ENCLOSURE 2

MFN 08-420 R1

Surveillance Plan for GNF Thick/Thin Channel-Control Blade Interference Monitoring for BWR/6 (S-Lattice) Plants

Non-Proprietary Information - Class I (Public)

IMPORTANT NOTICE

This is a non-proprietary version of Enclosure 1 to MFN 08-420 R1, from which the proprietary information has been removed. Portions of the enclosure that have been removed are indicated by open and closed double square brackets as shown here [[ ]].

Surveillance Plan for GNF Thick/Thin Channel-Control Blade Interference Monitoring for BWR/6 (S-Lattice) Plants

1.0 Background and Scope

The increased fuel exposure and control schemes characteristic of current fuel cycles has led to an increased observance of control blade friction in BWR/6 S-Lattice plants. Several investigations have determined the cause to be channel-control blade interference due to greater-than-expected channel deformation, consistent with the primary channel deformation modes of bulge and bow. Channel bulge results from the channel's response to the stresses induced by the pressure difference from the inside to the outside of the channel wall. Two contributing sources of channel bow have been identified as: (1) fast fluence gradient-induced channel bow, and (2) control blade shadow corrosion-induced channel bow. Fast fluence gradient-induced channel bow arises from an accumulated fast fluence gradient across opposite channel faces, such as can develop by operation in the fast flux gradient region near the core periphery. This fast fluence gradient causes differential irradiation growth of opposite channel faces and results in channel bow directed toward the higher fast fluence, higher growth channel face. Fast fluence gradient-induced channel bow can be directed either toward or away from the control blade. Control blade shadow corrosion-induced channel bow is activated by control rod insertion early in the operating life of the channel. The close proximity of the zirconium-alloy channel to the stainless steel control blade results in greater corrosion of, and absorption of corrosion-liberated hydrogen in, the channel faces adjacent to the control blade relative to those away from the control blade. This differential hydrogen concentration results in differential growth and corresponding channel bow directed toward the control blade.

Potential effects of channel-control blade interference include implications for control rod scram time, fuel bundle lift, and loads on reactor internals (including fuel and control rods). Evaluations of channel-control blade interference in BWR/2-5 plants indicated that reactor scram with the reactor at less than full system pressure (e.g., less than 950 psig) could be impeded in control rods exhibiting increased friction. This concern arises if control blade friction increases to a level that exceeds the ability of the control rod drive (CRD) to insert the control rod into the core. However, this concern is not relevant to BWR/6 plants because of the increased CRD system capacity (i.e., Hydraulic Control Unit scram accumulator pressure and volume) in those plants.

The potential impact of a seismic event combined with substantial channel – control blade interference has also been evaluated. This analysis found that scram performance for the BWR/6 plants is not adversely impacted by seismic events (Operating Basis Earthquake, OBE, or Safe Shutdown Earthquake, SSE).

The recommendations provided in this document are based on a comprehensive evaluation of channel-control blade interference for BWR/6 S-Lattice plants with GNF thick/thin channels and GEH control rods. The purpose of the recommendations is to assist operating staff in monitoring for and addressing control rod friction due to channel deformation.

To assure compliance with the plant Technical Specifications and adequately address the considerations noted above, a CRD surveillance plan is recommended. The CRD surveillance plan presented in this document is intended to augment the surveillance requirements in the plant Technical Specifications and defines the population to be tested until other mitigating actions can be identified and implemented. Due to differences in scram performance and sensitivity to driveline friction, separate surveillance plans were developed for BWR/2-5 C/D-Lattice plants and the BWR/6 S-Lattice plants. This document presents the surveillance plan applicable to BWR/6 S-Lattice plants with GNF thick/thin channels and GEH control rods, replacing the guidance and surveillance plan previously found in MFN 08-420 R0.

2.0 Susceptible Cell Determination and Recommended Test Population

Until 2005, experience-based thresholds were defined in order to identify the population of control cells that were considered to represent a potential risk for elevated levels of channel-control blade interference. Although the general experience with those "susceptibility" thresholds confirmed their effectiveness, some experience indicated those thresholds were not sufficiently comprehensive. To address this observation, GNF developed a Cell Friction Methodology and implemented it in the GNF three-dimensional core simulator. The Cell Friction Methodology predicts the combined channel deformations within each control rod cell due to elastic and permanent channel bulge, fast fluence gradient-induced channel bow, and control-blade shadow corrosion-induced channel bow. With the implementation of the Cell Friction Methodology in the GNF core simulator, the best possible assessment (using methods and models available at this time) of channel deformation, channel-control blade interference and resulting control blade friction is obtained through a thorough and detailed accounting of the actual operational details affecting channel deformation. The Cell Friction Methodology, with correspondingly appropriate inputs, is equally applicable to BWR/6 S-Lattice, BWR/4-5 C-Lattice, and BWR/2-4 D-Lattice plants.

With the Cell Friction Methodology, a parameter referred to as the Cell Friction Metric (CFM) is evaluated for each control rod (or cell) throughout the operating cycle, representing a statistically determined, relative indicator of anticipated friction with associated uncertainty. Although the Methodology, by its construct, will necessarily indicate greater (more conservative) levels of channel-control blade friction than will generally be observed, the metric provides a basis for identifying rods with the potential for an elevated friction condition. All control rods so identified by the Cell Friction Methodology are recommended for surveillance testing as outlined in Section 3 below. It is recognized that a low frequency of "no-settle" control rods may occur in the population that is not identified for surveillance testing by the Cell Friction Metric. However, the friction level that might be encountered in these cases will be limited and not expected to challenge control rod operability or the GEH/GNF design and licensing bases.

3.0 Surveillance Test Recommendation

3.1 Settle Time Test

The control rod settle time for each of the cells in the test population is monitored to detect possible increased slow-speed friction levels, which are an indicator of channel-control blade interference. The settle time at one notch position, between positions 00 and 08, is to be determined by performing a normal, single-notch withdrawal. The settle time is defined from initiation of the settle indicator light to initiation of the target (even) notch position indication.

3.2 Test Frequency and Recommended Actions

The test frequency and recommended actions are dependent on the specific conditions encountered for the CRD being monitored. An acceptable condition (continue with standard monitoring frequency) and one other action level have been identified:

A. Acceptable condition

If the control rod settle time is < 30 seconds, repeat the settle time test at 120-day intervals.

In addition, the first time a control rod settles in >10 seconds, perform the settle time test at or near (±1 even-notch) notch positions 04, 12, and 24, and at notch position 46 or 48 to determine whether the characteristics are consistent with channel-control blade interference. If it is determined that the control rod performance characteristics are not consistent with channel-control blade interference, a plant specific evaluation of the control rod performance is recommended.

B. Compensatory Action

If the settle time is > 30 seconds, either:

i. Take the actions required to have the affected cell control rod fully inserted, disarmed, and declared inoperable in accordance with plant Technical Specifications.

OR

ii. [[

]] the control rod should be inserted, disarmed, and declared inoperable in accordance with the Plant Technical Specifications.

Table 1-1
Drive Water Header Differential Pressures vs. CRD Insert Stall Flow**

(Continuous Full-Stroke Insertion Test For [[ ]])

[[			
			]]

* With [[ ]] Drive Water Header pressure and normal friction.

** With CRD System flow control valve in manual mode.

***Multiply by [[ ]] for plants with less than or equal to [[ ]].

**** If the CRD stops inserting before reaching the full-insertion over-travel position, then the friction is greater than approximately [[ ]] (with variation in this value due to variation in control rod weight).

Table 1-2
Insert Velocity vs. CRD Insert Stall Flow For [[ ]]**

(Continuous Full-Stroke Insertion Test Using Table 1-1 Pressures)

[[						
						]]

* With [[ ]] Drive Water Header pressure and normal friction.

** Lower insert velocity indicates a friction level higher than [[ ]].

*** Even-to-even notch time or odd-to-odd notch time.

Table 1-3
Insert Velocity vs. CRD Insert Stall Flow For [[ ]]**

(Continuous Full-Stroke Insertion Test Using Table 1-1 Pressures)

[[						
						]]

* With [[ ]] Drive Water Header pressure and normal friction.

** Lower insert velocity indicates a friction level higher than [[ ]].

*** Even-to-even notch time or odd-to-odd notch time.