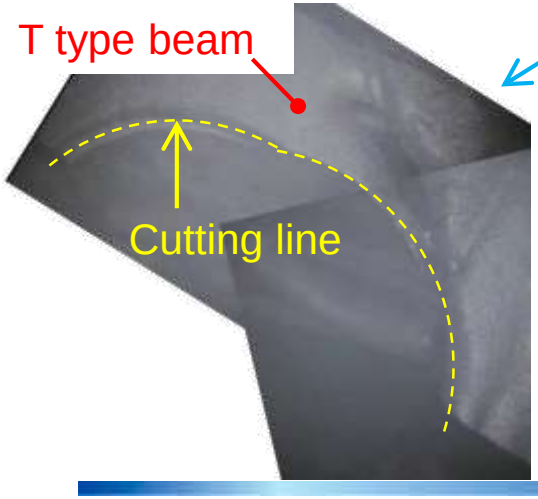
(i) Confirmation of the situation of Conduit E-1

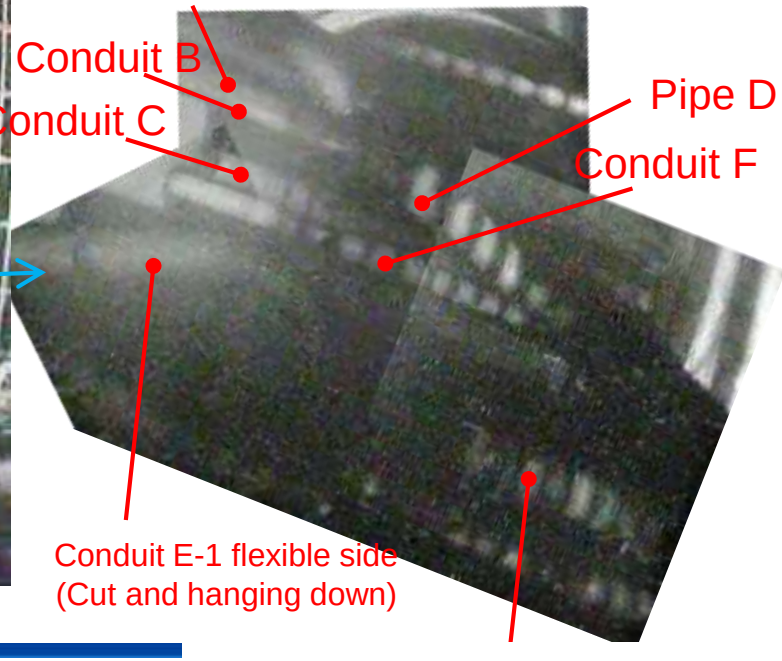
- The situation of Conduit E-1 was confirmed after cutting the lead wool mat and grating and the T type beam.
- It was found that the flexible side conduit had been cut and was hanging down.











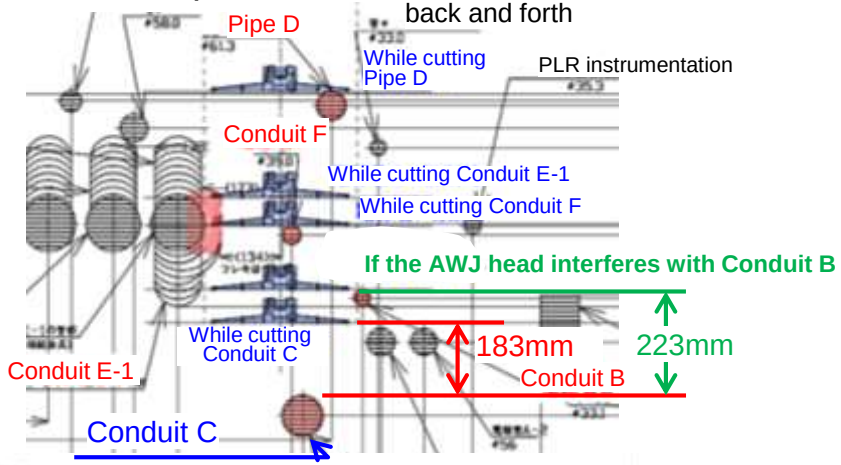
4.1 On-site demonstration of access route establishment
4.1.1 Detailed planning for establishment of access route (2) Study of cutting plan (2/2)

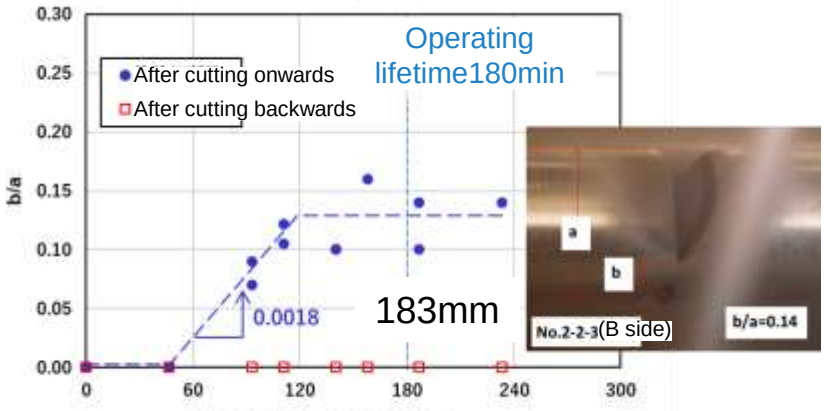
(ii) Conduit C cutting test

- Cutting would be difficult within the lifetime of the nozzle from a distance of 452mm. However, it was possible from a distance of 183mm as well as 223mm.
- In case that Conduit E-1 remained and is interfered with the AWJ head during cutting , it was decided that the conduit would be cut off.

(a) Realistic assumption

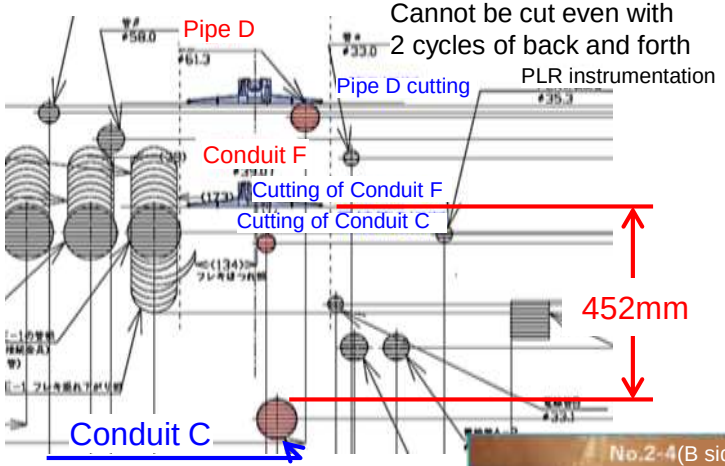
Can be cut with 1 cycle of back and forth





(b) Assuming that Conduit E-1 would not be cut while cutting the lead wool mat, etc.

Cannot be cut even with 2 cycles of back and forth



70° area x 2 cycles of back and forth

4.1 On-site demonstration of access route establishment
4.1.1 Detailed planning for establishment of access route (3) Cutting plan (1/4)

(i) Cutting the lead wool mat and grating

- The AWJ equipment that has been newly prepared for cutting the lead wool mat and grating will be used.
- After performing cutting in the onward direction, the cutting status will be confirmed and if some part has not been cut, cutting will be performed in the backward direction.
- Cutting in the onward direction will be performed in two parts, and the cutting in the backward direction will be performed in one go. The cutting will be performed in the order of washing with WJ, cutting in onward direction, and then cutting in backward direction. After every step, the dust inside the PCV will be confirmed and the necessity of the subsequent step will be determined.

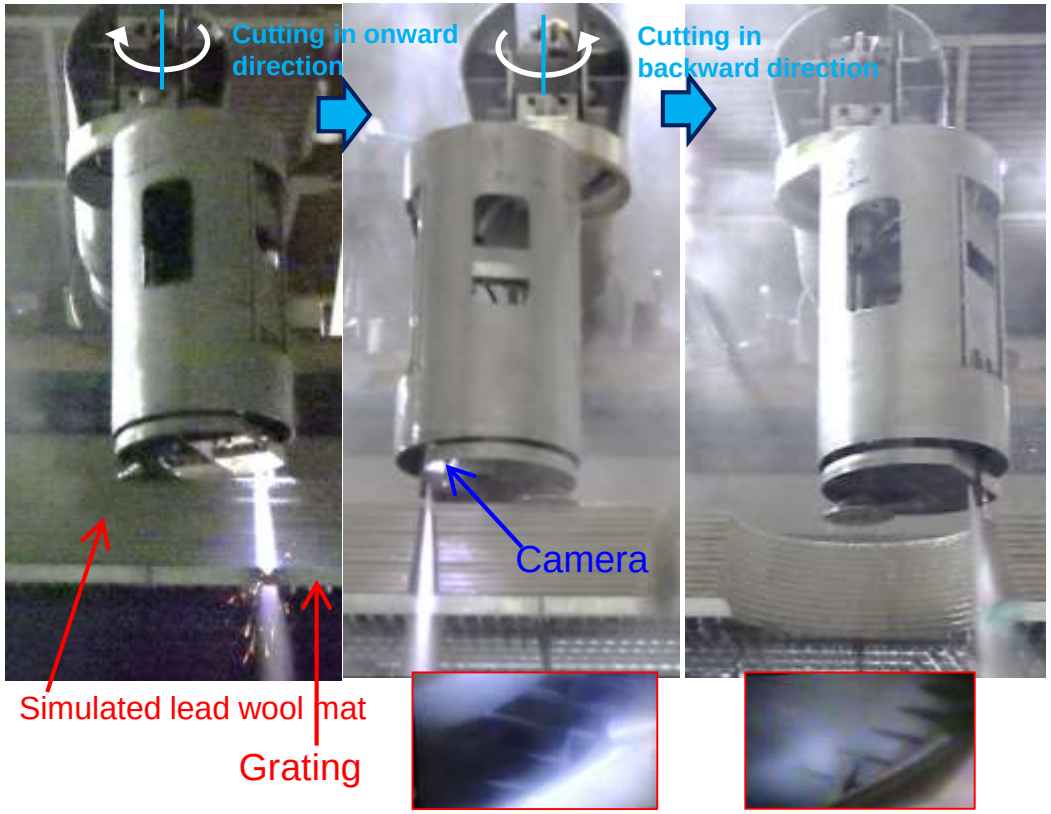


Figure 4.1.1(3)(i)-1 AWJ equipment for cutting the lead wool mat and grating

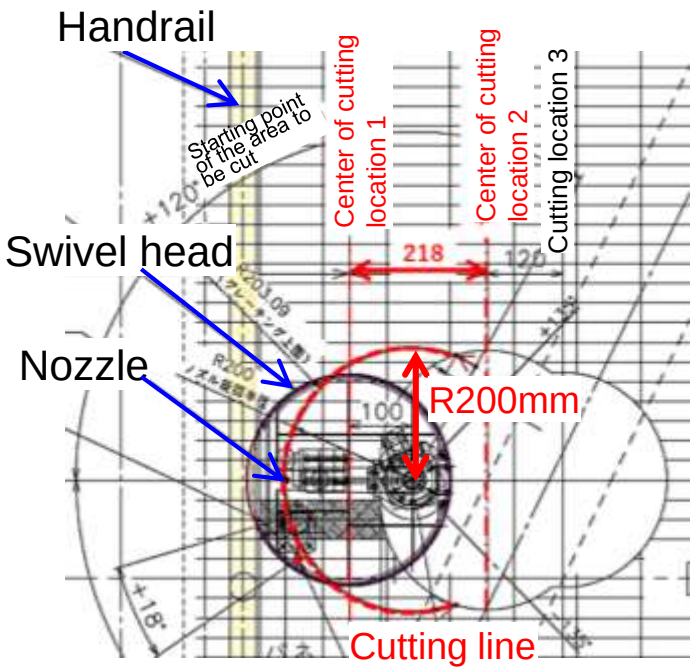


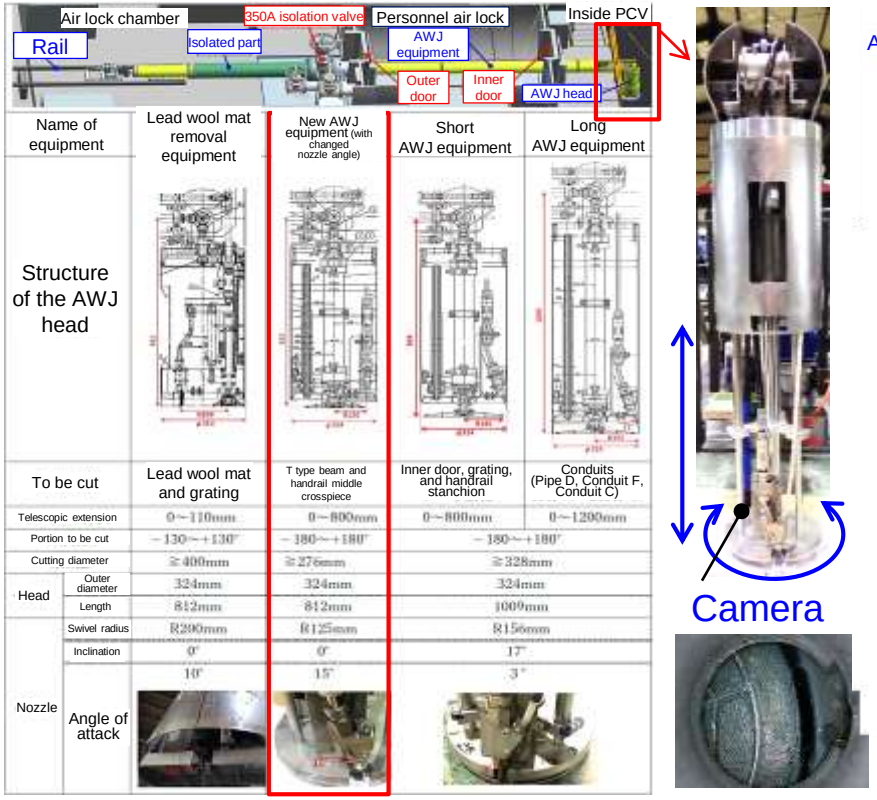
Figure 4.1.1(3)(i)-2 Cutting plan drawing

4.1 On-site demonstration of access route establishment

4.1.1 Detailed planning for establishment of access route (3) Cutting plan (2/4)

(ii) Cutting the T type beam

- In order to increase the distance between the water discharged from AWJ and the PLR instrumentation piping, the AWJ equipment newly prepared with a changed nozzle angle will be used.
- Since the cutting diameter is small, the cutting location will be changed and a wider cut will be taken so that the head of the long AWJ equipment does not interfere with the T type beam while cutting the conduits.
- After every cut, the status of the cut and the dust inside the PCV will be confirmed, and the necessity of the subsequent step will be determined.



Name of equipment		Lead wool mat removal equipment	New AWJ equipment (with changed nozzle angle)	Short AWJ equipment	Long AWJ equipment
Structure of the AWJ head					
To be cut		Lead wool mat and grating	T type beam and handrail middle crosspiece	Inner door, grating, and handrail stanchion	Conduits (Pipe D, Conduit F, Conduit C)
Telescopic extension		0~110mm	0~800mm	0~800mm	0~1200mm
Portion to be cut		−130°~+130°	−180°~+180°	−180°~+180°	
Cutting diameter		≧400mm	≧276mm	≧328mm	
Head	Outer diameter	324mm	324mm	324mm	
	Length	812mm	812mm	1009mm	
	Swivel radius	R200mm	R125mm	R156mm	
Nozzle	Inclination	0°	0°	17°	
	Angle of attack	10°	15°	3°	

Figure 4.1.1(3)(ii)-1 AWJ equipment with changed nozzle angle

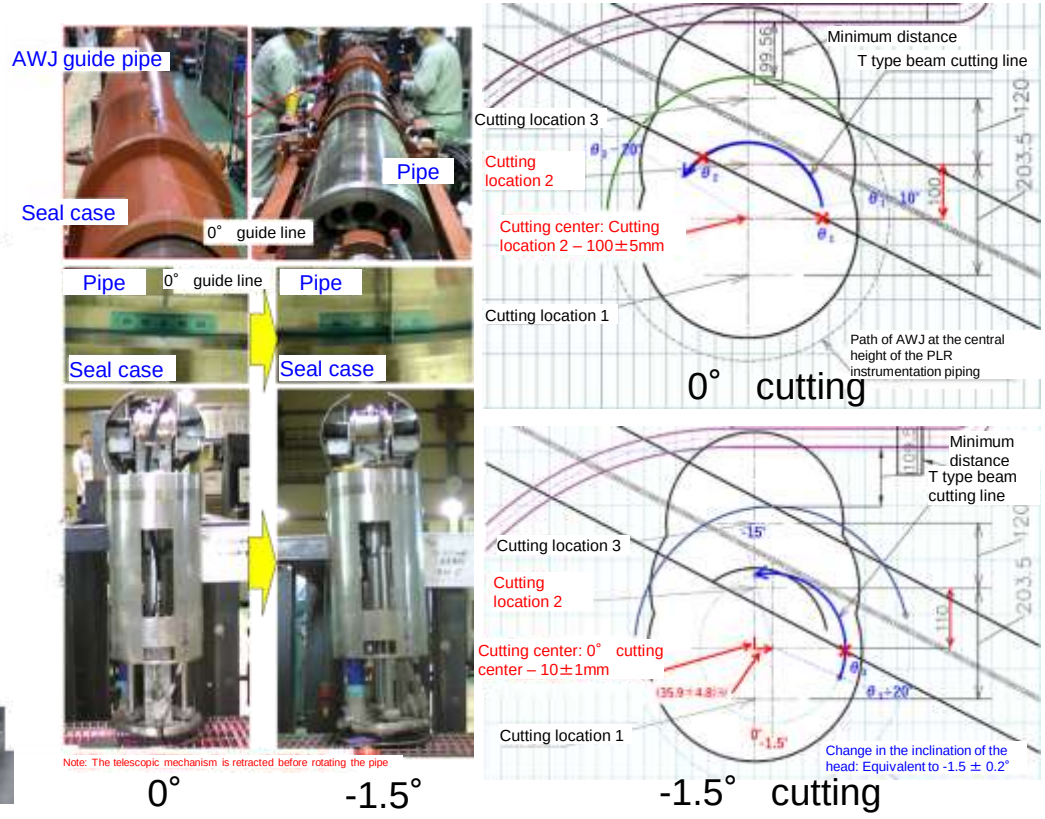


Figure 4.1.1(3)(ii)-2 T type beam cutting plan

4.1 On-site demonstration of access route establishment

4.1.1 Detailed planning for establishment of access route (3) Cutting plan (3/4)

(iii) Cutting the middle crosspiece of the handrail

- The middle crosspiece of the handrail will be cut at the stage when the AWJ equipment is pulled out after cutting the T type beam, so as to reduce the duration of the schedule.
- Since dust from inside the PCV tends to rise at the time of horizontal cutting, along with verifying the portion to be cut, the inside of the PCV will be washed by means of WJ, and after checking for dust inside the PCV, it will be determined whether or not further cutting is required.

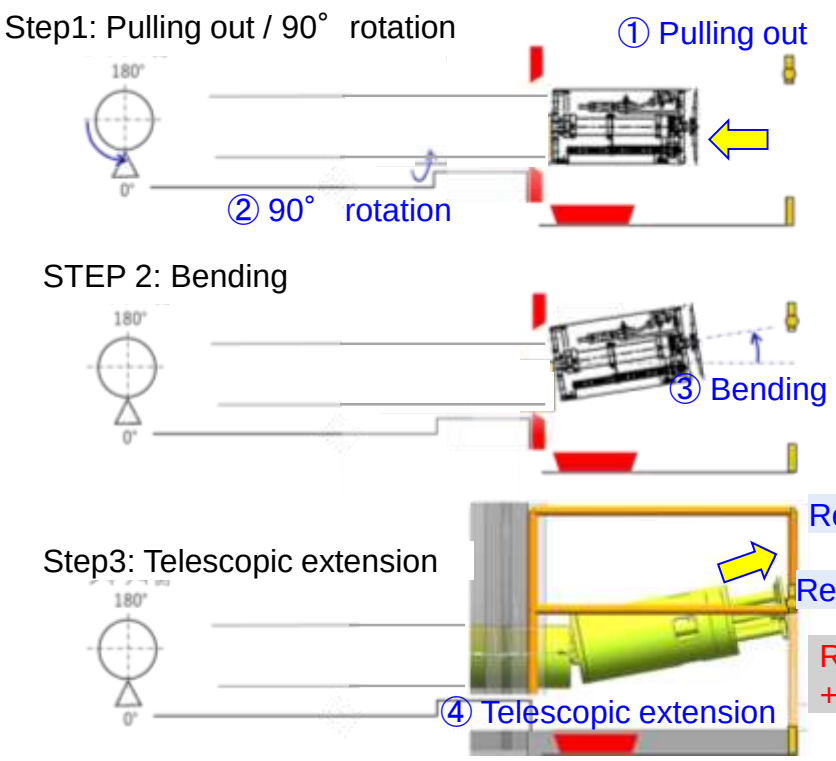


Figure 4.1.1(3)(iii)-1 Method of setting the AWJ head for cutting the middle crosspiece of the handrail

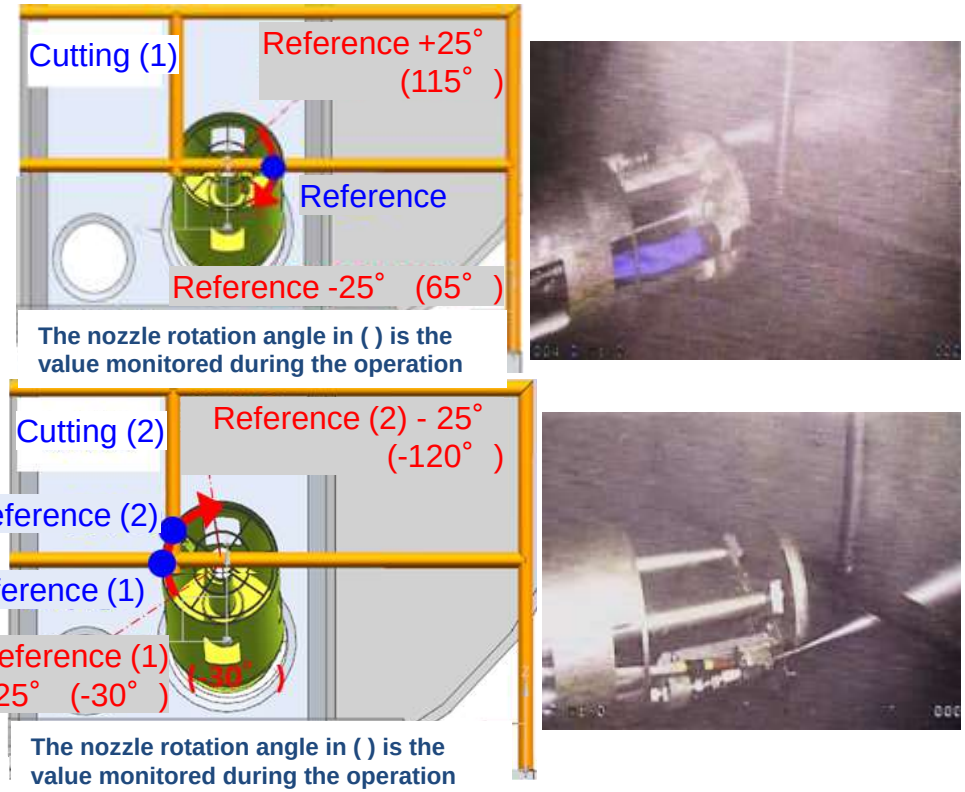


Figure 4.1.1(3)(iii)-2 Handrail middle crosspiece cutting plan drawing

4.1 On-site demonstration of access route establishment

4.1.1 Detailed planning for establishment of access route (3) Cutting plan (4/4)

(iv) Cutting of conduits

- Long AWJ equipment will be used.
- Pipe D, Conduit E-1 (if it interferes), Conduit F and Conduit C will be cut based on the results of verification of the situation of Conduit E-1 and of the Conduit C cutting test, and circumvention of the risk of cables for ROV getting caught which arises as a result of cutting off Conduit A-1.

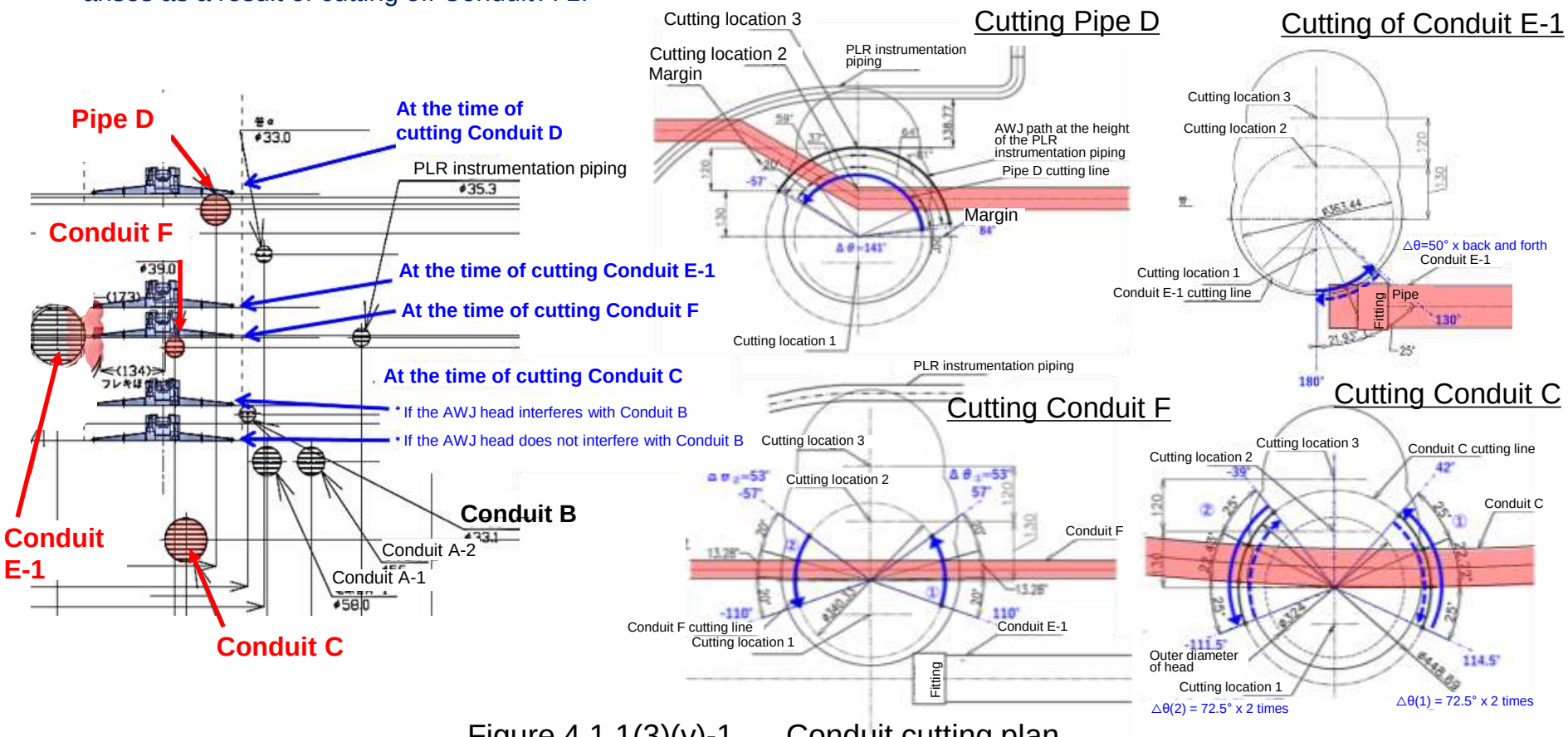


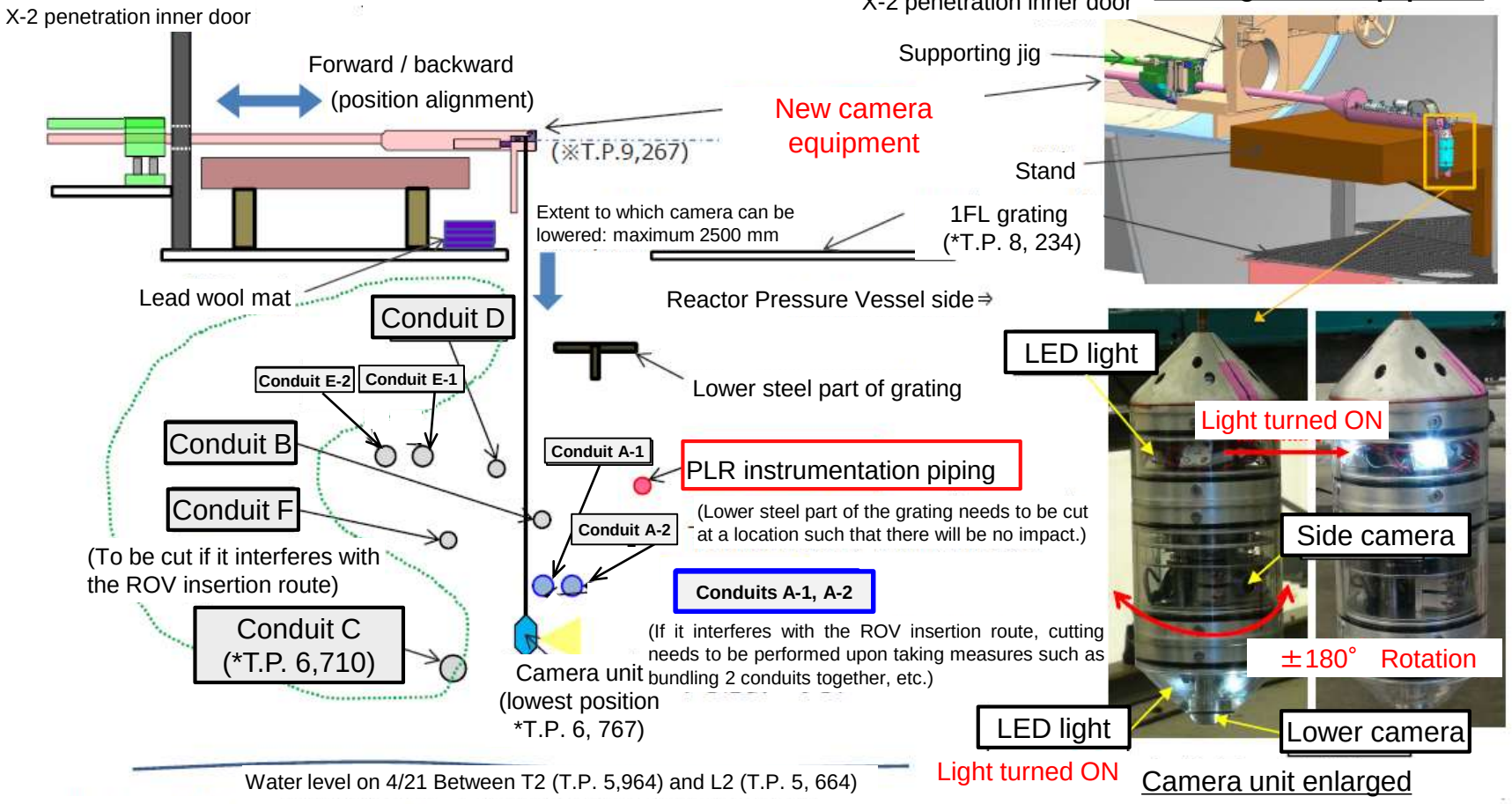
Figure 4.1.1(3)(v)-1 Conduit cutting plan

4.1 On-site demonstration of access route establishment

4.1.2 On-site demonstration of access route establishment (1) Interfering objects countermeasures (1/5)

- Investigation of interfering objects is carried out for understanding the detailed location of the interfering objects under the lower steel portion of the grating (PLR instrumentation piping and conduits).

Image of the investigation of interfering objects



Cited from materials available on the website of Tokyo Electric Power Company Holdings, Inc. https://www.tepco.co.jp/decommission/information/committee/ roadmap_progress/pdf/2021/d210427_09-j.pdf

4.1 On-site demonstration of access route establishment

4.1.2 On-site demonstration of access route establishment (1) Interfering objects countermeasures (2/5)

(ii) Removal of lead wool mat / Cutting of grating

Removal of lead wool mat, and cleaning and cutting of the grating were completed as planned.

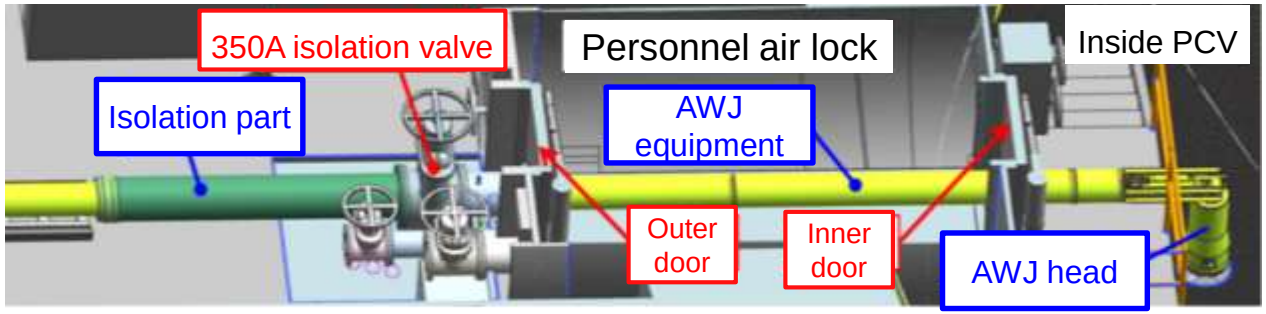


Figure 4.1.2 (1) (ii)-1 Status at the time of removal of lead wool mat / cutting of grating

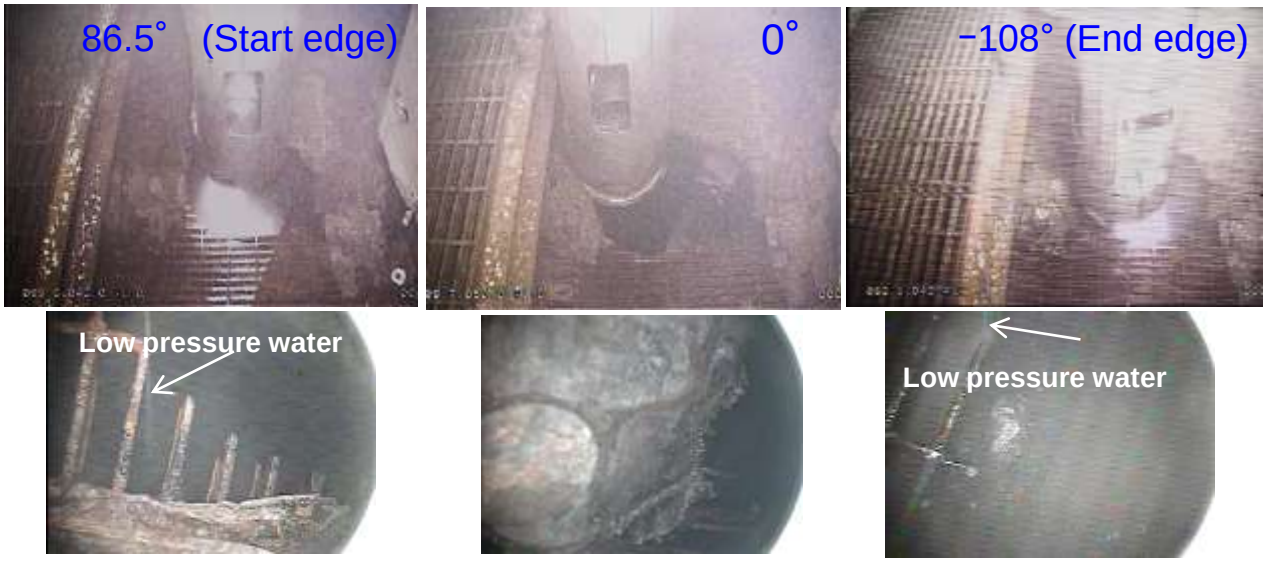


Figure 4.1.2(1) (ii)-2 Setting the lead wool mat / grating cutting area

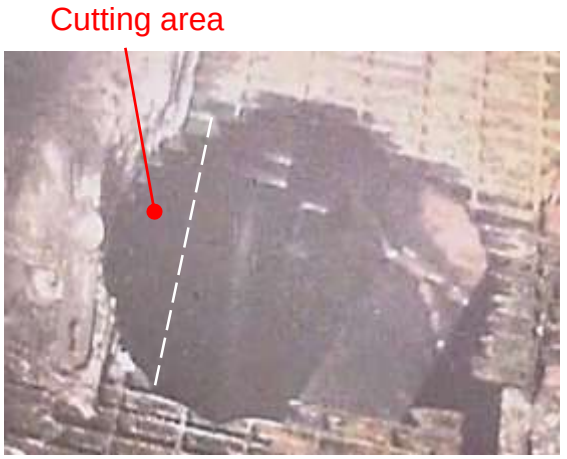


Figure 4.1.2(1) (ii)-3 Status after cutting

(iii) Cutting of the T type beam

- The 0° cut (first time) was too close to the longitudinal rib and the cut could not be made. Hence the position was moved 5mm and the cut was performed again (second time).
- Cutting was completed at positions by and large as per the plan.

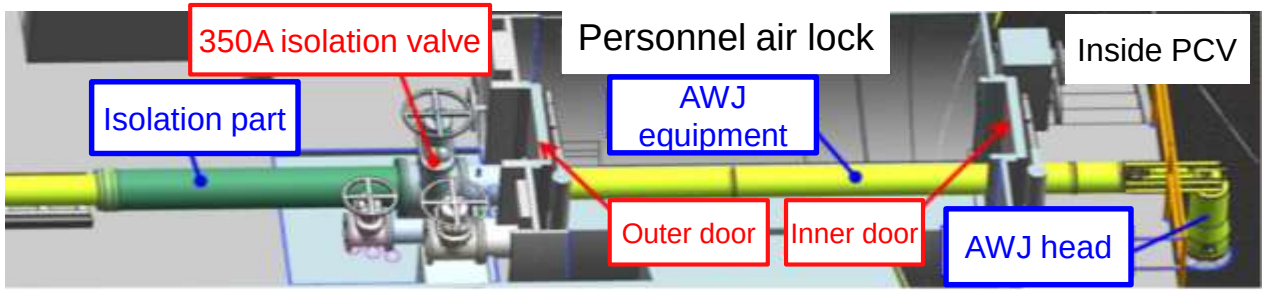


Figure 4.1.2 (iii)-1 Cutting the T type beam

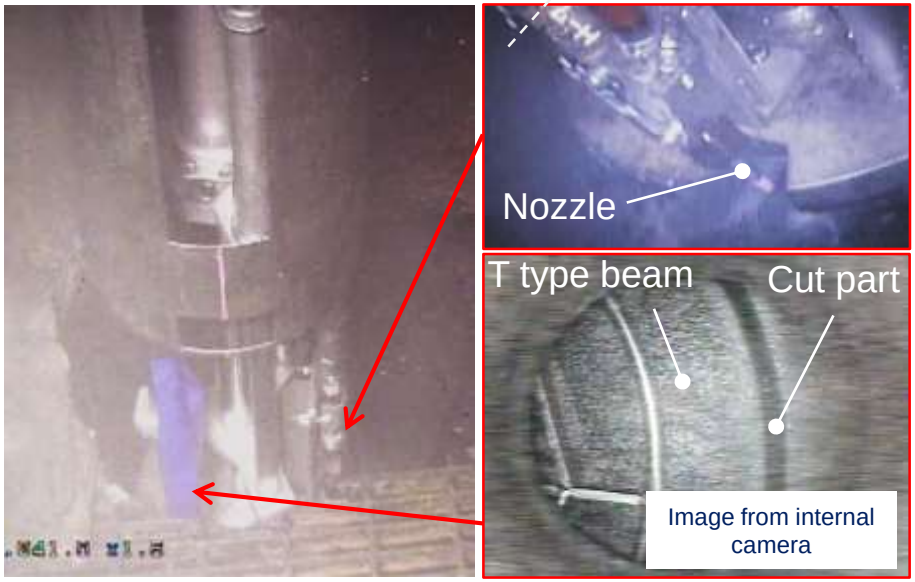


Figure 4.1.2 (iii)-2 Head at the time of cutting the T type beam

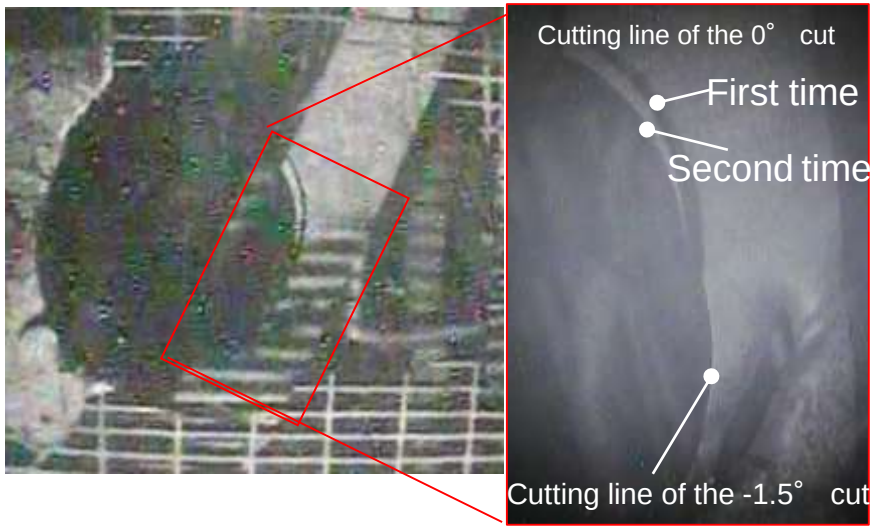


Figure 4.1.2 (iii)-3 After cutting

(iv) Cutting of the middle crosspiece of the handrail

- Cutting was completed at positions as per the plan.
- At the time of cutting on the north side, dust inside PCV increased beyond the operating value (1.7×10^{-2}Bq/cm^3), but it was lower than the maximum dust recorded in the past and there was no impact on the outside.

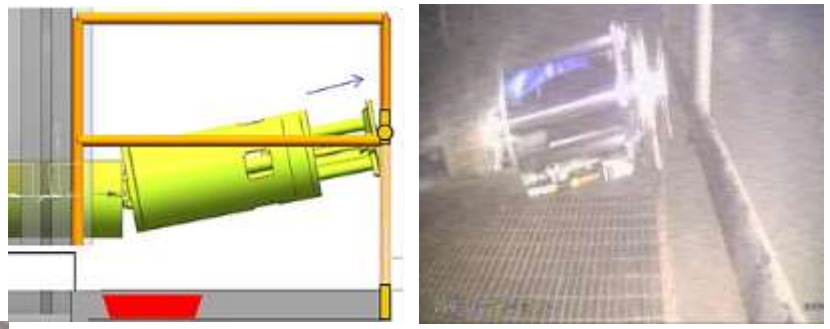


Figure 4.1.2 (iv)-1 After cutting the middle crosspiece of the handrail

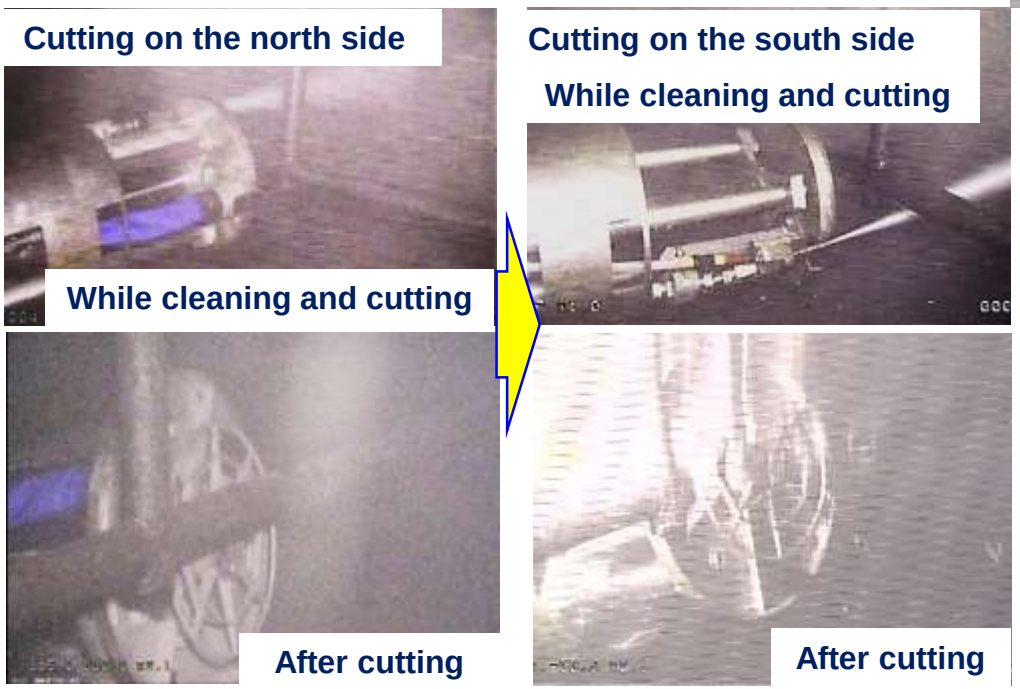


Figure 4.1.2 (iv)-1 Status while cleaning / cutting the middle crosspiece of the handrail and after cutting

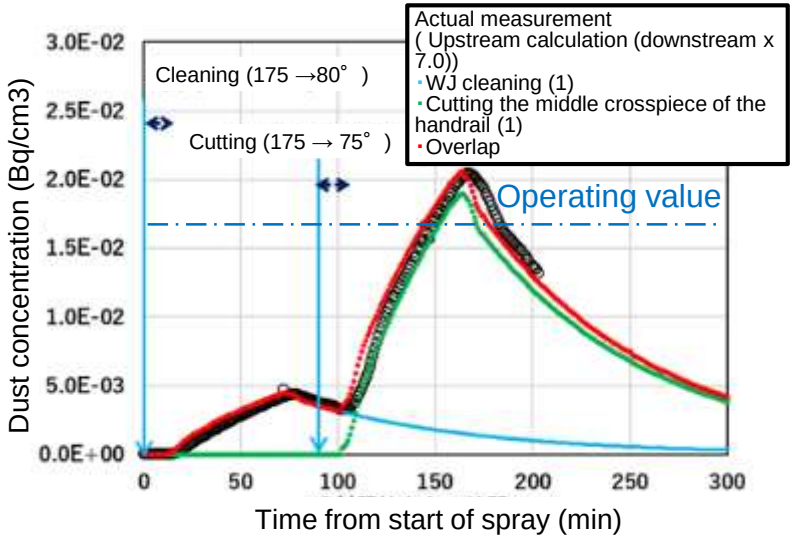


Figure 4.1.2 (iv)-3 After cutting

4.1 On-site demonstration of access route establishment

4.1.2 On-site demonstration of access route establishment (1) Interfering objects countermeasures (5/5)

(v) Cutting of conduits

- Cutting of Pipe D, Conduit F and Conduit C was completed as per the plan.
- The conduits were cut continuously for a maximum of approx. 60 minutes, but the dust level inside PCV was low on the whole.

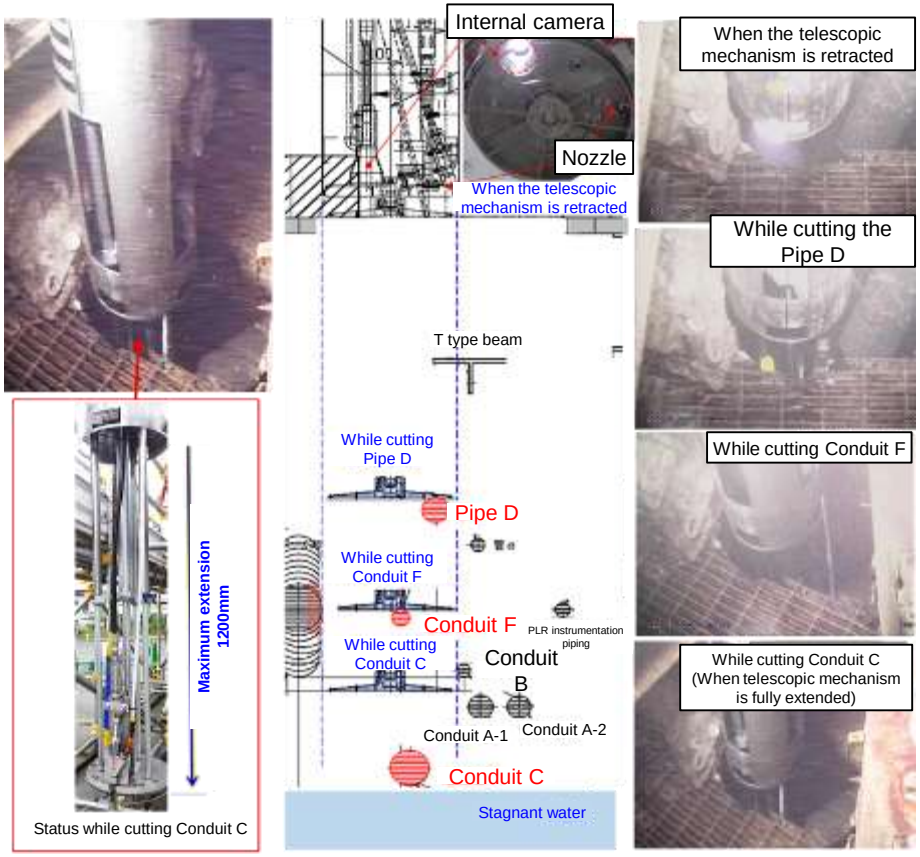


Figure 4.1.1 (v)-1 Equipment while cutting the conduits

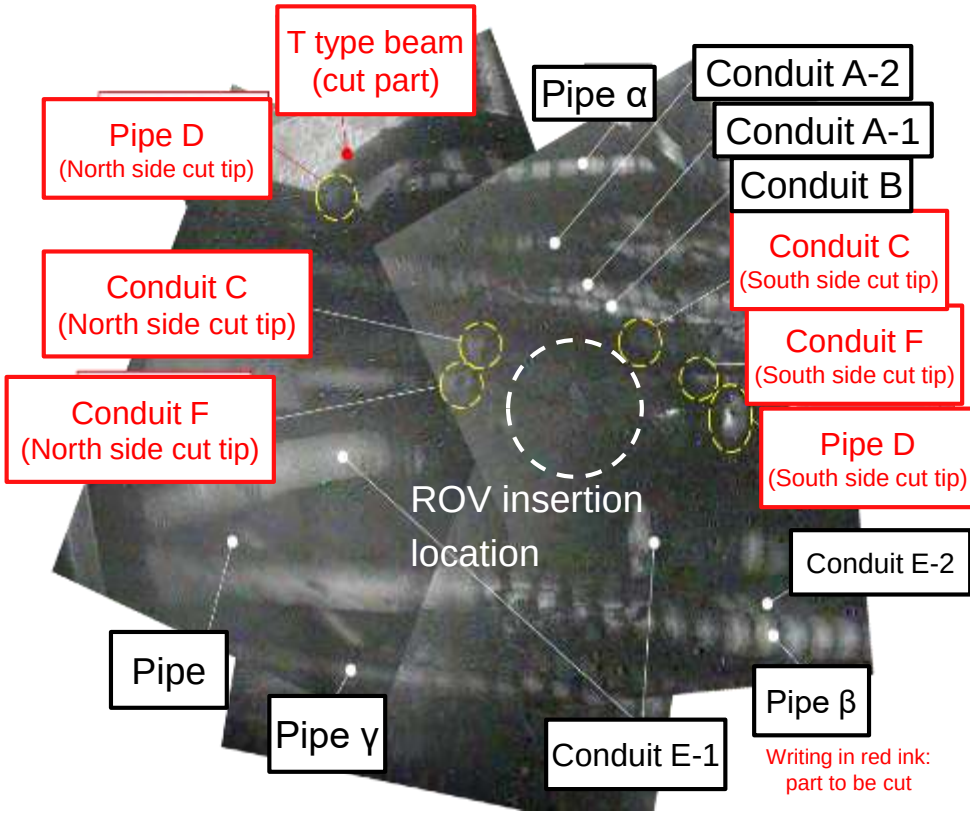
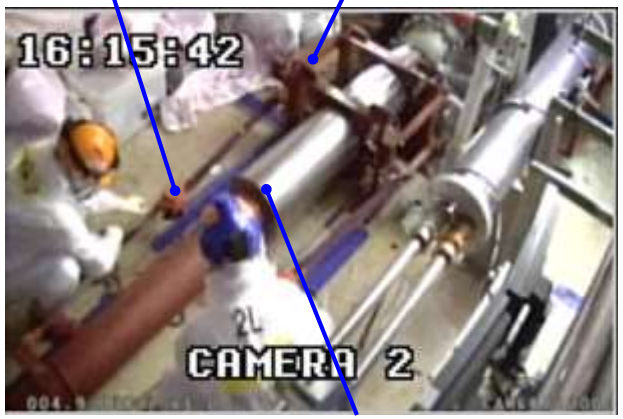


Figure 4.1.1 (v)-2 After cutting the conduits

4.1 On-site demonstration of access route establishment
4.1.2 On-site demonstration of access route establishment (2) Guide pipe installation (1/2)

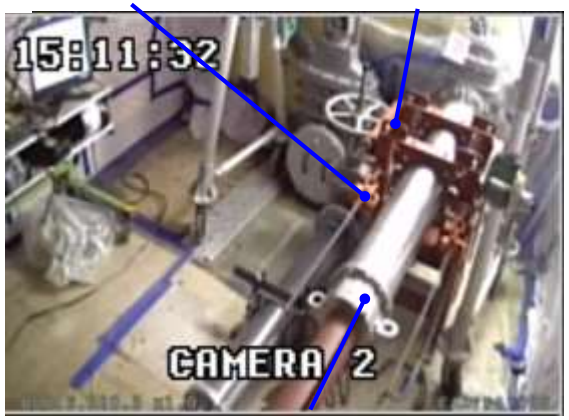
- Three guide pipes were installed as scheduled.

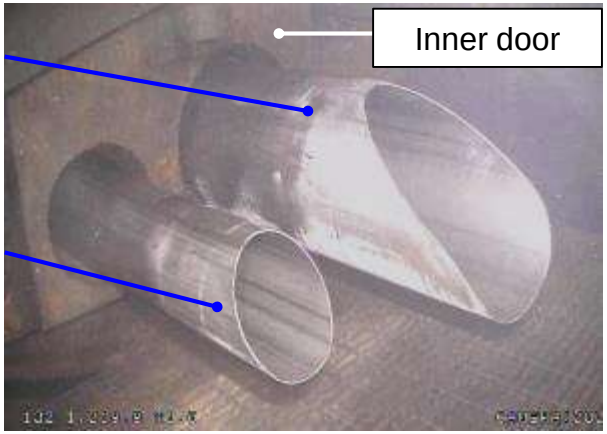
Installation of 350A guide pipe



Installation of 200A guide pipe

Installation of 250A guide pipe





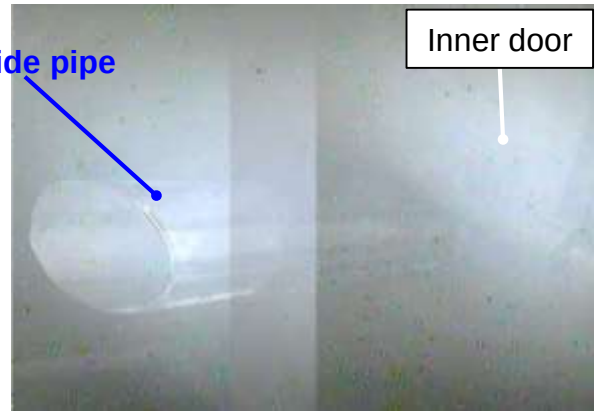
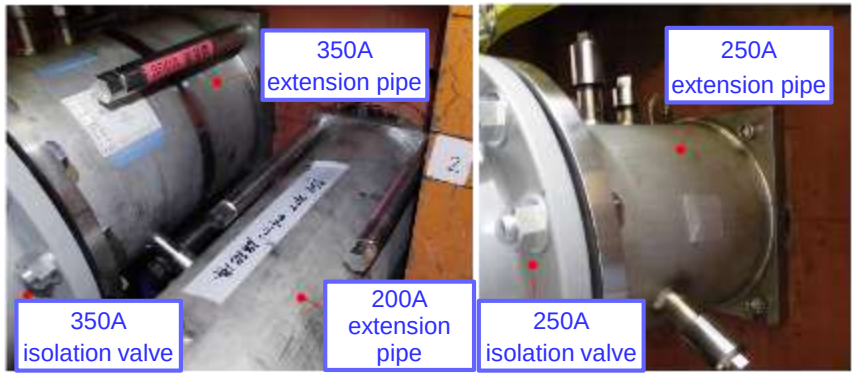
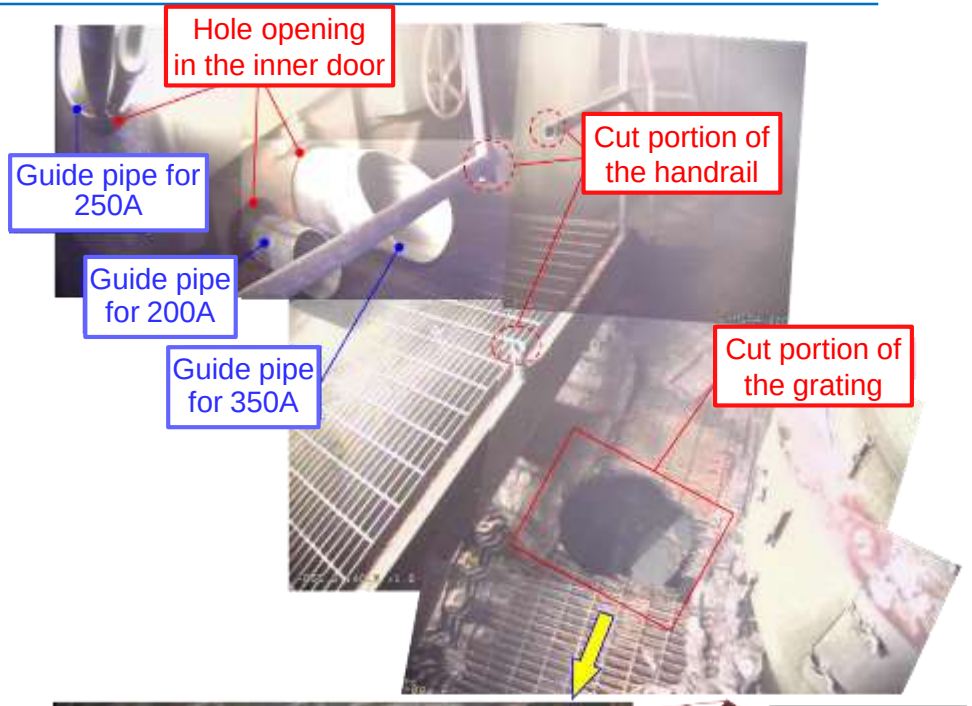


Figure 4.1.2 (2)-1 Photos while and after installing the guide pipe





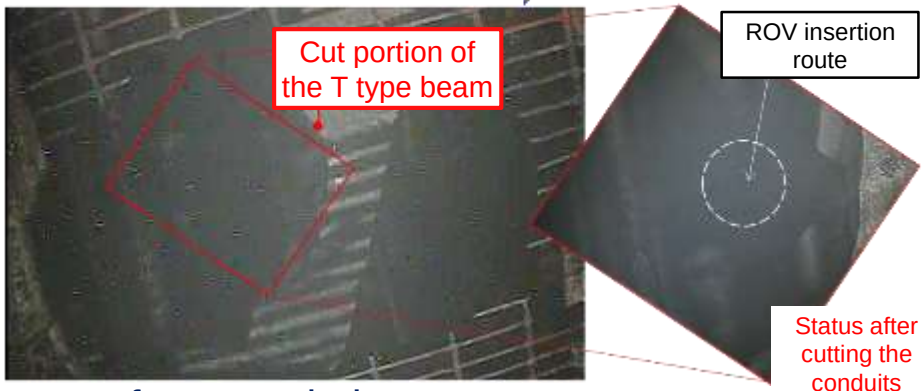


Figure 4.1.2(2)-2 External appearance after completion

4.2 On-site demonstration of detailed investigation inside PCV

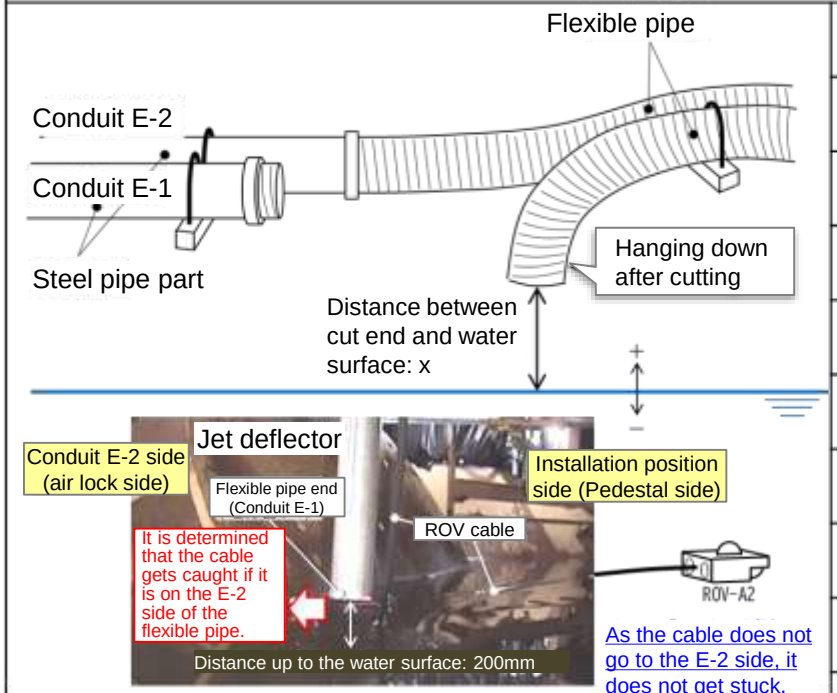
4.2.1 Detailed planning for detailed investigation inside PCV (1) Study on impact of interfering objects

It was found that the ROV cable getting caught in Conduit E-1 does not depend on its flexibility, but depends on ① the distance X between the cut end and water surface, and ② the distance between the ROV core and Conduit E-1.

A distance of 80mm between the ROV core and Conduit E-1 is assessed to be tough. It is believed that the cable does not get caught, as long as the position of ① the cut end and the water surface is such that when the cut end is above the water surface it is at a distance of 200mm or more from the water surface, and when it is below the surface it is submerged 300mm or more. Further, with regards to the cable getting stuck in the steel pipe part, since the location of the steel pipe at a height during AWJ cutting is generally above (or at the same level as) the flexible pipe (is not hanging down), as long as the above conditions are satisfied, ROV cable does not get stuck in the steel pipe. Therefore, it is considered that there is no risk of getting stuck on the route towards the south.

*The cable has neutral buoyancy but sinks one time when it is right under the installation equipment bucket. Since it sinks up to 200 to 250mm, as long as the flexible end is submerged approximately 300mm, the cable does not pass under the flexible pipe end.

○ : Not getting caught
× : Getting caught
*: Assumed based on test results



The test being conducted (200mm distance between the cut end and the water surface)
*Photographed with a birds-eye view camera for the mock-up test.
(The photo has been flipped to match it with the figure)

(1) Distance between cut end and water surface: x (mm)	Small ROV (ROV-A2): highly flexible		Large ROV (ROV-A): less flexible	
	(2) Distance between ROV core and Conduit E-1			
	80mm (minimum)	150mm (maximum)	80mm (minimum)	150mm (maximum)
500	○ (※)	○ (※)	○ (※)	○ (※)
200	○	○ (※)	○	○ (※)
150	×	○ (※)	×	○ (※)
100	×	○	×	○
50	× (※)	× (※)	× (※)	× (※)
0 Water surface	× (※)	× (※)	× (※)	× (※)
−50	× (※)	× (※)	× (※)	× (※)
−250	×	×	× (※)	× (※)
−300	○	○ (※)	○	○ (※)
−500	○ (※)	○ (※)	○ (※)	○ (※)

4.2 On-site demonstration of detailed investigation inside PCV

4.2.1 Detailed planning for detailed investigation inside PCV

(2) Study on impact of reduced water level inside PCV due to the earthquake off-shore of Fukushima Prefecture (2/13/2021)

Additional mock-up tests were conducted on anticipated matters of concern resulting from reduction in the water level inside Unit 1 PCV. Based on the constraints and operating conditions pertaining to ROV movement in water and investigation in the obtained low water level, the operation during the investigation with actual equipment was organized as follows:

[Operation policy concerning ROV movement in water]

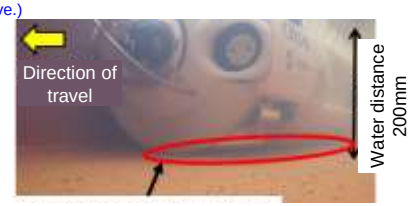
■ As long as there are no interfering objects, normal movement in water and investigation shall be carried out.

■ Measures to be taken if there are interfering objects above or below shall be as follows:

1) As primary assessment, the camera images shall be confirmed to find out whether or not the object can be clearly avoided, and then the advisability of avoiding the object or the necessity of measuring the dimensions shall be determined (*).
2) Assuming that the route for avoiding the object is on its lower side, the distance between the interfering object and the bottom surface shall be measured, and the advisability of avoiding the objects shall be determined.
3) If the route for avoiding the object is only above it, the distance between the interfering object and the water surface shall be measured, and then advisability of avoiding the objects shall be determined.
4) If avoiding the object from above it is difficult, the extent to which the water level needs to be raised for avoiding the object shall be calculated (while taking measurement errors into consideration), and subsequent response actions (*2) shall be discussed with TEPCO.

*1: The decision about avoiding the object taken at the stage of primary assessment shall be finalized upon discussion with TEPCO while taking into consideration the overall opinions of the Hitachi design personnel / ROV operators and other concerned persons.

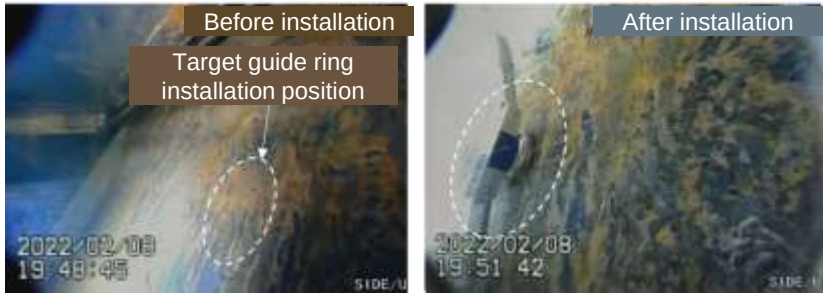
*2: Subsequent response actions: The ROV stand-by location and schedule (considering exposure of workers) until the water level is raised, needs to be coordinated.

Test name	a) Test for verifying the water distance required for ROV movement in water	b) Test for checking the necessity to return when the ROV runs aground on the deposits	c) Test for determining whether or not it is possible to return after having crossed over the mount of deposits
Large ROV (ROV-A)	Water distance required for movement in water: 250mm or more (If it is less than 250mm, the entire lower part of the ROV comes in contact with the bottom and the ROV cannot move.)  Condition when the entire lower part of ROV is making contact with the bottom and it cannot move through the water (large ROV, water distance 200mm)	Even if the ROV runs aground on the deposits, it can return by moving backwards.  The front part of the ROV is covered with deposits and with its driving force the ROV is unable to move any further, but it can move backwards. Condition when the ROV runs aground on the deposits (Large ROV, angle of inclination 5°)	If the ROV has levelled down the mount of deposits and moved ahead, it can return by moving backwards.  Moving ahead by levelling down the mount of deposits with the main body of the ROV. Condition when the ROV levels down the mount of deposits and moves ahead. (Large ROV, water distance 200mm)
Small ROV (ROV-A2)	Water distance required for movement in water: 200mm or more (If it is less than 200mm, some of the lower part of the ROV comes in contact with the bottom and the ROV cannot be controlled.)  Condition when some of the lower part of the ROV is making contact with the bottom and it cannot move through the water (small ROV, water distance 150mm)	Even if the ROV runs aground on the deposits, it can return by moving backwards.  The lower pan tilt camera of ROV-A2 is covered with deposits and with its driving force the ROV is unable to move any further, but it can move backwards. Condition when the ROV runs aground on the deposits (Small ROV, angle of inclination 5°)	If the ROV has levelled down the mount of deposits and moved ahead, it can return by moving backwards.  Moving ahead by levelling down the mount of deposits with the main body of the ROV Condition when the ROV levels down the mount of deposits and moves ahead. (Small ROV, water distance 100mm)

4.2 On-site demonstration of detailed investigation inside PCV
4.2.2 On-site demonstration of detailed investigation inside PCV

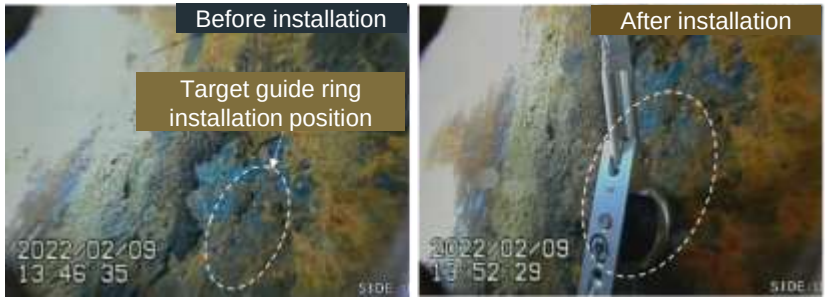
The work of installing guide rings for the four jet deflectors on the southern route was safely completed.

Jet deflector H



Jet deflector G

Jet deflector F



Jet deflector E

4.3 Level of achievement compared to the goal

Implementation items			Goal achievement indicators (FY2021)	Level of achievement
Detailed planning for establishment of access route	Study of ROV insertion route		Drafting the cutting plan (Not included in the scope of the goal achievement indicators)	Achieved
	Study of cutting plan			Achieved
	Cutting plan			Achieved
On-site demonstration of access route establishment	Interfering objects countermeasures	Implementation of detailed investigation of interfering objects	Completion of detailed investigation of interfering objects (Target TRL at completion: Level 6)	Achieved
		Removal of lead wool mat and cutting of grating	Completion of cutting (Target TRL at completion: Level 6)	Achieved
		Cutting of T type beam and middle crosspiece of handrail		Achieved
		Cutting of conduits		Achieved
	Installation of guide pipe		Completion of installation of guide pipe (Target TRL at completion: Level 6)	Achieved
Detailed planning for detailed investigation inside PCV	Study on impact of interfering objects		Drafting the cutting plan (Not included in the scope of the goal achievement indicators)	Achieved
	Study on impact of reduced water level inside PCV due to the earthquake off-shore of Fukushima Prefecture			Achieved
On-site demonstration of detailed investigation inside PCV	Guide ring installation (ROV-A)		Completion of guide ring installation (Target TRL at completion: Level 6)	Achieved

5. Summary

- The detailed plan for access route establishment was revised, countermeasures for interfering objects and guide pipes were installed, and on-site demonstration of access route establishment was completed.
- The detailed plan for detailed investigation inside PCV was implemented, and guide ring installation was completed.