Operating Plant Business

Baffle-Former Bolt Probabilistic Prediction Service

Background

U.S. operating experience (OE) in 2016 has demonstrated that Baffle-Former Bolts (BFB) in the reactor vessel internals in some Westinghouse design pressurized water reactors may be subject to extensive degradation as plants age. Concern for potential plant vulnerability to degradation events has created a need for a capability to reliably predict future BFB behavior. Planning for inspection activities and preparation of appropriate contingencies is limited by uncertainty in the timing and extent of BFB degradation from plant to plant. Predictive capabilities with improved accuracy provide nuclear plant operators with the information needed to make better-informed outage decisions, lowering risk and costs and supporting development of a long-term aging management strategy for BFBs.

Description

Westinghouse has been developing BFB analysis techniques, bolt design improvements, inspection technology, replacement tooling, and susceptibility predictions for more than twenty years. Based on BFB degradation OE from a 4 loop unit in 2010, Westinghouse has outlined an approach capable of explaining and modeling the clustered failures observed in 2016 (NSAL 16-1 Rev 1). This approach has been further developed and has resulted in a probabilistic BFB prediction methodology utilizing input from a Westinghouse Acceptable Bolting pattern Analysis (ABPA) to predict the stress and likelihood of failure for each BFB in a reactor internals baffle-former assembly.

Deliverables from the service include:

- A Westinghouse engineering letter that recommends the bolts to be replaced based on UT inspection results, provides details on the prediction methods used and gives a technical justification supporting future inspection frequency
- A stand-alone baffle-former bolt degradation prediction evaluation documented in a report presenting the inputs assumed, the evaluation results, and a summary of what the results mean for a particular plant. The results of this evaluation can be a key input to decision-making about the baffle-former assembly.
- Expanded capability of existing Aging Management products through addition of BFB predictive evaluations (i.e. – enhancing Aging Management Program Plans, Pre-Inspection Engineering Programs, Inspection Response Plans, Acceptable Bolting Pattern Analyses, and Replacement Bolting Pattern Analyses with BFB predictions)

Westinghouse's methodology combines operational experience with detailed mechanistic modeling to enhance accuracy and to enable forward-looking predictions for plants with limited operational experience.

Benefits

Westinghouse's bolt-by-bolt baffle-former bolt probabilistic prediction capabilities will:

- Support enhanced decision-making and long-term planning:
  - Inspection timing and frequency guidance
  - Level of contingencies (bolts, analyses, tooling reservations, etc.)
  - Expected quantity of replacements
- Provide a plant-specific BFB integrity assessment built on the subject plant's design and operating history details
- Complement ABPA (Acceptable Bolting Pattern Analysis) by enabling development of more probable pattern evaluations prior to the inspections

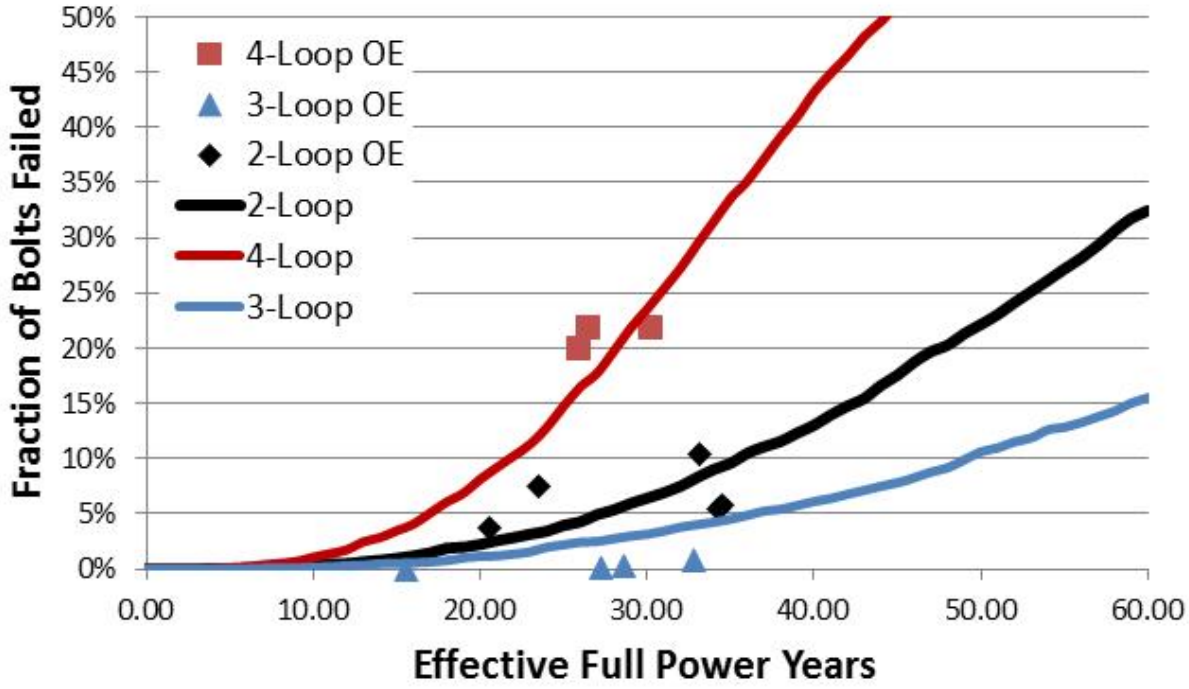
- Complement RBPA (Replacement Bolting Pattern Analysis) by proactively identifying more probable areas where clustering and localized degradation might occur
- Augment operability assessments by adding probabilistic arguments on bolt integrity
- Provide the inputs required for updating inspection requirements of MRP-227

Westinghouse predictive capability provides significantly more value than the capabilities of other suppliers:

- Westinghouse has all of the detailed inputs and design models for Westinghouse plant reactor vessel internals. These inputs and models are necessary to develop accurate predictions of BFB degradation and will be needed for technical basis justifications
- Westinghouse has the expertise and experience to utilize the inputs and design models to accurately predict BFB behavior and apply the results effectively
- Westinghouse's methodology combines operational experience with detailed mechanistic modeling to enhance accuracy and to enable forward-looking predictions for plants with limited operational experience. Use of operational experience alone or in combination with simple rules, also based on operational experience, is not likely to accurately predict future degradation.

Experience

Westinghouse has over 20 years of experience in analyzing and modelling of baffle-former bolt degradation that has been applied to development of the probabilistic prediction methodology. The graph below provides a sample of the prediction capability.



Westinghouse Electric Company
1000 Westinghouse Drive
Cranberry Township, PA 16066