§20. Measures to Radioactive Waste Arising from Fusion Reactor Operation

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For designing a facility of fusion reactor, it is indispensable to study on maintenance activities together with characteristics of the core components to be treated. Radiological characterization of the core components is an important item for not only maintenance but also waste management. In this study, maintenance work activities were structured by using the work breakdown structure method for evaluating the necessary steps of the maintenance and waste management. The study was based on by reviewing experiences of present nuclear facilities. The design of ITER was also referred in this study [1].

Evaluation of Maintenance Process

A work breakdown structure (WBS) is a hierarchical and incremental decomposition of a project into work packages. It is widely used in a project analysis to understand the component contents of a necessary work packages. In this study, a WBS was constructed to analyze necessary steps of maintenance of core components (sectors) in a fusion reactor. The major work activities during the process from reactor shutdown to long term storage of the sector assembly (blanket, diverter, back-plate, etc.) are abstracted as follows;

- Removal of tritium by electric discharge washing
- Cooling of the sectors to decrease its temperature
- Transfer of the sectors from the reactor core to the maintenance area
- Separation of the blanket and diverter from the sectors
- Storage of unusable materials being put in containers
- Temporal storage of containers in a cooling pool
- Dismantling of unusable components
- Selection of valuable materials from the blanket
- Storage of radioactive waste

Each work activity item was further decomposed into primitive work activities to evaluate the validity of maintenance scenarios. For instance, dismantling of unusable components consists of five primitive work activities; (i) transfer of the components from the cooling pool to dismantling area, (ii) opening of the containers, (iii)measurement of radioactivity, (iv) remote dismantling, and (v) classification of the components based on radiation levels. In total, 55 primitive work activities were identified as the necessary maintenance process.

Grouping of Components for Waste Management

In the maintenance process, components taken out of the core are classified into recyclable/reusable and non-usable ones. In terms of non-usable one which is of radioactive waste, components were classified into three categories referring the present safety regulation for nuclear facilities in Japan. In case of a fusion reactor of 1.5 GWth power, 8500 tons of radioactive waste in low and very low level is expected to be arisen from the maintenance every 3 years. Some cooling period is desirable for stabilization and encapsulation of the wastes in low level.

Scheduling of Maintenance Work Process

The time schedule of the work process was outlined as follows.

- Cooling of component in the core area: 25 days
- Transport of sectors to maintenance areal :1 day
- Disassembling of the sector: 4 months
- Cooling of components:3years
- Classification of components: 3 months

On the basis of the time schedule above mentioned, component characteristics such as decay heat and surface dose were calculated using computer codes, MCNP and ACT-4 to evaluate the detailed maintenance work Figure 1 shows the decay heat as time progress. The calculation results showed that decay heat of the blanket is about 27 MW at the time of just after operation. The surface dose is the order of 10^{11} micro Sv/h. After one year cooling, the decay heat and surface dose decrease to be 0.4 MW and the order of 10^{6} micro Sv/h, respectively [2].

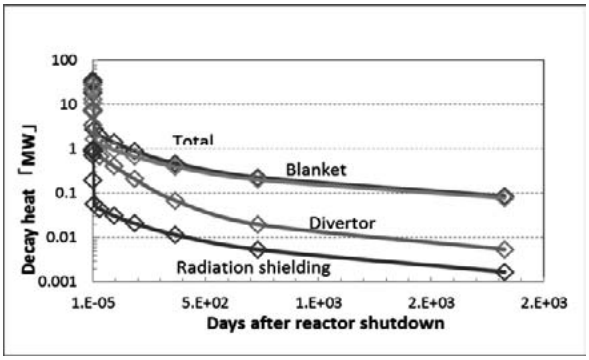

Fig.1 Decay hear after reactor shutdown

Concluding Remarks

The work process of sector maintenance scenario was discussed focusing on the work activities and radiological characterization of the sector assembly. The core design influenced the characteristics of waste arising. The radioactive waste of some 8500 tons should be managed in every 3 years even in a relatively small power reactor. The proper waste management including disposal site designing is an important item to be studied in the future.

1)Kakudate, S: J. Plasma Fusion Res. Vol.87, Supple., (2011) 193
2) Someya, Y, et.a.: Waste management scenario in the hot cell and waste storage for DEMO, ISFNT-11 ,2013