

Decommissioning Process “**Fuel Debris Retrieval**”
Investigation Subject “**Retrieval method and system**”
Issue “**Ensuring safety during fuel debris processing**”

Needs

1. Establishing a debris retrieval monitoring method

Desired state and reasons for it

- On the premise that safety functions are ensured, it is required to investigate the construction of system equipment, etc., while taking care not to use excessive equipment specifications, and based on the results, take necessary measures to ensure appropriate operation.
- In order to carry out fuel debris retrieval safely, it is desirable to establish a monitoring method having practical visual and measurement capabilities inside the RPV and the PCV.
- In order to implement fuel debris retrieval safely, it is desirable to monitor changes in the state of radioactive dust particles (alpha-dust) caused by cutting containing a large amount of alpha-nuclides.
- In order to implement fuel debris retrieval safely, it is desirable to obtain the properties of in-core sample by remote analysis before taking the samples out from the reactor.
- Since unexpected various events and situations may occur in the long-term decommissioning process, it is desirable to establish a system to cope with them.
- In order to properly operate facilities and equipment for safely retrieving and storing fuel debris, it is desirable to establish a system to ensure their safety functions.

Current state against ideal

- Tentative preconditions are being established and system design and layout are being investigated for the construction of a safety system integrating measurement systems (pressure, temperature, water level, radiation, etc.) for monitoring the internal conditions of the PCV.
- In order to understand the general behavior related to alpha dust dispersion, tests to obtain dispersion data for several processing methods and to analyze the differences among the methods are being conducted, and tests to improve the applicability of the system to on-site environmental conditions are also planned.
- Alpha nuclide monitoring has been applied to reprocessing and fuel processing facilities. Since the situation of fuel debris retrieval differs greatly from that of existing facilities, such as radiation dose, it is necessary to examine the applicability of existing technologies and confirm the existence of new development items.
- The use of long pulsed lasers in laser-induced plasma emission spectroscopy has been investigated as a remote analysis method for in-core samples before they are taken outside.

Issues to be resolved

- In order to understand the impact of alpha dust dispersion, it is necessary to measure data related to dust dispersion in test retrieval, etc., and to plan for the demonstration and confirmation of safety assessment methods. In particular, it is expected that the effects of heterogeneous compositions during thermal processing—containing actinide nuclides such as

uranium together with highly volatile fission products such as cesium—is expected to be clarified, as well as phenomena such as agglomeration that may occur during release from the water phase into the gas phase.

- It is necessary to obtain plasma emission characteristics and study the optimum conditions for observing elemental spectra in order to advance.
- It is necessary to establish a basic database to respond to unexpected situations and contingencies by consolidating knowledge about on-site information and its uncertainties, as well as efforts to resolve them. In addition, by disclosing such collective knowledge, it is necessary to gain a bird's eye view of the decommissioning progress in the related investigation issues, to optimize the decommissioning process as a whole, and to promote research efficiently.

2. Establishing a method of fuel debris stabilization

Desired state and reasons for it

- In order to ensure the safety of processing, packaging, transferring and storing in fuel debris retrieval, it is desirable to investigate the reliable and simple stabilization of fuel debris and MCCI products and the maintenance of the stability.

Current state against ideal

- Methods of preventing re-criticality and criticality detection are being investigated for large transport vessels that contain large structures with fuel debris attached in one piece. Specifically, criticality prevention measures by pre-injection of non-dissolvable neutron absorbent are being investigated, and the necessary amount of neutron absorbent required under conservative conditions is being evaluated.

Issues to be resolved

- In order to improve the reliability of criticality scenarios and risk assessment, it is necessary to incorporate new knowledge based on the results of PCV internal investigations.
- In order to consider specific fuel debris stabilization methods, it is necessary to clarify what exactly should be stabilized, considering the results of investigation of fuel debris aging (including chemical stability such as corrosion and nuclear physics stability such as re-criticality).

Relevant Issues

- FDR-102 "Understanding status of structures inside PCV and RPV"
- FDR-301 "Fuel debris retrieval inside PCV"
- FDR-302 "Fuel debris retrieval inside RPV"