Fuel Debris Retrieval

Toyoshi Fuketa

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Fuel debris

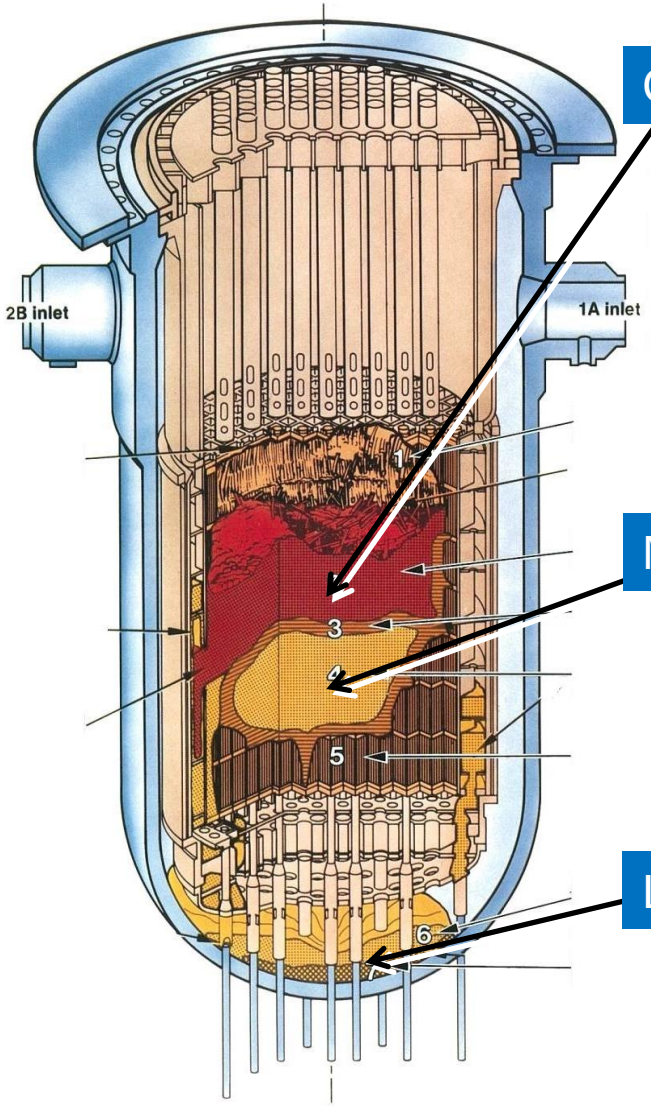
- ✓ Debris means “wreckage and fragments”.
- ✓ Nuclear fuel that has melted, flowed down, collapsed, or mixed with surrounding structures as a result of the accident is called "fuel debris”.
- ✓ At present, the fuel debris is stable and not in a state that requires urgent action.
- ✓ In the long term, it is important to retrieve fuel debris and transfer it to a properly controlled condition.
- ✓ The purpose is to transfer the radioactive material in a dispersed state to a sufficiently stable state. Removal of fission products (FP) including cesium is also important.

Three Mile Island Unit 2 (TMI-2) Accident

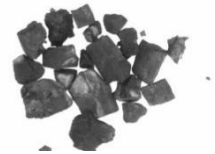
1979.3.28 4:37amEST

Approximately 45% of core got damaged, and approximately 20t fell to lower plenum

R.K. McCardell, Nucl. Eng. Des. 118(1990) 441



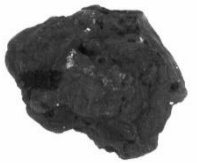
Core upper area



Mostly fractured fuel and resolidified molten fuel.

Control rod, cladding materials, structure materials seem to have mostly melted and moved without reacting with fuel.

Estimated max temp is approximately 2,000K in most areas.



Molten pool (approx. 3 m in diameter, central part thickness 1.5 m)

Mixture of structure materials, control rod and fuel materials. Mostly metal.

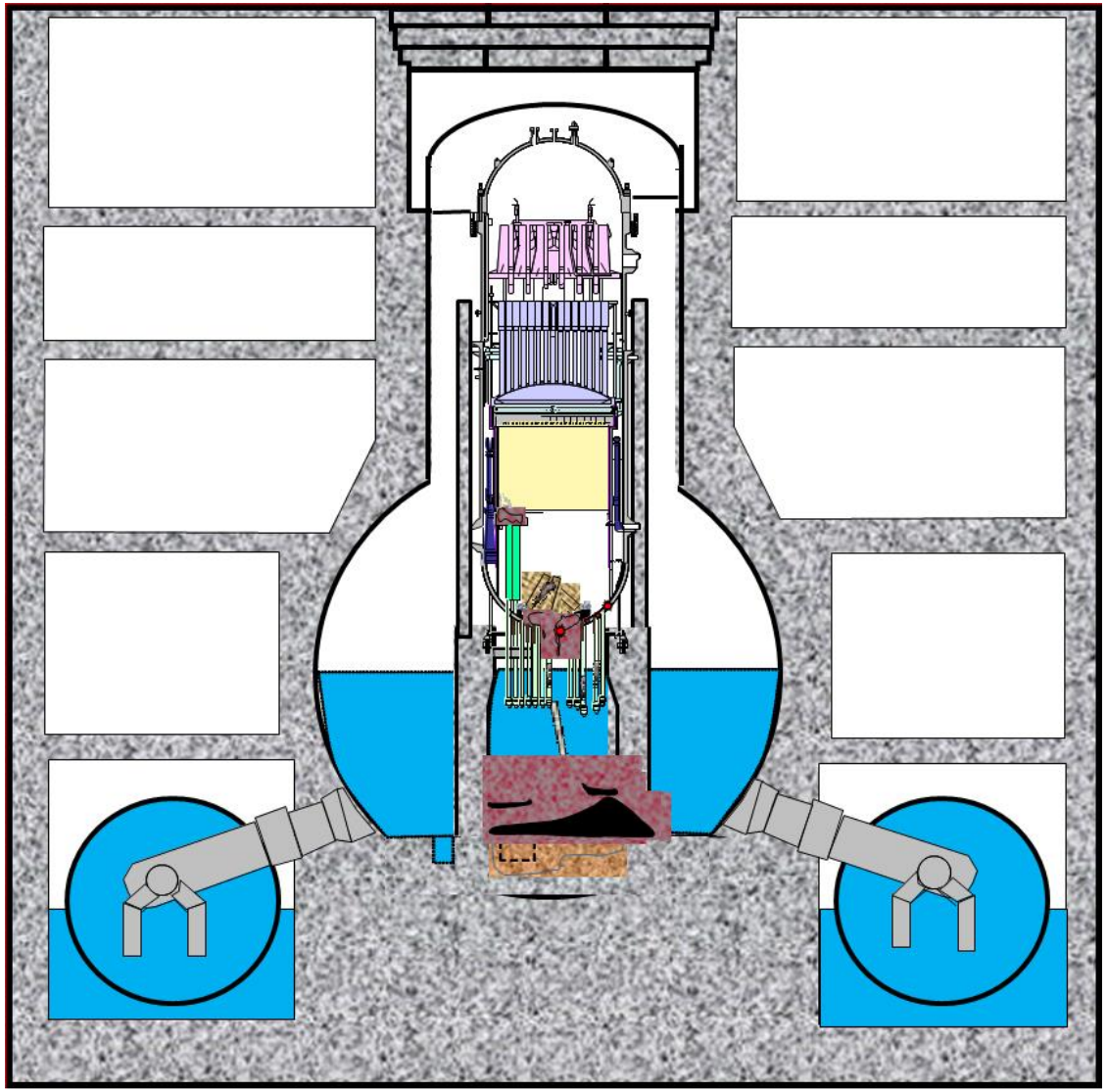
Estimated max temp is 2,700-3,100K.

Lower plenum (approx. 1 m thick deposit)

Size varies from 20 cm (rocks) to less than 0.1 mm (granules).

Resolidified molten ceramic ($(U,Zr)O_2$). Porous.

Fuel Debris at Fukushima Daiichi



Images courtesy of TEPCO Holdings, Inc.

- ✓ Full-scale retrieval starts with Unit 3.
- ✓ Properties and distribution of fuel debris greatly vary depending on the accident progression.

  Nearly intact stump-shaped fuel rod, fallen gravel-like fuel pellets, melted and solidified metal/ceramic materials, FP stuck in narrow segments, etc.

Study on Retrieval Method

NDF Sub-Committee for the Evaluation of Fuel Debris Retrieval Methods

- ✓ Fuel debris retrieval methods are studied focusing on:
  - (1) Partial submersion method
  - (2) Submersion method
  - (3) Filling and solidification method
- ✓ Practicable method will be selected while placing utmost priority on safety.
- ✓ Work period is rough estimate.
- ✓ Cost is not included in the study.

① Partial submersion method

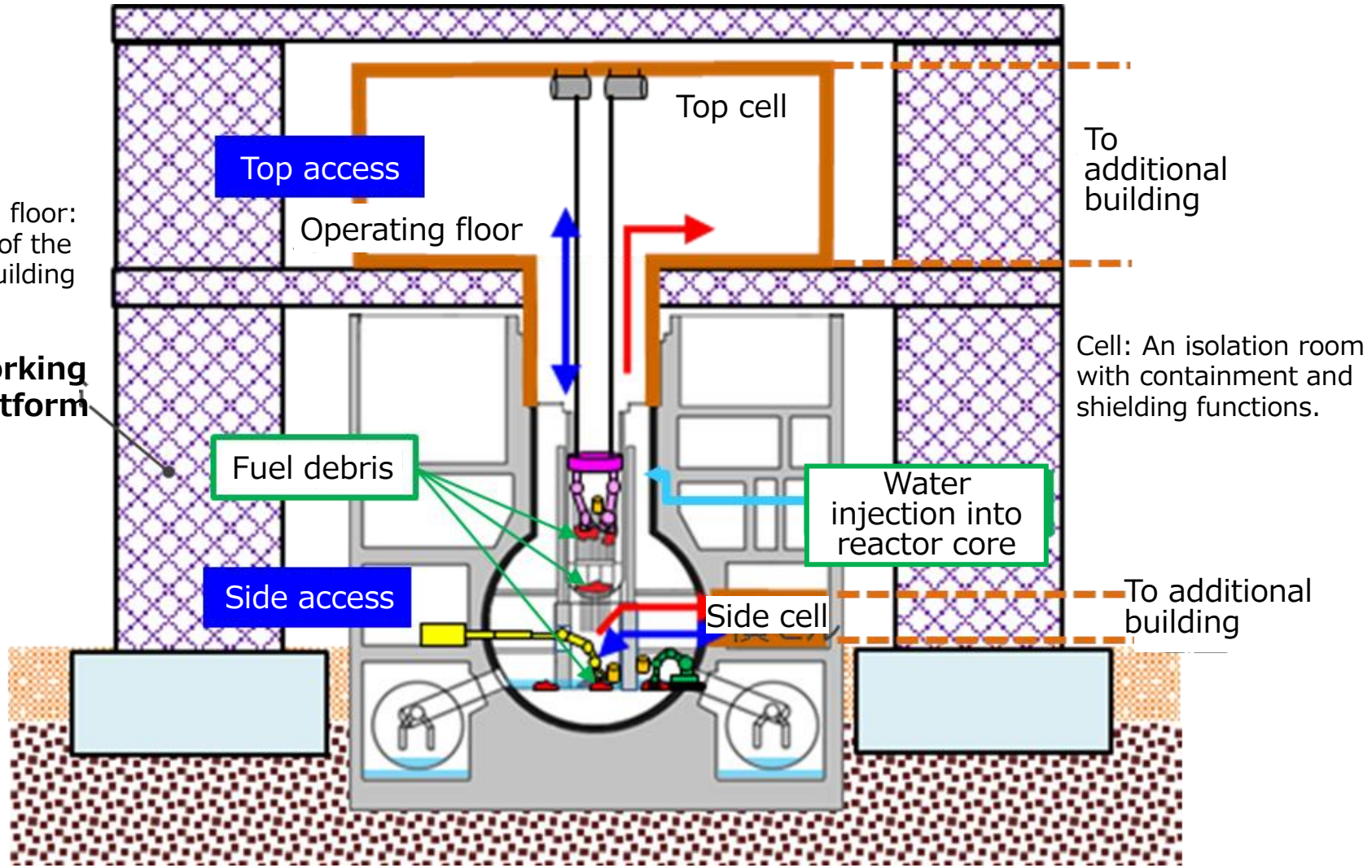


Diagram provided by TEPCO

② Submersion method

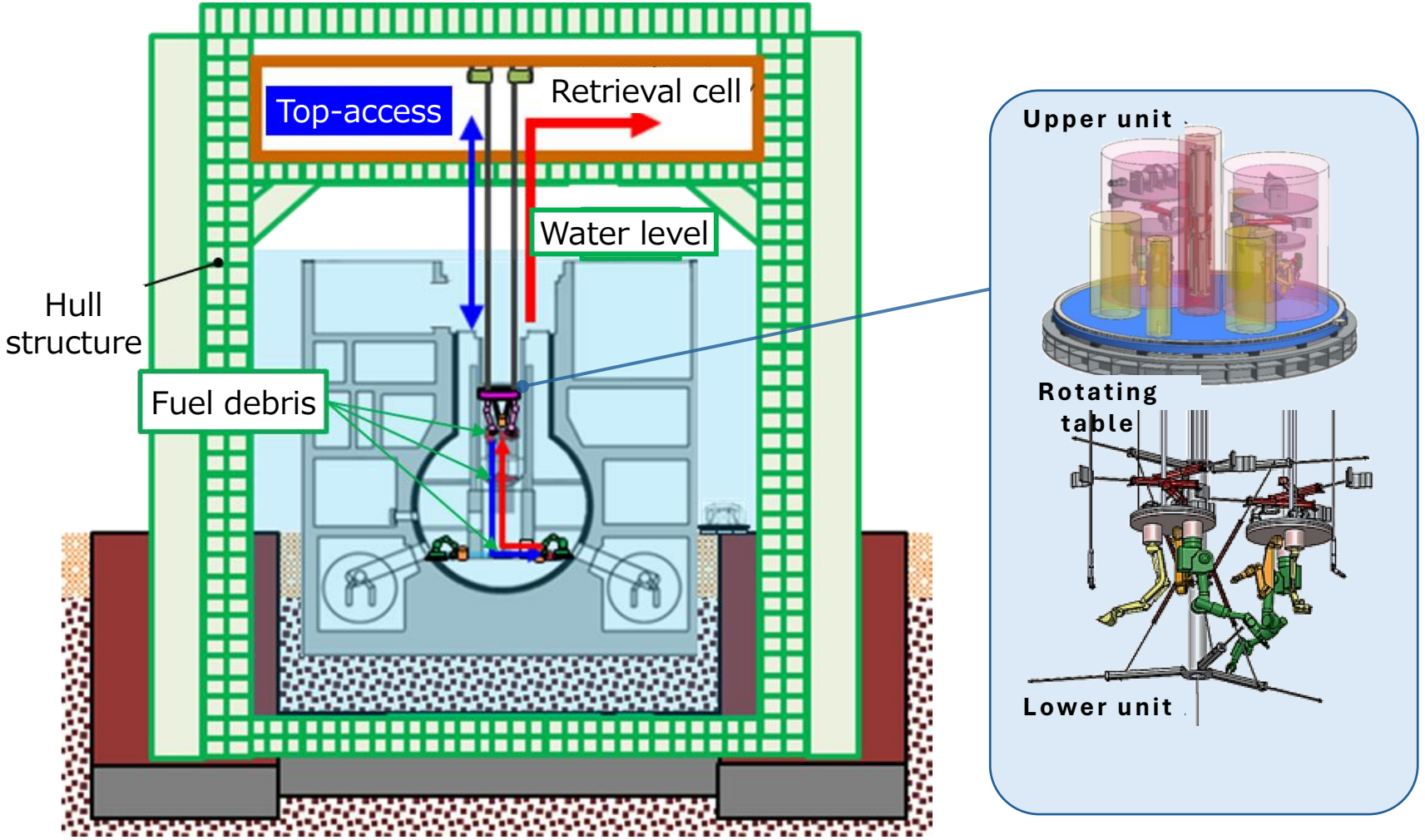
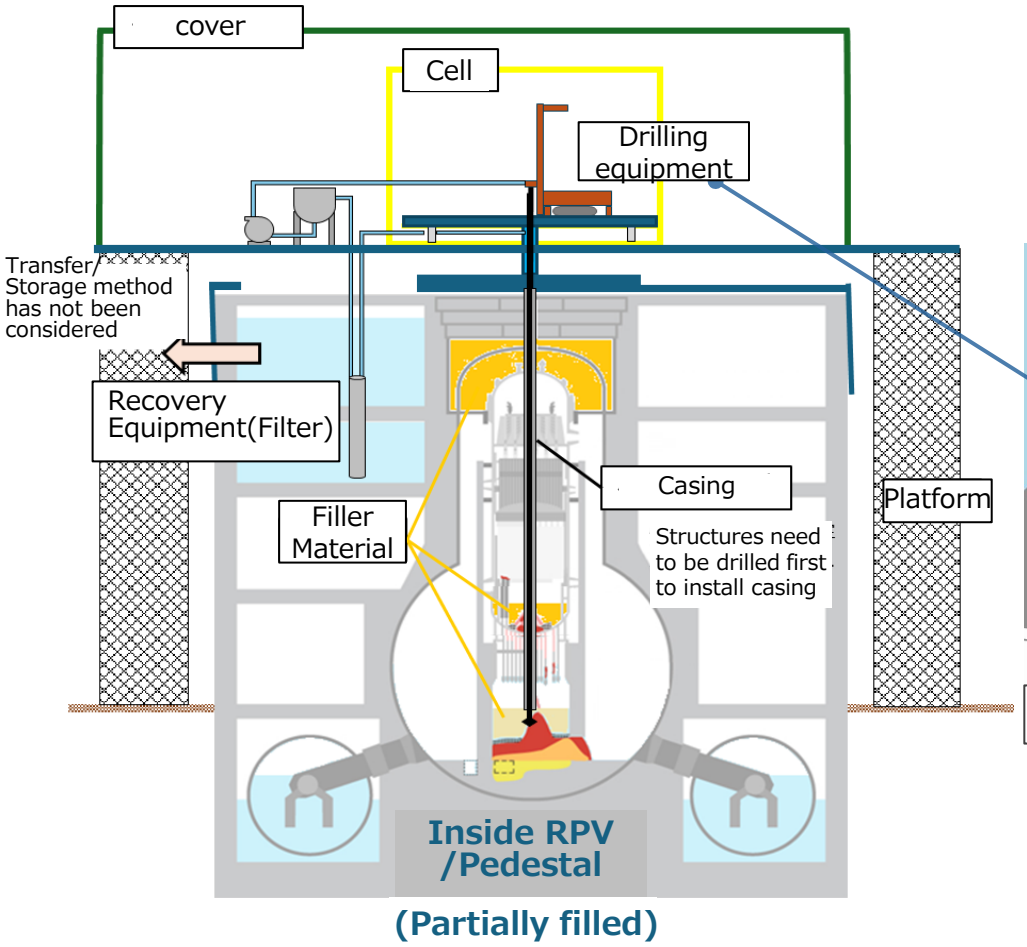
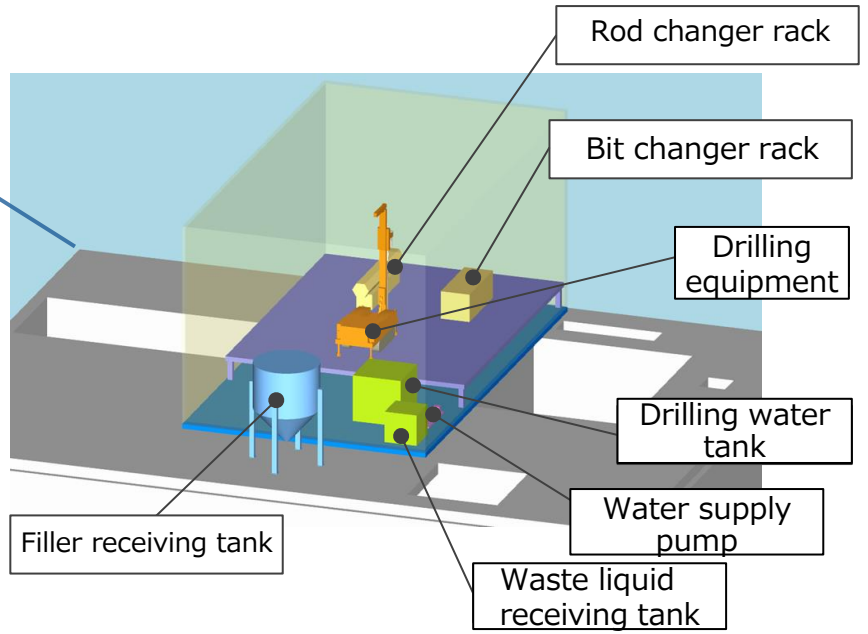


Diagram provided by TEPCO

③ Filling and solidification method





Recommendations for the selection of retrieval methods

NDF Sub-Committee for the Evaluation of Fuel Debris Retrieval Methods

- **Enough understandings of the situation inside the reactor are a prerequisite for its design and for ensuring its safety** at any retrieval method.
- Accelerating progress of **internal investigations** is important in the future, however, **it is essential to make parallel progresses on the selection of retrieval methods and its engineering study.**

✓ **Start design studies and research and development utilizing partial submersion method Option functions based on partial submersion method**

- In parallel with this, **internal investigations on a small-scale through top-access will be conducted.**
- **A retrieval method utilizing water shielding functions will also be studied.**

Next Step

- ✓ TEPCO is to proceed with a study on specific design based on the recommendations, and check technical feasibility;
- ✓ accelerate internal investigations and R&D at the same time;
- ✓ give shape to the plan for improving the environment (e.g., dismantling and removal of surrounding buildings) for starting fuel retrieval; and
- ✓ clarify the approach to ensuring safety as a project entity and reflect it on basic and detailed designs after discussions with regulatory authorities.

Sub-Committee will check progress of the above, but what to check is under discussion.

Proactive Decommissioning

- ✓ Utmost priority goes to ensuring safety during fuel debris retrieval.
- ✓ Both environmental risks to outside the NPS and work risks inside the NPS will be monitored.
- ✓ Purpose shared by all stakeholders is to reduce a long-term risk by the decommissioning.
- ✓ Rise in temporary risks while working is unavoidable. NRA will monitor the temporary risks to keep them at bay, and NDF will provide guidance and cooperation for steady reduction of long-term risks.
- ✓ Excessive (unscientific) fear of rise in temporary risks will significantly delay the decommissioning and cause long-term risks to remain high.

Summary

- ✓ TEPCO’s plan to bring the design into shape after the report made to the Sub-Committee in March this year is yet to be confirmed. What the Sub-Committee needs to check is under discussion.
- ✓ Internal investigations are urgent also in terms of giving shape to the design.
- ✓ Environmental improvement such as dismantling and removal of surrounding buildings is an important task which greatly affects the overall work period.
- ✓ Basic approach to ensuring safety needs to be discussed and considered among all stakeholders.

Thank you for your attention.