

Internal Flooding Probabilistic Risk Assessment

Background

An internal flooding (IF) risk assessment refers to the quantitative probabilistic risk assessment (PRA) treatment of flooding as a result of pipe and tank breaks inside the plants, as well as from other recognized flood sources. The industry consensus standard for Internal Events Probabilistic Risk Assessment (American Society of Mechanical Engineers/American Nuclear Society [ASME/ANS] RA-Sa-2009) includes high-level and supporting technical requirements for developing an internal flooding PRA (IF-PRA). This consensus industry standard was endorsed by the U.S. Nuclear Regulatory Commission (NRC), with clarifications, in Regulatory Guide 1.200, Revision 2, as an acceptable approach for addressing the risk contribution from IF events for risk-informed applications that require NRC approval. In addition, the NRC has stated that risk-informed applications that do not address the regulatory guide positions can be subject to rejection or low-review priority.

In 2009, the Electric Power Research Institute (EPRI) published a guideline for the development of IF-PRA that addresses the requirements of the ASME/ANS RA-Sa-2009 PRA consensus standard. The EPRI guideline delineates a level of detail and assessment complexity that has been significantly increased with respect to the guidance for IF assessment performed for the individual plant examination (IPE) to address Generic Letter 88-20. The main differences include:

- A more systematic approach to the definition of flood area
- The identification, screening and analysis of flooding sources and scenarios

- The calculation of the initiating-event frequency (IEF) based on the actual length and characteristics of the piping
- The inclusion of spatial effects such as spray from pipe leaks
- The specific documentation associated with the plant walkdowns

Description

Westinghouse has the expertise and capability to perform IF-PRAs that meet the requirements of the ASME/ANS PRA Standard and address the NRC's positions in Regulatory Guide 1.200, Revision 2.

Benefits

Upgrading the current internal flooding evaluation to meet the requirements of the consensus ASME/ANS PRA Standard (RA-Sa-2009) will result in several benefits to utilities. Plant safety will be improved by identifying and addressing potential flooding vulnerabilities and developing appropriate mitigating strategies. The utility will be able to prepare risk-informed submittals, such as risk-informed in-service inspection of piping, which will be readily accepted for review and approval by the NRC. The utility can also expect that the NRC will have minimal concerns during the risk-informed submittal reviews.

Experience

- Westinghouse performed full scope IF-PRAs for several nuclear power plants, exercising all the tasks of the EPRI guidelines for development of an IF-PRA, from the initial IF-dedicated walkdowns to the final model and quantification with different PRA codes. Peer reviews of IF-PRAs performed by Westinghouse determined that Capability Category II supporting requirements of RA-Sa-2009 were met.

- Westinghouse developed proprietary tools and methodologies to apply the EPRI guidelines and the PRA standard expectations for IF-PRA. These tools support and facilitate documentation and data gathering during walkdown, and automate some of the most labor-intensive steps such as flood-impact assessment and propagation-path considerations. All Westinghouse tools are capable of interacting with different PRA codes.
- Westinghouse performed a deterministic IF analysis to address new Swedish regulatory requirements for protection against internal floods.
- Westinghouse has performed the IF-PRA analysis for the AP1000® nuclear power plant and currently maintains the IF-PRA to reflect the impact of design finalization.
- Westinghouse actively participates in the Owners Group Regulatory Guide 1.200 peer review and self-assessment processes, which specifically include the risk from internal flooding events.
- Westinghouse was a contributing author of the EPRI IF-PRA guidelines and is leading the efforts to refine and update the supporting requirements for IF for the Addendum B of the industry consensus ASME/ANS PRA Standard.
- Westinghouse has also supported the development of industry training material that explains and clarifies the supporting requirements for internal flooding events.
- Westinghouse actively participates in industry organizations that maintain the ASME/ANS PRA Standard. This involves the responsibility of maintaining and upgrading the applicable part of the standard and guidance documents related to internal flooding.
- Westinghouse's involvements have kept the organization on the leading edge of IF-PRA methods and industry positions so that customers can be informed of ongoing industry activities related to internal flooding.

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