

Reactor Internals Baffle-Former Bolt Acceptable Bolting Pattern Analysis (ABPA)

Background

Age-related degradation of the reactor vessel internals is an important consideration as nuclear plants reach extended lifetimes. One component that is critical to maintaining the structural integrity of the internals, and has been shown operationally to be susceptible to aging mechanisms is the baffle-to-former bolts (or baffle bolts). The stainless steel baffle bolts attach the vertical baffle plates to the horizontal former plates within the internals for select Westinghouse and Combustion Engineering Pressurized Water Reactors. The original plant design basis is that all baffle bolts remain intact throughout the plant life. The aging mechanisms of concern include irradiation-assisted stress corrosion cracking (IASCC).

Westinghouse has developed an engineering analysis technique to demonstrate that even with many non-functional bolts a plant can operate safely and meet the design basis. This analysis method is called an Acceptable Bolting Pattern Analysis (ABPA). The method provides a new basis for the number and location of baffle bolts necessary to maintain the structural integrity of the reactor internals baffle region.

Description

The Westinghouse baffle-former bolt ABPA analytical technique consists of detailed modeling of the internals and evaluation of the thermal-hydraulic loads on the baffle bolts during normal, upset and faulted conditions to define maximum loads on bolts with varying numbers and distributions of intact bolts.

Westinghouse also offers real-time analysis (RTA) services for rapid turn-around evaluations during an inspection outage. To provide this service, ABPA preparatory work must be performed to have the necessary tools available and reviews completed prior to the start of the outage and inspection. Westinghouse recommends the RTA approach for plants that are planning on performing baffle bolt inspections, as it provides the most versatility for analyzing the plant's as-found condition.

The time needed before the outage to perform the required analysis is 9 to 12 months.

The Westinghouse baffle-former bolt ABPA methodology has been approved by U.S. Nuclear Regulatory Commission for use in establishing the required number and location of bolts.

Benefits

- Results allow plants to assess the impact of bolts found to be non-functional during plant inspections and to continue operation with non-functional bolts remaining in place, thus reducing outage delays significantly. (Time for replacement can be days or weeks depending on the availability of equipment and replacement bolts.)
- Pre-inspection analytical work provides the ability to define replacement bolting patterns, if replacement is necessary or desired.
- Results are valid for the life of the plant, except in cases where major modifications are made to the internals.

Deliverables

An engineering report is issued defining reduced bolting distributions that meet plant code acceptability limits and define a new design basis for baffle bolts. The number of bolting patterns that are analyzed can be customized to meet the customer's preference. This report can be used to evaluate inspection results and to disposition non-functional bolts, as well as support decision-making on the potential need for replacement bolts.

Experience

Westinghouse has performed the analysis for Westinghouse two-loop, three-loop and four-loop plants of various configurations and for Combustion Engineering design plants. To date, over 15 analyses have been performed to support baffle bolt inspection evaluations.

