Nuclear Services/Engineering Services

Fully Integrated Regulatory Guide 1.200 Simplified Level 2 Probabilistic Risk Assessment Model

Background

Regulatory Guide (RG) 1.200 endorses the American Society of Mechanical Engineers (ASME) consensus standard for internal events probabilistic risk assessment (PRA), which includes a set of minimal requirements for PRA modeling of large early release frequency (LERF). As the use of PRA in the nuclear industry matures, the capability of plant-specific LERF models, particularly those used in regulatory operations, must meet these standards.

Westinghouse has developed and refined a simplified Level 2 PRA model that facilitates full Level 1 fault tree integration and supports compatibility with online configuration risk-management tools. This allows for real-time LERF quantification, based on specific operational and maintenance configurations. The model also extends beyond LERF toward a full Level 2 model that is able to track both late and small early releases, as well as late and intact containment end states. Westinghouse designed its Simplified Level 2 model to meet most of the ASME PRA standard supporting requirements at a Capability Category II level.

Description

The Simplified Level 2 model includes detailed treatment of phenomenological considerations based on plant-specific features. These considerations include important fission product boundary challenges such as thermally induced steam generator tube rupture (SGTR); pressure-induced SGTR; intentional and unintentional post-core damage reactor coolant system depressurization; and early containment failures from hydrogen burns, direct containment heating and steam explosions. Through the use of recovery rules, event probabilities can also be applied conditionally, based on the availability of AC power.

The Westinghouse Simplified Level 2 model includes Level 2 event tree and fault tree development, as well as integration and quantification for baseline post-core damage end states that can easily be integrated into the most commonly used PRA software. Westinghouse will use uncertainty evaluations and modeling assumption sensitivity studies to determine both aleatory and parametric uncertainty. Westinghouse uses commonly accepted human-error calculation methodologies consistent with the remainder of the PRA to perform evaluations of human-failure probabilities. It also includes insights from plant-specific severe thermal hydraulic analyses (e.g., MAAP) to support considerations for the time to vessel breach, containment failure and thermally induced SGTR, as well as any timings necessary to support human-failure assessments.

Benefits

The greatest benefits of Westinghouse's Simplified Level 2 model are its complete treatment of LERF/Level 2 phenomenology and its full integration into the existing Level 1 PRA fault tree. These features allow for easy quantification of LERF for specific operational and maintenance configurations with online running tools.

Implementing Westinghouse's Simplified Level 2 model significantly increases the plant's compliance with RG 1.200 and other industry consensus standards such as

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those of the American Society of Mechanical Engineers (ASME) and the American Nuclear Society (ANS). This permits efficient U.S. Nuclear Regulatory Commission review of risk-informed applications where LERF may be an important risk metric.

Experience

Westinghouse has developed Simplified Level 2 models for several power plants in the United States. The initial projects use the Pressurized Water Reactors Owners Group methodology, while latter projects further advance and refine the developmental and implementation methodologies.

Westinghouse offers a team-oriented, turnkey implementation through which it provides an integrated, plant-specific model and stand-alone associated documentation that can support various utility applications.

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