Exelon. Nuclear

Exelon Generation
4300 Winfield Road
Warrenville, IL 60555

www.exeloncorp.com

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U. S. Nuclear Regulatory Commission
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Dresden Nuclear Power Station, Units 2 and 3
Renewed Facility Operating License Nos. DPR-19 and DPR-25
NRC Docket Nos. 50-237 and 50-249

Quad Cities Nuclear Power Station, Units 1 and 2
Renewed Facility Operating License Nos. DPR-29 and DPR-30
NRC Docket Nos. 50-254 and 50-265

Subject: Supplemental Information Concerning Backup Stability Protection Methodology

References:

1. Letter from M. Banerjee (NRC) to C. M. Crane (Exelon Generation Company, LLC), "Dresden Nuclear Power Station, Units 2 and 3, and Quad Cities Nuclear Power Station, Units 1 and 2 – Issuance of Amendment Re: Transition to Westinghouse Fuel and Minimum Critical Power Ratio Safety Limits (TAC Nos. MC7323, MC7324, MC7325 and MC7326)," dated April 4, 2006

2. Letter from P. R. Simpson (Exelon Generation Company, LLC) to NRC, "Request for Safety Evaluation Revision Regarding Backup Stability Protection Methodology," dated March 9, 2007

3. Letter from C. Gratton (NRC) to C. M. Crane (Exelon Generation Company, LLC), "Dresden Nuclear Power Station, Units 2 and 3, and Quad Cities Nuclear Power Station, Units 1 and 2 – Request for Additional Information Regarding Clarification of the Backup Stability Protection Methodology Evaluation (TAC Nos. MD4866 thru MD4869)," dated August 23, 2007

4. Letter from P. R. Simpson (Exelon Generation Company, LLC) to NRC, "Additional Information Supporting Request for Safety Evaluation Revision Regarding Backup Stability Protection Methodology," dated September 10, 2007

In Reference 1, the NRC issued license amendments for Dresden Nuclear Power Station, Units 2 and 3, and Quad Cities Nuclear Power Station, Units 1 and 2. The license amendments supported the transition to Westinghouse SVEA-96 Optima2 fuel. In Reference 2, Exelon Generation Company, LLC (EGC) requested the NRC to revise the safety evaluation for the Reference 1 amendment.

The NRC requested additional information to complete its review of this request in Reference 3, which EGC provided in Reference 4. The purpose of this letter is to provide supplemental information concerning the Westinghouse Backup Stability Protection Methodology. This information is provided in the attachment to this letter.

There are no regulatory commitments contained in this letter. If you have any questions concerning this letter, please contact Mr. John L. Schrage at (630) 657-2821.

Respectfully,

Darin M Benyak

Darin M. Benyak
Director – Licensing and Regulatory Affairs

Attachment:
Supplemental Information Regarding Backup Stability Protection Methodology - Dresden Nuclear Power Station, Units 2 and 3 and Quad Cities Nuclear Power Station, Units 1 and 2

cc: NRC Senior Resident Inspector
NRC Regional Administrator, Region III

NRC Request 1:

Provide additional justification for why the formula for the controlled entry region boundary is appropriate with respect to safety.

Response:

The backup stability protection (BSP) analysis is used to confirm or modify the existing plant procedures that would be followed in the event the oscillation power range monitor (OPRM) is declared inoperable. It consists of two boundary lines on the power/flow map – a scram line and a controlled-entry line.

Plant safety is assured by the scram line. Diverging power/flow oscillations (i.e., where the core decay ratio (DR) is greater than 1.0) can challenge the cladding minimum critical power ratio (MCPR) safety limit (SLMCPR). The BSP scram criterion (DR = 0.8) has been established, and approved by the NRC, to address potential differences between the predicted DR and the actual DR due to computational uncertainties and variations between the actual and the analyzed plant conditions.

Entry into the region bounded by the scram line requires an immediate plant scram, even if no indication of a power/flow oscillation is present. Thus, there is significant safety margin in the scram criterion to ensure that the SLMCPR is not challenged.

The controlled entry line establishes an operational buffer region where extended plant operation is not allowed. Diverging power/flow oscillations are not expected to occur in this region. Any power/flow perturbations that might occur within this region are expected to decay, which assures that cladding integrity is maintained. The Westinghouse BSP methodology generates exclusion region boundaries in terms of power/flow conditions that result in pre-determined decay ratios. Sensitivity studies performed by Westinghouse have shown that the predicted decay ratio is most sensitive to variations in radial peaking.

To establish a controlled-entry line criterion, Westinghouse has developed a cycle uncertainty (*cu*) factor. The cycle uncertainty factor conservatively accounts for variations in assembly power distributions relative to the assumptions in the cycle design analysis. Therefore, this parameter is dependent on the cycle design.

The cycle uncertainty factor was determined by perturbing the cycle design to increase the radial peaking factor (RPF). The RPF variation used in the determination of the cycle uncertainty factor was chosen as a reasonable upper bound. Thus, the cycle uncertainty factor provides high confidence that diverging power/flow oscillations will not occur in the buffer region, as discussed above.

The variation in RPF was chosen, by engineering judgment based on operational experience, to be larger than the expected RPF variation during a cycle. A baseline analysis was performed using the Quad Cities 2 Cycle 19 core to determine the impact of the RPF variation on the predicted decay ratio. The result of this analysis determined an increase in DR. This increase in DR was used to establish the value of the cycle uncertainty factor. Therefore, the controlled entry region criterion is established as DR = 0.8 – *cu*.

Experience has shown that this methodology produces a controlled-entry boundary line that is approximately 5% lower in power than the scram line boundary. For normal plant operation in this region of the power/flow map (e.g., startup/shutdown, other power maneuvers), this margin is sufficient for the operators to take corrective measures prior to entering the scram region. Thus, the use of the formula for the controlled entry region boundary is appropriate because it provides an operational buffer zone for the operators to take action to ensure that the DR remains less than 0.8 (assuring plant safety) without an unnecessary plant scram.

NRC Request 2:

Describe the calculation of controlled entry region boundary.

Response:

The method used to calculate the controlled entry region was originally described in a letter from P. R. Simpson (Exelon Generation Company, LLC) to the U. S. NRC dated September 10, 2007. The following provides clarification of this method.

a) A representative reload cycle design is analytically perturbed, at the limiting cycle exposure and at a limiting stability point (i.e., high power/low flow), resulting in an increase of the RPF at or near a pre-established upper bound. The basis for this upper bound is described in the response to NRC Request 1.

b) The decay ratio for this "perturbed" case is calculated, along with the analytical RPF, resulting in $DR_{perturbed}$ and $RPF_{perturbed}$.

c) These values are compared to the decay ratio and RPF for the unperturbed cycle design. The difference in the calculated decay ratios (i.e., $DR_{perturbed} - DR_{unperturbed}$), normalized for the associated RPFs (i.e., $RPF_{perturbed}$ and $RPF_{unperturbed}$), is the cycle uncertainty (*cu*) factor.

d) Although the original calculation was cycle specific, subsequent operational data from Dresden Nuclear Power Station (DNPS) and Quad Cities Nuclear Power Station (QCNPS), as discussed in the response to NRC Request 4, has validated that the value is conservative, and can thus be applied generically.

NRC Request 3:

Provide additional justification why the application of the calculated controlled entry region boundary for DNPS Units 2 and 3 and QCNPS Units 1 and 2 is appropriate with respect to safety.

Response:

The Westinghouse reload stability process is applied to determine cycle-specific BSP regions. The cycle-specific regions are defined by two boundary lines on the power/flow map – a scram line and a controlled-entry line. Plant safety is assured by the scram line.

The controlled-entry line establishes an operational buffer region where extended plant operation is not allowed. As discussed previously, diverging power/flow oscillations are not expected to occur in this region, and any power/flow perturbations that might occur within this region are expected to decay, assuring that cladding integrity is maintained.

As described in the response to NRC Request 1, the controlled-entry line criterion is based on the cycle uncertainty (*cu*) factor. The cycle uncertainty factor was determined by perturbing an existing design to increase the RPF. The RPF variation has been selected to bound actual cycle variations, assuring that the cycle uncertainty factor is also bounding. Thus, the cycle uncertainty factor provides high confidence that diverging power/flow oscillations will not occur in the buffer region, as discussed above.

Therefore, the use of the cycle uncertainty (*cu*) factor to establish that the controlled-entry region for DNPS Units 2 and 3 and QCNPS Units 1 and 2 is appropriate because it results in a buffer region that provides appropriate margin to the scram region that assures plant safety.

NRC Request 4:

Provide additional justification for the applicability of the RPF adder to both current and future reloads at DNPS Units 2 and 3 and QCNPS Units 1 and 2.

Response:

The BSP scram criterion (DR = 0.8) addresses potential differences between the predicted DR and the actual DR due to computational uncertainties and variations between the actual and the analyzed plant conditions, and provides the required plant safety for stability events. The use of controlled entry region boundary based on a DR equal to 0.8 – *cu*, where the value of *cu* is based on a bounding RPF deviation to account for cycle uncertainty, provides a buffer region to the scram region.

The RPF deviation was selected as the maximum expected deviation in RPF during a cycle. Because RPF deviations have the largest impact on core stability, this RPF deviation was used to determine a baseline cycle uncertainty (*cu*) factor that is expected to bound the cycle specific *cu* values. As discussed in the response to NRC Request 2, the baseline *cu* value was determined based on an analysis for Quad Cities Unit 2 Cycle 19. This value of *cu* is expected to bound the cycle specific *cu* values, and this expectation is verified each cycle, in accordance with Westinghouse procedures.