A Severe Accident Analysis Based on the NPP Radiological Emergency Response Plans

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1. Introduction

An objective of emergency planning is to simplify the choice of possible responses so that judgments are required only for viable and useful alternatives when an emergency occurs. To achieve this goal, it is very helpful to simplify the various emergency scenarios and let the emergency planning officials know the essential information on the scenarios. The authors noted that identifying the essential information requires a severe accident analysis. The MAAP code analysis was selected for the severe accident analysis.

This research reviews a radiological emergency response plan for KSNP, which consist of various accident scenarios leveled as white, blue, and red. The three-level emergency scenarios are integrated and then they are properly rearranged and grouped for the simplification in this work. These simplified emergency scenarios are inputted into the MAAP code analysis in order to derive the essential information for the emergency planning.

2. Simplification of Emergency Scenarios

A radiological emergency plan deals with the accident entry conditions for nuclear power plants. The accident entry conditions are directly related to critical safety function impairment, loss of fission product barriers, radiation levels, spent fuel pool events, security, fire, natural and other events. The authors noticed that the emergency scenarios in the radiological emergency plan are leveled according to their severity. This means that some lower level scenarios are tightly coupled with other higher level scenarios. Thus, this research integrates the three-level emergency scenarios, which are then properly rearranged and grouped for the simplicity. Table 1, 2, and 3 are parts of the simplified emergency scenarios.

Level	ID	Description
White	5	Reactor Coolant Leakage Rate is Over 50GPM
Blue	1	LOCA Exceeding Charging Pump Capacity
Red	5A	LOCA and Inoperable Safety Injection
Red	5E	LOCA and Probable Fuel Impairment through Vessel Cooling Function Loss
Red	2	Impairment of 2 out of 3 Protective Barriers for Fission Products and Probable Impairment of the Rest

Table 1. Emergency Scenario for LOCA

Level	ID	Description
White	(1 AND 3) OR (3 AND 9)	1: Fuel Cladding Impairment 3: SGTR 9: RCP Stuck Causing Fuel Impairment
Blue	4	Reactor Coolant Leakage Rate is Over 50GPM and Steam Line Break (SLB) and Fuel Impairment
Red	5B	Loss of Primary and Secondary Cooling Functions

Table 2. Emergency Scenario for SGTR, SLB, and Fuel Impairment

Level	ID	Description
White	2	Station Block Out (SBO) and SGTR
Blue	3	Station Block Out (SBO) and Progressed SGTR

Table 3. Emergency Scenario for SBO and SGTR

The above tables show that one or more events may develop severe accidents and thus some combined events can construct a severe accident scenario. To prove this statement, it is necessary to perform severe accident analysis.

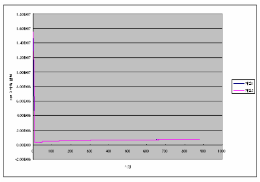
3. Severe Accident Analysis Using MAAP

Based on the emergency scenarios in Chapter 2, the inputs for the MAAP code analysis were constructed. With the inputs, the MAAP code produced various results from which we could derive the essential information for the emergency planning.

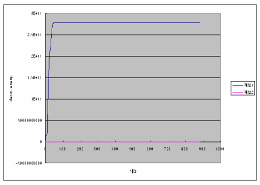
Table 4 presents the sequence of events, which is a result from the MAAP code with the input based on Table 1. Although the sequences of events are omitted in this article, those based on Table 2 and Table 3 are also resulted from the MAAP code. With these results, we can verify if the integrated and simplified emergency scenarios correctly represent the real accident progresses in NPP. Figure 1 shows the trends of some important process variables resenting the accident progress. In addition, based on the results, it is possible to conjecture the environmental impact of the accident.

Accident Progress in Primary System	**Time**
Reactor Scram, Main FW OFF, Main Steam Isolation Valve (MSIV) Closed	0 sec
RCP OFF	3.1 sec
Accumulator Water Depleted	49.1 sec
Max. Core Temp Exceeds 2200°F (1477 K)	2309 sec
Max. Core Temp Exceeds 2499 K	2525.9 sec
RELOCATION OF CORE MATERIALS TO LOWER HEAD	3931.3 sec
VESSEL FAILED BY EJECTION OF INSTRUMENT PENETRATION TUBES	7619 sec
Accident Progress in Containment Building	**Time**
Pressure Up due to Reactor Coolant Release	0 sec
Continuous Pressure Up due to H2	2309 sec
TH COMPT CORIUM POOL TEMP. > CONCRETE MELT TEMP.	7619.3 sec

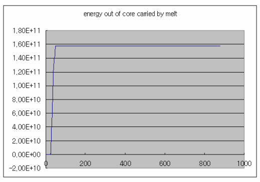
Table 4. Accident Progress of Large LOCA from MAAP



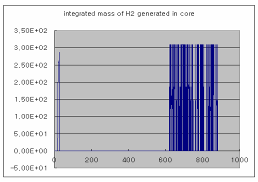
PPS Pressure



Decay Energy



Energy from Melt Core



H2 Mass

Figure 1. Variables Representing Accident Progress

The MAAP code also produces the information on time of containment failure, mass balances including mass released to environment, and so on. This information is very helpful to the emergency planning.

4. Conclusions

This work shows that it is possible to perform a severe accident analysis based on the radiological emergency plans. Through the simplification of emergency scenarios of the plans, we can easily obtain the inputs for a severe accident analysis code. Various additional informative results from the code will surely help us improve the emergency planning.

We are now studying to derive the source term information from the MAAP code results. The information may enable us to classify the severity of the emergency scenarios.

REFERENCES

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