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M200087

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

Subject: 10 CFR Part 21.21(d)-Reportable Condition:
Non-Conservative BWR/6 Side Entry Orifice (SEO) Loss Coefficients

Pursuant to 10 CFR 21.21(d), GEH is reporting this condition that Nonconservative BWR/6 Side Entry Orifice (SEO) Loss Coefficients have been discovered in a limited number of plants. Enclosure 1 identifies the potentially affected plants, Enclosure 2 contains the report information, Enclosure 3 provides additional details of the evaluation, and Enclosure 4 provides information to assist plants that may desire to perform an operability determination.

For core monitoring, GNF applies different hydraulic loss coefficients to BWR/6 fuel bundles as a function of location. The Side Entry Orifice (SEO) loss coefficient varies in BWR/6 plants, depending on the orientation of the SEO relative to intersecting core support beams. The SEO loss coefficient for some bundle locations are underpredicted, which results in a local overprediction of Minimum Critical Power Ratio (MCPR) margin. Specifically, the SEO loss coefficients for fuel bundle locations adjacent to Intermediate and Source Range Monitor (IRM/SRM) locations should be higher than the current “one beam” values that are applied. The MCPR effect on affected bundles under conditions where they are near limits can reduce margin by 0.02 in CPR. The condition is not a substantial safety hazard, but the MCPR effect is above the threshold that GNF applies for reportability.

GNF has completed its evaluation and concluded that this issue is a reportable condition under 10 CFR 21.21(d). The basis for reportability is that the change in MCPR associated with this issue could contribute to the exceeding of a safety limit, as defined in the technical specifications of a license for operation issued under 10 CFR Part 50.

Please contact me if there are any questions.

Sincerely,

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Enclosures:

1. US BWR Plants Potentially Affected
2. Reportable Condition per §21.21(d)
3. Description of Evaluation
4. Assessment of 06.07 Scope of Operability Determinations (OD)

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PLM Spec 006N1605

Enclosure 1
US BWR Plants Potentially Affected

RC	Utility	Plant
	Detroit Edison Co.	Fermi 2
	Dominion	Millstone 1
	Energy Northwest	Columbia
X	Entergy	Grand Gulf
X	Entergy	River Bend
	Exelon	FitzPatrick
	Entergy	Pilgrim
	Entergy	Vermont Yankee
X	Exelon	Clinton
	Exelon	Dresden 2-3
	Exelon	LaSalle 1-2
	Exelon	Limerick 1-2
	Exelon	Nine Mile Point 1-2
	Exelon	Oyster Creek
	Exelon	Peach Bottom 2-3
	Exelon	Quad Cities 1-2
X	FirstEnergy Nuclear Operating Co.	Perry 1
	Florida Power & Light	Duane Arnold
	Nebraska Public Power District	Cooper
	Talen Energy	Susquehanna 1-2
	Progress Energy	Brunswick 1-2
	PSEG Services Corp.	Hope Creek
	Southern Nuclear Operating Co.	Hatch 1 - 2
	Tennessee Valley Authority	Browns Ferry 1-3
	Xcel Energy	Monticello
	North East Utilities	Millstone

RC – Reportable Condition

Enclosure 2 – Reportable Condition per §21.21(d)

(i) Name and address of the individual or individuals informing the Commission.

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(ii) Identification of the facility, the activity, or the basic component supplied for such facility which fails to comply or contains a defect.

GNF's core monitoring software contains a defect.
See Enclosure 1 for a list of potentially affected U.S. plants

There are currently no US ABWR plants in operation that would potentially be affected by this evaluation. The potential error in the core monitoring system does not affect the NRC certified design of the ABWR or the GEH ABWR design certification renewal application currently under review. The unique core support structure design of the BWR6 and ABWR is not shared by earlier BWR plants or the ESBWR.

(iii) Identification of the firm constructing the facility or supplying the basic component which fails to comply or contains a defect.

Global Nuclear Fuel- Americas, 3901 Castle Hayne Rd., Wilmington NC 28402

(iv) Nature of the defect or failure to comply and the safety hazard which is created or could be created by such defect or failure to comply.

Incorrect hydraulic loss coefficients for IRM/SRM locations are included in the databanks applied to GNF core monitoring software for the BWR/6 customers identified in Enclosure 1. This defect could contribute to the exceeding of a safety limit, as defined in the technical specifications of a license for operation issued under 10 CFR Part 50.

(v) The date on which the information of such defect or failure to comply was obtained.

A Potential Reportable Condition evaluation was initiated by a GNF employee in accordance with 10 CFR Part 21 and GEH procedures on April 28, 2020.

(vi) In the case of a basic component which contains a defect or fails to comply, the number and location of these components in use at, supplied for, being supplied for, or may be supplied for, manufactured, or being manufactured for one or more facilities or activities subject to the regulations in this part.

Core monitoring software is applied to monitor fuel assemblies during operation. The defective software is a GNF product for BWR/6 customers. The four affected US plants are identified in Enclosure 1.

Enclosure 2 – Reportable Condition per §21.21(d)

(vii) The corrective action, which has been, is being, or will be taken; the name of the individual or organization responsible for the action; and the length of time that has been or will be taken to complete the action.

Affected plants should review section viii and contact their GNF account representative for schedule and delivery dates for updated core monitoring databanks. Updated core monitoring databanks for the affected BWR/6 plants are scheduled to be completed by July 10, 2020.

(viii) Any advice related to the defect or failure to comply about the facility, activity, or basic component that has been, is being, or will be given to purchasers or licensees.

For affected plants that use GNF core monitoring software, the long-term corrective action is to implement an updated core monitoring databank with corrected SEO loss coefficient values. Affected plants should contact their GNF account representative for schedule and delivery dates. If necessary, a short-term corrective action such as an administrative MCPR penalty on IRM/SRM locations, should be applied to the core monitoring system. An effective short-term measure would be to assure that IRM/SRM locations are 0.02 less than the Maximum Fraction of Limiting CPR limit (e.g., MFLCPRlimit = 1.00). This condition is met if the core wide MFLCPR is 0.02 below the limit (e.g., MFLCPR < 0.98), because the IRM/SRM locations will be bounded. Note that this recommended short term or interim measure was developed on a standalone basis and does not supplant any existing MFLCPR limit reductions established for other purposes.

For non-affected plants (See Enclosure 1), there are no recommended actions. GNF recognizes that other non-GNF fueled plants, safety analysis methodologies, and core monitoring systems may have different design bases and address SEO losses by other means.

(ix) In the case of an early site permit, the entities to whom an early site permit was transferred.

Not Applicable.

Enclosure 3 –Description of Evaluation

Summary

For core monitoring, GNF applies different hydraulic loss coefficients to BWR/6 fuel bundles as a function of location. The Side Entry Orifice (SEO) loss coefficient varies in BWR/6 plants, depending on the orientation of the SEO relative to intersecting core support beams. The SEO loss coefficient for some bundle locations are underpredicted, which results in a local overprediction of Minimum Critical Power Ratio (MCPR) margin. Specifically, the SEO loss coefficients for fuel bundle locations adjacent to Intermediate and Source Range Monitor (IRM/SRM) locations should be higher than the current “one beam” values that are applied. The MCPR effect on affected bundles under conditions where they are near limits can reduce margin by 0.02 in CPR. The condition is not a substantial safety hazard, but the MCPR effect is above the threshold that GNF applies for reportability.

GNF has completed its evaluation and concluded that this issue is a reportable condition under 10 CFR 21.21(d). The basis for reportability is that the change in MCPR associated with this issue could contribute to the exceeding of a safety limit, as defined in the technical specifications of a license for operation issued under 10 CFR Part 50.

Introduction

In 2002, GE issued a Reportable Condition (RC) notification and Transfer of Information (Reference 1) under 10 CFR 21.21(d,) as well as a safety information communication to inform plants that may have been similarly affected but were not GE customers (Reference 2). The subject of these communications was the hydraulic loss coefficient used to calculate the pressure loss and flow rate into the Side Entry Orifice (SEO) at the fuel bundle entrance in BWR/6 plants. The issue was that the SEO loss coefficient was underpredicted for some fuel bundle locations, which could result in an overprediction of MCPR margin in core monitoring applications. The nonconservative overprediction was a result of flow area restrictions associated with cross beams (structural supports underneath the core plate) in BWR/6 plant designs and ABWRs operating in Japan. The issue evaluated here is an extension of the original reportable condition. It has been discovered that some fuel bundle locations may have higher SEO losses than originally identified.

The BWR/6 and ABWR plant designs have supporting cross beams that form a grid structure underneath the core plate. The orientation of SEOs relative to the beams produces the different losses due to differences in upstream flow areas. The BWR/2-5 plants have a different core support structure that is more open so that multiple SEO losses are not applied to evaluations for those plants. The ESBWR core support plate design is also different, and this issue is not applicable. The SEO loss coefficients for different beam configuration are applied in core monitoring applications for GNF customers; there are no ABWRs or ESBWRs being monitored at this time in the United States.

The BWR/6 SEO inlet loss area dependency is well known. GE evaluated full-scale tests of different SEO configurations in the late 1980s. In 2002 it was discovered that advanced fuel designs were more sensitive to this loss coefficient and changes were incorporated into core

Enclosure 3 –Description of Evaluation

monitoring databanks to address the issue. However, in 2002, the effect of in-core instrumentation tube locations on the pressure loss coefficient was not known. This issue was recently discovered following detailed reviews of core support plate drawings. GNF determined that the IRM/SRM locations have more restrictive inlet flow areas immediately upstream of the SEO, which justifies an increased SEO loss based on full-scale experimental data. For US BWR/6 plants, the increase in the updated SEO loss for these locations is approximately 98% of the most restrictive (two beam) value. Local Power Range Monitors (LPRMs) are another form of in-core instrument, but these locations are not affected by the issue. The presence of LPRMs has a relatively small effect on SEO inlet flow area and was considered in the choice of the original SEO loss coefficients. Figure 1 shows a diagram of the geometry of interest (not to scale). The SEO inlet locations are designated A, B, C, D or D' and the dashed lines are lines of symmetry. In the 2002 notification, location D' was not identified.

The most recent operating cycles for four US-based BWR/6 plants have been evaluated with updated SEO loss coefficients. This correction results in a redistribution of power, flow, and MCPR margin. However, in each case, the evaluations demonstrated that these plants have maintained margin to the Operating Limit MCPR (OLMCPR). The OLMPCR provides transient margin to the Technical Specification MCPR Safety Limit or SLMCPR. While operating margin was reduced at some core locations, there was no significant effect on the limiting bundle and overall core MCPR margin. However, the potential effect on MCPR is in the nonconservative direction and has the potential to occur at a limiting core location. GNF's evaluation shows that the potential MCPR effect at limiting locations is 0.02, which is greater than the criterion that GNF has historically applied for reporting that a Technical Specification Safety Limit could have been exceeded as defined under 10 CFR Part 21.

Description of Discovery

While evaluating work performed by KKL engineers as part of their investigation into crud deposits ("vee marks") on fuel rods, it was suggested that pressure loss coefficients for some orifice locations may be higher than previously thought. Specifically, fuel bundles adjacent to source and intermediate range monitor locations (SRMs and IRMs) may have more restrictive side entry orifice loss coefficients than the currently assigned values. Supporting information has been provided to GNF by KKL. GNF-A's previous reportable condition on this subject (applicable to BWR/6 plants), ML022820162, Fuel Support Side Entry Orifice Loss Coefficient in Core Monitoring System Databank (Reference 1), did not identify this more restrictive loss.

Extent of Condition

The extent of condition is limited to the original scope (Reference 1), which is BWR/6 and ABWR plants. The reason the potential effect is limited to BWR/6 and ABWR plants is that these plants have a unique core support structure design, which is not shared by earlier BWR plants or the ESBWR.

Enclosure 3 –Description of Evaluation

Potential Safety Significance and Conclusions

This condition does not produce a significant safety hazard, but the calculated effect on MCPR is more than 0.01, so it is significant relative to roundoff errors and biases. If unaddressed, the condition could occur at a limiting bundle location and reduce transient margin, which could result in exceeding the SLMCPR and leads to the conclusion that it represents a reportable condition and must be addressed by corrective action.

ABWR and ESBWR Design Certification Documentation Applicability

ABWR plants do not apply core monitoring software in the US. Therefore, while this plant's design is susceptible to this issue, the issue is not applicable in the United States.

This is a component specific issue not applicable to the ESBWR.

Recommendations

For affected plants that use GNF core monitoring software, the long-term corrective action is to implement an updated core monitoring databank with corrected SEO loss coefficient values. Affected plants should contact their GNF account representative for schedule and delivery dates. If necessary, a short-term corrective action such as an administrative MCPR penalty on IRM/SRM locations, should be applied to the core monitoring system. An effective short-term measure would be to assure that IRM/SRM locations are 0.02 less than the Maximum Fraction of Limiting CPR limit (e.g., MFLCPRlimit = 1.00). This condition is met if the core wide MFLCPR is 0.02 below the limit (e.g., MFLCPR < 0.98), because the IRM/SRM locations will be bounded. Note that this recommended short term or interim measure was developed on a standalone basis and does not supplant any existing MFLCPR limit reductions established for other purposes.

For non-affected plants there are no recommended actions. For these plants, GNF does not have the capability to perform an evaluation to determine if a similar condition or defect exists. GNF recognizes that other (non-GE) plant designs, safety analyses, and core monitoring systems may have different bases. The information in this letter is furnished to support any evaluations of SEO losses and potential effects that may be necessary.

Corrective/Preventive Actions

GNF recognizes that licensees should perform operability evaluations. To assist licensees, the result of GNF's assessment of Section 3.01 of Reference 3, "Scope of Operability Determinations," is provided as Enclosure 4.

References

1. ML022820162 (MFN 02-067), Subject: Fuel Support Side Entry Orifice Loss Coefficient in Core Monitoring System Databank, October 4, 2002.
2. Safety Communication 02-15, Subject: Fuel Support Side Entry Orifice Loss Coefficient in Core Monitoring System Databank, October 4, 2002.
3. ML19273A878, NRC Inspection Manual Chapter 0326, Operability Determinations, effective date 10/01/2019.

Enclosure 3 –Description of Evaluation

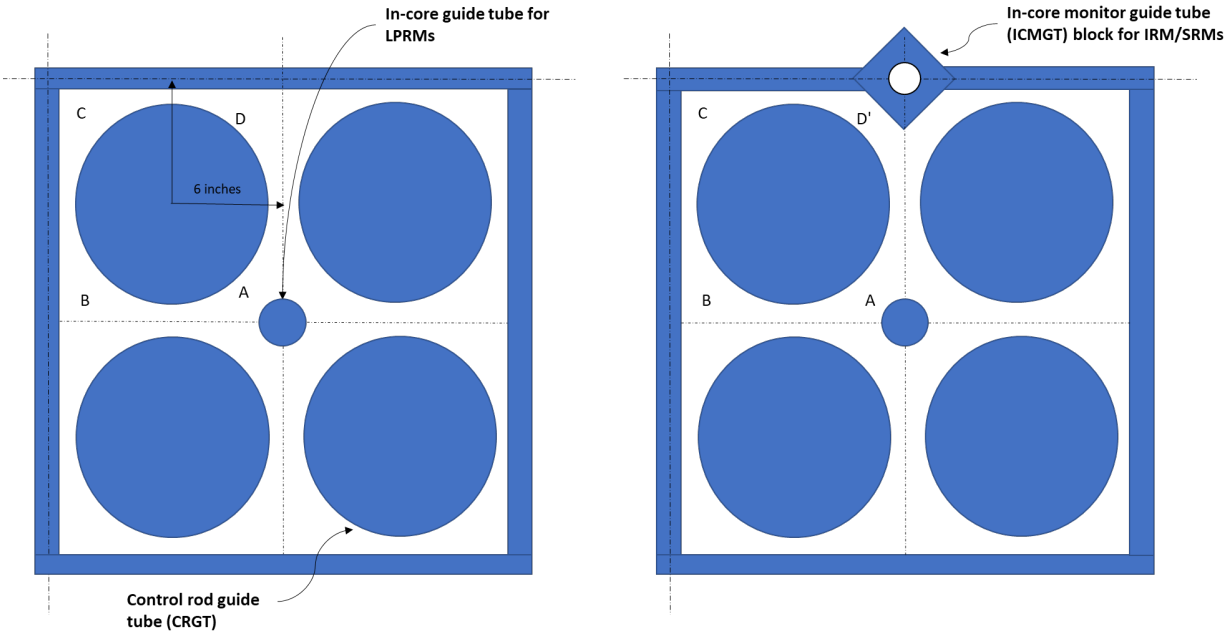

Figure 1 Illustrations of BWR/6 interior (central core) cells with surrounding support beams (not to scale)

Enclosure 4 – GNF Assessment of 06.07 Scope of Operability Determinations

Item	Point to Address	GNF Assessment
a.	Possible elements of an OD include:	
(1)	The SSC affected by the condition,	Fuel assemblies are affected by the degraded condition. Core monitoring software is applied to monitor fuel during operation and assure that applicable safety limits are met.
(2)	The extent of condition for all similarly affected SSCs,	There are no other affected SSCs.
(3)	The CLB requirements or commitments established for the affected SSC,	Core monitoring software provides a means to assure that fuel is operated in a manner that conforms to applicable safety limits and CLBs.
(4)	The specified safety function(s) performed by the affected SSCs,	In general, most SSCs (e.g., control blades, safety relief valves, etc.) have a function that protects nuclear fuel assemblies, which are the SSCs of concern. As long a fuel is operated within applicable limits, such as the Technical Specification Safety Limit MCPR or SLMCPR, fuel cladding integrity is maintained.
(5)	The effect or potential effect of the condition on the affected SSC's ability to perform its specified safety function(s), and	The degraded condition can affect the monitoring of fuel assemblies during operation. If a fuel assembly were operated beyond the Operating Limit MCPR (OLMCPR) due to incorrect core monitoring software, then an event with a single failure has the potential to lead to exceeding the SLMCPR.
(6)	Whether there is a reasonable assurance of operability, including the basis for the determination and any compensatory measures put in place to establish or restore operability.	The identified compensatory measures are expected to be effective so that the fuel assemblies can be operated and monitored within applicable limits. Implementation of the recommended corrective action restores the core monitoring system so that fuel can be operated as normal. The recommended interim measure assures adequate margin for operability.

Enclosure 4 – GNF Assessment of 06.07 Scope of Operability Determinations

Assessment of 06.07 Scope of Operability Determinations (OD) continued

Item	Point to Address	GNF Assessment
b.	The following should be considered when reviewing ODs:	
(1)	Design basis events are plant-specific, and plant-specific TS, bases, and safety evaluations may contain plant-specific considerations related to operability,	Plant specific safety evaluations are unaffected by this issue. Corrective action will restore the capability to monitor and will preserve the existing TS and bases. The recommended interim measure will assure adequate margin to the existing TS and bases.
(2)	An SSC's operability requirements are based on safety analyses of specific design basis events for one mode or specified condition of operation and may not be the same for other modes or conditions of operation; therefore, all applicable modes and conditions of operation should be considered,	Corrective action will restore the capability to monitor to existing limits and conform to existing bases, which includes all applicable licensed modes of operation. The recommended interim measure will assure adequate margin to the existing limits and bases, which includes all applicable modes of operation.
(3)	The operability requirements for an SSC encompass all necessary support systems (per the TS definition of operability) regardless of whether the TS explicitly specifies operability requirements for the support functions,	Core monitoring software is applied to support fuel operation. Corrective action will restore the capability of the computer system to monitor to existing bases and TS requirements. The recommended interim measure will assure adequate margin to the existing bases and TS requirements.
(4)	In order to evaluate conditions, it is assumed in the OD that the design basis event occurs. The occurrence of multiple simultaneous design basis events should be considered only to the extent that they are required as a part of the plant's Current Licensing Basis (CLB), and	Corrective action will restore the capability of the computer system to monitor fuel assemblies, which supports conformance to the plant's CLB. The recommended interim measure will assure adequate margin to limits and supports conformance to the plant's CLB.
(5)	Compensatory measures may be established to restore or maintain operability of an SSC..	The identified corrective action is all that is required to restore the capability of the core monitoring system. The identified interim measure assures adequate margin to support operation.