Comparison of Risk Assessment Results for Korean Nuclear Power Plants

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1. Introduction

Safety assessments of domestic nuclear power plants have been performed for core damage frequency and containment failure probability. Effects, however, of fatalities due to radiological materials release are still in the middle of study.

In this study, health effects assessments have been performed for ULCHIN (UCN), WOLSUNG (WS) and YOUNGGWANG (YGN) using MACCS2[1] (MELCOR Accident Consequence Code System 2) developed by NRC (Nuclear Regulatory Commission). Local meteorological data, such as wind direction and speed, atmosphere stability and cumulative precipitation, and local site data, such as population distribution, land fraction, region index and watershed index, are utilized as input data for the most probable scenario of severe accident scenarios. Effective dose for 60 radioisotopes and dose conversion factors for 12 organs are also used as input data.

2. Methods and Results

Consequence analyses for UCN, WS and YGN are performed using MACCS2 developed by NRC during LOCA.

2.1 Structure of MACCS2 Code

MACCS2 is divided into three primary modules: ATMOS, EARLY and CHRONC.

ATMOS performs all of the calculations pertaining to atmospheric transport, dispersion, and deposition, as well as the radioactive decay that occurs prior to release and while the material is in the atmosphere. The results of the calculations are stored for use by EARLY and CHRONC. The downwind transport of up to four plumes can be modeled. A number of parameters are stored. In addition to the air and ground concentrations, ATMOS stores information on wind direction, arrival and departure times, and plume dimensions. EARLY performs all of the calculations pertaining to the emergency phase. The emergency phase begins, at each successive downwind distance point, when the first plume of the release arrives. The duration of the emergency phase is specified by the user, and it can range between 1 and 7 days. The exposure pathways considered during this period are cloudshine, groudshine, and resuspension inhalation. Mitigative actions that can be specified for the emergency phase include evacuation, sheltering, and dose-dependent relocation. CHRONC performs all of the calculations pertaining to both the intermediate and long-term phases. The intermediate phase begins, at each successive downwind distance point, upon the conclusion of the emergency phase. The duration of the intermediate phase is specified by the user, and it can range between 0 and 1 year. The long-term phase begins, at each successive downwind distance point, upon the conclusion of the intermediate phase. The exposure pathways considered during this period are groundshine, resuspension inhalation, and food and water ingestion. Fig. 1 shows the main pathways of radioactive materials.

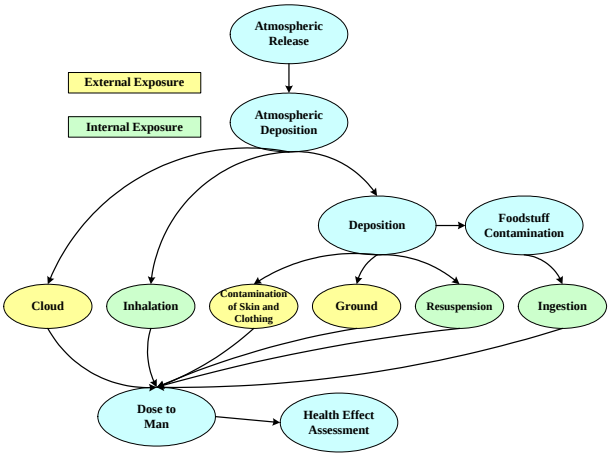

Figure 1. Main pathways of radioactive materials.

2.2 Main Input Data

Main input data of MACCS2, a consequence analysis tool, are following. Firstly, in case of core inventory, that of end of cycle is used for conservative analysis. Secondly, release fractions of MAPP results of the LOCA scenario selected in PSA report[2] are utilized. The results of release fraction of 9 radioisotope groups for the selected scenario are showed at table 1. WASH-1400[3] shows that I and Te are related to early health effects, Cs to latent health effect, and Kr and Ru to marrow and lung. Thirdly, it is assumed that 95% of people evacuate out of a radius of 16km and the rest remain within a radius of

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16km. Fourthly, population distribution within a radius of 80km in FSAR is used as input data. Besides, local ground data and local meteorological data are used as input data, and default values are used as main factors.

Table 1. Release fraction for isotope groups in release

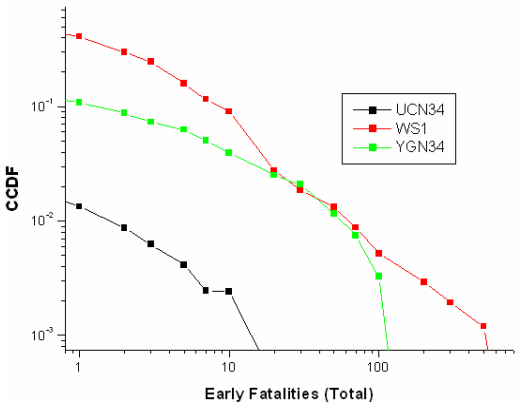
	Xe /Kr	I	Cs	Te	Sr	Ru	La	Ce	Ba
UCN 3&4	9.40 E-1	1.17 E-3	2.74 E-3	1.60 E-2	3.72 E-4	1.10 E-3	1.28 E-4	3.50 E-4	8.96 E-4
WS 1	1.00 E+0	7.70 E-3	8.50 E-3	5.20 E-3	2.60 E-4	1.20 E-6	4.70 E-6	2.50 E-8	2.50 E-8
YGN 3&4	6.10 E-1	2.89 E-2	3.45 E-2	4.98 E-2	1.05 E-6	1.76 E-5	8.63 E-8	4.84 E-7	9.95 E-6

2.3 Results of MACCS2

The results of this study are summarized using the MACCS2 code as follows.

1) CCDF[5](Complementary Cumulative Distribution Function) for ULCHIN 3&4, WOLSUNG 1 and YOUNGKWANG 3&4
2) Early fatalities and Cancer fatalities within a radius of 80km
3) Average individual risk and whole-body dose
4) Acute dose and Lifetime dose of each important organ

Health effects which are the main results are stochastically calculated by MACCS2 for UCN, WS and YGN. These results of CCDF (Complementary Cumulative Distribution Function) are showed in Figure 2. The results of CCDF for early fatalities and latent cancer fatalities are mainly dependent on local meteorological data and population distribution. In case of UCN, the results of CCDF are much lower than those of YGN and WS. It is considered that this results from the difference of population distribution. In addition, wind frequency which dominantly has east direction may be another main reason.



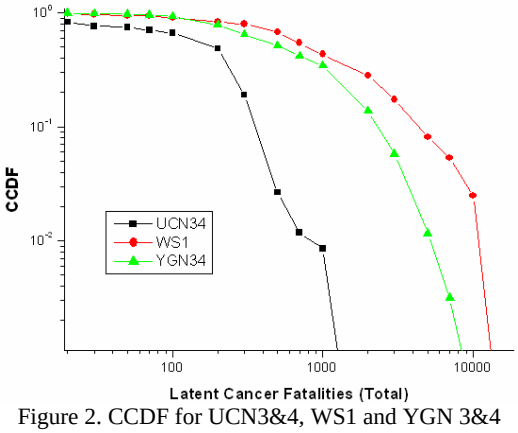


Figure 2. CCDF for UCN3&4, WS1 and YGN 3&4

3. Conclusion

In this study, input data were made with source terms from level 2 PSA, population distribution, local meteorological data and ground data. Then heath effect assessments were performed using MACCS2, a consequence analysis tool, with these input data. A study on uncertainty of input data, source terms, local meteorological data, needs to be performed for more reliable level 3 PSA. Then health effect assessments with these data will be applied to Public Acceptance, Accident Management Plan and Risk Informed Regulation and Application.

Acknowledgements

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