Phase: **Preparation**

Decommissioning Process **"Fuel Debris Retrieval"**
Investigation Subject **"Understanding status inside buildings"**
Issue **"Understanding contamination status inside buildings"**

Needs

1. Measuring and evaluating doses in the building

Desired state and reasons for it

- In order to reduce the risk of exposure during decontamination of the building, fuel debris retrieval work and final dismantling, it is desirable to understand information related to the contamination status, such as radionuclides presence in the building, concentration in air, and surface density.
- For exposure control, it is desirable to clarify the difference between the dose rate and a radioactivity (source) distribution and then set up the original purpose and applications.

Current state against ideal

- Currently, data on air dose rates are collected for each location of each unit, as shown in "Survey map of Fukushima Daiichi Nuclear Power Station" on the website of Tokyo Electric Power Company Holdings, Inc. (https:／／www.tepco.co.jp／decommission／data／surveymap／).
- In addition, as part of safety and efficiency improvements for work planning, "Project of Decommissioning, Contaminated water and Treated Water Management" included the development of digital techniques to visualize environmental and source distributions by identifying radiation sources using environmental survey data. As a result, the effectiveness of a system that includes functions such as reverse inference of source locations from dose-rate distributions at the site and the ability to estimate and store work-related occupational doses in cyberspace was confirmed.

Issues to be resolved

- In order to apply the radiation source visualization system to the field, it is desirable to build a system that can continuously acquire field data, improve analytical accuracy, and accumulate knowledge.

2. Determining the contamination status of the work area

Desired state and reasons for it

- Since a specific area in the building will be used as a work site during fuel debris retrieval, it is necessary to understand the radiation dose at the work site and to take further measures to reduce the dose as necessary in order to proceed with the concrete and detailed investigation of the work process.
- In order to reduce the risk of exposure during decontamination of the building and fuel debris retrieval, it is desirable to evaluate the measured contamination status and to estimate the

optimal decontamination procedure and access route. In particular, the area around the X-6 penetration on the first floor of the reactor building, which is being considered for fuel debris retrieval inside the PCV, and the operation floor, where the environment needs to be improved for fuel debris retrieval inside the RPV, are important.

- In order to ensure safety in case of processing is needed during fuel debris retrieval, it is desirable to consider the effects of secondary diffusion of radioactive dust into the building due to dry-up of the turbine building and access into the PCV for debris retrieval.

Current state against ideal

- In order to properly implement radiation protection, which is indispensable in the work area, it is necessary to understand the work environment (target nuclides, dose equivalent rate, air concentration, surface density) by analysis and measurement in the area within the building accessed by workers.
- In order to understand the radiation environment in an integrated manner, in addition to the development of equipment that enables remote dosimetry, a system for understanding the environment and the environmental information is currently under construction to enable integrated and organized evaluation and prediction of the spatial distribution of radiation sources and dose rates.
- Therefore, it is desirable to construct a sensing network that can be used to remotely monitor plant conditions, etc., and quickly control robots remotely, with minimal human exposure in a building with high radiation. Since it is being investigated digital twinning within the 1F building regardless of whether communication network is 5G or Beyond 5G, 5G and beyond communication standards that are ultra-high speed, ultra-low latency, and capable of ultra-multiple connections are attractive in grasping the situation on site in real time. In addition, it is desirable to monitor not only contamination status but also structural integrity and other conditions over the medium to long term.
- It is very difficult to understand the contamination condition in the building. It is desirable to decontaminate areas with high inventories in a priority manner. However, in order to understand the distribution of contamination, not only spatial air doses but also surface doses need to be understood. In other words, since the acquisition of data itself is difficult and the measurement of surface doses is costly, a technology for efficient and easy analysis is required.
- However, the inside of the reactor is covered with thick concrete and shielded. GPS cannot reach there. In the case of the 1F building, there is no Wi-Fi or PHS signal installed in the building due to the accident, so robots are used to investigate the situation. In addition, although workers may measure radiation doses, etc., in such a case, their location information is only managed in an analog manner, and it is difficult to accurately capture location information from the viewpoint of reducing radiation exposure.
- In addition, there is currently no permanent lighting but temporarily illuminated in the building.

Issues to be resolved

- In addition to the system currently under investigation, it is a future issue to establish an integrated system to understand the environment by creating a path to consider integrating the distribution of airborne radioactivity concentration as well. In addition, it is also necessary to establish a system for operating this system over the long term and accumulating knowledge.
- Therefore, it should be constructed a sensing network that can be used to remotely oversee the plant conditions, etc., and quickly control remote robots, minimizing human exposure in a building with high radiation. While communication network is not restricted to 5G or Beyond 5G, it is under investigation on digital twinning inside 1F building, and 5G and later communication standards are attractive because of their ultra-high speed, ultra-low latency, and ultra-multiple

connectivity for real-time understanding of the on-site situation. In addition, It is desirable to understand not only contamination status but also structural integrity and other conditions over the medium to long term.

- Without the use of GPS, and in the absence of Wi-Fi or other environment, it is desirable to accurately determine the position of the robot and the measurer continuously and in real time.
- To improve the workability in the work area in the building, it is also necessary to increase visibility in the building.

Relevant Issues

- FDR-202 “Shielding and decontamination measures”
- FDR-203 “Exposure control of workers inside buildings”
- FDR-204 “Site boundary dose assessment”
- FDR-217 “Establishing access route to fuel debris”
- FDR-218 “Developing fuel debris retrieval equipment and devices”
- BST-001 “Remote control technology”
- BST-002 “Visualization technology (including 3D)”
- BST-003 “Measurement and analysis technology”