A Comparative Risk Assessment of Extended Integrated Leak Rate Testing Intervals

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1. Introduction

This paper presents the risk impacts of extending the Integrated Leak Rate Testing (ILRT) intervals (from five years to ten years) of Younggwang (YGN) Unit 1&2. These risk impacts depended on the annual variances of meteorological data and resident population. Main comparisons were performed between the initial risk assessment (2005) for the purpose of extending ILRT interval and risk reassessment (2009) where the changed plant internal configurations (core inventory and radioisotope release fraction) and plant external alterations (wind directions, rainfall and population distributions) were monitored. The reassessment showed that there was imperceptible risk increase when the ILRT interval was extended compared to the initial risk assessment. In addition, the increased value of the Large Early Release Frequency (LERF) also satisfied the acceptance guideline proposed on Reg. Guide 1.174.

The MACCS II code was used for evaluating the offsite consequence analysis. The primary risk index were used as the Probabilistic Population Dose (PPD) by considering the early effects within 80 km. The Probabilistic Safety Assessment (PSA) of YGN 1&2 was applied to evaluate the accident frequency of each source term category and the used PSA scope was limited to internal event.

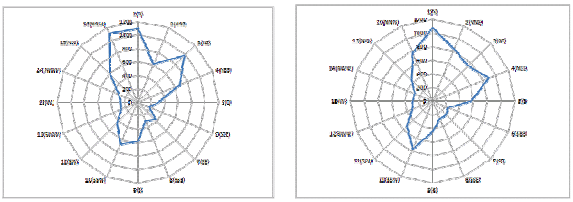
2. MACCS II Code Simulation

MACCS II was used to estimate the radiological doses, health effects, and economical consequences that could result from the postulated accidental release of radioactive materials to the atmosphere. This code consists of three primary modules (ATMOS, EARLY, and CHRON). The ATMOS module conveys the information of radionuclides and their atmospheric dispersion model. The EARLY module performs all of the calculations that pertain to the emergency phases. The CHRON module performs the calculations regarding the intermediate and long-term effects.

The reassessment considered only the changes in meteorological data and the population distribution in the offsite consequence analysis since the plant's internal configurations, such as core inventory or radioisotope release fraction, are the same as the initial assessment.

2.1 Meteorological data

Contained in the meteorological data file are wind direction, wind speed, accumulated precipitation and atmospheric stability. Wind direction is one of the influential factors in the analysis of population dose. Figure 1 presents the wind directions of 2005 and 2009 analysis. The change of the main wind's direction is observed to be from north to northeast, which results in a negative impact on the total risk perspectives since a relatively high population area is located in the northeast of YGN 1&2.



(2005) (2009)

Figure 1. Wind Direction of 2005 and 2009

2.2 Population distribution

The population distribution and land use information are specified in the site data input file. The input file defines 160 input blocks with 10 spatial distances to 80 km and 16 directions. The population analysis in 2009 demonstrates that the total population within 80 km has increased to 2.6% compared with 2005. Particularly, the short-range population has grown to 4%, which has high impacts on the risk increase according to the 2009 analysis.

2.3 Core inventory and radioisotope release fraction

Core inventory data were derived from the results of the ORIGEN code simulation for 60 radioisotopes that were specified in the MACCS II ATMOS module. Release fractions for the 9 radioisotope groups that MACCS II required were determined by reorganizing the results of the MAAP analysis. Since there was no change in the PSA model of YGN 1&2 in 2005 and 2009, the identical data for the core inventory and radioisotope release fraction were applied to the offsite consequence analysis.

3. Results

3.1 Offsite consequence analysis

The MACCSS II provided a population dose, early fatality, and cancer fatality as the result of the offsite consequence analysis. As the result of the offsite consequence analysis, the approach used in the paper adopted the population dose that limited in early effect, and PPD considered the accident frequency depending on the source term category. Particularly, PPD is the risk index that was used in the NUREG-1493

methodology. Table 1 presents the comparison of the offsite consequences that were performed in 2005 and 2009. The values of the PPD increased slightly, but the absolute values had very small risk impact on the public and the environment. Moreover, the individual dose, i.e. the probabilistic dose of every personnel within 80 km due to the operation of YGN 1&2, showed extremely small values.

Table 1. Results of Offsite Consequence Analysis

		YGN 1,2 (2005)	YGN 1,2 (2009)
Population Dose [man.rem]	Early	8.88E+06	1.12E+07
	Early+Late	4.32E+07	3.86E+07
Probabilistic Population Dose [man.rem/year]	Early	2.05E+00	2.65E+00
	Early+Late	9.15E+00	8.08E+00
Individual Dose (Early) [rem/year]		6.43E-07	8.09E-07

Figure 2 indicates the PPD value depending on the source term category. STC 14, 17 and 18 contribute to most of the PPD value. The differences between 2005 and 2009 occurred because of the changes in main wind direction and short-range population.

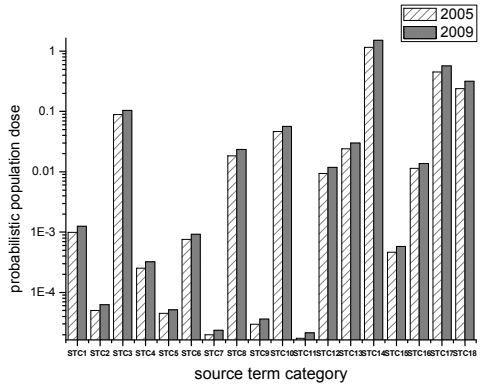


Figure 2. Probabilistic Population Dose

3.2 Risk Assessment (NUREG-1493)

The risk assessment was performed based on the methodology described in NUREG-1493 and the NEI interim report. However, this study only dealt with the results of NUREG-1493. The risk associated with ILRT is the value of STC 1 and 2, assuming there was no containment failure. NUREG-1493 use 3% as the Leak Undetectable Probability (LUP) but this study used 5% by considering the regulatory recommendation.

Table 2. Results of Risk Assessment for ILRT

		YGN 1,2 (2005)	YGN 1,2 (2009)
Probabilistic Population Dose [man.rem/year]		2.05	2.65
Risk Increase (%)	LUP 3%	0.056	0.057
	LUP 5%	0.060	0.061
Individual Dose(Early) [rem/year]		6.43E-07	8.09E-07

The increase rate of risk that was obtained by the methodology in NUREG-1493 was calculated as 0.056% and 0.057% with respect to 2005 and 2009. Those two values reveal an imperceptible risk increase where placed in allowable ranges in terms of risk changes.

4. Conclusion

A comparative risk assessment of extending the ILRT interval for YGN 1&2 by considering the environmental changes between 2005 and 2009 was performed. The major factors that were associated with the risk changes were the meteorological data and population distribution. These two factors resulted in an increase in the PPD value, but the increase rate that was defined in NUREG-1493 had no substantial impact on the environment and public.

From this study, it is determined that it is necessary to establish a comprehensive program that can perform the offsite consequence analysis, as well as risk assessment, that uses systemic method and procedure for effective risk managing and monitoring of the ILRT extension.

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