Design Characteristics for Ease of Dismantling of Research Reactor

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1. Introduction

In order to obtain permission for the construction and operation of nuclear reactors and related facilities, an initial decommissioning plan must be submitted pursuant to Article 10 and 11 of the Nuclear Safety Act. Article 5, Clause 5 of the Nuclear Safety Commission Notification Regarding the Preparation of Nuclear Power Plants Decommissioning Plans, etc., describes the characteristics of the design considering the ease of dismantling and the measures for dismantling during construction or operation [1]. This paper describes the initial decommissioning plan for the design characteristics and measures for ease of dismantling of Hanaro and related facilities that have been operating normally since 1995.

2. Design characteristics

Hanaro was designed to be easy to dismantle and minimize the amount of radioactive waste generated. It minimizes the dose exposure for workers and has design characteristics that can provide accessibility and sufficient working space for dismantling [2].

2.1 Design characteristics considering ease of dismantling in accordance with ALARA principle

The research reactor was designed and constructed by applying the ALARA design concept to facilitate dismantling work during dismantling and to minimize the dose exposure to dismantling workers. To this end, during normal operation, the process systems are designed to keep the reactor safe and to prevent unnecessary radioactive leakage and to minimize the dose exposure.

The process system simplifies testing and maintenance by minimally activating devices. It was designed to be easy to access and reliable when needed.

2.2 Design characteristics applied to minimize the possibility of leakage of radioactive materials in structures, systems and parts

HANARO was designed to minimize leakage of radioactive materials from structures, systems, and parts through the concept of negative pressure at inside the buildings and multi-barrier walls. Major equipment such as piping, and the heat exchanger during operation minimized the possibility of leakage of radioactive materials through seismic analysis, vibration evaluation, fabrication test, commissioning test, and in-service inspection. The chimney, which is a reactor structure, mixes the cooling water passing through the flow tube and the water tank rising along the bypass channel to the cooling water outlet. In addition, a hot water layer, shown in Figure 1, is placed in the upper part of the pool to suppress the radioactive materials in the cooling system.

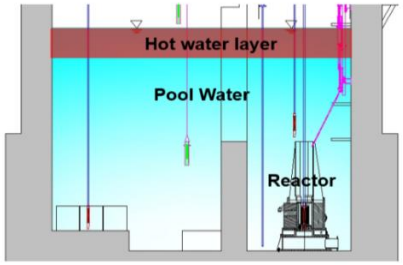

Fig. 1. Hot water layer in the upper part of the pool.

2.3 Design characteristics applied to minimize radioactive contamination in the planned and uncontrolled state and to minimize the generation of radioactive waste during operation

As an engineering safety facility, the reactor containment system is designed to minimize the leakage of radioactive material from nuclear reactor buildings through penetration isolation, building airtightness and negative pressure maintenance. The reactor building is a radiation controlled area, which adopts the concept of semi-containment building to the nuclear reactor building structure to prevent diffusion and leakage of radioactive material, and keeps the inside of the building at negative pressure. The design criteria for environmental impacts during normal operation of Hanaro are in accordance with the provisions of the Nuclear Safety Commission

Regulation No.17, “Regulations on technical criteria for reactor facilities, etc.” [3].

2.4 Design characteristics that can demonstrate optimization of facility layout for accessibility and demolition of workers

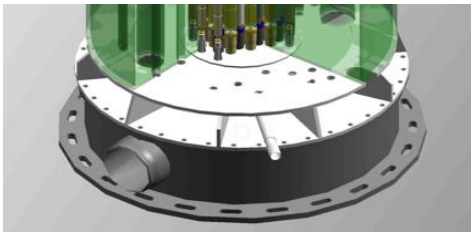

Fig. 2. Reactor structure with bolt holes.

A ceiling crane with a capacity of 30 tons is installed in the reactor hall and can be used for decommissioning activity. The reactor structure, which is the main equipment of the research reactor, is composed of the inflow cavity, the lower grid plate, the flow tube, the reflector tank, and the chimney along the circulation path of the cooling water, and is locked in the reactor pool. The reactor structure is assembled with bolts, as shown in Figure 2, so that each part of the reactor can be separated and disassembled if easily them cutting.

3. Action Plan

3.1 Measures to minimize leakage, radioactive contamination and radioactive waste generation during operation

To minimize the leakage of radioactive materials during operation and the occurrence of radioactive contamination and radioactive waste through it, Hanaro was designed to prevent leaks and take measures through immediate leakage detection in case of radioactive material leakage.

The leak detector for detecting leakage is as follows. Where there is a potential for leaks in the primary cooling system, heat exchangers and pumps are commonly used in nuclear reactors. Even if there is leakage through the gasket, there is a drain groove connected to the liquid waste treatment system at the bottom of the equipment room under the heat exchanger so that the leaked cooling water collects in the drainage groove. The leak detector installed in the home detects a leak and an alarm is sounded in the control room OWS (Operator Workstation). If the alarm sounds, the operator immediately stops the reactor operation [4].

3.2 Management plans and methods for key records of design, construction and operation that can affect dismantling

Major records on the design, construction, and operation that may affect the dismantling of Hanaro are registered with the Advanced Nuclear Safety Information Management System (ANSIM) at KAERI. It is organized by the task. In document management, the design documents, design drawings, procedures, and manuals of HANARO and utilization facilities, as well as operation experience reports are registered.

4. Conclusion

Hanaro is a research reactor that was designed and constructed over a period of 10 years from 1985, and has been operated to date. In this research reactor, design characteristics consisting of four design characteristics are considered, from design to consideration of ease of dismantling in accordance with the ALARA principle. First, measures were taken to minimize leakage, radioactive contamination and radioactive waste generation during operation. Second, management plans and methods for key records on the design, construction and operation were built into the system. The ease of dismantling is based on the safety analysis report.

REFERENCES

[1] U.S. Nuclear Regulatory Commission, Regulatory Guide 4.21, “Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning”, June 2008.

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[4] Seung-Kook Park, Kook-Nam Park, etc., “Analysis of Design Characteristics for Ease of Decommissioning of HANARO and Related Facilities”, Technical Report, KAERI/TR-6677/2016, pp 23-36.