Fault Tree Analysis of an Accident Probability for Pyroprocessing Facility

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1. Introduction

Since the 1970s, the countries who joined the IAEA are preparing the legal and institutional of physical protection system of nuclear facility due to its importance. Especially, all of the nuclear operation utility should set the vital area identification(VAI) of the each facility with the enhanced physical protection system requirements because of the 9.11.

The pyroprocessing technology is one of the spent fuel recycling technologies. Korea Atomic Energy Research Institute(KAERI) started the R&D about the pyroprocessing technology in 1997. The physical protection system requirements based on the VAI should be prepared for applying the pyroprocessing facility in Korea.

In this study, we have arranged the accidents which can be happened in pyroprocessing facility. Then, we have obtained the accident path according to the hazards.

We can expect that this study will be taken to the VAI as a basic data.

2. Methods and Results

2.1 Study target

The pyroprocessing facility has a function that the spent fuel recycling for reuse. Almost engineering process of the pyroprocessing facility like the pretreatment process, electrolytic reduction, electro-refining, electro-winning, salt treatment are conducted in a hot cell of the pyroprocessing facility [1][2][3][4]. Even though we have analyzed accidents which can be occurred at inside and outside hot cell, we have focused the accident of inside hot cell in this study.

2.2 Conditions for fault tree analysis

Some conditions should be set before making the fault tree of an accident for the pyroprocessing facility.

2.2.1 Set the top event

Getting an accident probability of the pyroprocessing facility is main goal in this study. In the beginning of the study, I had to set the top event of FTA and assumptions. The probability of unstable state in pyro processing facility by an accident is set as a top event of this fault tree. To obtain the goal, we have set that the top event name is probability of unstable in the pyroprocessing facility by an accident.

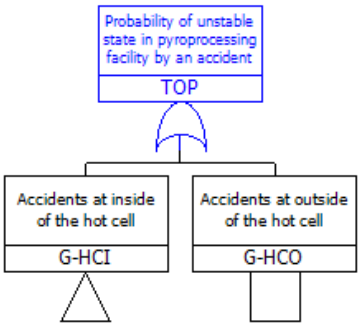

Fig. 1. Setting the top event of event tree for this study.

2.2.2 What kind of accidents in the pyroprocessing facility

Many accidents in the pyroprocessing facility can be categorized to the two group like an internal accident and an external accident. The internal accident is caused by the malfunction of various component and equipment which are related to the pumps, pipes, valves and etc in the pyroprocessing facility. The external accident is caused by the earthquake, flooding and a collision with something like plane. Some assumptions for an accident are considered. The first, the accidents give a disturbance to the normal operation. The second, the accidents occur at hot cell inside only. The last, the accidents are caused by component failures.

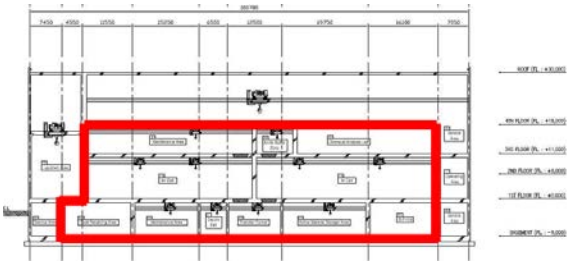

Fig. 2. Hot cell cross section.

2.3 Making the fault tree

The PSA method using the AIMS is used to make the fault tree of this study [5][6].

We have set top event of fault tree and some assumptions for making fault tree at the 2.2 section. We have constructed the fault tree based on the fundamentals of quantitative risk assessment which has 6 steps to make the fault tree for top event [6]. After setting the top event, we have defined system of the

pyroprocessing facility in terms of what constitutes normal operation and can be a disturbance to the normal operation.

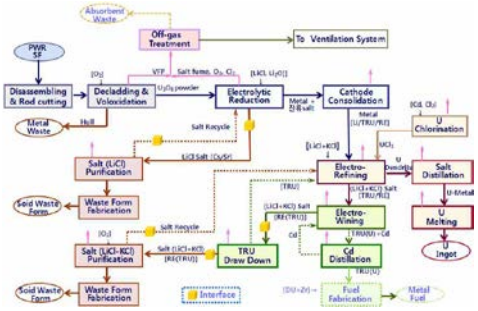

Fig. 3. The pyroprocessing process diagram [4].

Leakage of the LiCl or LiCl-KCl solution is one of the main problem due to the radioactive material in LiCl or LiCl-KCl solution. If a temperature sensor has an error at electro refiner equipment of the electro refining process, the temperature of LiCl-KCl solution in the equipment will be increasing to evaporate easily. Then, evaporated LiCl-KCl can be leaked from that equipment easily. Also, if the LiCl or LiCl-KCl solution has low temperature in the LiCl or LiCl-KCl solution transporting pipe, it can be solidified. On the other hands, the LiCl or LiCl-KCl solution has high temperature, the pipe can have a crack easily.

These are the examples of the accident causes which can occurred at the hot cell inside. We have investigated these accidents of hot cell inside which are related to all process of the pyroprocessing.

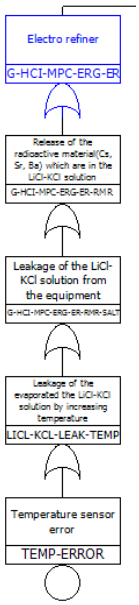

Fig. 4. The example of making the fault tree for an accident.

2.4 Quantifying the fault tree

We faced with some troubles what is no specific data for the pyroprocessing facility because there is no final design for the pyroprocessing facility in Korea. We have been taking some assumptions to obtain the quantifying for the each event of the pyroprocessing facility.

3. Conclusions

The fault tree is not complete yet. The fault tree for an accident probability of pyroprocessing facility is being made according to the hot cell area and each process. Conclusions will be handled after finishing the fault tree analysis.

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