Consequence Analysis for PWR and PHWR Using the MACCS 2 Code

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1. Introduction

The Level 3 PSA[1] being termed accident consequence analysis is defined to assess effects on health and environment caused by radioisotopes released from severe accidents of nuclear power plants. The consequence analysis has been now partly performed for the advanced nuclear power plants, APR (Advanced Power Reactor)-1400. In this study consequence analysis on health effects in KSNP (PWRs) and CANDU plant (PHWR) has been performed using MACCS 2[2] code in the small LOCA sequence. The FSAR (Final Safety Analysis Report) and plant specific data, such as source terms, weather data and population data, are utilized as input for the MACCS 2 calculations.

2. Structure and Method of MACCS 2

The models in MACCS 2 are implemented in three modules: ATMOS, EARLY and CHRONC.

- ATMOS - This module treats the atmospheric dispersion and transport of material and its deposition onto the ground
- EARLY - This module models direct exposure pathways, dosimetry, mitigative actions and health effects during the emergency phase
- CHRONC - This module models the direct and indirect exposure pathways, dosimetry, mitigative actions, and health effects during the period that follows the emergency phase: the intermediate and long-term phases. It also models the economic costs with the mitigative actions during the emergency, intermediate, and the long-term phases.

In this study the consequence analysis to assess effects on health and environment caused by released radioisotopes has been performed for two types of a nuclear power plant, ULCHIN 3&43), WOLSUNG 1. Under the scenarios of evacuation, early and cancer fatalities are calculated for these plants using the MACCS 2 code for SLOCA, which is the most probable accident in LOCA. Release fractions have been estimated using the results of FSAR and MELCOR4) code in case of ULCHIN 3&4. Release fraction of WOLSUNG 1 has been analyzed using the results of FSAR. Table 1 shows the result of release fraction for each plant.

Table 1. Results of release fraction in ULCHIN 3&4 and WOLSUNG 1 (Small LOCA)

	Xe /Kr	I	Cs	Te	Sr	Ru	La	Ce	Ba
1	9.4 E-1	2.4 E-3	1.7 E-3	1.6 E-2	4.4 E-4	1.1 E-3	1.5 E-4	4.3 E-4	1.0 E-3
2	1.0 E+0	7.7 E-3	8.5 E-3	5.2 E-3	2.6 E-4	1.2 E-6	4.7 E-6	2.5 E-8	1.3 E-4
3	9.62 E-1	9.62 E-1	1.48 E-1	1.71 E-2	9.61 E-2	4.36 E-2	1.39 E-3	4.50 E-4	9.61 E-2

* 1. UCN 3&4 FSAR2. WS 1 FSAR3. UCN 3&4 MELCOR

In addition, core inventory in FSAR, topographical data, Meteorological data, population data are utilized as input for the MACCS 2 calculations.

3. Result and Discussions

The results of this study are summarized as follows.

- CCDF (Complementary Cumulative Distribution Function) for ULCHIN 3&4 and WOLSUNG 1 is obtained as shown in Figure 1.
- Early fatalities, Cancer fatalities and Population weighted risk under evacuation scenarios are quantified.
- Average individual risk and whole-body dose are calculated.
- Acute and Lifetime dose for each important organ with respect to the distance are evaluated.

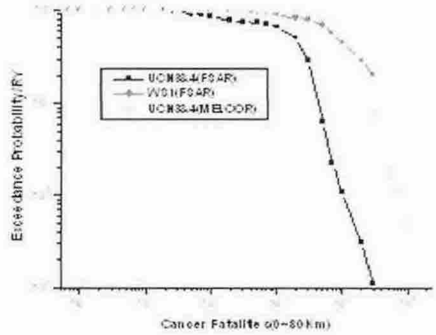

Fig 1. CCDF in ULCHIN 3&4 and WOLSUNG 1

Figure 1 and 2 show analysis results regarding the CCDF and average individual risk for UCN 3&4 and WOLSUNG 1 in small LOCA, respectively. The values of CCDF, early and latent cancer fatalities during emergency evacuation in PHWR are shown to be higher than those in the PWR. It is because the population of the PHWR reference plant is denser than that of the PWR reference plant. Instead, average individual risk of the PWR is higher than the PHWR due to the amount of radioactive materials release as shown in Fig. 2.

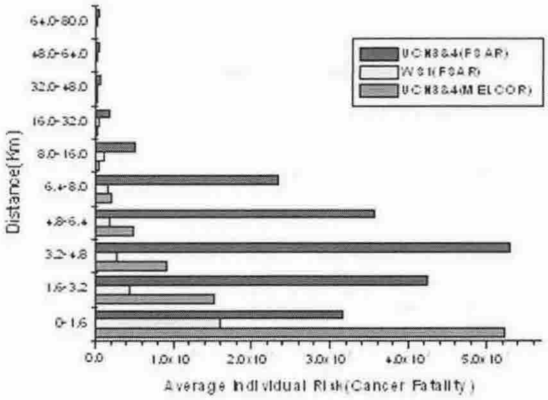

Fig 2. Average Individual Risk in ULCHIN 3&4 and WOLSUNG 1

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