Recent Findings from Fukushima Daiichi Unit 1 Primary Containment Vessel Investigations

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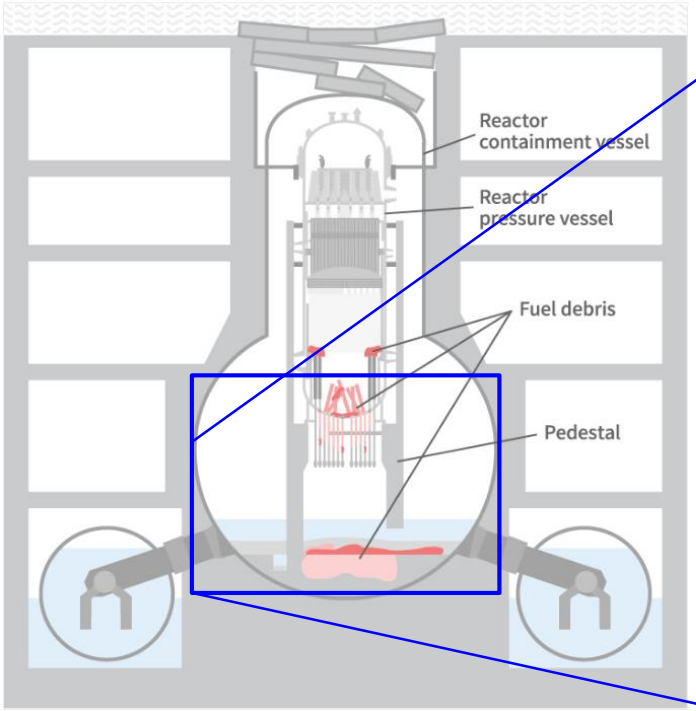
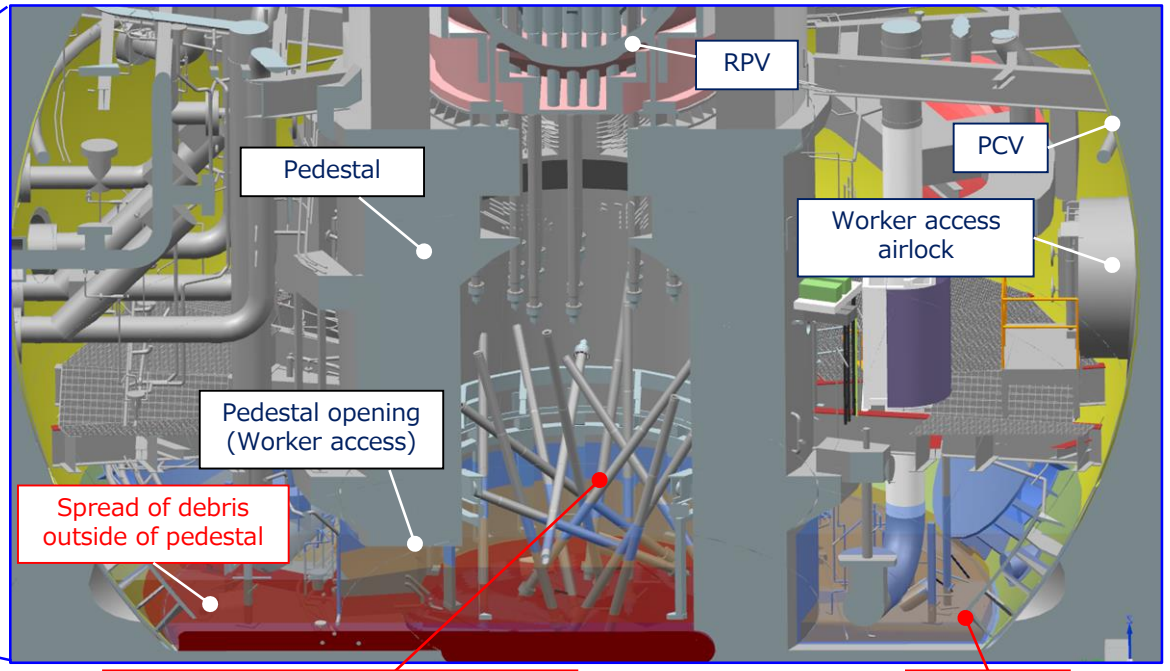
General information

- Plant type: BWR-3
- Containment type: Mark I
- Investigation tool: submersible ROVs
- Investigated area: PCV D/W floor
- Water level: about 2 m

- Pedestal radius: 2.5 m
- Pedestal wall thickness: 1.2 m
- Pedestal axis to shell (floor lvl.): ~6.5 m
- Pedestal floor area: ~20 m^2
- D/W floor area: ~90 m^2



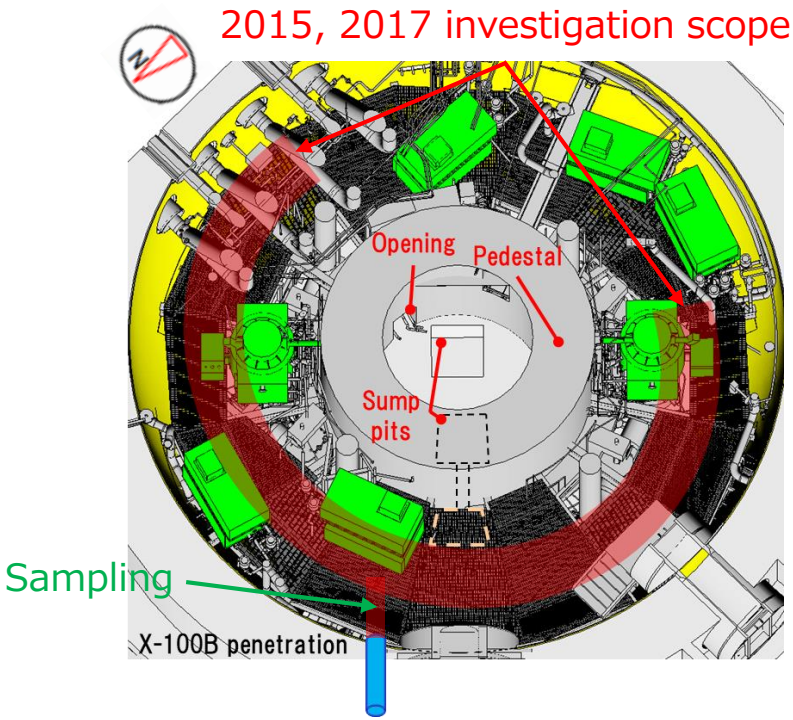
Estimated state based on previous analyses and investigations



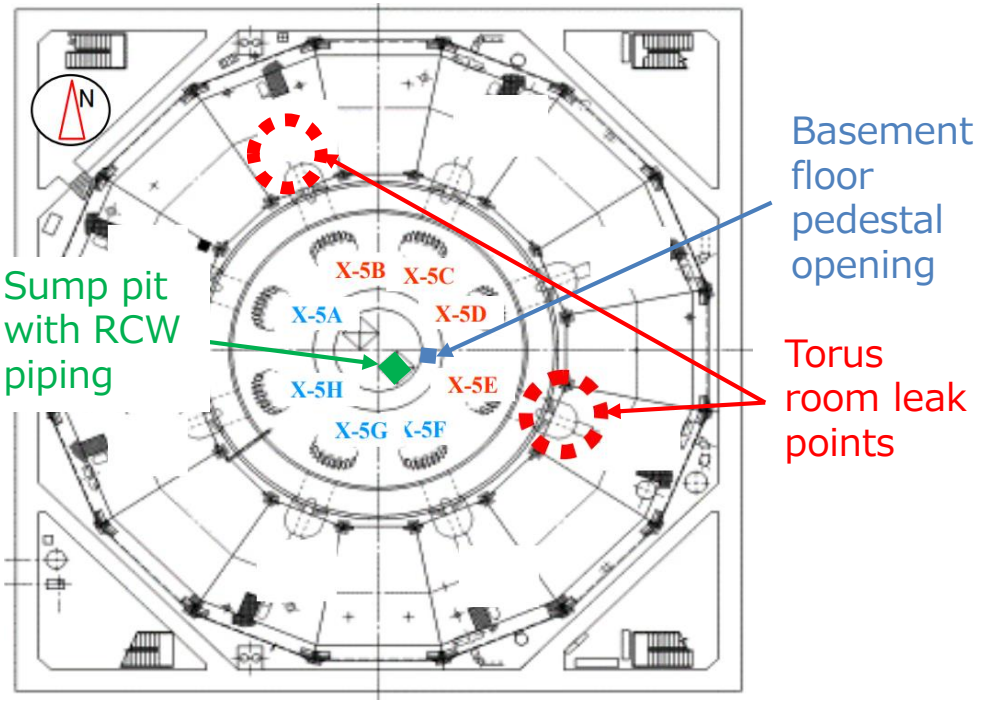
Source : International Research Institute for Nuclear Decommissioning (IRID)

Investigation results up to 2022

- High contamination of reactor building closed cooling water (RCW) system (2011 R/B investigation)
- Water leakage from sand cushion pipe (2013) and vacuum breaker (2015) in torus room
- No large fuel mass detected in the core region (cosmic muon radiography in 2015)
- 1st floor of PCV investigated (2015, 2017) and deposits found below on D/W floor
- Corrosion products largely found in deposit samples (2017)



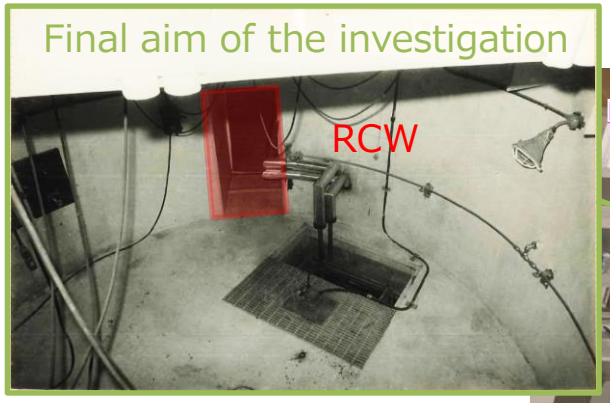
D/W 1st floor

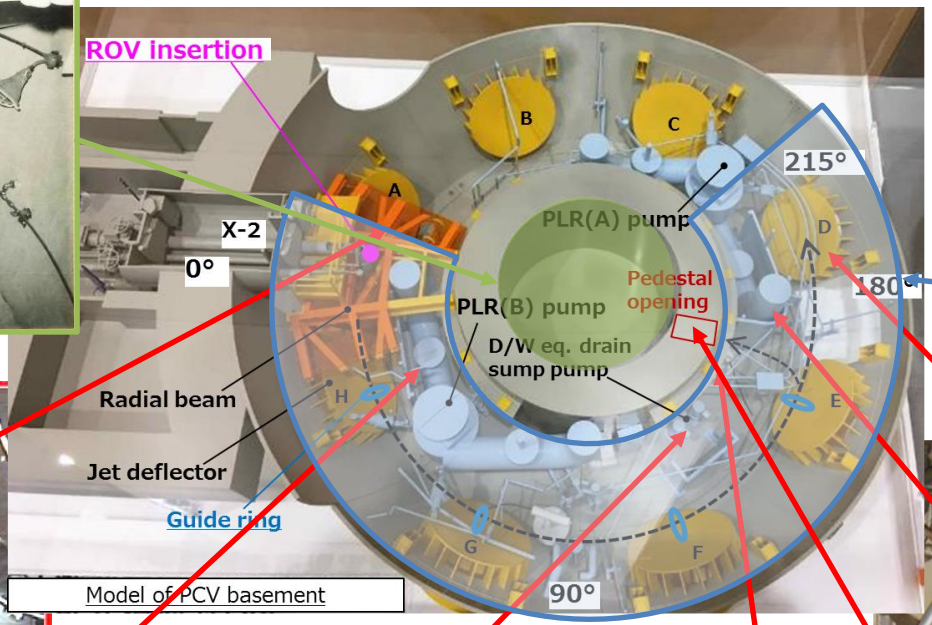


D/W basement floor

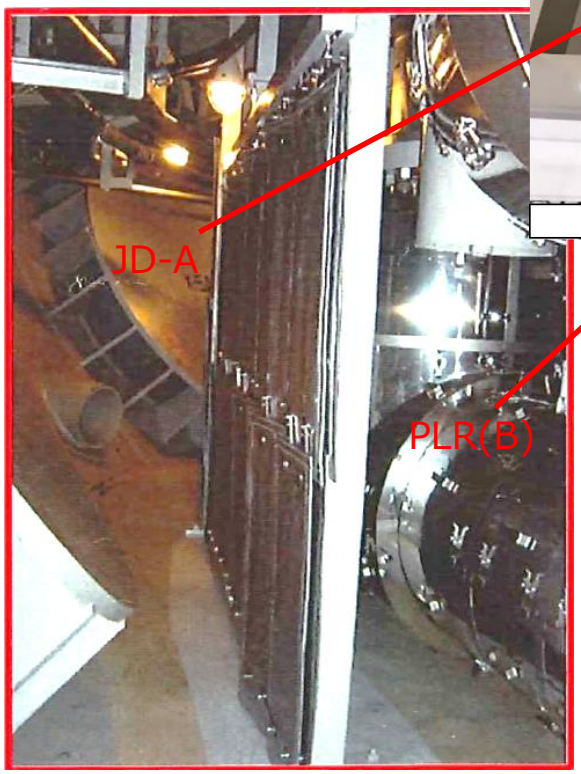
Source：International Research Institute for Nuclear Decommissioning (IRID)

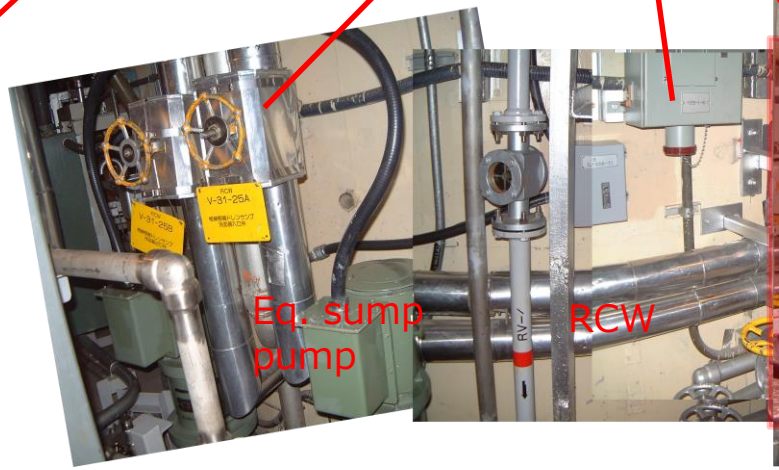
State of the PCV basement before accident

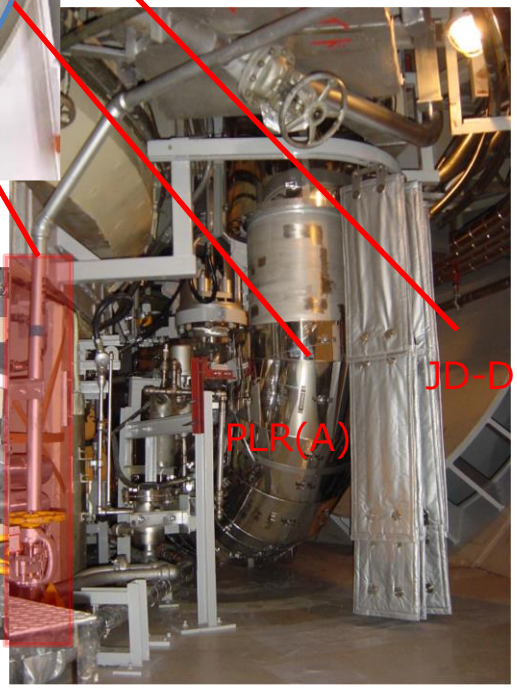




Scope of the investigation



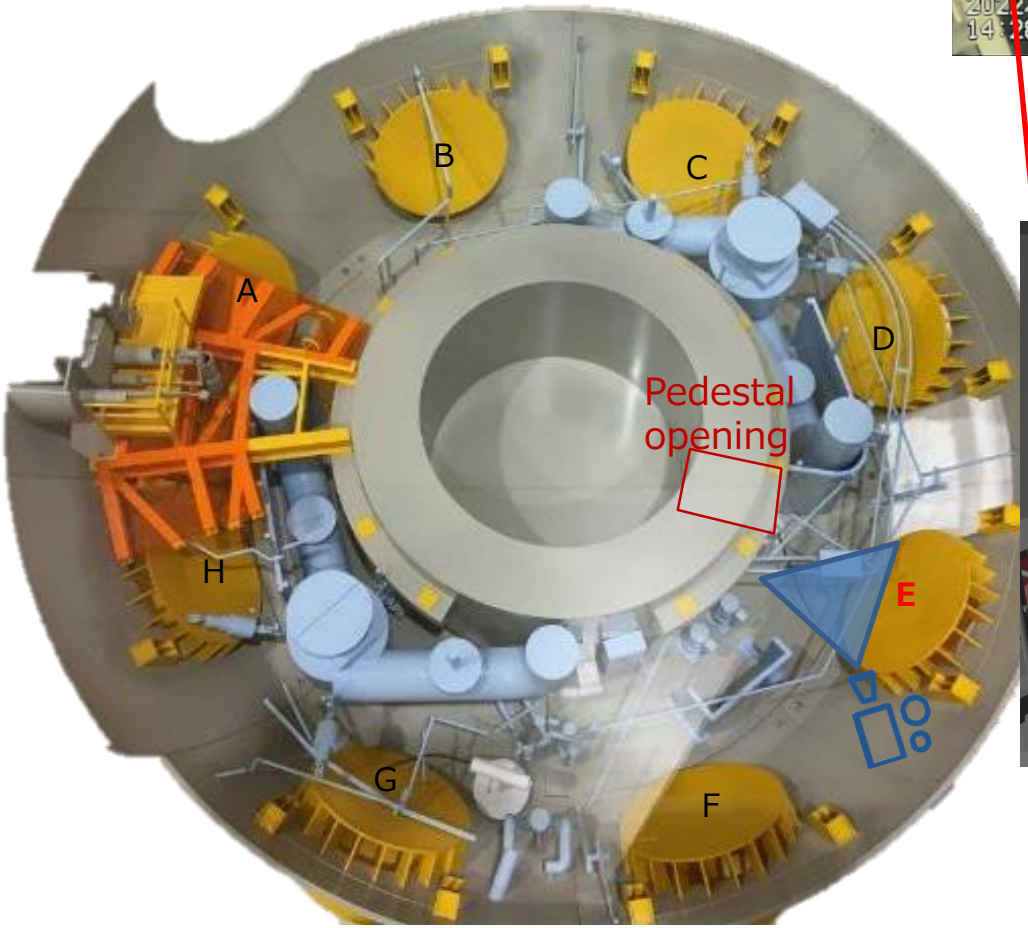


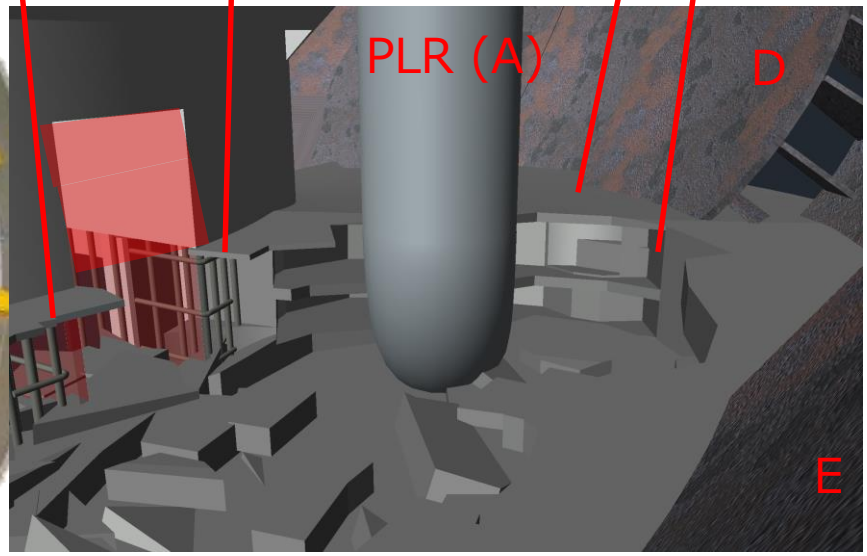


Source：International Research Institute for Nuclear Decommissioning (IRID)

Image of state in front of the pedestal opening

- Deteriorated pedestal concrete exposing rebar
- Shelves attached to the pedestal concrete
- 2 layers of shelves attached to the D/W liner
- Collapsed shelves in front of opening





*Rendering created based on the past investigation results and might differ from the actual state

E: Jet deflector connecting D/W with torus room water leakage

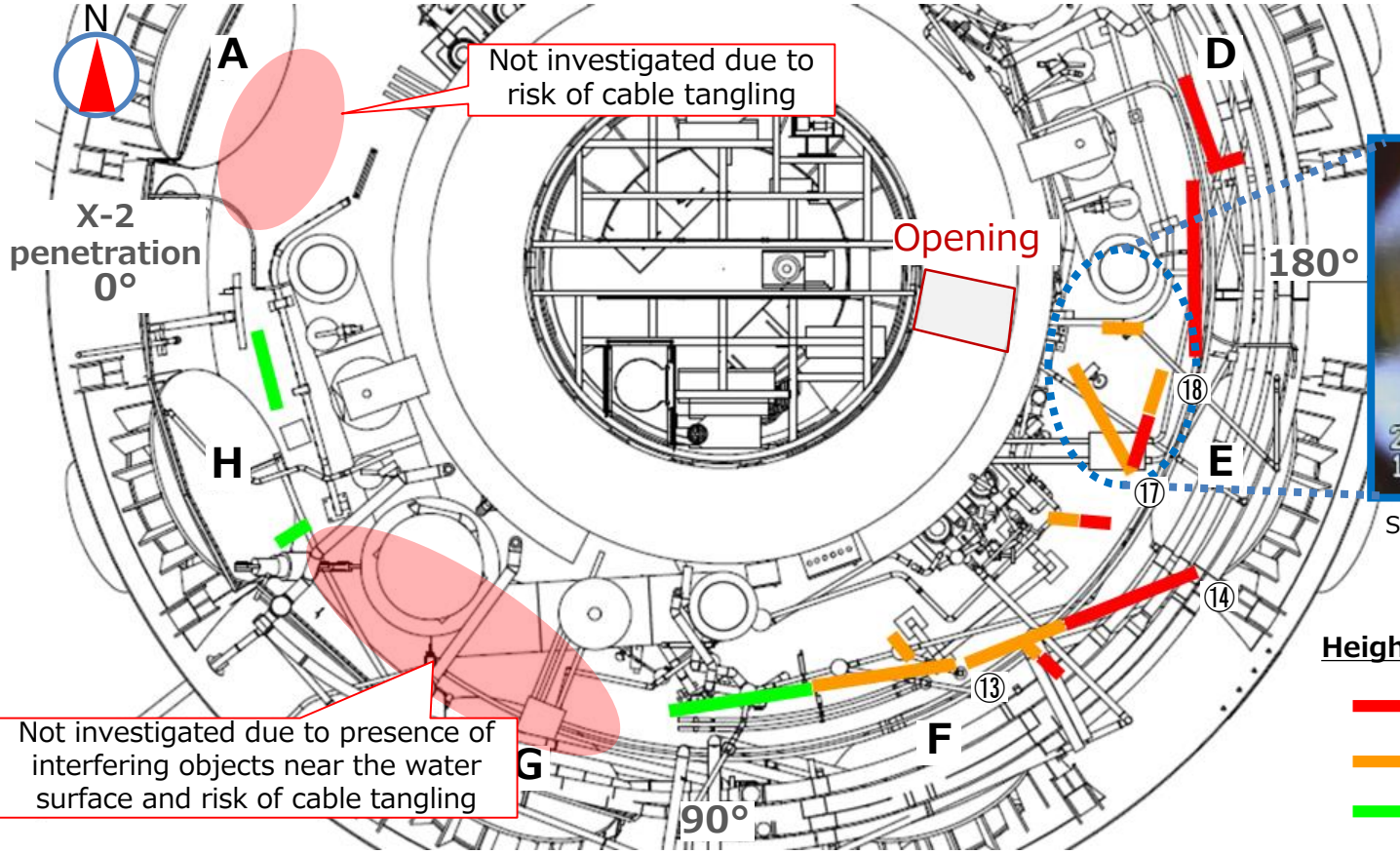
Source：International Research Institute for Nuclear Decommissioning (IRID)

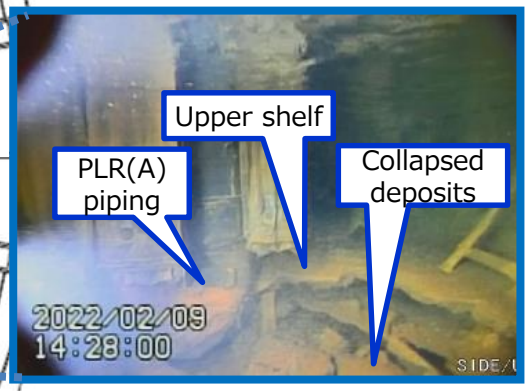
Results of the deposits height distribution investigation

- Generally decreasing height with increase of the distance from the pedestal opening
- **Maximum** evaluated height of **～1.1 m** (**outside of pedestal**)

Contrast with estimate of core and reactor internals piled only in the pedestal: ～ 1.1 m*

*rough estimate not considering equipment inside pedestal, sump pits and downwards progression of MCCI





State in front of the pedestal opening

Height from the D/W floor

- 0.8～**1.1m**
- 0.4～0.8m
- 0.2～0.4m

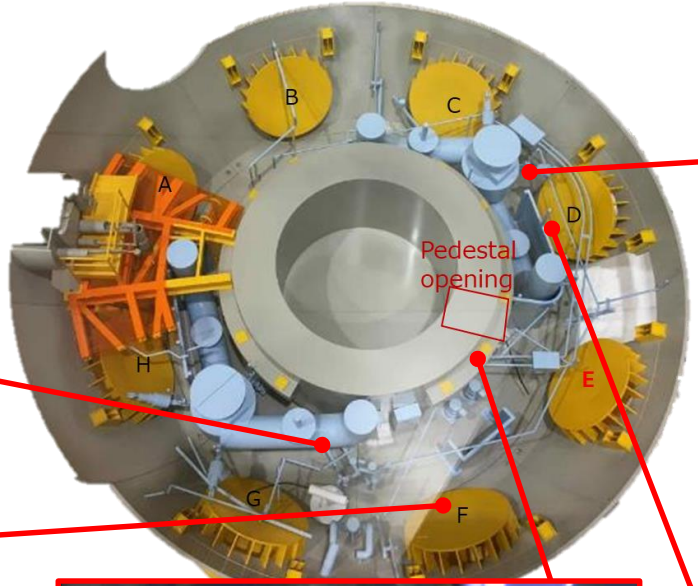
Measurement: Ultrasonic waves transmission/reflection while moving on the water surface

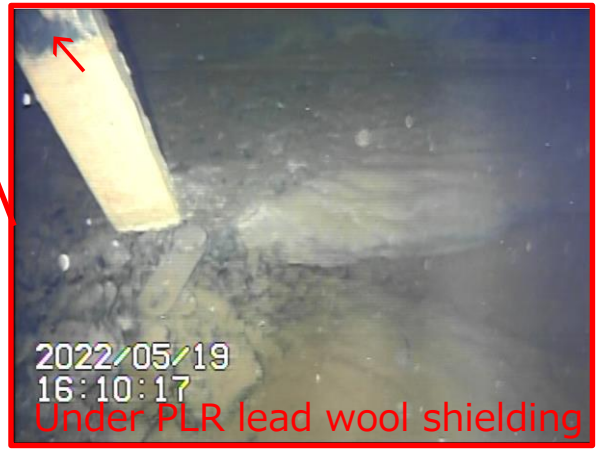
Evaluation: height of deposits from the D/W floor based on design data and water level of 2.0 m

Source：International Research Institute for Nuclear Decommissioning (IRID)

Distribution of deposits

- Deposits height increasing with distance from the pedestal opening in some areas
- Could some of them come from upper floors?



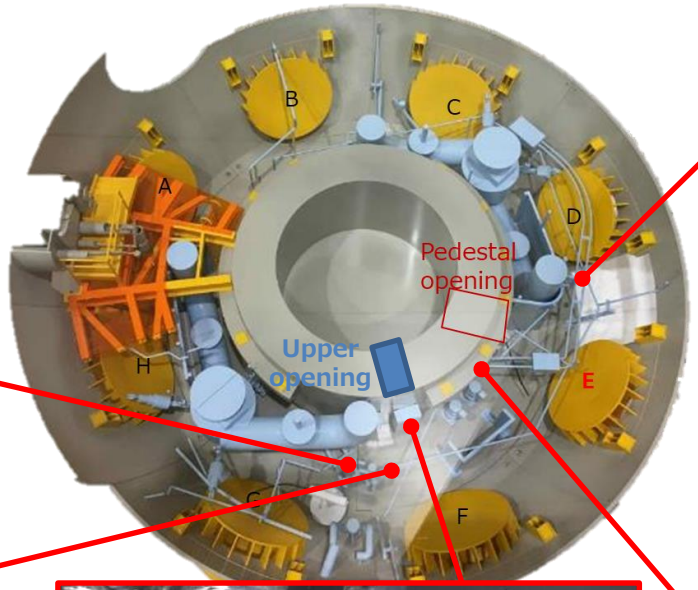


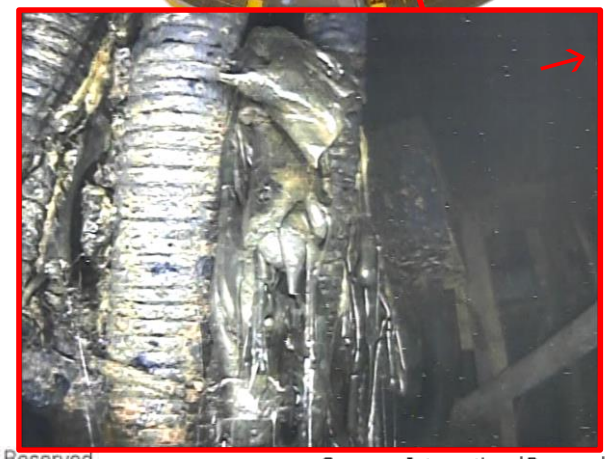
→ :direction towards the pedestal opening

Source：International Research Institute for Nuclear Decommissioning (IRID)

Deposits above water level

- Deposits hanging on pipes and supports
- Traces of solidified metal found on RCW and other piping





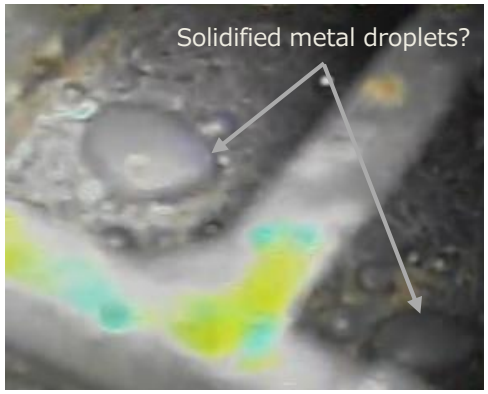
→ :direction towards the pedestal opening

Source：International Research Institute for Nuclear Decommissioning (IRID)

What could contribute to the amount of deposits?

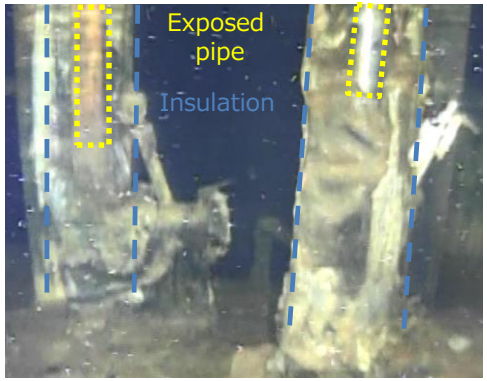
- Lead shielding and Zn galvanized grating from all D/W area (relatively small amount)
- Piping insulation materials?
- Materials coming from the pedestal area through the 1st floor opening?

Has to be considered to correctly distinguish and evaluate the spread of molten core



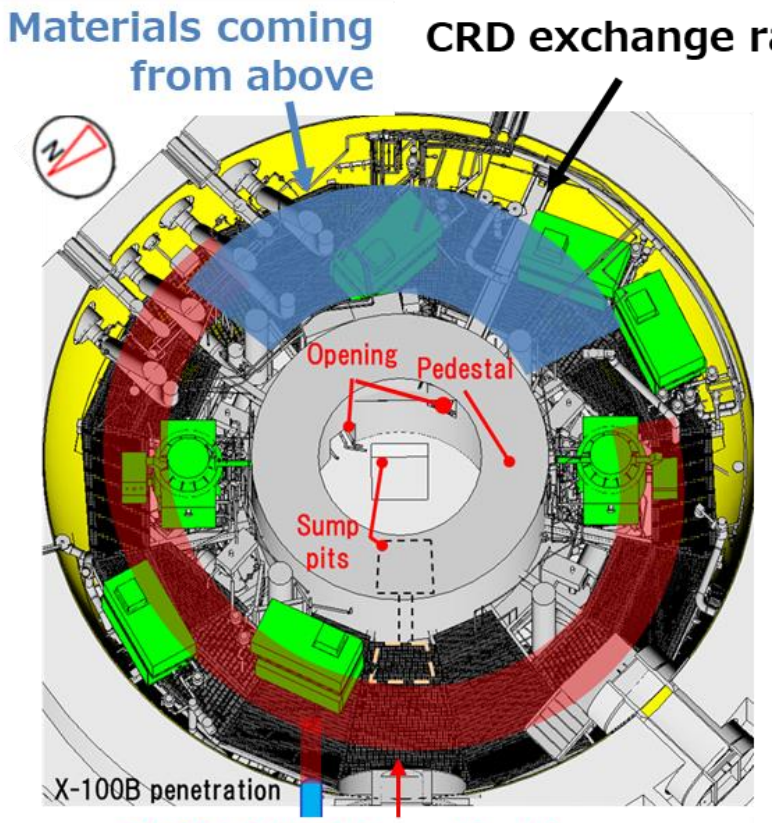
2015 investigation of
1st floor grating area

Gratings of Unit 4 of Fukushima Daini
(experienced temperature ~150°C)



RCW piping near equipment drain sump pump (under water)

RCW piping above water



D/W 1st floor

Source：International Research Institute for Nuclear Decommissioning (IRID)

State of the pedestal opening

- No significant damage to the upper part of concrete
- Deposits shelves on the right side of the wall increasing in height towards pedestal
- “lavacicles” on bottom surface of the shelves

Free space existed below the shelves when “lavacicles” formed

Conduit

Conduit

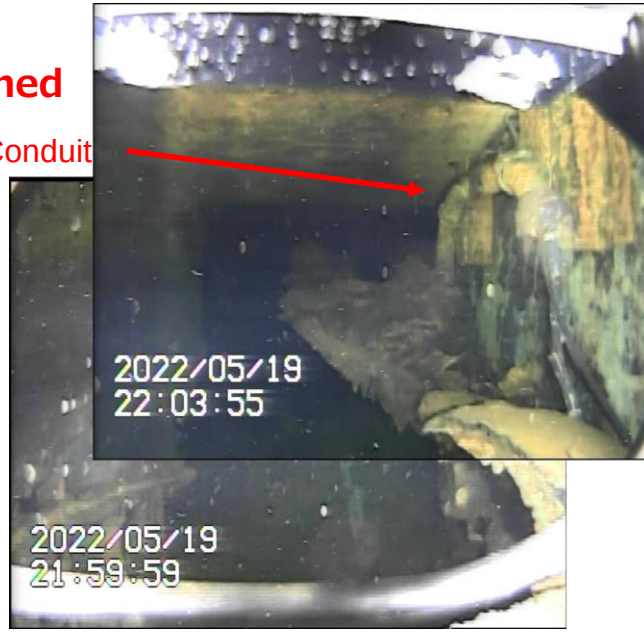
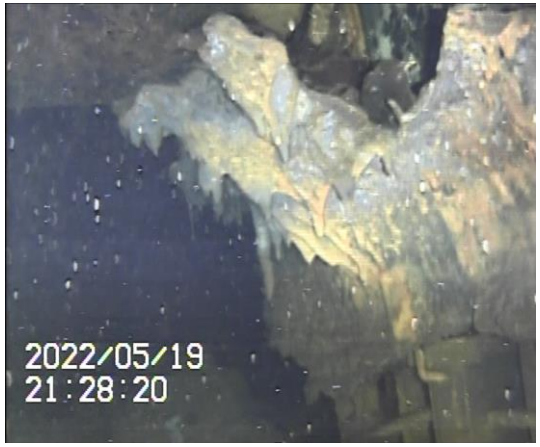


Photo of the middle part taken before 2011 not available



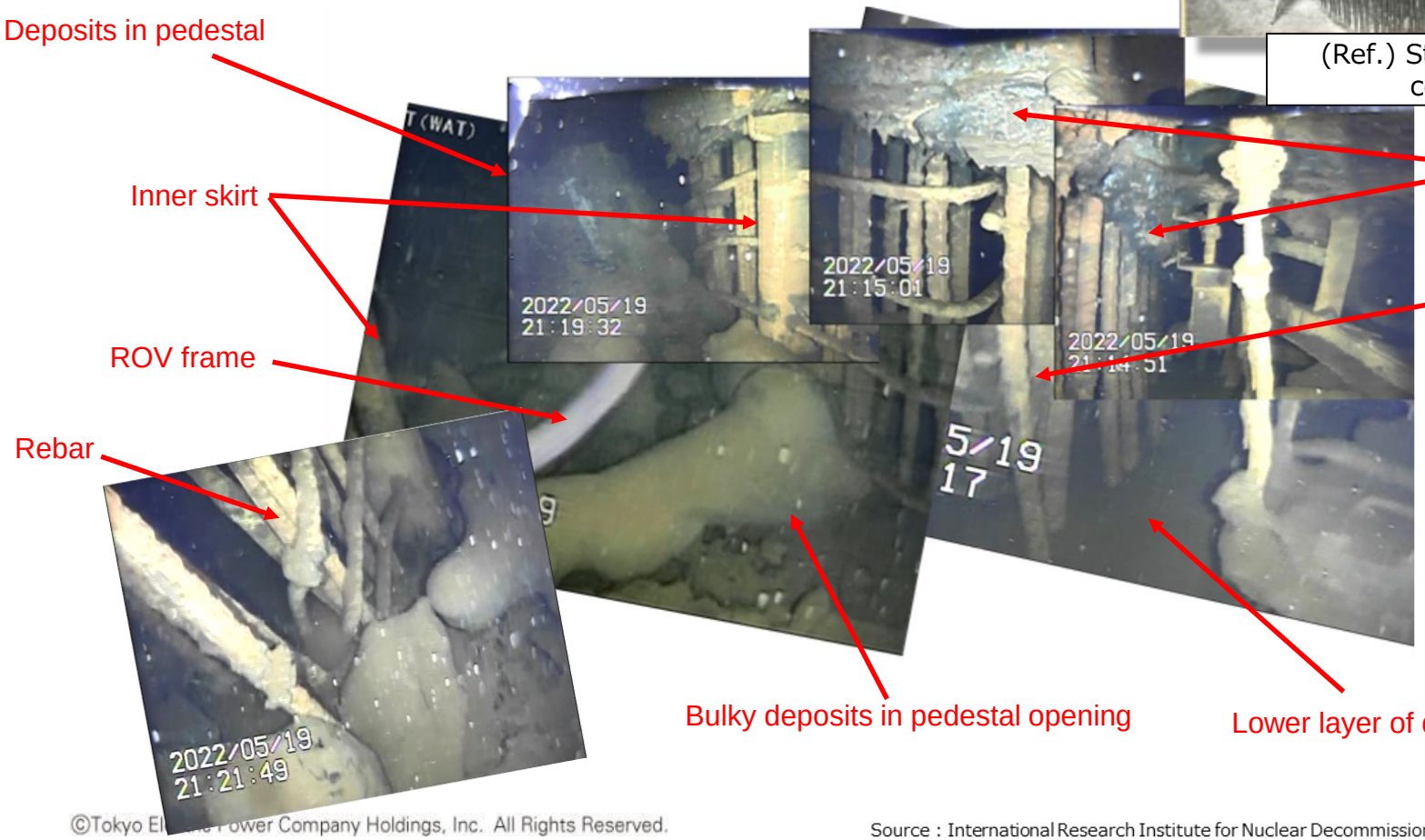
Source：International Research Institute for Nuclear Decommissioning (IRID)

Pedestal concrete degradation below shelves

- Concrete degraded up to ~1 m from the floor
- No significant deformation of inner skirt
- Minor deformation of rebar (embossed pattern still visible)
- Height of the deposits in the pedestal ~1 m

Possibility of heat being transferred by inner skirt/rebar

(Ref.) State at the time of construction



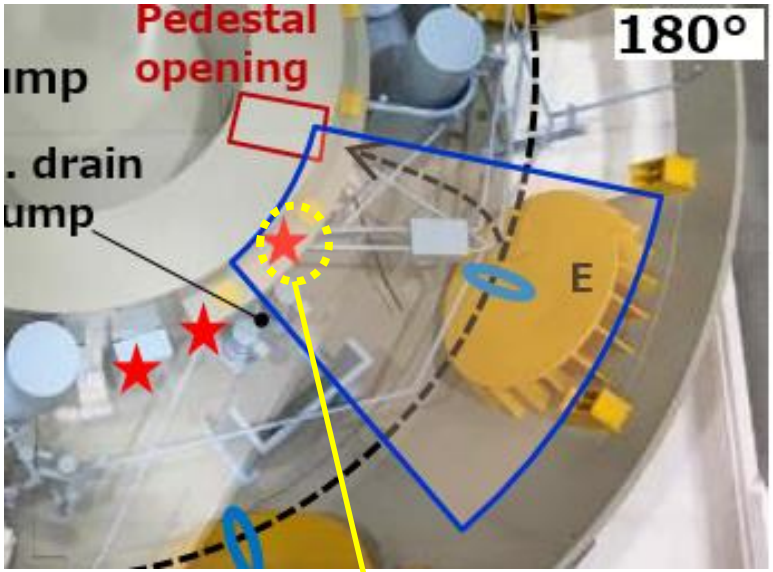
Source：International Research Institute for Nuclear Decommissioning (IRID)

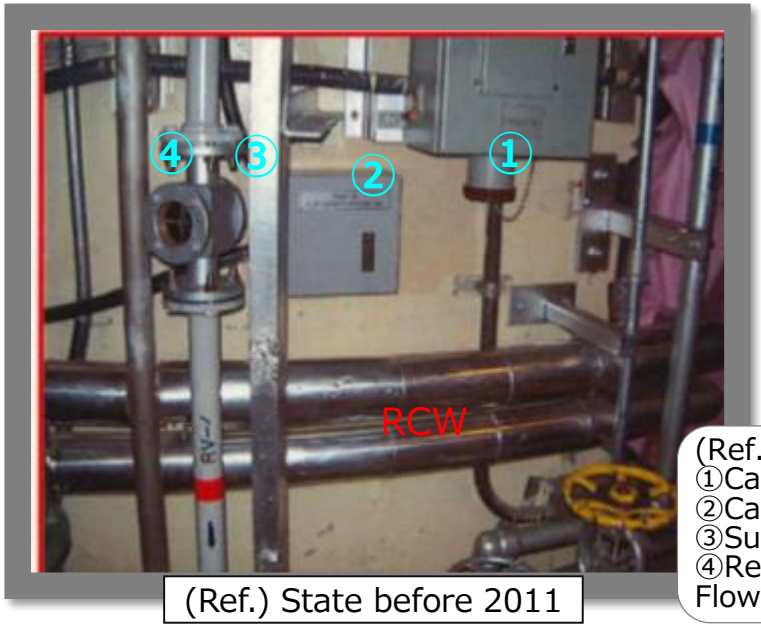
Pedestal concrete degradation below shelves

- Many metallic structures found to be relatively without deformations under the shelf
- RCW piping not found
- Rebar found without significant deformation

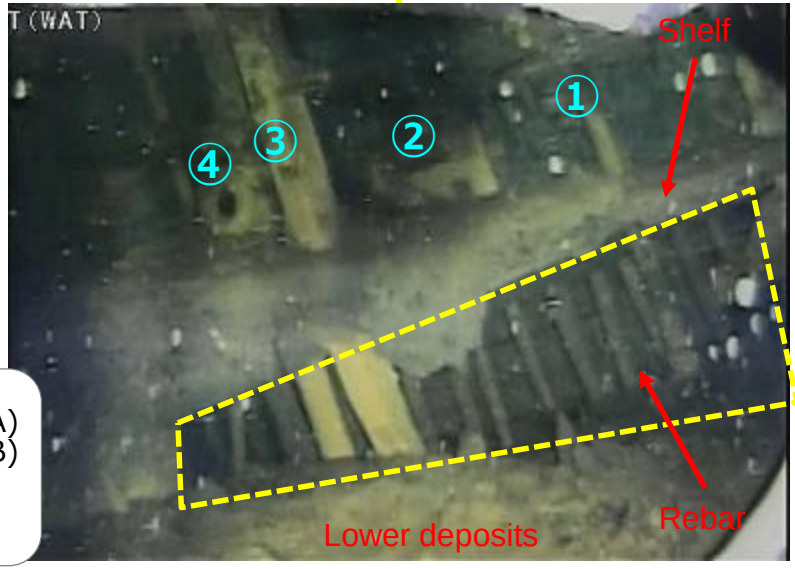
Low temperature concrete degradation?

Long term effects (coolant flow, etc.)?





(Ref.) State before 2011

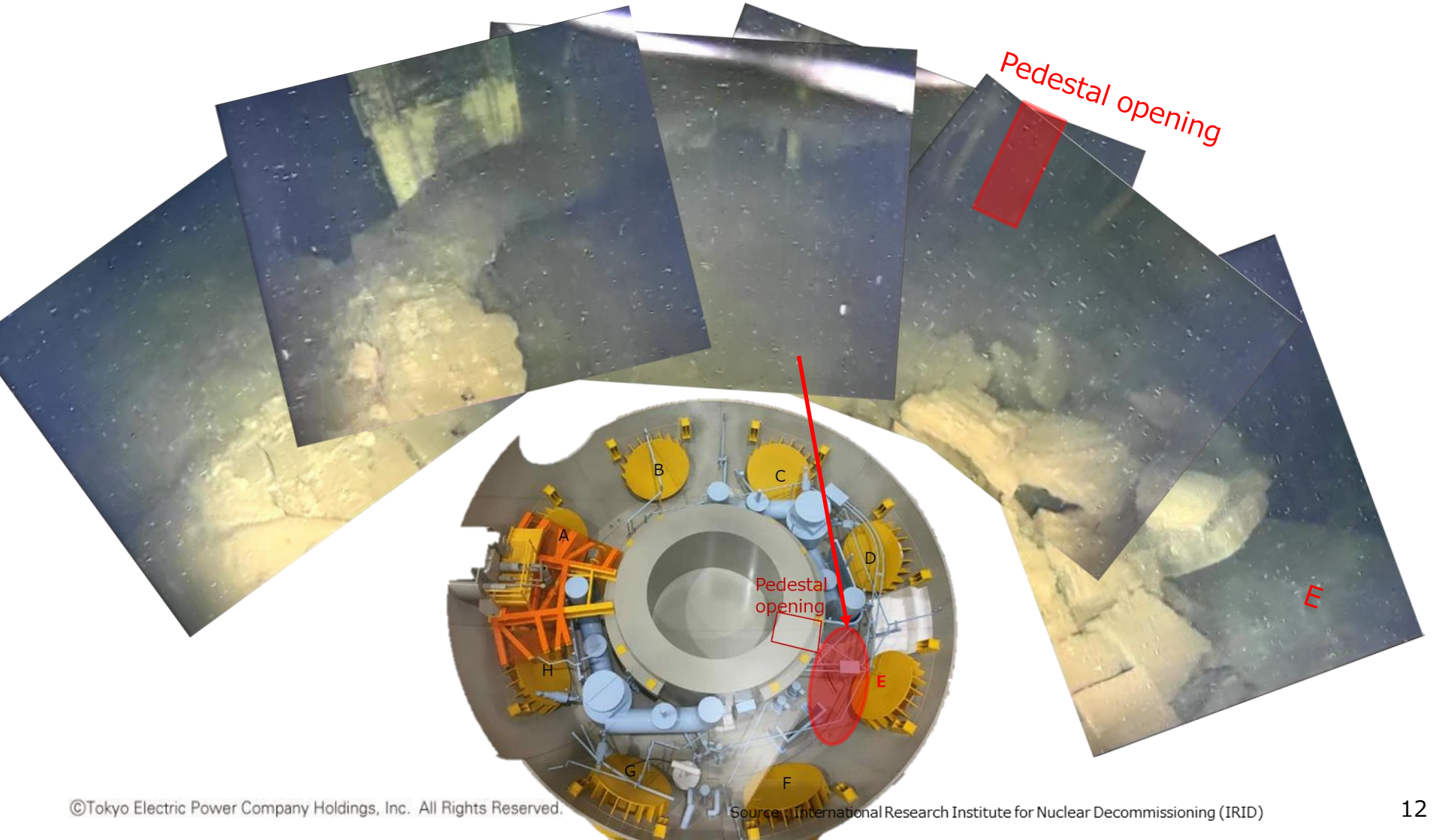


(Ref.)
①Cable relay box (A)
②Cable relay box (B)
③Support
④Reactor Vent line
Flow glass

Source：International Research Institute for Nuclear Decommissioning (IRID)

Formation of cavities and shelves

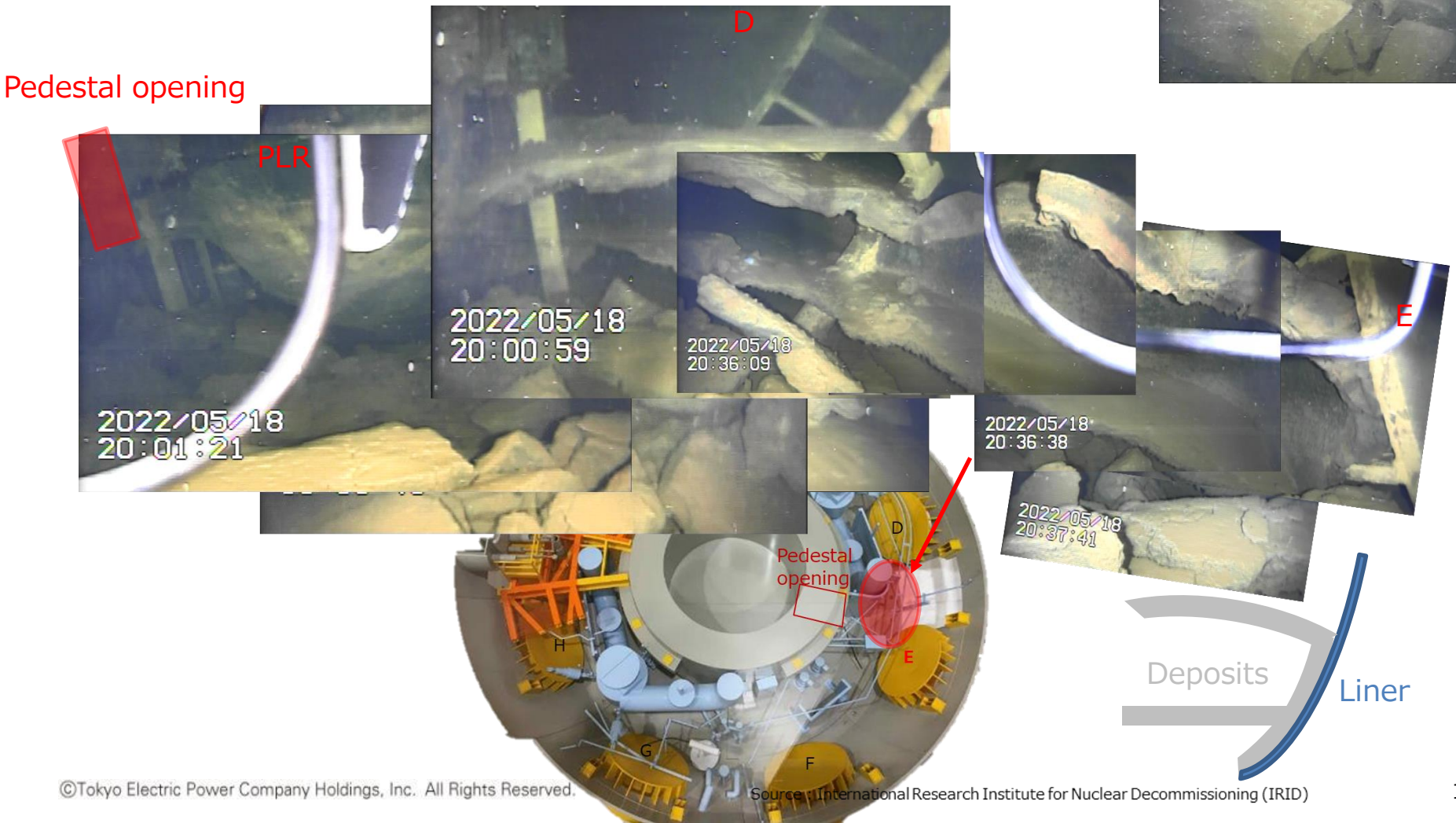
- Cavities found under the deposits
- Collapsed shelves found in higher amount near Jet Deflector E and PLR piping



Source : International Research Institute for Nuclear Decommissioning (IRID)

Formation of cavities and shelves

- Collapsed shelves seemingly forming one layer before
- Upper shelf coupled with the lower near liner
- No visible deformation of jet deflectors, PLR piping or support structures



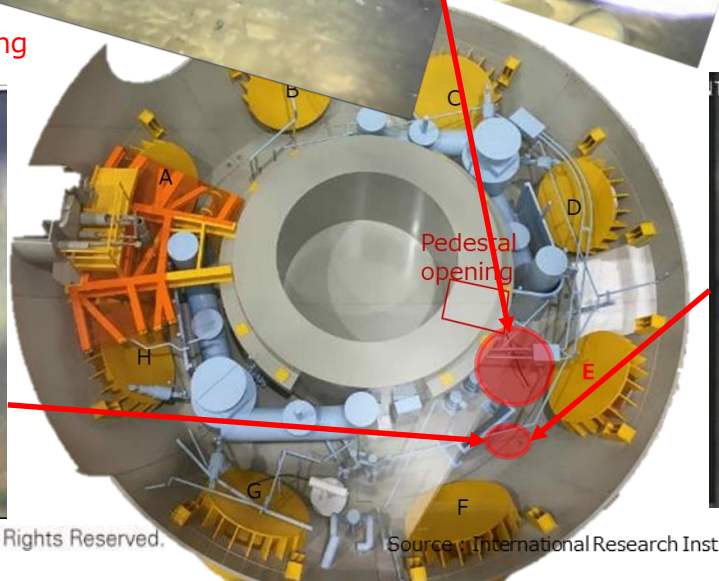
Source : International Research Institute for Nuclear Decommissioning (IRID)

Formation of cavities and shelves

- Only one shelf with deposits piled from above
- Collapsed shelves not found in big amounts

Different in nature than shelves near PLR and Jet Deflector E or buried in other materials?

→ :direction towards the pedestal opening



Source : International Research Institute for Nuclear Decommissioning (IRID)

Summary

Several currently unexplained observations need to be investigated in more detail for improved understanding of SA phenomena:

- the origin and nature (fuel content, physicochemical properties, etc.)of the materials comprised in D/W deposits (material balance)
- formation mechanism of deposit shelves and cavities
- relatively low temperature pedestal concrete erosion mechanism
- soundness of PCV shell and other metallic structures in the vicinity and under the shelves
- degree of pedestal wall concrete damage above/below the deposit shelves
- effect of events (cooling water flow, etc.) in long term after the accident and possible contribution of time-related deterioration to currently observed state

Thank you for your attention