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**Attachment 3 contains Proprietary Information.
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RS-12-157

10 CFR 50.90
10 CFR 2.390

October 9, 2012

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

Braidwood Station, Units 1 and 2
Facility Operating License Nos. NPF-72 and NPF-77
NRC Docket Nos. STN 50-456 and STN 50-457

Byron Station, Units 1 and 2
Facility Operating License Nos. NPF-37 and NPF-66
NRC Docket Nos. STN 50-454 and STN 50-455

Subject: Additional Information Supporting Request for License Amendment Regarding Measurement Uncertainty Recapture Power Uprate

References:

1. Letter from Craig Lambert (Exelon Generation Company, LLC) to U. S. NRC, "Request for License Amendment Regarding Measurement Uncertainty Recapture Power Uprate," dated June 23, 2011

2. Letter from J. S. Wiebe (U. S. NRC) to M. J. Pacilio (Exelon Generation Company, LLC), "Byron Station, Unit Nos. 1 and 2, and Braidwood Station, Units 1 and 2 - Request for Additional Information Related to Measurement Uncertainty Uprate (TAC Nos. ME658, ME6588, ME6589, and ME6590)," dated September 27, 2012 [ML12216A000]

In Reference 1, Exelon Generation Company, LLC (EGC) requested an amendment to Facility Operating License Nos. NPF-72, NPF-77, NPF-37 and NPF-66 for Braidwood Station, Units 1 and 2, and Byron Station, Units 1 and 2, respectively. Specifically, the proposed changes revise the Operating License and Technical Specifications to implement an increase in rated thermal power of approximately 1.63% based on increased feedwater flow measurement accuracy.

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NRR

In Reference 2, the NRC has requested additional information (RAI) to support review of the proposed changes within 30 days of September 27, 2012. The response to this RAI is provided in Attachment 1 to this letter.

In accordance with 10 CFR 2.390, "Public inspections, exemptions, requests for withholding," EGC requests withholding of Attachment 3. Attachment 3 contains information considered proprietary by Cameron International Corporation, the owner of this information. An affidavit from Cameron International Corporation supporting this request is included in Attachment 4. With Attachment 3 removed, this letter and the remainder of the attachments are non-proprietary.

EGC has reviewed the information supporting a finding of no significant hazards consideration and the environmental consideration provided to the NRC in Reference 1. The additional information provided in this submittal does not affect the bases for concluding that the proposed license amendment does not involve a significant hazards consideration. Furthermore, the additional information provided in this submittal does not affect the bases for concluding that neither an environmental impact statement nor an environmental assessment needs to be prepared in connection with the proposed amendment.

There are no regulatory commitments contained in this letter.

Should you have any questions concerning this letter, please contact Leslie E. Holden at (630) 657-3316.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 9th day of October 2012.

Respectfully,

Kevin F. Borton
Manager, Licensing - Power Uprate

Attachments:

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|---|---|
| Attachment 1: | Response to Request for Additional Information (Non-Proprietary) |
| Attachment 2: | Byron Unit 1 Observation of Upward Trend in Secondary Parameters Troubleshooting Plan Outline (Non-Proprietary) |
| Attachment 3: | Engineering Report: ER-968 Rev. 1 - Analysis of the Trends and Uncertainties of the LEFM Indications at Byron 1, Cameron Measurement Systems, Caldon Ultrasonics (Proprietary) |
| Attachment 4: | Cameron International Corporation Affidavit Supporting Withholding of Information in Attachment 3 |

**ATTACHMENT 1**

**RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION**
**NRC Letter dated September 27, 2012**
**[ML12216A000]**

**(NON-PROPRIETARY)**

***NRC Request***

*In reviewing the Exelon Generation Company's (Exelon's) submittal, related to measurement uncertainty recapture for the Braidwood Station, Units 1 and 2, and Byron Station, Unit Nos. 1 and 2, the U.S. Nuclear Regulatory Commission staff has determined that the following information is needed in order to complete its review:*

1. *During a May 31, 2012, phone conference, Exelon identified [discussed] a divergent trend between the Leading Edge Flow Meter (LEFM) and plant secondary systems parameters.*
   a. *Provide a summary of the Byron Station, Unit 1, determination of cause of the LEFM versus secondary plant parameter drift that occurred from June to September 2011.*
   b. *Provide the Cameron report on Byron Station, Unit 1, LEFM calibration that came out of the determination of the cause of the LEFM versus secondary plant parameter drift that occurred from June to September 2011.*
   c. *Provide information to verify that this adverse trend did not result in operation above the licensed power level.*

**Response - Question 1.a**

Complex Troubleshooting Plan

As discussed in the May 31, 2012 phone conference, a complex troubleshooting plan was prepared and executed to investigate and identify the cause of the observed upward trend in secondary parameters from May to September 2011 on Byron Unit 1. The complex plan investigated six primary failure modes with a total of 29 troubleshooting steps as outlined in Attachment 2 and discussed below. The troubleshooting began immediately after the upward trend in secondary parameters was first identified in September 2011 and it lasted through April 2012. This plan included external challenge board reviews from subject matter experts, as well as a detailed evaluation of the LEFM system by Cameron.

The results of the extensive troubleshooting plan concluded that no anomalies were identified with the LEFM system and that it is performing within its stated mass flow uncertainty. Further, no anomalies were identified by any of the troubleshooting steps that would have resulted in the observed upward trend in the secondary parameters.

A list of each primary failure modes along with a summary of findings that led to the overall conclusion, is stated below.

- Potential Failure Mode 1: LEFM Problem Causing Erroneous Readings

  This part of the troubleshooting focused on reviewing the LEFM system by both Exelon and Cameron. Troubleshooting steps included a review of LEFM commissioning, calibration records from Alden Labs, environmental conditions, potential hardware and software problems, industry operating experience, and other internal or external influences that could impact LEFM performance. Ten troubleshooting steps were performed to investigate this potential failure mode (refer to Attachment 2); no anomalies were identified.

In addition, Cameron evaluated all of the potential contributors within the LEFM algorithm that could lead to a drift or bias. This included potential errors in meter factor, internal diameter of the flow element, time of flight measurements, velocity of sound in the fluid, and the angle between the chordal path and the axis of the flow element. The results provided in their report, ER-968, "Analysis of the Trends and Uncertainties of the LEFM Indications at Byron 1,"(Reference A-1), show that the possible changes in LEFM system indication based on these potential contributors was small (i.e., in the range of 0.05% to 0.079% of total flow measurement). This is well within the stated mass flow uncertainty provided in ER-800, "Bounding Uncertainty Analysis for Thermal Power Determination at Byron Unit 1 Nuclear Generating Station using LEFM CheckPlus System" (Reference A-4). The Cameron report is provided in Attachment 3.

- Potential Failure Mode 2: External Interaction with Venturi/LEFM Spools by Either Polyacrylic Acid (PAA) or Erosion/Corrosion

  This part of the troubleshooting plan addressed possible impacts on the LEFM due to PAA injection or erosion/corrosion. Four troubleshooting steps were performed to investigate this potential failure mode (refer to Attachment 2). Based on the results of this part of the troubleshooting plan, as discussed in the following paragraphs, no anomalies were identified.

  In April 2009, Exelon began adding low concentrations of PAA dispersant to the feedwater flow streams as a method for reducing the accumulation of iron oxide deposits onto the secondary-side surfaces of the steam generators.

  Since PAA injection was occurring during the initial upward trend in secondary parameters, Exelon evaluated the possible impact of PAA on the LEFM system and secondary parameters. This evaluation was based on actual plant testing and a documented engineering study, prepared by Dominion Engineering.

  Exelon conducted plant tests to (1) identify if LEFM performance was impacted when PAA was completely secured and (2) identify any LEFM impact when PAA was injected at higher concentrations.

  (1) PAA injection was secured for a two month duration beginning in early November 2011. The trend data for both the LEFM and secondary parameters was studied to determine whether the upward trend, which previously stabilized prior to the test, began to reoccur or if the trend reversed. Results of this test show that the trend data during this two month period was not influenced by securing PAA. The LEFM, venturi, and secondary parameters tracked consistently over this time period.

  (2) The second test was performed on both Byron Unit 1 and 2, for a one month duration that began in February 2012. The purpose of this test was to increase PAA injection to concentrations greater than those that existed when the upward trend in secondary parameters occurred. Results of this test show that the trend data for both units was not influenced by the increased concentrations of PAA. The LEFM, venturi, and secondary parameters tracked consistently over this time period.

  Dominion Engineering independently evaluated whether PAA deposits could occur in the LEFM spool pieces such that a mass flow reading error would

occur. This evaluation concluded that PAA accumulation in the spool pieces was an unlikely cause in the upward trend in secondary parameters.

Erosion/corrosion of the spool pieces was evaluated by measuring the wall thickness utilizing an ultrasonic thickness gauge at eight prescribed locations, where the exterior surface is prepared to facilitate the measurements. Measurements obtained during a maintenance outage in March 2012 were compared to original post-fabrication measurements. Results show that the difference in measured internal diameters of approximately -0.002 inches to +0.004 inches (-2 to +4 mils) is small (Reference A-1, pages 9 and 10) and well within the 0.015 inch (15 mils) allowance listed in Engineering Report ER-157(P-A) Rev. 8 and Rev.8Errata, "Supplement to Caldon Topical Report ER-80P: Basis for a Power Uprates with an LEFM Check or an LEFM CheckPlus System" (Reference A-2, page A-20).

- Potential Failure Mode 3: Process Computer Interface to LEFM is Causing Errors in the Data

  Two troubleshooting steps were performed to investigate this potential failure mode (refer to Attachment 2). Based on the results of this part of the troubleshooting plan, as briefly discussed in the following paragraphs, no anomalies were identified.

  An interim programmable logic controller (PLC), located in the signal wiring between the LEFM system and plant process computer (PPC), was being used when the upward trend in secondary parameters occurred. This PLC, unique to Byron Unit 1, converted the LEFM output digital signals, representative of mass flow, temperature and pressure, to an analog signal that can be read by the PPC. The other Byron and Braidwood units already had an upgraded PPC in place that allowed the digital signals to be read directly (i.e., no PLC required). Since the PLC was only being used at Byron Unit 1, which was the only unit that had an upward trend in secondary parameters, the PLC interface was considered as one of the potential failure modes during troubleshooting. This troubleshooting focused on a calibration check of the PLC interface to verify that the digital input signals for mass flow, temperature, and pressure matched the analog output signals.

  In addition, calorimetric programming for tempering line flow, which bypasses a small portion of the feedwater flow around the LEFM and venturi measurement, was verified to be correct.

- Potential Failure Mode 4: Feedwater Loop Calibration or Drift Issue is Causing the Discrepancy

  This part of the troubleshooting focused on anomalies associated with the feedwater flow venturis. This included troubleshooting steps associated with venturi differential pressure transmitter calibration, use of correction factors, instrument drift (including potential effects of moisture carryover), potential sources of bypass flow around the venturis, and tempering/ blowdown flow impacts. Eight troubleshooting steps were performed to investigate this potential failure mode (refer to Attachment 2); no anomalies were identified.

- Potential Failure Mode 5: Installation Configuration Results in Hydraulic Impacts Causing the LEFM to Read Lower than Actual

  This part of the troubleshooting focused on anomalies within the piping system that could result in an error in LEFM feedwater flow indication. This included a review of LEFM spool piece orientation, potential upstream flow obstructions or interferences (e.g., thermowell protruding into pipe), and foreign material concerns. Three troubleshooting steps were performed to investigate this potential failure mode (refer to Attachment 2); no anomalies were identified.

- Potential Failure Mode 6: Calorimetric Input or Program Fault

  This part of the troubleshooting plan evaluated the calorimetric inputs (e.g., feedwater flows, feedwater temperature, steam pressure, etc.) and the calorimetric program used in calculating the correct core thermal power based on these inputs. Two troubleshooting steps were performed to investigate this potential failure mode (Attachment 2); no anomalies were identified.

Re-Commissioning of LEFM System

Following troubleshooting, as an added conservative measure, the LEFM system was re-commissioned in April 2012. This review analyzed the transducer gains, signal strengths, coherent noise, random noise, alarm limit and default settings, fluid velocity and sound velocity ratios, hydraulic performance of site data (e.g., profile factor, individual plane balance values, swirl, velocity profiles, etc.), independent flow calculations, and initialization (INI) file parameters. Cameron's re-commissioning confirmed (Reference A-3) that the LEFM CheckPlus system is operating within its stated mass flow and thermal power uncertainty as provided in ER-800, "Bounding Uncertainty Analysis for the Thermal Power Determination at Byron Unit 1 Nuclear Generating Station Using the LEFM CheckPlus System" (Reference A-4).

Conclusion

Based on the above, the LEFM system is operating properly within its stated mass flow and thermal power uncertainty. Further, no specific anomalies were identified in any of the troubleshooting steps that would have caused the upward trend in secondary parameters.

A challenge board, including subject matter experts from MPR Associates, Inc., ILD, Inc., and Dominion Engineering, Inc., was organized to evaluate the troubleshooting plan and results. This team reviewed the troubleshooting steps, presented additional challenges, and acted as the collegial review board to provide an independent review of the troubleshooting plan results. The challenge board concurred with the above conclusion of the troubleshooting plan.

**Response - Question 1.b**

A copy of Cameron's proprietary Engineering Report: ER-968 Rev. 1, "Analysis of the Trends and Uncertainties of the LEFM Indications at Byron 1," is provided in Attachment 3.

**Response - Question 1.c**

Following startup from the outage (B1R17) when the LEFMs were installed (late April 2011) until the LEFMs were implemented (early June 2011), the venturis were

used to calculate core thermal power. During this time period prior to the initial commissioning, Byron Unit 1 was conservatively derated to 98.5% power based on initial differences between the LEFM and venturi feedwater flow readings. During this same time period, the LEFM was generally indicating a higher feedwater flow (and hence a higher calculated core power) than the venturis. This 1.5% margin conservatively bounded these differences to ensure that the licensed thermal power limit was not exceeded.

Once the LEFM was verified to be performing within its stated mass flow and thermal power uncertainty as part of it's original commissioning, and it's use was implemented in early June 2011, the unit's derating (i.e., 98.5%) was removed and the LEFM system was used in the calculation of core thermal power. Power operation to 100% was based on existing Station procedures and guidance. Since the LEFM system was verified to be performing within its stated mass flow and thermal power uncertainty, which was reconfirmed as part of the troubleshooting efforts, the associated core thermal power indication was well within the 2% calorimetric uncertainty allowed under the current operating license.

In September 2011, following the discovery of the upward trend in secondary parameters, the unit was again conservatively derated this time initially by 0.5% power (later revised to 0.4% in November 2011 based on the initial troubleshooting results) to provide additional margin. The unit remained derated until the troubleshooting efforts were complete in April 2012. These derating values bound the 0.2-0.3% estimated magnitude of the secondary parameter's upward trend and was well within the 2% calorimetric uncertainty allowed under the current operating license.

Based on the above, licensed thermal power was not exceeded during the upward trend in secondary parameters.

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REFERENCES:

A-1 Cameron, Caldon Ultrasonics, Engineering Report: ER-968 Rev. 1, "Analysis of the Trends and Uncertainties of the LEFM Indications at Byron 1,", March 2012

A-2 Cameron, Caldon Ultrasonics, Engineering Report: ER-157(P-A) Rev. 8 and Rev.8Errata, "Supplement to Caldon Topical Report ER-80P: Basis for a Power Uprates with an LEFM Check or an LEFM CheckPlus System," May 11, 2009

A-3 Letter from Ryan Hannas (Cameron) to David Eder (Exelon), "LEFM√+ System Re-Commissioning Letter for Byron Unit 1 NPP," dated April 13, 2012

A-4 Cameron, Caldon Ultrasonics, Engineering Report, ER-800, Rev. 2, "Bounding Uncertainty Analysis for Thermal Power Determination at Byron Unit 1 Nuclear Generating Station using LEFM CheckPlus System," May 2011

**ATTACHMENT 2**

**BYRON UNIT 1**
**OBSERVATION OF UPWARD TREND IN SECONDARY PARAMETERS**
**TROUBLESHOOTING PLAN OUTLINE**

**(NON-PROPRIETARY)**

# Byron Unit 1 Observation of Upward Trend in Secondary Parameters Troubleshooting Plan Outline

The six potential failure modes included in the troubleshooting plan and the associated troubleshooting steps are listed below.

1. **LEFM Problem Causing Erroneous Readings**
   - Concerns with commissioning changes made by Cameron that could impact performance
   - Meter factor differences when compared to other loops (e.g., A vs. B, C, and D) and original Alden Labs data.
   - Other significant differences when compared to other loops (e.g., A vs. B, C, and D) and original Alden labs data.
   - LEFM parameters are out of tolerance or significantly outside acceptable range when compared to Alden Labs data for the same parameters (e.g., signal strength, coherent noise, random noise).
   - Environmental conditions are impacting readings.
   - Industry OE that may identify Cameron LEFM latent defects or inherent problems.
   - System power supply drift or out of tolerance
   - Bad sensor inputs (pressure and/or temperature) that are creating an error.
   - Internal integration errors of the LEFM electronics are causing a problem.
   - Other LEFM problems

2. **External Interaction with Venturi/LEFM Spools by Either Polyacrylic Acid (PAA) or Erosion/Corrosion**
   - PAA impact not correlated in venturi flow indication
   - PAA impacting LEFM flow indication
   - Erosion/corrosion of spools interacting with indication
   - PAA impacting plant performance

3. **Process Computer Interface to LEFM is Causing Errors in the Data**
   - Differences in LEFM mass flow indication in the plant process computer and actual LEFM indicated flow is causing the discrepancy.
   - Tempering line flow is not properly considered in the determination of net feedwater flow in the process computer programming.

4. **Feedwater Loop Calibration or Drift Issue is Causing the Discrepancy**
   - Current instrument-loop span calculations and the last three calibration checks of the feedwater flow rate instrument loops induce bias or uncertainty.
   - Existence of calibration correction factors of transmitters that induce a bias in readings.
   - Drift in secondary feedwater flow rate data. Evaluate data and thermal performance balance sheets for same or analogous Byron/Braidwood unit.
   - Venturi bypass flow is cause of inaccurate flow measurements

- Discharge coefficient extrapolation method in error.
- Flow bypassing calorimetric inputs
- Validate tempering line flows
- Validate steam generator blowdown flow impacts

5. **Installation Configuration Results in Hydraulic Impacts Causing the LEFM to Read Lower than Actual**
   - Differences in hydraulic piping configurations between loops A, B, C, and D are causing a flow discrepancy.
   - Upstream flow obstructions are causing a flow discrepancy; these obstructions are visible by external inspection, for example, thermowell protruding into the piping.
   - Flow obstructions due to foreign material is causing flow discrepancies.

6. **Calorimetric Input or Program Fault**
   - Validate calorimetric inputs are proper
   - Validate calorimetric program