Phase: **Design**

Decommissioning Process **"Fuel Debris Retrieval"**
Investigation Subject **"Confining radioactive material"**
Issue **"Measures against dust"**

Needs

1. Investigating measures to control and recover debris chips

Desired state and reasons for it

- In order to evaluate the exposure of the workers and the surrounding environment during fuel debris retrieval and dismantling works, it is desirable to understand the properties and behavior of radioactive airborne particles containing alpha-emitting nuclides (alpha dust) in the gas and liquid phases when a large amount of alpha dust is generated during fuel debris cutting.
- In order to reduce the amount of chips released into the gas or liquid phase due to cutting during fuel debris retrieval, regardless of the presence or absence of alpha dust, it is also desirable to establish a fuel debris processing method and a corresponding recovery method and to be able to evaluate the amount of waste.
- In order to suppress the diffusion of dust into the air as much as possible, it is desirable to collect and purify generated dust near the processing point.
- It is desirable to establish a comprehensive confinement function and its performance evaluation method for dust dispersion and suppression. This includes not only the preliminary assessment of alpha dust through mock-up tests, but also verification based on actual measurements of alpha dust generated during fuel debris retrieval.
- It is desirable to evaluate the exposure dose caused by alpha dust scattering. It is also desirable to set the criteria for the exposure conditions during operation.

Current state against ideal

- For fuel debris cutting (in air or liquid), mechanical methods such as core boring, disk saw, and chisel, thermal methods such as laser, and high-pressure jet blasting have been considered and developed, in consideration of the processability requirement according to the properties of fuel debris, the effect of dust generated in processing, and other factors.
- Development of elemental technologies related to materials that improve the scattering suppression of dust generated during processing by coating or spraying before and after fuel debris processing is being conducted in Government-led R&D Program on Decommissioning and Contaminated Water Management.
- In order to control the migration of dust to the gas phase, fuel debris is processed underwater as much as possible. However, not all processing can be done underwater, and therefore, for fuel debris that is not submerged, the control of dust migration to the gas phase by pouring water or other means is being investigated.
- In the Project of Decommissioning and Contaminated Water and Treated Water Management, data acquisition on dust dispersal rate, etc. under various conditions, and evaluation technology for dust dispersal rate during fuel debris cutting are being investigated using the method currently under investigation as a cutting method. In addition, an evaluation test of scattering

behavior using simulated debris containing uranium and data acquisition and organization are underway.

- In addition, assessments are being conducted to understand the impact on the environmental transfer rate during fuel debris processing, along with studies on impact-assessment technologies related to dust dispersion.
- Although CFD is being tested as a comprehensive confinement function and performance evaluation method for suppressing and controlling dust dispersion, the boundary conditions inside the PCV are highly complex and real-time computation is difficult. For this reason, development is underway on methods for setting calculation conditions and on high-speed surrogate technologies.

Issues to be resolved

- When fuel debris is mechanically or laser cut at higher temperatures, a large amount of dust is expected to be generated, and it is necessary to organize the concept of confinement management, monitoring, and reference values.
- It is important to develop a processing method to minimize the dust generated during fuel debris processing, to investigate the theoretical value of dust particle size distribution during such processing, and to establish a method to control the generated dust.
- In order to predict the behavior inside the PCV of the dust generated during fuel debris processing, it is important to research and develop technology for a combination of airflow analysis inside the PCV and aerosol behavior analysis. It is also important to develop an analytical model for predicting the behavior in the R／B.
- The radioactive airborne particles generated in the 1F decommissioning process include particles generated from the fuel debris during fuel debris retrieval and particles generated from contaminated structures. There are two types of radioactive materials: alpha nuclides and beta- or gamma- nuclides. In order to minimize internal exposure, it is important to control radioactive airborne particles (alpha dust) of alpha nuclides represented by plutonium. In order to minimize overall exposure, attention should also be paid to beta- or gamma- nuclides such as cesium.
- The data on the dispersion rate of the generated alpha dust were obtained from the decommissioning of JPDR at Japan Atomic Energy Agency and the glove box dismantling at Japan Nuclear Cycle Development Institute. The problem is that the data on alpha dust generated from nuclear fuel itself is not systematically organized.
- To enhance the removal efficiency of dust in the Greenfield gap region (approximately 0.1–0.3 μm), which is difficult to capture even with HEPA filters or spray scrubbing, a key challenge is the development of technologies that promote dust agglomeration and settling inside the PCV by utilizing electromagnetic forces, acoustic vibration, and other methods that have not been actively applied to date.
- A further challenge is to conduct evaluations not only for dust behavior during normal fuel debris retrieval operations but also for exceptional events caused by internal or external factors during the retrieval process.
- Although dust evaluation methods using simulated fuel debris have been largely established, in actual fuel debris retrieval the dust itself becomes a contamination source, and decontamination of equipment after use is difficult. Therefore, a challenge is the development of evaluation methods that do not rely on post-use decontamination.

Relevant Issues

- FDR-204 “Site boundary dose assessment”