

May 23, 2003

Mr. John Skolds, President
Exelon Nuclear
Exelon Generation Company, LLC
4300 Winfield Road
Warrenville, IL 60555

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION (RAI) RELATED TO THE
STAFF'S REVIEW OF THE LICENSE RENEWAL ENVIRONMENTAL REPORT
FOR THE QUAD CITIES NUCLEAR POWER STATION, UNITS 1 AND 2
(TAC NOS. MB6845 AND MB6846)

Dear Mr. Skolds:

The staff is reviewing the license renewal Environmental Report (ER) submitted by Exelon Generation Company, LLC (Exelon) as part of the application for license renewal for the Quad Cities Nuclear Power Station, Units 1 and 2 (QCNPS), and has identified areas where additional information is needed to complete its review. The staff's RAIs are enclosed. The areas where additional information is required are Severe Accident Mitigation Alternatives and transmission lines.

The staff has received your letter dated May 14, 2003, which provided supplemental information for analysis of the transmission lines identified in the QCNPS ER. The staff would be agreeable to meeting with your representatives if such a meeting were desired after reviewing the enclosed RAIs related to transmission lines.

You are requested to provide a response to the enclosed RAI by July 18, 2003, as discussed with your staff. If you have any questions about this RAI, please contact me at (301) 415-1444.

Sincerely,
/RAI

Louis L. Wheeler, Senior Project Manager
Environmental Section
License Renewal and Environmental Impacts Program
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket Nos.: 50-254 and 50-265

Enclosure: As stated

cc w/enclosure: See next page

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OFFICE OF NUCLEAR REACTOR REGULATION
REQUESTS FOR ADDITIONAL INFORMATION (RAIs) RELATED TO
THE STAFF'S REVIEW OF THE ENVIRONMENTAL REPORT (ER)
RELATED TO LICENSE RENEWAL FOR
QUAD CITIES NUCLEAR POWER STATION, UNITS 1 AND 2
(TAC NOS. MB6845, MB6846)

RAIs related to Severe Accident Mitigation Alternatives

1. The Severe Accident Mitigation Alternatives (SAMA) analysis is based on the most recent version of the Quad Cities Nuclear Power Station (QCNPS) Probabilistic Safety Assessment (PSA) for internal events, i.e., Revision 02B, which is a modification to the updated individual plant examination (IPE) submittal transmitted to the U.S. Nuclear Regulatory Commission (NRC) in December 1996. Please provide the following information regarding this PSA model:
 - a. a summary description of any peer reviews of the Level 1 and Level 2 portions of this PSA beyond the normally-performed internal second checker reviews (e.g., QCNPS BWROG Peer Review, Independent Peer Review),
 - b. a characterization of the findings of these internal and external peer reviews (if any), and the impact of any identified weaknesses on the SAMA identification and evaluation process,
 - c. a breakdown of the internal events core damage frequency (CDF) by major contributors, initiators and accident classes, such as loss of offsite power (LOOP) [both single- and dual-unit], station blackout (SBO) [both single- and dual-unit], transients, anticipated transients without scram (ATWS), loss-of-coolant accident (LOCA), interfacing-systems loss-of-coolant accident (ISLOCA), internal floods, and other,
 - d. a description of the major differences from the updated IPE submittal, including the plant and/or modeling changes that have resulted in the new core damage frequency (CDF), along with the corresponding CDF.
2. The CDF cited and used in the SAMA analysis is based on the risk profile for internal events at QCNPS Unit 1. Please provide the internal events CDF for Unit 2, and a discussion of the reasons for any differences from Unit 1. Discuss the impact on the SAMA analysis, including the impacts of external events, and results if the analysis were based on Unit 2 rather than Unit 1.
3. In the Extended Power Uprate (EPU) Amendment application, Exelon indicates that the Level 2 analysis is based on NUREG/CR-6595. However, there is no such indication in the SAMA portion of the Environmental Report (ER). Based on the above, please provide a description of the following:

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- a. the changes in the Level 2 methodology since the updated IPE submittal, including major modeling assumptions, containment event tree (CET) structure, binning of end states.
 - b. the methodology and criteria for binning CET endstates into release categories used in the Level 3 analysis. Include the definitions of the release characteristics listed in Column 2 of Table 4-5.
 - c. each release (consequence) category used in the Level 3 analysis (as listed in Column 1 of Table 4-5), the specific source terms used to represent each release category, and a containment matrix describing the mapping of Level 1 results (plant damage state frequencies) into the various release categories.
4. Please provide the following information concerning the MELCOR Accident Consequences Code System (MACCS) analyses:
- a. The MACCS analysis assumes all releases that occur at ground level and has a thermal content the same as ambient. These assumptions could be non-conservative when estimating offsite consequences. Please provide an assessment of the sensitivity of offsite consequences (doses to the population within 50 miles) to these assumptions.
 - b. The discussion of meteorology indicates that there are data voids in the 2000 data set used. Interpolation was used between hours if only a brief period of data was missing, and hourly observations from the airport were used to fill larger data voids. Provide a characterization of the magnitude and extent of the data voids and the rationale for using the airport data rather than interpolation. Confirm that the 2000 data set is representative of the QCNPS site and justify its use.
 - c. Clarify the time periods used for am and pm for the atmospheric mixing heights, (e.g., midnight to noon and noon to midnight, versus sunrise to sunset.)
5. According to Table F-1 of the Environmental Report (ER), Exelon evaluated 280 SAMA candidates. Of these 280 candidates, 30 were obtained from QCNPS-specific documents. It is not clear that the set of SAMAs evaluated in the ER addresses the major risk contributors for QCNPS. In this regard, please provide the following:
- a. a description of how the dominant risk contributors at QCNPS, including dominant sequences and cut sets from the current Probabilistic Risk Assessment (PRA) and equipment failures and operator actions identified through importance analyses (e.g., Fussell-Vesely, Risk Reduction Worth, etc.) were used to identify potential plant-specific SAMAs for QCNPS.
 - b. the number of sequences and cut sets reviewed/evaluated and what percentage of the total CDF they represent.

- c. a listing of equipment failures and human actions that have the greatest potential for reducing risk at QCNPS based on importance analysis and cut set screening.
 - d. for each dominant contributor identified in the current PRA (Revision 02B), a cross-reference to the SAMAs evaluated in the ER which addresses that contributor. If a SAMA was not evaluated for a dominant risk contributor, justify why SAMAs to further reduce these contributors would not be cost beneficial.
 - e. a general description of the group of 81 insights mentioned in the original IPE and a discussion of how and whether insights not implemented were factored into the SAMA evaluation.
6. The SAMA analysis did not include an assessment of SAMAs for external events. The QCNPS IPE for External Events (IPEEE) has shown that the CDF due to internal fire initiated events is about 7×10^{-5} per reactor year, which is substantially greater than the internal events CDF on which the SAMA evaluation is based. The risk analyses at other commercial nuclear power plants also indicate that external events could be large contributors to CDF and the overall risk to the public. In this regard, the following additional information is needed:
- a. NUREG-1742 ("Perspectives Gained From the IPEEE Program," Final Report, 4/02), lists the significant fire area CDFs for QCNPS (pages 3-24 and 3-24 of Volume 2). While these fire-related CDF estimates may be conservative, they are still large relative to the QCNPS internal events CDF. For each fire area or dominant fire sequence, please explain what measures were taken to further reduce risk, and explain why these CDFs can not be further reduced in a cost effective manner.
 - b. NUREG-1742 lists seismic outliers and improvements for QCNPS (Tables 2.7 and 2.12 of Volume 2). Please confirm that all of the "Plant improvements" that address the outliers have been implemented. If not, please explain why within the context of this SAMA study.
 - c. In the IPEEE submittal, Exelon estimated that after the resolution of the seismic outliers, the plant high confidence in low probability of failure (HCLPF) would be at least 0.24g which is less than the 0.3g review level earthquake used in the IPEEE. During the EPU evaluation, the staff noted that if the HCLPF capacity was increased to 0.3g, the resulting CDF would be about an order of magnitude reduction in risk from the IPEEE plant condition. Please identify the systems, structures, and components (SSCs) that limit the plant HCLPF. For those SSCs below 0.3g, justify why modifications to increase seismic capacity would not be cost beneficial when evaluated consistent with the regulatory analysis guidelines.
7. The SAMA analysis did not include an assessment of the impact that PRA uncertainties and external event risk considerations would have on the conclusions of the study. Some license renewal applicants have opted to double the estimated benefits (for internal events) to accommodate any contributions for other initiators when sound reasons exist to support such a numerical adjustment, and to incorporate additional

margin in the SAMA screening criteria to address uncertainties in other parts of the analysis (e.g., an additional factor of two in comparing costs and benefits of each SAMA). At QCNPS, external events (both fire and seismic) are dominant contributors to the total CDF, and are over a factor of 10 greater than internal event contributions. On that basis, please provide the following information to address these concerns:

- a. an estimate of the uncertainties associated with the calculated core damage frequency (e.g., the mean and median internal events CDF estimates and the 5th and 95th percentile values of the uncertainty distribution),
 - b. an assessment of the impact on the Phase 1 screening if risk reduction estimates are increased to account for uncertainties in the risk assessment and the additional benefits associated with external events (as applicable), and
 - c. an assessment of the impact on the Phase 2 evaluation if risk reduction estimates are increased to account for uncertainties in the risk assessment and the additional benefits associated with external events (as applicable). Please consider the uncertainties due to both the averted cost-risk and the cost of implementation to determine changes in the net value for these SAMAs.
8. For certain SAMAs considered in the ER, there may be lower cost alternatives that could achieve much of the risk reduction. As one example, Phase 2 SAMA #3 evaluated the use of fuel cells instead of lead-acid batteries, but lower cost alternatives, such as adding a diesel-driven battery charger, were not explored. Please confirm that low cost alternatives to Phase 2 SAMAs were considered, and provide a brief discussion of these alternatives.
 9. During the review of the EPU application, the staff noted several areas where the PSA should be modified to reflect modifications to the plant or changes in success paths. These include: a plant modification to install a recirculation pump runback control circuit; a plant modification to trip the condensate/booster pump D in the event of a LOCA to prevent an overload condition from occurring; a change in success criteria for reactor pressure vessel (RPV) depressurization in a transient without a stuck open relief valve (two valves under EPU conditions); a change in success criteria for RPV overpressure protection in ATWS sequences (12 of 13 valves under EPU conditions). Confirm if these model changes, as well as others, have been incorporated in the PSA used for the SAMA analysis. For those not incorporated, provide an assessment of the impact that the model change would have on the SAMA analysis.
 10. During the review of the EPU application, the staff noted that there is potentially a new means of inducing a LOOP initiating event under EPU conditions. The end result could be an overduty condition on the unit auxiliary or reserve auxiliary transformer. Given this new condition, please provide an evaluation of the costs and benefits associated with the replacement of the affected transformer with a higher capacity transformer.
 11. In the original IPE (1993), the CDF was dominated by a dual-unit LOOP (contributing 56% to the internal events CDF). The Fussell-Vesely importance measure indicated that the most significant hardware contributors toward total CDF are the failures of the

diesel generators (DGs), and the quantitative importance of emergency AC power sources is influenced significantly by the dependency of the plant on electrically-driven systems for long-term decay heat removal. In the modified IPE submittal (August 1996), the contribution for dual-unit LOOP remained unchanged. In the updated IPE (December 1996), the contribution to CDF has dropped to 33% (after two station blackout (SBO) DGs were added), however, the contribution to CDF remains significant. SAMAs that involve adding a DG, adding batteries, and the like were evaluated by QCNPS but eliminated on the basis that the plant already has five DGs, spare batteries, and the other SAMAs are too costly. Other than these improvements, please describe what measures or evaluations have been performed at QCNPS to reduce the risk from single- and dual-unit LOOP. Include a discussion of how the new SBO DGs are modeled in the current PSA including key assumptions.

12. In Section 4.20.5 of the ER, Exelon states that a preliminary cost estimate was prepared for each of the remaining candidates (surviving the initial screening). In Section 4.20.6, it is stated that a more detailed implementation cost assessment is made only if the benefit is close to the estimated implementation cost. However, no implementation costs were provided for any of the Phase 2 SAMAs. Please provide the estimated implementation costs (preliminary cost estimates) for the 14 Phase 2 SAMAs, so that the staff can readily determine if any of these SAMAs are potentially cost-beneficial when considering the impact of external events and uncertainties. In addition, indicate what minimal costs were assumed for procedure changes, and what minimal costs were assumed for hardware changes.
13. For the Phase 2 SAMAs, the following information is needed to better understand the modification and/or the modeling assumptions:
 - a. Phase 2 SAMA 1: The benefit of this SAMA is said to be a decrease in the CDF which applies primarily to loss of decay heat removal and late SBO scenarios. One of the proposed improvements is a procedure for opening the safe shutdown makeup pump (SSMP) doors and using portable fans for SSMP room cooling. It is unclear how this improvement would work under SBO conditions. Please clarify if this improvement is only meant to work for loss of decay heat removal scenarios, and how it might work under SBO conditions.
 - b. In the IPE, one of the unique features identified at QCNPS is the ability to cross-tie between units in emergency buses 14-1 and 24-1. Phase 2 SAMA 4 evaluates the development of procedures to allow the following cross-ties to be performed:

Bus 14-1 to Bus 24-1 from EDG 1
 Bus 24-1 to Bus 14-1 from EDG 2
 EDG 1 / 2 to Buses 13-1 and 23-1

Explain why procedures have not already been developed for a cross-tie (Bus 14-1 to 24-1) that has been acknowledged in the IPE. Clarify whether this capability currently exists and is credited in the current PSA. If it is credited, please provide the key assumptions regarding this action (e.g., timing and

operator non-procedural capability/knowledge) and the human error rate and its basis.

- c. Phase 2 SAMA 5: The following statement is made in Section 4.20.6.5 of the ER, "An additional EDG cooling source may be cost beneficial for Quad Cities." However, the analysis indicates that there is no benefit (averted risk). Explain why there is no benefit, and also explain why it was believed that such an improvement would be cost beneficial when there is no benefit.
- d. For several Phase 2 SAMAs (6, 10, and 14), it appears that a majority of the effort would be in writing/revising procedures and training, and engineering work. Given the additional benefit of these SAMAs in external events and the impact of uncertainties, the benefit of these SAMAs could be substantially higher than assumed in the ER. Explain why these SAMAs would not be cost beneficial when the benefits associated with external events, and the impact of uncertainties are considered.

RAIs Related to Transmission Lines

1. Regarding the consideration of electric shock:

- a. The staff has determined that NRC regulations, specifically 10 CFR 51.53(C)(3)(ii)(H), require the consideration of electric shock for all transmission lines constructed for the specific purpose of connecting the plant to the transmission system. The staff recognizes the Final Environmental Statement (FES) for initial plant operation states in Section V.A.3 that according to the applicant, approximately 45 miles of transmission line were planned and would have been built even if the Quad Cities station had not been built. However, the FES also states in Section III.B that these lines were planned and would have been built to an alternate source of power in the area had the Quad Cities station not been built. Therefore, the staff's understanding is that the lines were constructed for the specific purpose of connecting the plant to the transmission system. The staff has determined that 10 CFR 51.53(C)(3)(ii)(H) requires the Quad Cities license renewal ER to include consideration of 27 miles of the Davenport line (0401) to Substation 56 and 17.5 miles of the Barstow line (0402) to Substation 39. Similarly, the consideration of electric shock is required for both Nelson lines (0403 which traverses 41.9 miles to the Nelson substation, and 0404 which traverses 39.7 miles to the Nelson substation).
- b. Also, during its review, the staff noted in Table 4-3 of the ER that one transmission line (0404) is not in conformance with the recommendation of the National Electric Safety Code (NESC) for preventing electric shock from induced current. The staff is not persuaded by the discussion in ER Section 4.13 regarding the absence of a need for mitigation measures. Please describe the measures which will be taken to mitigate the non-conformance of the 0404 line with the NESC recommendation.

2. Regarding the applicability of the Endangered Species Act (ESA) to various portions of the transmission lines, the staff articulated a position which was documented in a letter from Cynthia A Carpenter, NRC, to Mr. William R. McCollum, Jr., Duke Energy Corporation, dated May 10, 1999, during the review of the Oconee license renewal application. Specifically, the ESA is applicable to the same areas of the transmission system which are subject to the NRC regulation regarding electric shock. Please provide additional information regarding threatened and endangered species for the portions of the transmission system identified above in the request regarding consideration of electric shock.

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