Risk-Informed Regulatory Review of Containment ILRT Interval Extension

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1. Introduction

The reactor containment must be capable of withstanding the pressurization of a hypothesized accident with a quite small leak rate. Containment leak tests are periodically conducted in compliance with MOST Notice 2004-15 [1] and the technical specification of each nuclear power plant.

In 1992, the US Nuclear Regulatory Commission (NRC) began developing requirements for containment testing that are less prescriptive and more performance-oriented and risk-based than the then requirements [2,3]. Referring to the NRC experiences, MOST Notice 2004-15 includes relaxing the frequency of integrated leak rate tests (ILRTs) from the current one every 5 years to one every 10 years under the conditions of high safety and good performance.

This paper presents a technical approach and acceptance criteria for the regulatory review on plant-specific changes of ILRT interval.

2. Containment Integrated Leak Rate Tests

2.1 Costs

ILRT is known as a high-cost test. The ILRT is conducted as critical path work during the outage. During the test, the containment is isolated preventing any other maintenance work on the containment from being performed. A single test results in ~2.5 lost days of generating capacity [4]. Replacement power is estimated at almost 80% of the total costs of ILRTs [2]. Workers are exposed to the radiological dose and industrial hazards while performing the test. Economic and occupational exposure costs are directly related to the frequency of tests.

2.2 Effectiveness

The vast majority of leak paths are identified by local leak rate tests (LLRTs) of containment isolation valves. ILRTs identify only a few potential containment leak paths that LLRTs cannot identify. Although the availability and reliability of containment integrity are important, the extremely low leak rates prescribed by current regulations and the tests may not be necessary.

2.3 Risk Contribution

Reactor accident risk is dominated by low-probability and high-consequence scenarios in which the containment fails or is bypassed. In these types of accident, little benefit is derived from a high degree of containment leak-tightness.

The information on reactor accident risks can be derived from probabilistic Safety Assessments (PSAs) [2]. Some releases occur during normal operation. However, these releases are very small and the dose received by public is much smaller than the dose received from background radiation.

During ILRTs, the containment is placed in a simulated post-loss of coolant accident (LOCA) condition with only a single reactor heat removal train available to cool the core. Because the core and containment are isolated and only a single cooling train is available, the shutdown risk is increased.

2.4 Performance-based Requirements

In 1992, the NRC concluded that decreasing the prescriptiveness of some regulations could increase their effectiveness, by giving the licensees the flexibility to implement more cost-effective safety measures. To increase flexibility, the detailed and prescriptive technical requirements could be replaced with performance-based requirements and supporting regulatory guides. The performance-based requirements would reward superior operating practices. The revised regulation in Appendix J to US 10CFR50 [5] is a performance-based requirement. The revised regulation is accompanied by some guidelines which will be utilized by licensees to implement the new regulation. These guidelines are NRC Regulatory Guide 1.163 [6], NEI 94-01 [7], and ANSI/ANS-56.8-1994 [8]. These guidelines are deemed necessary for relaxing the ILRT frequency from the current one every 5 years to one every 10 years.

3. Risk Impact Assessment of ILRT Interval

3.1 Risk Measures

In case that licensee initiates a licensing basis (LB) change requests of ILRT interval extension, the plant-specific risk impacts must be evaluated in compliance with MOST Notice 2004-15. The licensee should assess the expected changes in the following risk measures:

1) the change in large early release frequency (ΔLERF)
2) the percentile change in radiological consequences (e.g., population dose rate, number of early fatalities and early injuries expected to occur with 1 year of accident, total latent cancer fatalities, and individual latent cancer fatalities in the population living within 1 mile of reactor site boundary)

3.2 Accident Scenarios

In Level 2 PSAs, several release classes are defined as the spectrum of plant release. In order to evaluate the risk impacts of ILRT interval changes, new release classes **A** and **B** must be additionally defined as shown Table 1. Only the classes **A** and **B** are affected by the ILRT interval because the ILRT only changes the probability that a pre-existing leak would go undetected. The frequency for each release class is obtained directly from the plant's PSA, excluding classes A and B.

Table 1. Additional Release Classes

Class	Description
A	Small pre-existing leak in containment structure or liner, identifiable by ILRT (not CF)
B	Large pre-existing leak in containment structure or liner, identifiable by ILRT (LER, CF)

3.3 Pre-Existing Leak

Relaxing the ILRT interval increases the average time that a leak detectable only by an ILRT would go undetected. The probability and leak-rate of pre-existing leak affect the release classes **A** and **B** in their consequences. Table 2 provides our recommended assumption of the pre-existing leak.

Table 2. Recommended Assumption of Pre-existing Leak

Class	Leak rate	Frequency	
		One every 5 years	One every 10 years
A	10 La	0.0375 x CDF	0.075 x CDF
B	35 La	0.0125 x CDF	0.025 x CDF

3.4 Acceptance Criteria

An example of criteria used in the risk-informed regulatory decision would be those of the NRC RG 1.174 [9]. These criteria are imposed on ΔCDF and ΔLERF that would result from a proposed change in the licensing basis. When ΔLERF is taken as being less than 10^{-7}/RY, the change will be considered regardless of whether there is a calculation of the total LERF. When ΔLERF is in the range of 10^{-7}/RY to 10^{-6}/RY, applications will be considered only if it can be reasonably shown that the total LERF is less than 10^{-5}/RY.

Inferring from RG 1.174, the change will be considered when the percentile change in its radiological consequences is also less than 1%.

4. Conclusion

We have presented a technical background and acceptance criteria for the regulatory review on plant-specific changes of ILRT interval. These results will be used in regulatory reviews of relaxing the ILRT frequencies of PWRs from the current one every 5 years to one every 10 years.

REFERENCES

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