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Early Fatality Risk Evaluation Following Severe Accident

GilJoon Lee, ChaiChul Im

Korea Power Engineering Company, Inc., 360-9 Mabukdong, Gyheong-gu, Yongin-si, Gyeonggi-do, Korea, 449-713
leejoon@kopec.co.kr, cci@kopec.co.kr

1. Introduction

Release of radioactive materials to environmental atmosphere following a severe accident such as the Chernobyl NPP accident would cause a health hazard and social and economical loss to the inhabitants around the nuclear power plants. In Korea, the severe accident policy [1] was published by Ministry of Science and Technology (MOST) and the quantitative health objectives(draft) focused on the early fatality risk and the latent cancer fatality risk were proposed by Korea Institute of Nuclear Safety (KINS) [2]. In this paper, MACCS2 code is used to evaluate the early fatality risk based on the source terms of advanced NPP (APR1400), and the evaluated result are compared with the quantitative health objectives(draft) of KINS, the safety goal of US NRC, and the early fatality risks of five plants in NUREG-1150 [3].

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2. Methods and Results

In this section, the severe accident policy and the quantitative health objectives(draft) are described. The methodology used to evaluate the early fatality risk and the primary inputs are described. The evaluated results are also presented.

2.1 Quantitative Safety Goal

The severe accident policy was published by Ministry of Science and Technology (MOST) in 2001. The quantitative safety goals focused on the early fatality and the cancer fatality risk were prescribed in "Severe Accident Policy of NPP" in order to minimize a health risk to the public even if a severe accident occurs. The primary contents are presented as follows.

"The risk to an average individual in the vicinity of a nuclear power plant of prompt fatalities that might result from reactor accidents should not exceed one-tenth of one percent (0.1 percent) of the sum of prompt fatality risks resulting from other accidents to which members of the Korean population are generally exposed."

The quantitative health objectives for the early fatality risk and the latent cancer risk (draft) were proposed by KINS to be used in determining achievement of the quantitative safety goals. They are 4.0E-7/RY and 1.0E-6/RY for the early fatality risk and the latent cancer fatality risk, respectively, which are less than NRC's quantitative health objectives of 5.0E-7/RY and 2.0E-6/RY.

2.2 Evaluation Method

To evaluate the early fatality risk, MACCS2 code [4] is used. The primary input includes source terms derived from Level 2 PSA, and meteorological data and population data. Source terms are categorized by the containment failure mode and the frequency of each category is summed up to consider all frequencies of source term categories.

In NUREG-1150, such an evaluation was performed for 5 nuclear power plants (Surry, Peach Bottom, Sequoyah, Grand Gulf, and Zion). The following assumptions on emergency planning in NUREG-1150 were applied to evaluate the early fatality risk: 99.5 percent inhabitants in emergency planning zone are evacuated and moved outward at a constant velocity, considering the elapsed time following the initial accident. The remaining 0.5 percent inhabitants are sheltered in the building. Within the time from 12 hours to 24 hours after the radioactive cloud pass through, all inhabitants are evacuated.

In this study, the early fatality risk for APR 1400 was evaluated using the source terms of Korean advanced NPP (APR 1400) and the same emergency planning assumptions as those in NUREG-1150.

The meteorological data and population data are changed yearly. Accordingly, in this analysis, meteorological data of 1998, which were obtained from Kori site, were used and the expected population data of 2010, which is presented in PSAR(Draft) of SKN 3&4, were used. The emergency planning zone(EPZ) is 10 mile for USA but in MOST Notice 2003-15 [5], the EPZ may be selected within a distance between 8 Km and 10 Km apart from NPP. In this analysis, 10 Km is used as EPZ conservatively. The evacuation velocity is assumed to be the same velocity as that of Surry, which is 4.0 mile/hr(=1.8 m/sec).

2.3 Evaluation Result

The evaluation result using the data and assumptions as discussed in Section 2.2 is 1.13E-10/RY and is much less than the quantitative health objectives of KINS and the safety goal of US NRC, which are 4.0E-7/RY and 5.0E-7/RY, respectively. The evaluation result of the early fatality risk for APR 1400 is presented on Figure 1 including the early fatality risks for 5 NPPs in NUREG-1150.

As shown on Figure 1, comparing five plants in NUREG-1150 with the evaluation result, the early fatality risk for APR 1400 is less than the risk of pressurized water reactor type such as Surry, Sequoyah,

and Zion nuclear power plants but is bigger than that of boiled water reactor type such as Peach Bottom and Grand Gulf. The early fatality risk caused by each source term category(STC) is shown on Figure 2. As shown on Figure 1, the major STCs are STC-21(86%) and STC-20(6%), where STC-21 is the STC of Interfacing System LOCA and STC-20 is that of Isolation Failure and No Containment Spray Operation mode.

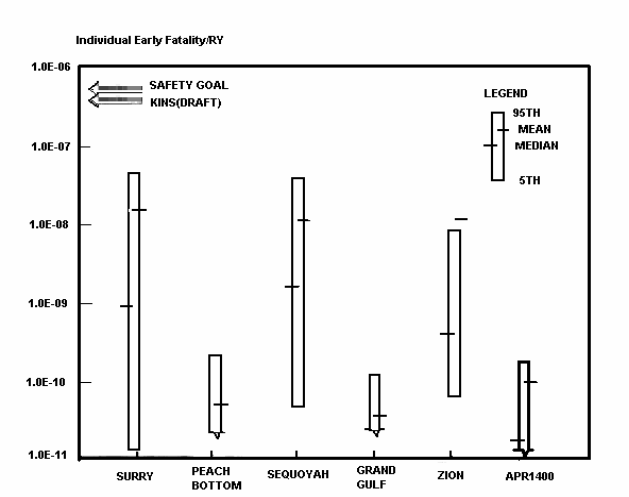

Figure 1. Early Fatality Risks of APR-1400 and NPPs in NUREG-1150

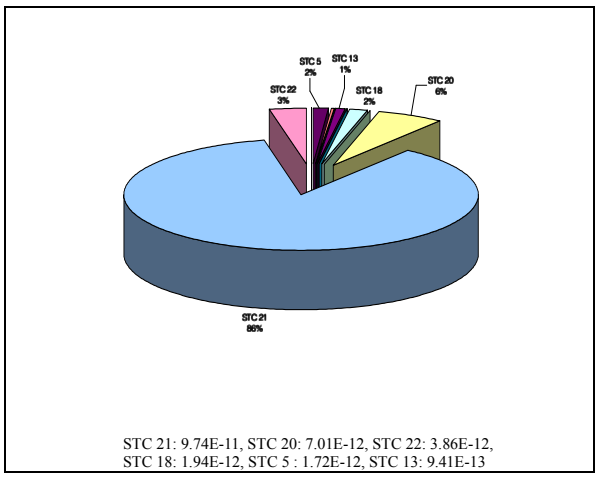

Figure 2. Early Fatality Risks due to Each STC

3. Conclusion

In this study, it is concluded that the advanced reactor(APR-1400) is safer than pressurized water reactor type such as Surry, Sequoyah and Zion nuclear power plants but isn't safer than that of boiled water reactor type such as Peach Bottom and Grand Gulf with respect to the early fatality risk.

REFERENCES

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