Fire Hazard Analysis for Advanced Fuel Science Building

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1. Introduction

The Advanced Fuel Science Building (AFSB) in the Korea Atomic Energy Institute (KAERI) is the basic intra-facility to produce HANARO fuel and to develop advanced nuclear fuels. The facility and its equipment have been safely operated with zero accidents for 18 years.

The fire hazard analysis for the AFSB consists of a fire disaster analysis and a process fire safety analysis. This analysis was carried out to verify that the design of the fuel fabrication facility satisfies the in-depth defense concept to protect public safety and the environment from fire and explosion hazards associated with handling and storage of materials authorized during normal operation, and the results verified the AFSB was designed to protect against fire and explosion that may increase radiation hazard.

The fire hazard analysis was performed in accordance with the relevant laws such as Nuclear Safety Act and the relevant regulation such as notification No.2020-1 of the Nuclear Safety and Security Commission.

Fig. 1. Advanced Fuel Science Building.

2. Scope and Contents

The scope of the fire hazard analysis for the AFSB was to cover the entire building, including rod and plate-type research reactor fuel fabrication facilities, the nuclear fuel development facility for research reactors, the nuclear fuel R&D facility for light water reactors, and auxiliary systems as common facilities. The main contents are as follows.

- ○ Establishment of analysis method and acceptance criteria
- ○ Classification of fire protection zones and preparation of fire area maps
- ○ Evaluation of the type and size of combustible materials
- ○ Confirmation of the suitability of fire structures
- ○ Evaluation of the suitability of fire detection and suppression equipment
- ○ Evaluation of the suitability of other fire protection equipment
- ○ Evaluation of ignition risk considering design-based fire
- ○ Evaluation of combustion expansion risk in fire zones
- ○ Evaluation of the impact on surrounding equipment due to the operation or failure of fire suppression equipment
- ○ Definition of the factors of process fire hazard
- ○ Evaluation of process fire hazard
- ○ Analysis of the possibility and results of nuclear criticality, and radioactive and toxic emission accidents due to fire.

3. Results

The AFSB was divided into a total of 21 fire areas, and a fire hazard analysis was performed for each fire area. There was no risk of expansion of combustion in the AFSB, and the probability of ignition was evaluated as low. Since water-based suppression equipment is not used in fire areas handling radioactive materials, there is no possibility of emission of radioactive materials outside of the radiation control area with fire extinguishing water. Since radioactive materials are filtered through the high-efficiency particle filter (HEPA) of the air cleaning unit (ACU), it was evaluated that there is no possibility that radioactive materials would leak outside the radiation control area. Furthermore, fire protection equipment directly or indirectly related to fire protection is properly installed to comply with relevant regulations.

As appropriate measures to prevent nuclear criticality were applied to the AFSB, it was evaluated that there was no possibility of a nuclear critical accident. Explosions and fire accidents that may cause the release of radioactive materials or toxic chemicals were evaluated to be unlikely to occur, and it was also found that all the exposure doses on exclusion area boundaries (EAB), site boundaries, and residential neighborhood area met the reference values in the results of evaluation of the exposure dose for a hypothetical accident

scenario. The effects of fires from forests or hills surrounding the AFSB site were also evaluated as negligible.

For the purpose of identifying potential fire hazards and safety equipment in each process for the fuel fabrication facility, R&D facility, and auxiliary systems in the AFSB, and suggesting appropriate measures when additional improvements are needed to the current safety equipment, a process fire hazard analysis was performed. Each process in the AFSB partially contains risk factors for fire and explosion, but it was evaluated that no further improvement was necessary because the current safety equipment such as process safety systems and facilities was adequately secured.

4. Conclusions

A fire hazard analysis for the AFSB was carried out to verify that the design of the fuel fabrication facility satisfies the in-depth defense concept against fire and explosion hazards. In the analysis, it was evaluated that there was no risk of expanding the combustion in the AFSB, and the probability of ignition was low. It was also confirmed that fire protection equipment is properly installed to comply with relevant regulations.