Access Hatch used for Debris Retrieval of the Fukushima Damaged Reactors-17094

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ABSTRACT

IHI have studied to establish debris retrieval technique for top and side access. Top access approaches to the reactor inside from the top floor. Side access is from the first floor. The top access is more regular technique in comparison with side access, because of same direction as fuel rods carrying in and out. Debris retrieval operation will be done under either flooding (in water) or air condition. Combination of them is also a possibility. This will be decided in 2017 by the Government.
As for both techniques, it is mandatory requirement to make confining and shielding boundary against inside PCV during operation. This access hatch is an important equipment to make the boundary. Top access will have an advantage over side access.
This paper introduces conceptual design of the access hatch of top access based on shielding calculation, strength calculation and system requirements.
The access hatch of top access will be installed on the refueling floor as the top of the reactor building. (See Fig.1.)

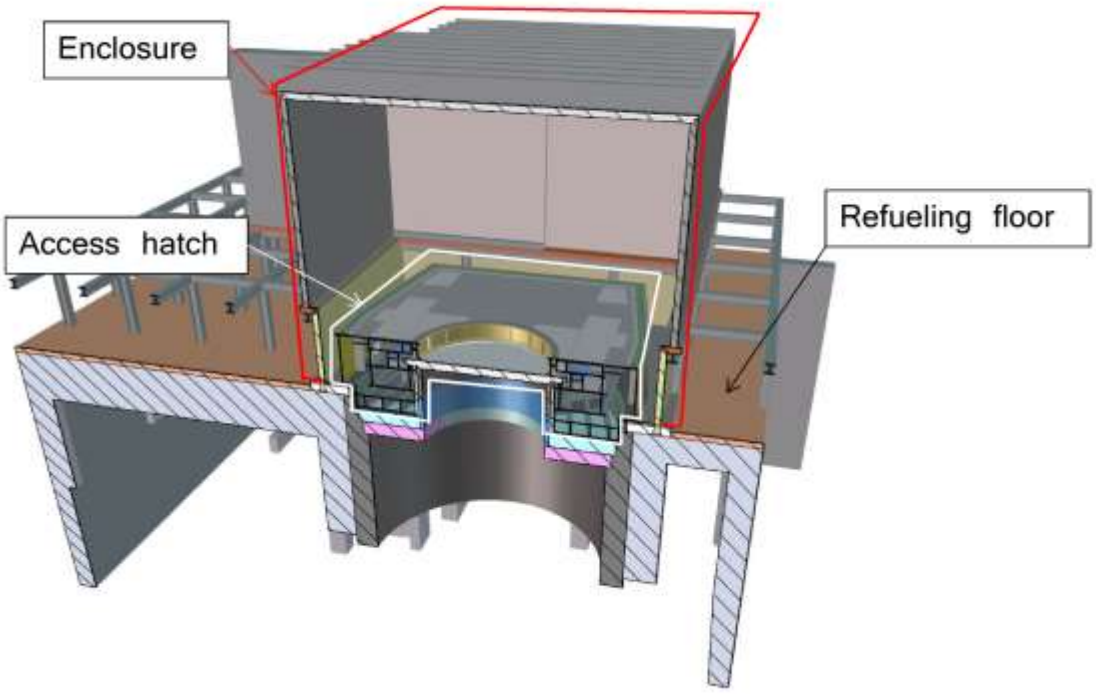

Fig.1.Access hatch used in top access

INTRODUCTION

The Fukushima Daiichi NPS unit 1, 2 and 3 have serious damage on reactor core. It is expected that all or a part of debris would fall down on the bottom of the pedestal.(See Fig.2.) The debris as well as solid waste will be retrieved under flooding (in the water) or air condition.

The top access is to approach the debris and solid waste after making an opening on concrete plug, RPV, and PCV.

After making an opening on concrete plugs, PCV and RPV, confinement and shielding boundary is needed to avoid spreading out contamination. The access hatch is set up on just above the reactor well.

This paper explains the functional requirements and design result of access hatch.

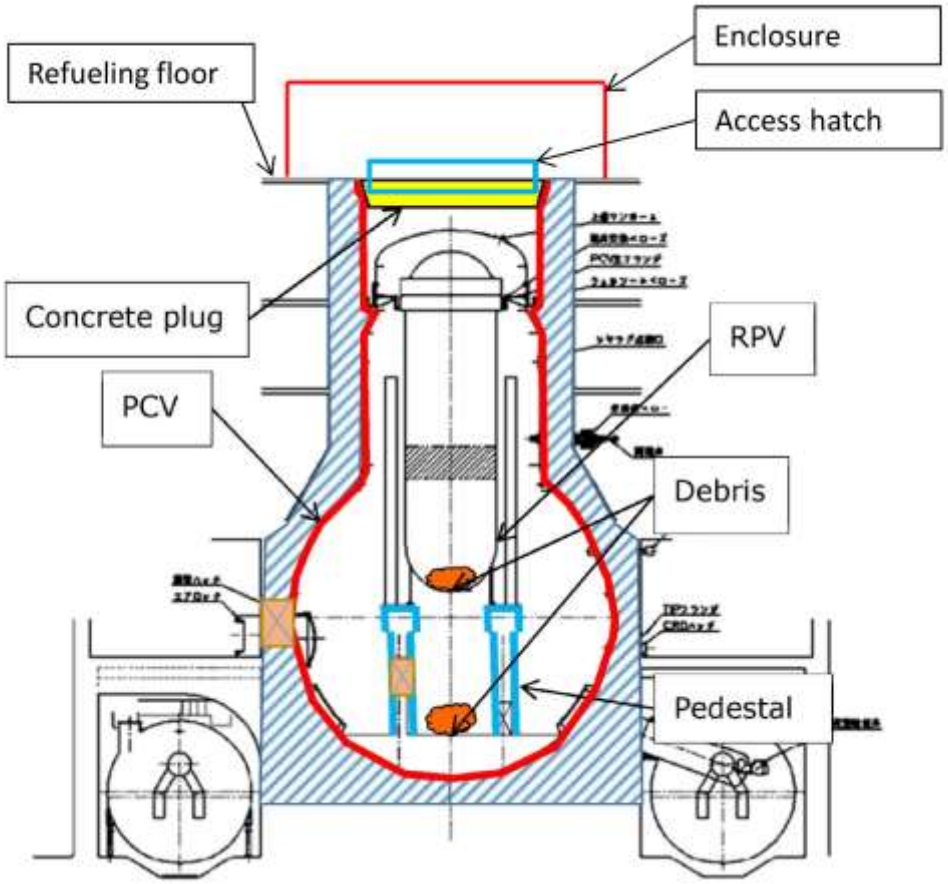

Fig.2. Estimated condition of debris

OUTLINE OF ACCESS HATCH

The access hatch and enclosure are installed on refueling floor in order to make confining and shielding boundary. The access hatch is placed in the enclosure. Access hatch and enclosure have a large diameter opening and door to pass through fuel debris, solid waste and the retrieval equipment. The doors do not open at the same time to keep confining boundary. The thickness of these doors has enough thickness for radiation shield. As a result, the access hatch becomes a heavy structure and needs to consider seismic loads.

FUNCTIONAL REQUIREMENTS

The main functions are (1) confining any contamination, (2) protecting radiation, (3) enabling equipment and debris to pass through, (4) securing rescue system for

moving parts.

(1) Confining contamination

The access hatch is installed in the isolated enclosure. After making an opening on concrete plugs, confining boundary is needed to avoiding contamination spreading.

(2) Protecting radiation

If debris will be retrieved under air without water, high radiation go through the opening. The dose rate on the top floor or around the outside enclosure shall be within the acceptance. For this protection, the door or other exposed parts shall have enough thickness against expected radiation source.

(3) Enabling equipment and debris to pass through

The equipment, solid waste or fuel debris will be carried in and out pass through the opening. The opening diameter shall be enough for passing them.
The door shall be smoothly opened or closed without stuck. The door and its driving system shall have enough strength and stiffness for seismic load.

(4) Securing rescue system for moving parts

Moving part such as driving system motor has trouble, it can be easily exchanged with manipulation system.

The above are basic requirements for the access hatch.

DESIGN RESULTS

The access hatch consists of (1) door, (2) supporting structure and shielding sleeve, (3) air tight cover, (4) inflatable seal between door and air tight cover, (5) driving system. (See Fig.3.)

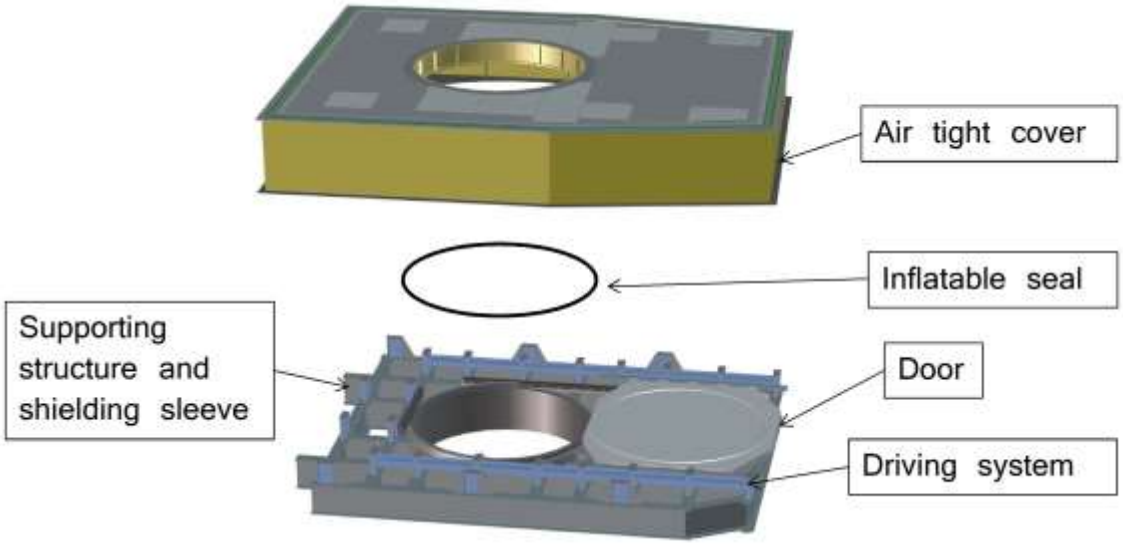

Fig.3. Access hatch image

The following are explanation of main parts.

Each item is to be designed in accordance with the functional requirements.

(1)Door

The door makes a part of radiation and confinement boundary. Even though door would be either single or double door, single door was chosen, because double door was difficult to make confining boundary at the matching surface between the doors. The thickness is enough to protect radiation come from the reactor inside. IHI performed radiation calculation. It gave the thickness as minimum 300mm. (See Fig.4) The other dimensions are width 6800mm, length for moving direction 6010mm. Its total weight is approximately 100 metric ton. Due to its heavy weight, the door is supported with rail on both sides along the moving direction. Driving system is rack and pinion with electrical motor.

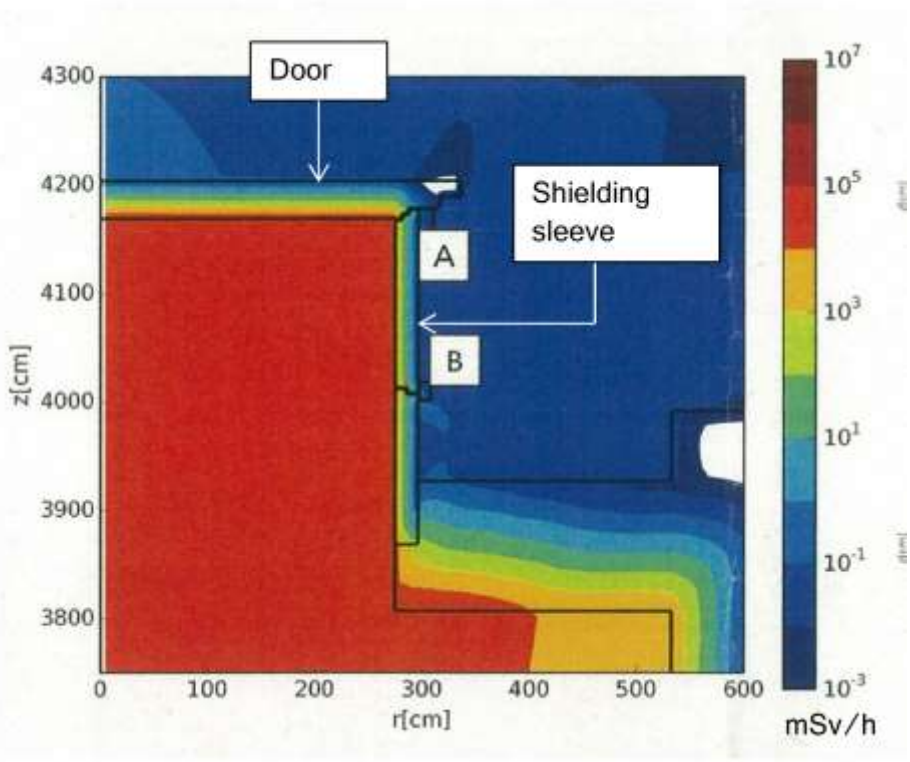

Fig.4. Result of radiation calculation

(2)Supporting structure and shielding sleeve

The supporting structure bears the weights of the door, driving system and shielding sleeve. It consists of heavy H section beams and has enough stiffness avoiding excessive deformation and response against seismic load. IHI performed the strength calculation and determine the H section size as H1000X400X19/32.

The shielding sleeve is deployed underneath the door. It composes a part of radiation shield with the door. The thickness was determined as 200mm from radiation calculation as well as the door. The length is approximately 1680 mm and its weight is 50 metric ton. The interface at closed condition between the door and sleeve is labyrinth with 10mm gap. The sleeve is embedded into the shield plugs of 2nd layer for shielding radiation and supporting seismic load. (See.Fig.5.)

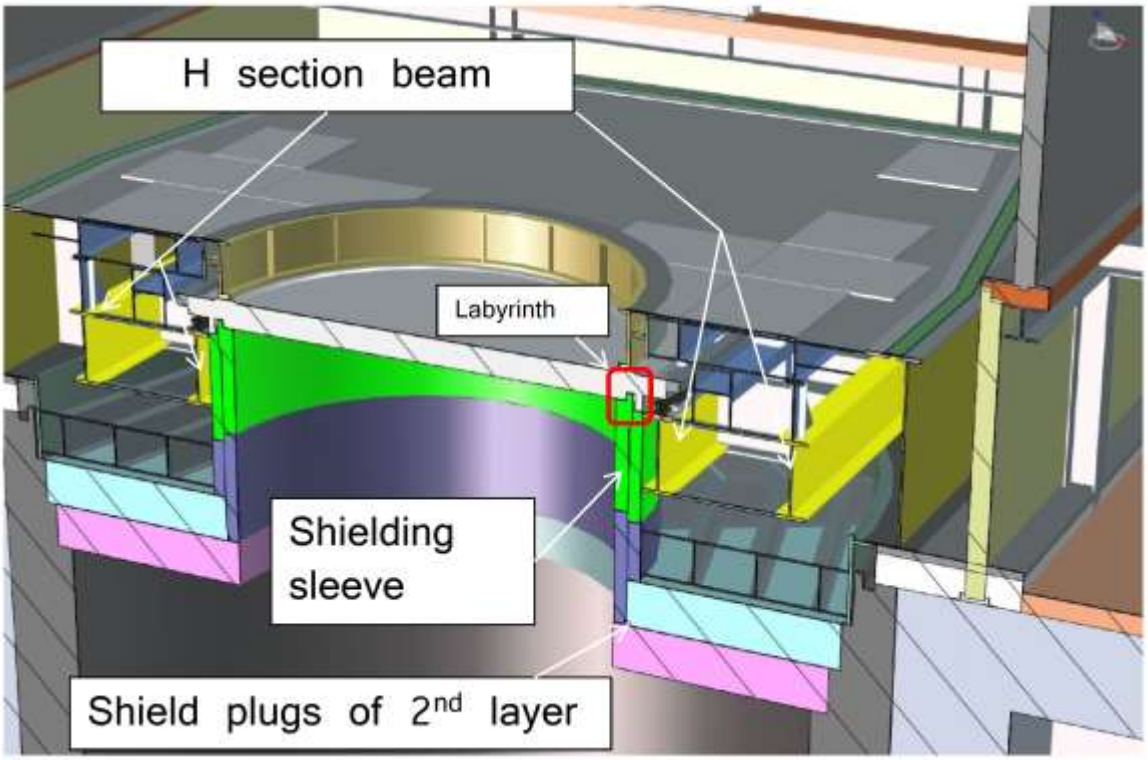

Fig.5. Supporting structure and shielding sleeve image

(3)Air tight cover

The air tight cover compose confinement boundary with the door. (See Fig.6.) It encloses the supporting structure, driving system and a part of door to make air tight boundary. Its inside keeps negative pressure to avoid spreading contamination.

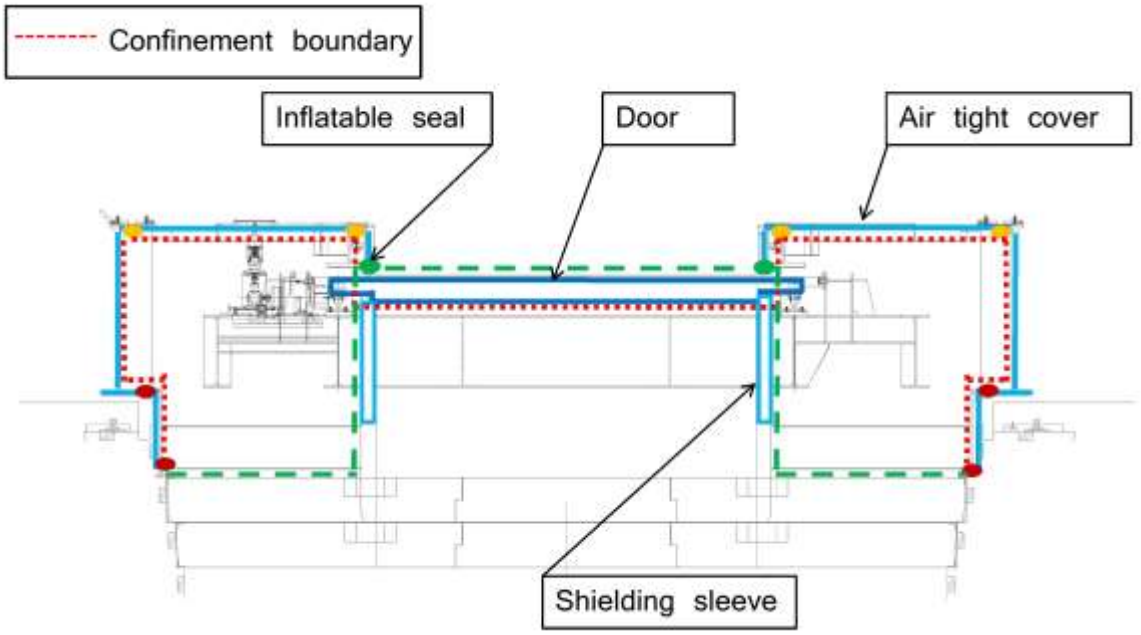

Fig.6. Confinement boundary

(4)Inflatable seal

An inflatable seal is used to the interface between the door and air tight cover. The seals are widely used in a building door with a gap. It is composed with a tube. The tube is pressurized and inflated to fill the gap and sealed, when seal is needed. (See Fig.7.) The material of the tube will be EPDM (ETHYLENE POLYMER DINO MONOMOR), because it has widely been used in nuclear facility.

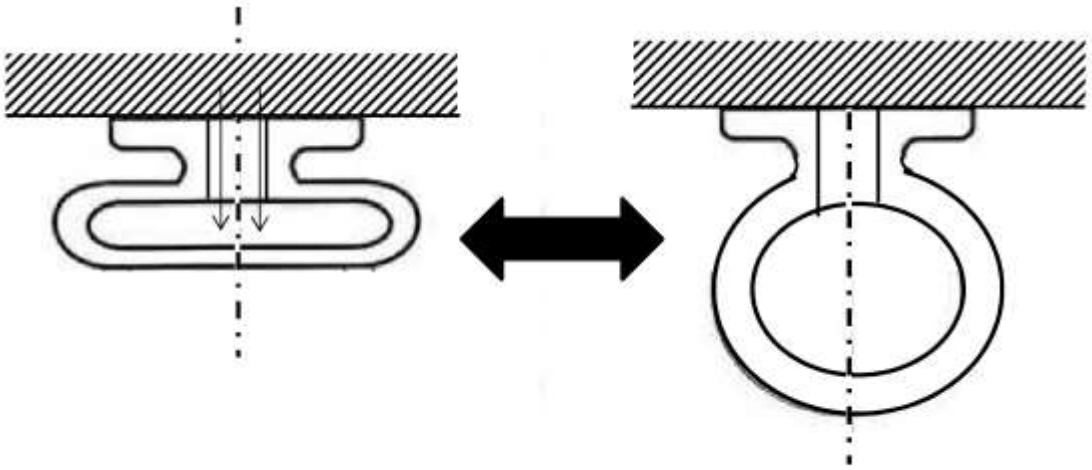

Fig.7. Operation principal of an inflatable seal

(5)Driving system

The interface between door and H section as supporting structure is rail and roller. The door is supported with 4 rollers at the one side and total 8 rollers. Ruck and pinion gear system is placed near outside the rail and roller of both sides. (See Fig.8.) That is, double system. The pinion is driven by one electric motor. When trouble occurs on the one side, the other side can move the door by only itself. The troubled motor and gear also can be changed with remote manipulation system. The feed speed of the door will be 1m/min. Stopping the door at the both ends will be done with limit switches.

According to the seismic design requirement, the door is fixed with pin connection at both open and close ends. Pin connection at the open end is double system. When pin connection has trouble and cannot pull out, it avoids remaining door opened.

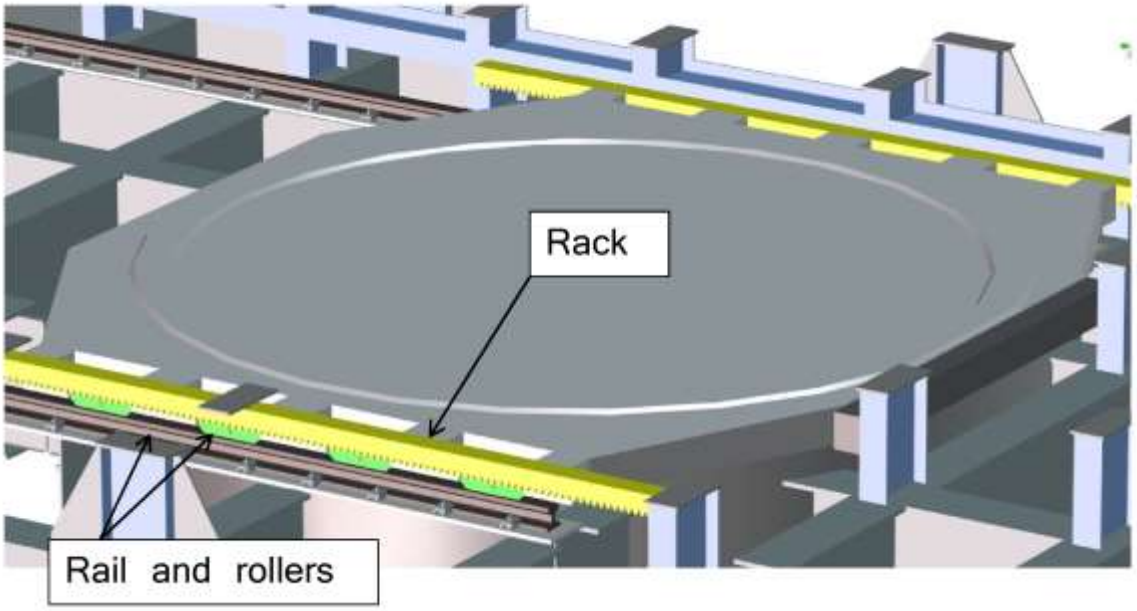

Fig.8. Driving system image

TECHNICAL ISSUES

Technical issues to be resolved are as follows.
(1)Installation technique for the heavy weight block on the contaminated area.
(2)Establishing performances of moving/electrical parts under traditional condition.
(3)Rescuing parts or system with manipulation system.

CONCLUSIONS

IHI have completed the conceptual design of the access hatch for top access with the conditions. IHI will continue to study the retrieval technique and refine the design in accordance with resolving the conditions

ACKNOWLEDGMENTS

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