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An assessment of the Postulated indirect Consequences Associated with Piping Failure

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1. Introduction

Inservice Inspections (ISI) of piping elements are performed to identify pipe degradation that may lead to leaks or ruptures. Risk-informed ISI is presently being applied as an alternate approach to the traditional method for establishing ISI requirements. As a part of this process, an assessment of the postulated indirect (spatial) consequences associated with piping failure is made in order to further distinguish the piping segments. The indirect effects assessment is accomplished through an investigation of existing plant documentation on pipe breaks, flooding, and plant layout along with a focussed plant walkthrough. An assessment of the indirect (spatial) consequences for Ulchin Unit 3 has been completed in July 2008 as a part of Risk-informed ISI. This paper defines the evaluation process for the identification of indirect effects and shows the results of Ulchin Unit 3 & 4.

2. Methods and Results

In this section defines the evaluation process and results from Ulchin Unit 3 evaluations.

2.1 Evaluation Process[1][2]

The purpose of evaluating indirect consequences is to identify potential indirect effects/consequences from piping failures that would differentiate piping segments from each other in the risk evaluation.

This analysis evaluates system interactions due to piping failures. The following potential pipe failure-induced conditions are considered Flooding, Water Spray, Pipe whip, High environmental temperatures (e.g. Steam line break) Jet impingement. The first two conditions are usually evaluated using the internal flooding PSA assessment process developed to quantify the impact (the base information used to screen the various plant areas; before any quantitative screening is performed). This information is used to identify the impact of postulated flooding scenarios. The remaining conditions are analyzed using previous high energy and moderate energy postulated break hazards analyses.

The indirect effects to be considered include:

- Failures that cause an initiating event such as a LOCA or reactor trip
- Failures that disable a single train or system
- Failures that disable multiple trains or systems
- Failures that cause any combination above

The following summarizes the process steps:

<u>Pre-walkthrough</u>

- Review existing documents which examine the local effects of piping failures for the systems in the risk-informed ISI program
- Develop walkthrough sheets for key areas

<u>Walkthrough</u>

- Perform walkthrough and document results, actions, issues

<u>Post Walkthrough</u>

- Evaluate results
- Map indirect effects to piping segments and required leak or rupture failure probabilities

2.2 Discussion of Major Assumption

The major assumptions resulting from the information gathered before, during, and after the walkthrough follow:

1. Generally, the operator actions can not stop the indirect effect itself. The indirect effect of flooding can sometimes be prevented by the operator action isolating the leak before any equipment is flooded.

2. If the indirect effects are the same or involved as the consequences in the direct effects, the indirect effects are not described in the indirect effects analysis.

3. The standby systems such as safety injection system which are moderate energy line due to the relatively short time that they are above the criteria for high energy are treated as high energy lines in the RI-ISI program.

2.3 Summary of Results

Piping segments and indirect (spatial) effects have been identified for the risk-informed inservice inspection process. The potential indirect consequences of pipe failure-induced damage (i.e., additional to the direct impact of piping failure) inside containment is assumed to be small. So we did not assess that inside containment building. The following identifies the postulated indirect effect for the primary auxiliary building.[3]

- Failure of cycling operation in AFW MDP/TDP
- Failure of modulating operation in AFW MDP and TDP
- Loss of HP header HPI, HPR and HPH to RCS loop cold leg
- Loss of emergency boration, Loss of pressurizer auxiliary spray
- Loss of HP header 2 to RCS 1B cold leg, and Loss of containment sump inventory resulting in loss of HPR, HPH, LPR and CSR
- Loss of Startup Feed water to Steam Generator
- Failure to blow down ruptured Steam Generator to prevent overfill
- General Transients
- Loss of HPH to RCS loop hot leg

3. Conclusions

The indirect effects resulting from pipe breaks within the plant have been identified and listed in the above section “Summary of Results”. Hazards have been identified for each area and targets within each area have also been identified. The next task in the process is to match the pipe segments with the above identified indirect effects. This task was performed by reviewing plant arrangement and piping drawings in conjunction with the segment definitions. Based on this review, the applicable indirect effects were assigned to the pertinent segments.

REFERENCES

[1] “Application of Risk-Informed Methods to Piping Inservice Inspection,” TR-KHNP-0019, Revision 0, July 2006, page 36~38
[2] “Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report, WCAP-14572, Revision 1-NP-A, ”February 1999, page 62~71
[3] “Risk-Informed ISI Indirect consequence evaluation for Ulchin Unit 3