Accident Case Analysis for Safety Assessment of Decommissioning

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1. Introduction

In order to evaluate the safety assessment for decommissioning, it is necessary to analyze and investigate possible accidents/hazard during decommissioning. In Korea, according to Nuclear Safety and Security Commission Notice No. 2015-8, "Provisions on Preparation of Nuclear Power Plants Decommissioning Plan, etc.", "abnormal accidents" are expected to occur more than once during the decommissioning process. In addition, that the decommissioning activities and work are not proceeding as planned [1]. According to the "IAEA Safety reports series No. 77 Safety Assessment for Decommissioning", "hazard" is classified as a cause of radioactive and non-radioactive cause, which is a potential influence on human health and the environment due to facilities, It means [2]. In this study, the definition of abnormal accidents and the cases of accidental decommissioning of nuclear power plants were investigated.

2. Types of Accidents that Occur When Decommissioning Activities

2.1 Nuclear and Radiation Accidents

2.1.1 Criticality. In a permanently shutdown nuclear power plant, nuclear fuel is completely removed from the storage facility, so that a critical accident does not occur. However, there is a possibility of occurrence of criticality in fissile material treatment plants or waste storage tanks used in nuclear fuel fabrication plants, spent fuel reprocessing plants, nuclear fuel enrichment plants,

2.1.2 Exposure. The presence of contaminants such as radioactive materials and contaminants in the event of an accident occurring during decommissioning increases the likelihood of external exposure. For example, workers working around the radioactive stainless steel of a reactor pressure vessel may be exposed to external exposure. If radioactive materials are present as surface contaminants, internal exposure due to inhalation and ingestion by workers or residents may occur. When working in decommissioning areas, caution should be exercised for the risk of inhalation of radionuclides that release alpha rays.

2.1.3 Release of Radioactive Materials. Because of the nature of nuclear decommissioning work, it includes cutting and decontamination processes, so the wastes generated here have different characteristics from the wastes generated during operation of nuclear power plants. Liquid wastes are generated more than in nuclear power plants due to decontamination process, but gaseous wastes occur less than in nuclear power plants. Concrete, metal, etc. can reach limit when they reach below the decontamination standard, so there is a possibility that some materials exceeding the decontamination standard are included and are erroneously released.

2.2 Non-radioactive Accidents

2.2.1 Combustible and flammable materials. The material used in the cutting and decontamination process may cause a fire, and the instantaneous heating of the combustible material may increase the risk of fire. Explosions may also be caused by solutions or flammable materials used during demolition operations.

2.2.2 Hazardous Materials. Toxic and harmful materials emitted during decommissioning of nuclear power plants include thermal insulators, asbestos, lead paint, electrical insulators, PCBs, decontamination solutions, etc., which must be treated in a special way.

2.2.3 Physical Hazards. There may be a collision due to the use of temporary structures or structures during the demolition work, and there is a possibility of collision of heavy equipment, injury due to sharp materials, and equipment fall at high level, and human accidents during equipment use.

2.2.4 Natural Hazards. Natural disasters such as typhoons, earthquakes and floods have a higher risk of decommissioning than during operation of nuclear power plants.

3. Accidents Case of the Decommissioning

Table 1 presents the highest doses in each of four categories of radiological accidents as obtained from licensing-basis documents. The highest doses result from postulated fuel-related accidents and radioactive-material-related accidents. All accidents that were reviewed used conservative assumptions to calculate the offsite dose [3].

Table 1. Highest Offsite Doses Calculated for Postulated Accidents in Licensing-Basis Documents [3]

Accident Description	Offsite Whole-Body Dose, rem_
Fuel-Related Accidents	
Shipping cask or heavy load drop into fuel element storage well	0.186
Loss of pre-stressed concrete reactor vessel shielding water	0.035
100% fuel failure	0.027
Simultaneous failure of fuel assemblies	0.016
Spent fuel handling accident	0.013
Fuel assembly drop	0.0026
Radioactive Material-Related Accidents (Non-Fuel)	
Spent resin handling accident	0.96
Explosion inside vapor container	0.44
Radioactive liquid waste system leaks and failure	0.23
Materials-handling event	0.16
Fire in intermodal container of waste	0.1
Decontamination events	0.039
External-Events Initiated Accidents	
Natural disaster, tornado	0.0001
Physical security breach	<0.000001
Offsite Transportation Accidents	
Reactor pressure vessel railroad accident and fire	0.00014
Transportation accident	<0.000001

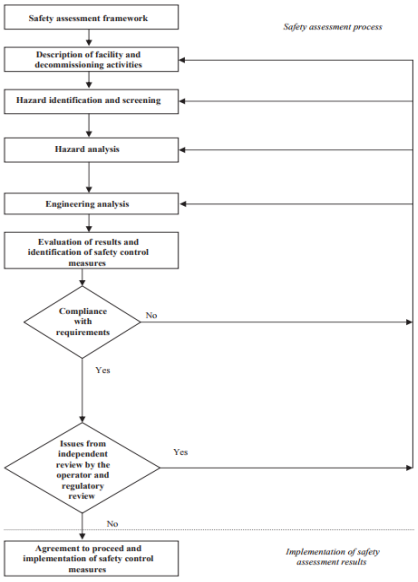

Fig. 1. Main steps of safety assessment [2].

4. Conclusions

In this study, we conducted a survey on accident cases, which is one of the important factors for nuclear safety evaluation. As a result of the study, detailed data were constructed for each accident case in countries with nuclear decommissioning experience. However, in Korea, which is about to decommissioning Kori Unit 1, there is a lack of data on accident investigation and legal regulations. Research is required for successful nuclear decommissioning and accurate safety assessment.

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REFERENCES

[1] NSSC, Nuclear Safety and Security Commission Notice No. 2015-8, "Provisions on Preparation of Nuclear Power Plants Decommissioning Plan, etc.", 2015.

[2] IAEA, Safety Assessment for Decommissioning, "IAEA Safety reports series No. 77, 2013.

[3] NRC, Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Regarding the Decommissioning of Nuclear Power Reactors, 2002.