A Study on the Verification Using Regulatory PSA Model for RI-ISI Application Review

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1. Introduction

RI-ISI(Risk-informed In-Service Inspection) is presently being applied as an alternate approach to the traditional method to screen piping segments for ISI. In US, risk-informed methodology for ISI has been applied and enforced to nuclear power plants. Regarding this, RI-ISI methodology was developed for Ulchin nuclear unit 3&4(UCN 3&4), and was applied for pilot application. The applicant submitted the topical report to regulatory body and the review on this report is going on.

This study was performed to verify the assessment results by applicant using regulatory PSA model(MPAS) and to evaluation the importance of PSA model used during the RI-ISI evaluation process in terms of Core Damage Frequency(CDF). Also, risk significance evaluation based on the quantification results was performed in order to compare the risk ranking of piping.

2. Methods and Results

2.1 RI-ISI Methodology

Major development procedure of RI-ISI program consists of the screening for piping systems, determination of risk significance, ISI program development and implementation of developed program. RI-ISI methodology in WCAP-14572 by Westinghouse Owners Group(WOG) is presented in Fig. 1. This methodology was applied initially to the Ulchin nuclear unit 3 RI-ISI.[3]

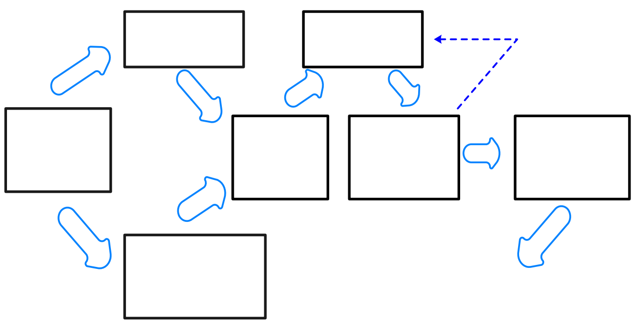

Fig. 1 RI-ISI processing task flow chart.

2.2 Method of Verification Calculation

To evaluate the effect of PSA model change in RI-ISI Methodology, results from segment definition and consequence evaluation, piping failure probability and surrogate component selection by applicant were used.[4,5,6]

2.3 PSA Model

PSA model used by applicant for RI-ISI evaluation was based on the UCN 3&4 risk monitor(revision 1) by Korea Atomic Energy Research Institute(KAERI). This PSA Model was to evaluation CDF for full power internal event. CDF from this Model was 8.19e-6/Ry.[3]

PSA model used in this study is PRiME 2.0 Model which is minor upgrade version of MPAS model and PRiME 2.0 model was developed by KAERI. PRiME 2.0 model was developed to meet the quality requirements from ASME PSA Standard and NEI PPRP Guidance. This improved risk monitor model was evaluated as Capability Category I+ level by ASME PSA Standard. The scope of PSA model used in this study is limited to full power operation and internal event, and this model is for 16 initial events. CDF of this Model was 5.49e-6/Ry.[2]

2.4 Method of Result Comparison

The base CDFs of PSA model used by the applicant and used in this study showed difference. Therefore it has no significant meaning to compare the quantitative values for each PSA run case directly. To compare the quantitative result, the equation (1) in which the factors to normalize the difference of relative values were applied was used.

$$\Delta F = \frac{RAW_{KINS} - RAW_{KHNP}}{RAW_{KINS}} \qquad (1)$$

where,

RAW_{KINS}: Risk Achievement Worth for PSA run case from PSA model used in this study

RAW_{KHNP}: Risk Achievement Worth for PSA run case from PSA model used by the applicant

The process flow of Input and output data through risk assessment result table was shown in Fig. 2. SRRA failure probability and segment test interval were used as it was presented by the applicant. Plant CDF and PSA Run values obtained from the calculations for verification were put into that table.[7]

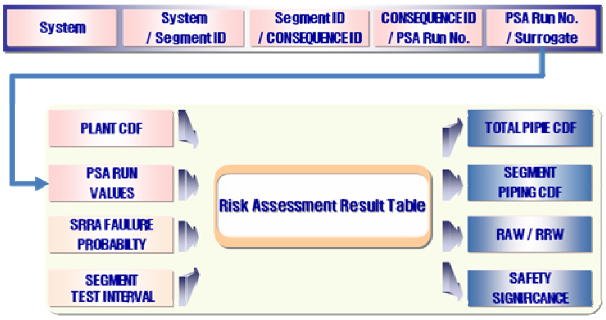

Fig. 2 The process flow of Input and output data through risk assessment result table

2.5 Comparison Result

The PSA run cases that △F is exceeded 100% among 265 run cases related to 30 systems were compared. 44 cases were not quantified because of the model difference. System which showed the largest difference was high pressure safety injection system(HPSIS). The number of the PSA run cases those showed △F more than 100% in HPSIS is 14 run cases. Fig. 3 shows the comparison of quantification results for the HPSIS.

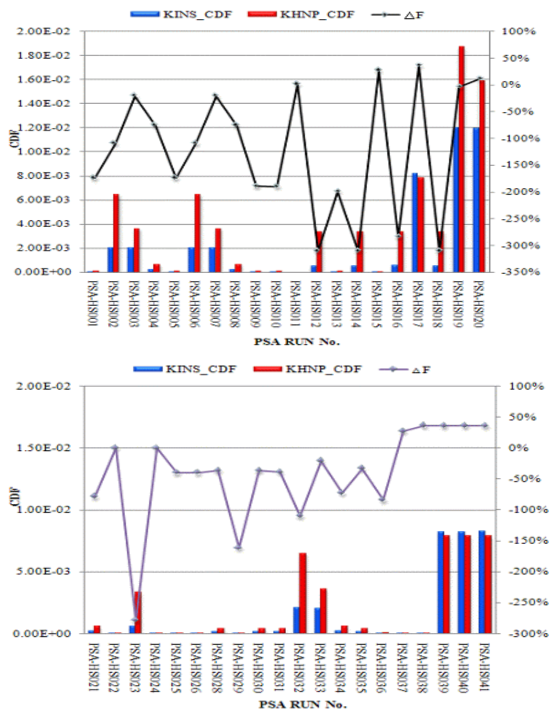

Fig. 3 Comparison result for HPSIS.

Reevaluated CDF quantification results were put to the result table for risk assessment in order to determine the risk ranking.

Comparison of results by the applicant showed 64 difference in segment classification as in Fig. 4.

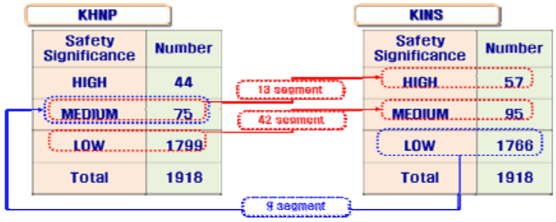

Fig. 4 Comparison result of segment classification

3. Conclusions

From the comparison performed in this study showed that the PSA model change can affect the risk ranking in RI-ISI process. However, this difference can be covered by the expert panel process. Even though the difference in risk evaluation can be covered by the expert panel, the PSA model used in RIR program such as RI-ISI can affect the input to the expert panel. Therefore, the quality-assured PSA model should be used in the risk-informed regulation and application.

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