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November 18, 2013

U. S. Nuclear Regulatory Commission
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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: Supplemental Response to NRC HELB Audit Request for 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 and Suspension of Review of License Amendment Request for Power Uprate (TAC Nos. ME6587, ME6588, ME6589, and ME6590)," dated December 6, 2012
3. Letter from David M. Gullott (Exelon Generation Company, LLC) to U. S. NRC, "Additional Information Supporting Request for License Amendment Regarding Measurement Uncertainty Recapture Power Uprate," dated July 5, 2013
4. E-Mail from J. S. Wiebe (U. S. NRC) to David M. Gullott (Exelon Generation Company, LLC), "Preliminary RAI Regarding TB Bldg HELB," dated August 29, 2013
5. Letter from David M. Gullott (Exelon Generation Company, LLC) to U. S. NRC, " Supplemental Response to NRC HELB Audit Request for Information Supporting Request for License Amendment Regarding Measurement Uncertainty Recapture Power Uprate," dated September 5, 2013

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.

In Reference 2, the NRC requested additional information (RAI) pertaining to the High Energy Line Break (HELB) analysis and an audit to complete their detailed review of the power uprate. The response to this RAI was provided in Reference 3. On July 17 and 18, 2013, the NRC conducted the audit. As follow-up to this audit, in Reference 4 the NRC requested additional information regarding the assumed Turbine Building HELB break locations. Specifically, the NRC requested EGC to provide the following information:

> *"Describe in detail the postulated piping failures and their locations utilized for the analyses of M&E release from piping located in the TB that could affect safety-related equipment located in adjoining auxiliary building rooms and how this information was used to provide input the Gothic analysis. If bounding conditions have been utilized for these analyses identify the piping failures utilized, their bounding M&E and the bounding locations that would envelop the resulting effects on the safety-related equipment located in adjoining auxiliary building rooms. In addition, justify how this/these M&Es and location(s) bound others. This justification should include, but is not limited to, consideration of a HE release near a HELB damper that would allow pressurization of room while the damper is closing while another room is not yet pressurizing because its damper is farther away from the HE release, thereby creating differential pressure across the wall that separates the two rooms."*

An initial response to the Reference 4 request was provided in Reference 5.

The Attachment to this letter provides additional quantitative detail and information to the Reference 4 request as discussed during a meeting on November 14, 2013, between EGC (David Gullott, et.al.) and the NRC (Joel Wiebe, et.al.).

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 18th day of November 2013.

Respectfully,

David M. Gullott
Manager – Licensing
Exelon Generation Company, LLC

Attachment: Supplemental Response to NRC Request for Additional Information (Non-Proprietary)

ATTACHMENT

SUPPLEMENTAL RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION

November 18, 2013

(NON-PROPRIETARY)

NRC Request

"Describe in detail the postulated piping failures and their locations utilized for the analyses of M&E release from piping located in the TB that could affect safety-related equipment located in adjoining auxiliary building rooms and how this information was used to provide input the Gothic analysis. If bounding conditions have been utilized for these analyses identify the piping failures utilized, their bounding M&E and the bounding locations that would envelop the resulting effects on the safety-related equipment located in adjoining auxiliary building rooms. In addition, justify how this/these M&Es and location(s) bound others. This justification should include, but is not limited to, consideration of a HE [high energy] release near a HELB damper that would allow pressurization of room while the damper is closing while another room is not yet pressurizing because its damper is farther away from the HE release, thereby creating differential pressure across the wall that separates the two rooms."

Additionally, based on discussion with the NRC on November 14, 2013, this response should also provide quantitative justification in lieu of engineering judgment to demonstrate the approach regarding uniform pressurization. The NRC specifically noted the example of the Division 1 and 2 Engineered Safeguards Feature (ESF) Switchgear Rooms as needing to be quantitatively validated.

Response:

Introduction

The Exelon Generation Company, LLC (EGC) Turbine Building (TB) High Energy Line Break (HELB) analysis considered the potential that the location of a line break could result in one damper closing prior to the other, thereby creating a differential pressure across the wall separating two ESF divisions.

EGC's review of the divisional wall differential pressure concluded that the impact of break location is significantly less than the impact due to damper performance characteristics, and is well within the conservative margins contained in the differential pressure calculations. The technical justification for this approach is based the following considerations.

- There is no direct jet impingement on the HELB dampers
- Pressure propagates through the TB air at sonic velocity and initiates closure of the HELB dampers early in the event
- Pressure waves travel the distance between adjacent HELB dampers in a maximum of 0.05 seconds, which is significantly less than overall damper closure times
- There is no direct impact due to equipment blockage between adjacent dampers

Jet Impingement

As described in Reference A.1, the comprehensive jet impingement analysis performed by EGC concluded that there were no pipe breaks within 20 pipe diameters of the Diesel Generator (DG) Room, ESF Switchgear Room, and Miscellaneous Electric Equipment Room (MEER) HELB dampers that would result in a HELB fluid jet load affecting the dampers. The key result from the jet impingement analysis (Reference A.2) is that none of the DG Room, ESF Switchgear Room, or MEER HELB dampers are within the zone of influence (ZOI) of a line break jet and the jet pressure would dissipate to ambient TB pressure prior to reaching a HELB damper. Therefore, damper operation is not influenced by the jet pressure, and is instead governed by the bulk TB environment.

As an example of this conclusion, the 10" Main Steam (MS) line break on TB Elevation 426' is presented. This break location is 5.03 pipe diameters horizontally and 4.35 pipe diameters vertically from the 2VX17Y damper. The jet impingement analysis calculated that the distance from the break location to the damper is greater than 5 pipe diameters, which is beyond the jet's ZOI. Therefore, the jet pressure decreases to ambient TB pressure within a much shorter distance than the distance between the break and the HELB damper.

Bulk TB Environment

The GOTHIC analysis (Reference A.3) determined the time between the initiation of the HELB event and when TB environment reaches 100% relative humidity. Utilizing the HELB damper differential pressure and closure time characteristics, the GOTHIC analysis also determined the time each damper achieves full closure following the initiation of the HELB event. EGC has compared these times and concluded that for each HELB event where relative humidity reaches 100%, both adjacent divisional HELB dampers are closed well before 100% relative humidity is reached.

Following the initiation of the HELB event, prior to reaching 100% relative humidity, the bulk TB environment outside the HELB dampers is air, as opposed to a steam-air mixture or pure steam, and behaves as an ideal gas. Therefore, when the HELB occurs, the mass and energy released into the TB from the line break displaces the air surrounding the break location. The displacement of air creates a pressure increase that propagates through the TB volume at sonic velocity (i.e., sonic pressure wave).

Sonic Pressure Wave Impact

EGC has calculated the effect of this sonic pressure wave on HELB dampers' closure; specifically the time the sonic pressure wave will travel the distance from the break location to each of the adjacent HELB dampers (Reference A.4). This time is a function of the speed of sound in air and the distance traveled to each HELB damper. At Braidwood and Byron Stations, the distance is bounded by the 58 feet between the Division 1 and 2 ESF Switchgear Room dampers on Elevation 426'. The calculated difference for sonic pressure waves to travel through the TB Elevation 426' air from the break to the adjacent HELB dampers is 0.0422 seconds. This value is conservatively rounded up to 0.05 seconds throughout the remainder of the evaluation.

EGC has quantified the differential pressure across the divisional wall between ESF Switchgear Rooms that corresponds to a 0.05 second time delay in adjacent damper response. Using the GOTHIC analysis for the 10" main steam line break on TB Elevation 426', the 0.05 second time difference in localized TB pressurization outside the adjacent HELB dampers translates to a differential pressure across the divisional separation wall of 0.0031 psid (Reference A.4).

Consideration of Equipment Blockage

EGC has determined there is no impact on the propagation of the sonic pressure wave through the TB environment due to blockages or obstructions. There is no large equipment or walls located between adjacent HELB dampers. Similar to sound waves in air, the sonic pressure wave will move around small obstructions and blockages without impact on its propagation through the bulk volume.

Analyzed Divisional Wall Differential Pressure

The GOTHIC analysis performed by EGC calculated the bounding differential pressure across each of the divisional walls based on differences in damper closure characteristics. This

analysis involved maximizing the closure time of one HELB damper and minimizing the closure time of the adjacent HELB damper. EGC used the design maximum HELB damper cycle time to close of 0.5 seconds and determined minimum damper cycle time to close based on empirical test measurement uncertainties and damper performance variations.

For the case of the 10" main steam line break in TB Elevation 426', the differential pressure across the ESF Switchgear Room divisional wall due to damper closure characteristics was calculated to be 0.0490 psid in the GOTHIC analysis. Using the same damper closure characteristics, the GOTHIC analysis calculated the highest differential pressure across this ESF Switchgear Room divisional wall to be 0.0659 psid, which is created by the 26" Heater Drain line break on TB Elevation 451'. However, this break is not located local to one of the HELB dampers, therefore the sonic pressure wave time delay in damper closure would be less than 0.05 seconds.

In addition to the differential pressure resulting from the damper closure characteristics, the GOTHIC analysis also considered the differential pressure created from the operation of the Auxiliary Building (AB) room ventilation system. This calculated differential pressure is based on one division's ventilation in operation and the other division's ventilation shutdown.

Margins

There are significant margins and conservatisms included in the GOTHIC analysis differential pressure calculations due to damper performance and ventilation system operation. As demonstrated below, these margins encompass the relatively insignificant impact of the differential pressure created by the time delay due to the sonic pressure wave traveling through the TB environment.

In order to maximize the time one damper remained open while its corresponding adjacent damper was closed, EGC evaluated the empirical test measurement uncertainties, damper performance variations, and additional margin. Each set of adjacent HELB dampers was evaluated to determine the specific stroke time difference for the pair of dampers. This information was used in the GOTHIC analysis to maximize differential pressure on the associated divisional separation wall. Using this information, the minimum margin and uncertainties for any set of dampers is 35% of the maximum design damper cycle time of 0.5 seconds; over 21% represents actual margin (Reference A.4).

As calculated previously, the maximum damper closure delay time between two adjacent dampers due to the sonic pressure wave traveling through the TB environment is 0.05 seconds. This time delay is only 10% of the maximum design damper cycle time and within the minimum 21% margin calculated for damper performance.

An additional source of margin for the calculated differential pressures in the ESF Switchgear Rooms and the MEERs is due to the use of the bounding Diesel Generator (DG) ventilation system parameters in all differential pressure calculations. The differential pressure created from the operation of one division of DG ventilation while the other division is shutdown is 0.0451 psid. This differential pressure bounds the differential pressure created by the individual room ventilation systems for the ESF Switchgear Rooms and MEERs. The GOTHIC analysis conservatively applied this bounding DG ventilation differential pressure to all the divisional wall differential pressure calculations. When compared to the actual ESF Switchgear Room ventilation system differential pressure of 0.0204 psid, this approach results in an additional 0.0247 psid margin in the differential pressure calculation (Reference A.4). This margin is significantly more than the 0.0031 psid created by the sonic pressure wave in the TB.

A summary of the margins in the GOTHIC analysis for the divisional separation wall between the ESF Switchgear Rooms is provided in Tables 1 and 2 below:

Table 1

Individual DP Components	Differential Pressure (psid)	Margin (psid)
DP due to maximum time delay for adjacent TB damper closure due to sonic pressure propagation (0.05 sec)	0.0031	-----
HELB DP due to damper characteristics and tolerance for 10" MS line break on TB Elevation 426'	0.0490	>0.0031
HELB DP due to damper characteristics and tolerance for 26" HD line break on TB Elevation 451' (bounding break for ESF Switchgear walls)	0.0659	>0.0031
DP due to DG ventilation system operation	0.0451	0.0247

0.0031 psid is about 6% of 0.0490 psid and equates to approximately 0.09 inch wg.

Table 2

HELB Scenario Analyzed DPs	Total Differential Pressure (psid)	Margin to 10" MS Break (psid)
10" MS line break on TB Elevation 426' (Reference A.3) (DG ventilation DP (0.0451 psid) and DP due to damper characteristics and tolerance (0.0490 psid))	0.0941	N/A
26" heater drain line break on TB Elevation 451' (Bounding break in GOTHIC analysis) (Reference A.3) (DG ventilation DP (0.0451 psid) and DP due to damper characteristics and tolerance (0.0659 psid))	0.1110	0.0169
ESF Switchgear Room structural analysis maximum wall design DP (Reference A.5)	0.1318	0.0208

Conclusion

EGC's evaluation has determined the maximum time delay in local TB pressure due to the distance between HELB dampers is 0.05 seconds. The differential pressure across DG Room, ESF Switchgear Room, and MEER divisional separation walls, created as a result of this time delay, has a very small contribution to the overall calculated differential pressure. EGC has quantitatively demonstrated that this 0.05 second time delay contribution is encompassed by the significant margins and conservatisms in the divisional wall differential pressure calculations. Therefore, EGC's approach considering the uniform pressurization of the TB is technically justified through analysis and is consistent with the Braidwood and Byron design and licensing basis requirements.

References

A.1. Letter from David M. Gullott (Exelon Generation Company, LLC) to U. S. NRC, "Supplemental Response to NRC HELB Audit Request for Information Supporting Request for License Amendment Regarding Measurement Uncertainty Recapture Power Uprate," dated October 8, 2013

A.2. Byron/Braidwood Calculation No. BYR13-078 / BRW-13-0023-M, "Turbine Building HELB Jet Impingement on Auxiliary Building Openings," Rev. 0, 8/23/13

A.3 Byron/Braidwood Calculation No. BYR12-070 / BRW-12-0084-M, "Auxiliary Building Environment Following a High Energy Line Break in the Turbine Building," Rev. 1, 7/3/13

A.4 Byron/Braidwood Engineering Technical Evaluation EC 396096, "Supplemental Information for NRC RAI on TB HELB Analysis," Rev. 0, 11/18/13

A.5 Byron/Braidwood Transmittal of Design Information (TODI) No. BYR-13-005 / DIT-BRW-2013-0007, Rev. 0, 2/1/13