Status of R&D for the Trial Removal of Fuel Debris from Unit 2

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Tokyo Electric Power Company Holdings, Inc.

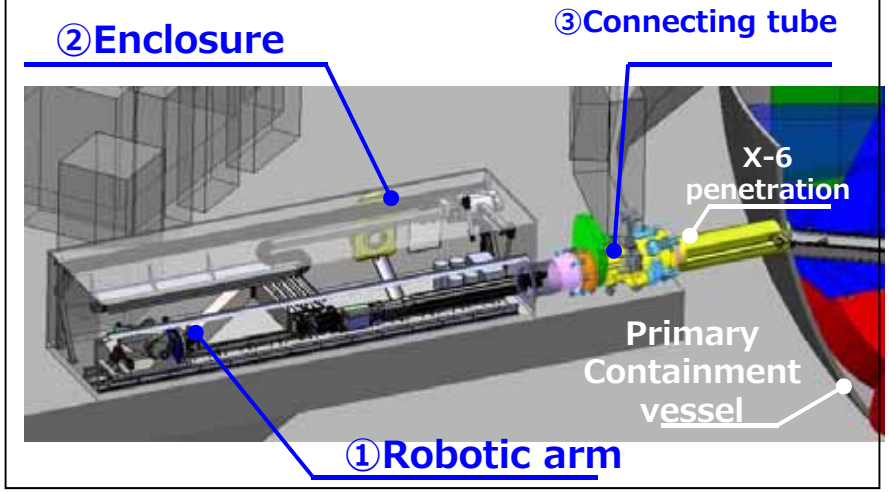
Overview of devices to be used for the trial removal of fuel debris from Unit 2

- **A robotic arm** will be used to access the fuel debris after which **powder like fuel debris inside the primary containment vessel shall be removed several times (approximately 1g each time) using a device that employs a metal brush and vacuum tube.**
- **IRID (handled by Mitsubishi Heavy Industries)** and **VNS ("OTL"※1)** are currently developing the robot arm in the UK※2.

<Overview of trial removal device>

- The trial removal device is comprised of three types of devices.

①Robotic arm
②Enclosure (used to house the robotic arm and contain radioactive materials)
③Connecting tube
(Connects the enclosure to the X-6 penetration of the containment vessel)



<Robotic arm>

- Robotic arm used to remove the fuel debris on to the end of which devices for recovering fuel debris are attached※3
- **Made of high tensile stainless steel** that will not bend when the arm is extended.

※3 Specifications: length: approximately 22m, height: approximately 40cm, width: approximately 25cm, weight: approximately 4.6 tons, radiation resistance: approximately 1MGy (accumulated)

End of fuel debris recovery device

<Metal brush type>

<Vacuum tube type>

※1 : Abbreviation for Oxford Technologies Ltd.. Known as Veolia Nuclear Solutions (UK) Limited ("VNS(UK)") prior to 2018 when a merger resulted in change of name.
※2 : The International Research Institute for Nuclear Decommissioning (IRID) has made a video entitled, "status of joint development between Japan and the UK on a robotic arm used to access fuel debris" that can be found at the following link. (Japanese only)
https://youtu.be/8LhDa5z51GQ

Dealing with difficulties/challenges to trial removal

- **Since the equipment remotely operated in a challenging environment** (limited knowledge about the area of operation and limited visibility, high radiation levels/high contamination, confined spaces, etc.) **a mockup will be used to test the equipment and train personnel.**
- Furthermore, in preparation for trial removal, **obstructions must be removed** from the X-6 penetration, which will serve as the access route. **Devices to prevent the dispersion of dust are being developed** for this purpose.

<Mockup for testing and training>

- Aim simple mockup will be used to **confirm that the robotic arm can reach fuel debris** (**UK RACE**※1)
- Then, a more realistic mockup will be used to **confirm the operation of the entire device and train remote operation personnel** on the use of the robotic arm fuel debris recovery device (**JAEA Naraha**)

Mockup (UK RACE)

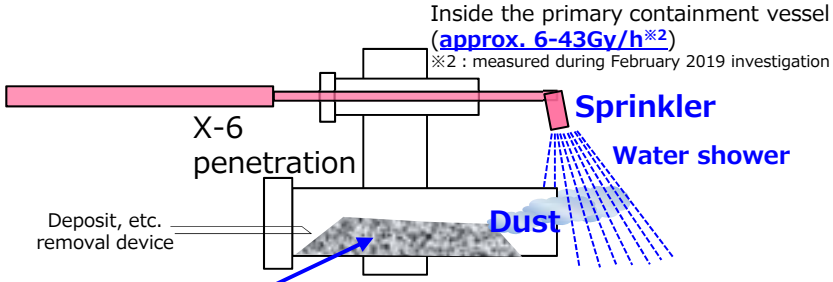
・Size: Approx. 8m x Approx. 30m
・Height: Approx. 7m

Mockup (JAEA Naraha)

・Size: Approx. 10m x Approx. 30m
・Height: Approx. 8m

<Dust dispersion prevention device (example) >

- Agitated dust is **forced to fall to the ground by water showering from above** thereby suppressing dispersion



Highly radioactive obstructions
(photographed in January 2017)

Dust dispersion prevention tests
(being developed by Mitsubishi Heavy Industries, photographed in January 2020)

※1 : Abbreviation for Remote Applications in Challenging Environments. Remote handling and robotics test facility operated by the UK Atomic Energy Authority

Handling fuel debris that has been removed on a trial basis

- **Mass and dose of the fuel debris shall be measured inside a glove box (sealed container made of plastic resin)** after which the debris shall be **put inside metal, sealed transport containers and transported to an existing analysis facility** in Ibaraki Prefecture.
- **The dose rate of the removed fuel debris,** which has been estimated based upon the amount that shall be removed, **should be approximately 6mSv/h at a distance of 20cm from the debris. Since manned work is necessary, measures to reduce exposure shall be implemented,** such as 1. shortening work time by training, and 2. installing lead shielding.

<Glove box (being manufactured) >

- **Device for handling fuel debris that enables workers to handle fuel debris with rubber gloves thereby preventing direct contact.**
- **Radioactive materials are contained** by keeping the atmospheric pressure inside the box lower than that outside the box

Specifications: Approximately 4m(L) x 1m(W) x 1m(H) (excluding platform)

<Sealed metal transport containers (tentative) >

- Deposits from inside the primary containment vessels at the Fukushima Daiichi Nuclear Power Station **have been transported before** to the existing facility in Ibaraki Prefecture
- **The metal shielding should enable safe transport** of fuel debris. The actual containers to be used will be manufactured going forward.

The container pictured is one possible design. Changes may be made in the future.

Specifications: Size: Approximately 1 square meter; weight: Approximately 3 tons