



Order No. EA-12-049

RS-14-213

August 28, 2014

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

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: Third Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049)

References:

1. NRC Order Number EA-12-049, "Issuance of Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," dated March 12, 2012
2. NRC Interim Staff Guidance JLD-ISG-2012-01, "Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," Revision 0, dated August 29, 2012
3. NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," Revision 0, dated August 2012
4. Exelon Generation Company, LLC's Initial Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049), dated October 25, 2012
5. Exelon Generation Company, LLC Overall Integrated Plan in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049), dated February 28, 2013 (RS-13-025)
6. Exelon Generation Company, LLC First Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049), dated August 28, 2013 (RS-13-129)
7. Exelon Generation Company, LLC Second Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049), dated February 28, 2014 (RS-14-015)

8. NRC letter to Exelon Generation Company, LLC, Quad Cities Nuclear Power Station, Units 1 and 2 – Interim Staff Evaluation Relating to Overall Integrated Plan in Response to Order EA-12-049 (Mitigation Strategies) (TAC Nos. MF1048 and MF1049), dated November 22, 2013

On March 12, 2012, the Nuclear Regulatory Commission (“NRC” or “Commission”) issued an order (Reference 1) to Exelon Generation Company, LLC (EGC). Reference 1 was immediately effective and directs EGC to develop, implement, and maintain guidance and strategies to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities in the event of a beyond-design-basis external event. Specific requirements are outlined in Attachment 2 of Reference 1.

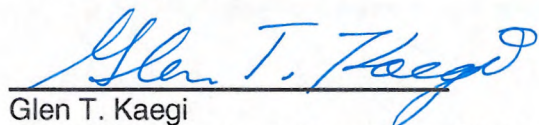
Reference 1 required submission of an initial status report 60 days following issuance of the final interim staff guidance (Reference 2) and an overall integrated plan pursuant to Section IV, Condition C. Reference 2 endorses industry guidance document NEI 12-06, Revision 0 (Reference 3) with clarifications and exceptions identified in Reference 2. Reference 4 provided the EGC initial status report regarding mitigation strategies. Reference 5 provided the Quad Cities Nuclear Power Station, Units 1 and 2 overall integrated plan.

Reference 1 requires submission of a status report at six-month intervals following submittal of the overall integrated plan. Reference 3 provides direction regarding the content of the status reports. References 6 and 7 provided the first and second six-month status reports, respectively, pursuant to Section IV, Condition C.2, of Reference 1 for Quad Cities Station. The purpose of this letter is to provide the third six-month status report pursuant to Section IV, Condition C.2, of Reference 1, that delineates progress made in implementing the requirements of Reference 1. The enclosed report provides an update of milestone accomplishments since the last status report, including any changes to the compliance method, schedule, or need for relief and the basis, if any. The enclosed report also addresses the NRC Interim Staff Evaluation Open and Confirmatory Items contained in Reference 8.

This letter contains no new regulatory commitments. If you have any questions regarding this report, please contact David P. Helker at 610-765-5525.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 28th day of August 2014.

Respectfully submitted,



Glen T. Kaegi
Director - Licensing & Regulatory Affairs
Exelon Generation Company, LLC

Enclosure:

1. Quad Cities Nuclear Power Station, Units 1 and 2 Third Six-Month Status Report for the Implementation of Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events

cc: Director, Office of Nuclear Reactor Regulation
NRC Regional Administrator - Region III
NRC Senior Resident Inspector – Quad Cities Nuclear Power Station, Units 1 and 2
NRC Project Manager, NRR – Quad Cities Nuclear Power Station, Units 1 and 2
Ms. Jessica A. Kratchman, NRR/JLD/PMB, NRC
Mr. Jack R. Davis, NRR/DPR/MSD, NRC
Mr. Eric E. Bowman, NRR/DPR/MSD, NRC
Mr. Jeremy S. Bowen, NRR/DPR/MSD/MSPB, NRC
Mr. Robert L. Dennig, NRR/DSS/SCVB, NRC
Mr. John P. Boska, NRR/DPR/MSD/MSPB, NRC
Illinois Emergency Management Agency - Division of Nuclear Safety

Enclosure

Quad Cities Nuclear Power Station, Units 1 and 2

**Third Six-Month Status Report for the Implementation of Order EA-12-049, Order
Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-
Design-Basis External Events**

(18 pages)

Enclosure

Quad Cities Nuclear Power Station, Units 1 and 2 Third Six Month Status Report for the Implementation of Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events

1 Introduction

Quad Cities Nuclear Power Station, Units 1 and 2, developed an Overall Integrated Plan (Reference 1 in Section 8) documenting the diverse and flexible strategies (FLEX) in response to Reference 2. This enclosure provides an update of milestone accomplishments since submittal of the last status report, including any changes to the compliance method, schedule, or need for relief/relaxation and the basis, if any.

2 Milestone Accomplishments

Unit 1 Modification Development has been completed since the last update. U2 Modification Development has been completed since the last update. The FLEX storage building and Seismic Deep Well Modifications are in progress.

3 Milestone Schedule Status

The following provides an update to Attachment 2 of the Overall Integrated Plan. It provides the activity status of each item, and whether the expected completion date has changed. The dates are planning dates subject to change as design and implementation details are developed.

The revised target completion dates impact the order implementation date. An explanation of the impact of these changes is provided in Section 5 of this enclosure.

Milestone Schedule

Milestone	Target Completion Date	Activity Status	Revised Target Completion Date
Submit 60 Day Status Report	Oct 2012	Complete	
Submit Overall Integrated Plan	Feb 2013	Complete	
Contract with National SAFER Response Center		Complete	
Submit 6 Month Updates:			
Update 1	Aug 2013	Complete	
Update 2	Feb 2014	Complete	
Update 3	Aug 2014	Complete with this submittal	
Update 4	Feb 2015	Not Started	

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Milestone	Target Completion Date	Activity Status	Revised Target Completion Date
Update 5	Aug 2015	Not Started	
Update 6	Feb 2016	Not Started	
Update 7	Aug 2016	Not Started	
Submit Completion Report		Not Started	See Section 5 of this enclosure.
Modifications Development & Implementation¹:			
Unit 1 Modification Development (All FLEX Phases)	Feb 2014	Completed	April 2014
Unit 1 Modification Implementation (All FLEX Phases)	Apr 2015	Started	Mar 2015
Unit 2 Modification Development (All FLEX Phases)	Mar 2015	Completed	
Unit 2 Modification Implementation (All FLEX Phases)	Apr 2016	Not Started	
Common Unit Modification Development (Building and Deep Wells)		Started	Mar 2015
Common Unit Modification Implementation (Building and Deep Wells)		Started	Mar 2015
Procedures:			
Create Site-Specific Procedures	Apr 2015	Started	Mar 2015
Validate Procedures (NEI 12-06, Sect. 11.4.3)	Apr 2015	Not Started	Mar 2015
Create Maintenance Procedures	Apr 2015	Not Started	Mar 2015
Perform Staffing Analysis	Nov 2014	Started	
Storage Plan and Construction	Apr 2015	Started	Mar 2015
FLEX Equipment Acquisition	Apr 2015	Started	Mar 2015
Training Completion	Apr 2015	Started	Mar 2015

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Milestone	Target Completion Date	Activity Status	Revised Target Completion Date
National SAFER Response Center Operational	Dec 2014	Started	
Unit 1 FLEX Implementation	Apr 2015	Started	See Section 5 of this enclosure.
Unit 2 FLEX Implementation	Apr 2016	Started	See Section 5 of this enclosure.
Full Site FLEX Implementation	Apr 2016	Started	See Section 5 of this enclosure.

4 Changes to Compliance Method

The Modification to the implementation plan for the use of two Deep Wells which was detailed in the February 2014 OIP Six-Month update has been revised. Only one of the wells will be designed to withstand a seismic event. Neither well will be protected from high winds..

5 Need for Relief/Relaxation and Basis for the Relief/Relaxation

Quad Cities Station submitted the request for relaxation to the NRC by letter dated February 27, 2014 (Reference 5). The NRC approved the Quad Cities Station relaxation request for full compliance of NRC Order EA-12-049 by letter dated April 15, 2014 (Reference 9).

6 Open Items from Overall Integrated Plan and Draft Safety Evaluation

The following tables provide a summary of the open items documented in the Overall Integrated Plan (Reference 1) or the Draft Safety Evaluation (SE) (Reference 7), and the status of each item.

Section Reference	Overall Integrated Plan Open Item	Status
Sequence of Events (p. 4)	1. The times to complete actions in the Events Timeline are based on operating judgment, conceptual designs, and current supporting analyses. The final timeline will be time validated once detailed designs are completed and procedures are developed, and the results will be provided in a future six-month update.	Started

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Section Reference	Overall Integrated Plan Open Item	Status
Sequence of Events (p. 4,5)	2. Issuance of BWROG document NEDC-33771P, "GEH Evaluation of FLEX Implementation Guidelines," on 01/31/2013 did not allow sufficient time to perform the analysis of the deviations between Exelon's engineering analyses and the analyses contained in the BWROG document prior to submittal of this Integrated Plan. This analysis is expected to be completed, documented on Attachment 1B, and provided to the NRC in the August 2013 six-month status update.	Completed
Sequence of Events (p. 6)	3. Additional work will be performed during detailed design development to ensure Suppression Pool temperature will support RCIC operation, in accordance with approved BWROG analysis, throughout the event.	Completed
Sequence of Events (p. 7)	4. Initial calculations were used to determine the fuel pool timelines. Formal calculations will be performed to validate this information during development of the Spent Fuel Pool Cooling strategy detailed designs, and will be provided in a future six-month update.	Calculations have been approved. Action Completed.
Multiple Sections	5. Procedures and programs will be developed to address storage structure requirements, haul path requirements, and FLEX equipment requirements relative to the external hazards applicable to Quad Cities	Started
Programmatic controls (p. 8)	6. Quad Cities Nuclear Power Station will implement an administrative program for FLEX to establish responsibilities, and testing and maintenance requirements.	Started

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Section Reference	Overall Integrated Plan Open Item	Status
Multiple Sections	7. Detailed designs based on the current conceptual designs will be developed to determine the final plan and associated mitigating strategies. Analysis will be performed to validate that the plant modifications, selected equipment, and identified mitigating strategy can satisfy the safety function requirements of NEI 12-06. Once these designs and mitigating strategies have been fully developed, Exelon will update the integrated plan for Quad Cities Nuclear Power Station during a scheduled six-month update. This update will include any changes to the initial designs as submitted in this Integrated Plan.	Started
Maintain Core Cooling Phase 1 (p.13)	8. Guidance will be provided to ensure that sufficient area is available for deployment and that haul paths remain accessible without interference from outage equipment during refueling outages.	Started
Maintain Spent Fuel Pool Cooling Phase 1 (p.32)	9. Evaluation of the spent fuel pool area for steam and condensation has not yet been performed. The results of this evaluation and the vent path strategy, if needed, will be provided in a future six-month update.	Started
Safety Function Support (p. 42)	6.1.1 10. Habitability conditions will be evaluated and a strategy will be developed to maintain RCIC habitability	Started
Safety Function Support (p. 42)	6.1.2 11. Habitability conditions will be evaluated and a strategy will be developed to maintain Main Control Room habitability.	Complete. Duplicate of 3.2.4.6.A.
Safety Function Support (p. 43)	12. Battery Room Ventilation: Alternate ventilation will be provided to address Hydrogen generation and cold weather, as required.	Started

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Section Reference	Overall Integrated Plan Open Item	Status
Safety Function Support (p. 43)	13. Fuel Oil Supply to Portable Equipment: A detailed fuel oil supply plan will be developed.	Started
Attachment 1A, Item 20 (p.59)	14. Provide alternate cooling to the RCIC rooms. Procedure to be developed.	Started

Section Reference	Interim Safety Evaluation / Audit Questions Open Item	Status
3.2.3.A	<u>SIGNIFICANT OPEN Item</u> . Generic concern related to adoption of Revision 3 to the BWROG EPG/SAG [Emergency Procedure Guidelines/Severe Accident Guidelines] relating to potential detrimental effects on containment response.	Complete. See February 2014 Six-Month update.
3.2.4.6.A	<u>OPEN Item</u> Licensee asserts 120 °F used for habitability in SBO is adequate for FLEX. Habitability of the control room should consider 110 degree F temperature limits of NUMARC 87-00 and MIL-STD-1472C.	Started
3.3.2.A	<u>OPEN Item</u> Control of equipment and connections for unavailability needs to be addressed.	Started
3.4.B	<u>OPEN Item</u> Details not provided to demonstrate the minimum capabilities for offsite resources will be met per NEI 12-06 Section 12.2.	Complete. See February 2014 Six-Month update.
3.1.1.2.A	<u>Confirmatory Item</u> Studies for liquefaction and the effects on haul paths and storage location(s) are not complete.	Started
3.1.1.2.B	<u>Confirmatory Item</u> A postulated downstream dam failure from a seismic event is still being evaluated.	As discussed with the Second 6-month update Quad Cities Station will install two independent full capacity wells which will be utilized for all makeup water for a seismic event which causes the downstream dam failure. Therefore, no further evaluation on the downstream dam failure is being performed. Complete.

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3.1.1.2.C	<u>Confirmatory Item</u> Need to confirm implementation of strategy for power to move or deploy FLEX equipment and opening of doors.	Started
3.1.1.3.A	<u>Confirmatory Item</u> Plans for strategies have insufficient information to demonstrate alternate sources of instrument readings and adequate tolerances/accuracies if there is seismic impact to primary sources. Also, need identification of installed instrumentation location and power source.	Started
3.1.1.3.B	<u>Confirmatory Item</u> Need identification of instrumentation used to monitor FLEX electrical power equipment including measurement tolerance/accuracy.	The FLEX 480 VAC generators will be supplied by Cummins Power Generation. The instruments supplied with the generator will measure line to line and line to neutral voltage, phase current, and power output. Complete.
3.1.2.2.A	<u>Confirmatory Item</u> A detailed fuel supply plan is to be provided in a future 6-month status update including what is needed, what is available, and how it will be transported.	Started
3.1.3.2.A	<u>Confirmatory Item</u> Completion of development of an administrative program to ensure pathways remain clear or compensatory actions will be implemented to ensure all strategies can be deployed during all modes of operation. Procedures and programs are to be developed.	Started
3.1.3.2.B	<u>Confirmatory Item</u> Completion of assessment on the adequacy of the debris removal equipment and the effect on the timeline to assure the critical times are capable of being met. This will be tracked as an open item in the 6 month update.	Started
3.2.1.1.A	<u>Confirmatory Item</u> Need benchmarks to demonstrate Modular Accident Analysis Program (MAAP)4 is the appropriate code for simulation of ELAP.	See Attachment 4 for responses to MAAP4 information. Complete.
3.2.1.1.B.	<u>Confirmatory Item</u> The collapsed level must remain above Top of Active Fuel (TAF) and the cool down rate must be within technical specification limits in the MAAP4 analysis.	See Attachment 4 for responses to MAAP4 information. Complete.
3.2.1.1.C.	<u>Confirmatory Item</u> MAAP4 must be used in accordance with Sections 4.1, 4.2, 4.3,	See Attachment 4 for responses to MAAP4 information. Complete.

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	4.4, and 4.5 of the June 2013 position paper.	
3.2.1.1.D.	<u>Confirmatory Item</u> In using MAAP4, the licensee must identify and justify the subset of key modeling parameters cited from Tables 4-1 through 4-6 of the "MAAP4 Application Guidance, Desktop Reference for Using MAAP4 Software, Revision 2" (Electric Power Research Institute Report 1 020236).	See Attachment 4 for responses to MAAP4 information. Complete.
3.2.1.1.E.	<u>Confirmatory Item</u> The specific MAAP4 analysis case that was used to validate the timing of mitigating strategies in the integrated plan must be identified and available on thee-Portal for NRC staff to view. Alternately, a comparable level of information may be included in the supplemental response.	See Attachment 4 for responses to MAAP4 information. Complete.
3.2.1.2.A.	<u>Confirmatory Item</u> Questions remain unanswered regarding recirculation pump seal leakage rates. Aspects such as pressure dependence, leakage phase assumptions (single phase liquid, steam, mixed) are not discussed.	Started
3.2.1.3.A.	<u>Confirmatory Item</u> Need gap analysis between results of the licensee's analysis results and those of BWROG document NEDC-33771 P. Results are presented in 6 month update; however there is no analysis of the relevance of differences.	Started
3.2.1.3.B.	<u>Confirmatory Item</u> Licensee plans further review and analysis to ensure suppression pool temperature will support RCIC operation.	Started
3.2.1.3.C.	<u>Confirmatory Item</u> Need identification of the minimum voltage required for the dc buses and the basis of that determination.	Complete. See February 2014 Six-Month update.
3.2.1.4.A.	<u>Confirmatory Item</u> Water quality issue and guidance on priority of water source usage need to be addressed.	Started
3.2.1.4.B.	<u>Confirmatory Item</u> Need completion of current evaluation of FLEX generator sizing calculation.	Started
3.2.1.4.C.	<u>Confirmatory Item</u> Need design and working pressure of hoses and fittings.	Started
3.2.1.6.A.	<u>Confirmatory Item</u> Licensee identified	Started

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	protection of equipment for Hardened Vent is to Order EA-13-109 (Reference 22). Explain if this is equivalent to Order EA-12-049, as Order EA-13-109 does not require protection from external events.	
3.2.2.A.	<u>Confirmatory Item</u> The licensee identified modifications and procedures for SFP cooling are in development.	Started
3.2.4.2.A.	<u>Confirmatory Item</u> Modifications to restore RCIC room cooling are being developed by the licensee.	Modification development has completed.
3.2.4.2.B.	<u>Confirmatory Item</u> Modifications to restore ventilation to the battery rooms via use of the portable FLEX generators to address hydrogen and cold weather are being developed by the licensee.	Modification development has completed.
3.2.4.4.A.	<u>Confirmatory Item</u> Procedures for emergency lighting are to be developed for deployment of hands free flashlights.	Started
3.2.4.4.B.	<u>Confirmatory Item</u> Confirm upgrades to communication system that resulted from the licensee communications assessment. (ADAMS Accession Nos. ML 12306A 199 and ML13056A 135.)	Started
3.2.4.5.A.	<u>Confirmatory Item</u> Verify completion of drafted procedures for protected and internal locked area access.	Started
3.2.4.6.B.	<u>Confirmatory Item</u> Site industrial procedures and identification of protective clothing, ice vests/packs, bottled water, etc. is needed.	Complete. See February 2014 Six-Month Update.
3.2.4.6.C.	<u>Confirmatory Item</u> Need to address the use of appropriate human performance aids (e.g., component marking, connection schematics, installation sketches, photographs, etc.) which shall be included in the FLEX guidance implementing the FLEX strategies.	Started
3.2.4.8.A.	<u>Confirmatory Item</u> The licensee did not provide any information regarding loading/sizing calculations of portable diesel generators(s) and strategy for electrical isolation for FLEX electrical generators from installed plant equipment.	Started
3.2.4.9.A.	<u>Confirmatory Item</u> Need detailed fuel plan including fuel storage tank, truck, and day tank volumes and how fuel quality is	Started

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	maintained in the day tanks and in portable FLEX equipment.	
3.2.4.10.A.	<u>Confirmatory Item</u> Need detailed battery load profile for all mitigating strategies and a detailed discussion of loads that will be shed, how they will be shed, and what are the effects of the load shed.	Started
3.4.A.	<u>Confirmatory Item</u> Procedures for interface with the National SAFER Response Center need to be developed.	Started

7 Potential Draft Safety Evaluation Impacts

There are no potential impacts to the Draft Safety Evaluation identified at this time.

8 References

The following references support the updates to the Overall Integrated Plan described in this enclosure.

1. Quad Cities Overall Integrated Plan in Response to March 12, 2012, Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049),” dated February 28, 2013.
2. NRC Order Number EA-12-049, “Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events,” dated March 12, 2012.
3. NRC Order EA-13-109, “Issuance of Order to Modify Licenses with Regard to reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions,” dated June 6, 2013.
4. Quad Cities Nuclear Power Station, Units 1 and 2 First Six Month Status Report for the Implementation of Order EA-12-049, “Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events,” dated August 28, 2013.
5. Quad Cities Nuclear Power Station’s Request for Relaxation from NRC Order EA-12-049, "Order Modifying Licenses With Regard To Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" dated February 27, 2014.
6. RCIC Pump and Turbine Durability Evaluation – Pinch Point Study, February 2013, 0000-0155-1545-RO, DRF 0000-0155-1541, Revision 0
7. Quad Cities Nuclear Power Station, Units 1 and 2 – Interim Staff Evaluation Relating to Overall Integrated Plan in Response to Order EA-12-049 (Mitigation Strategies) (TAC NOS.MF 1048 and MF 1049), dated November 22, 2013.

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8. Quad Cities Nuclear Power Station, Units 1 and 2 Second Six Month Status Report for the Implementation of Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," dated February 28, 2014.
9. NRC Letter, Quad Cities Nuclear Power Station, Units 1 and 2 – Relaxation of Certain Schedule Requirements for Order EA-12-049, "Issuance of Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond Design Basis External Events," dated April 15, 2014.

9 Attachments

Quad Cities Response to Confirmatory items 3.2.1.1 A-E (Answers derived from QC-MISC-014 Rev. 0)

Attachment

Quad Cities Response to Confirmatory items 3.2.1.1 A-E

3.2.1.1.A Need benchmarks to demonstrate Modular Accident Analysis Program (MAAP)4 is the appropriate code for simulation of ELAP.

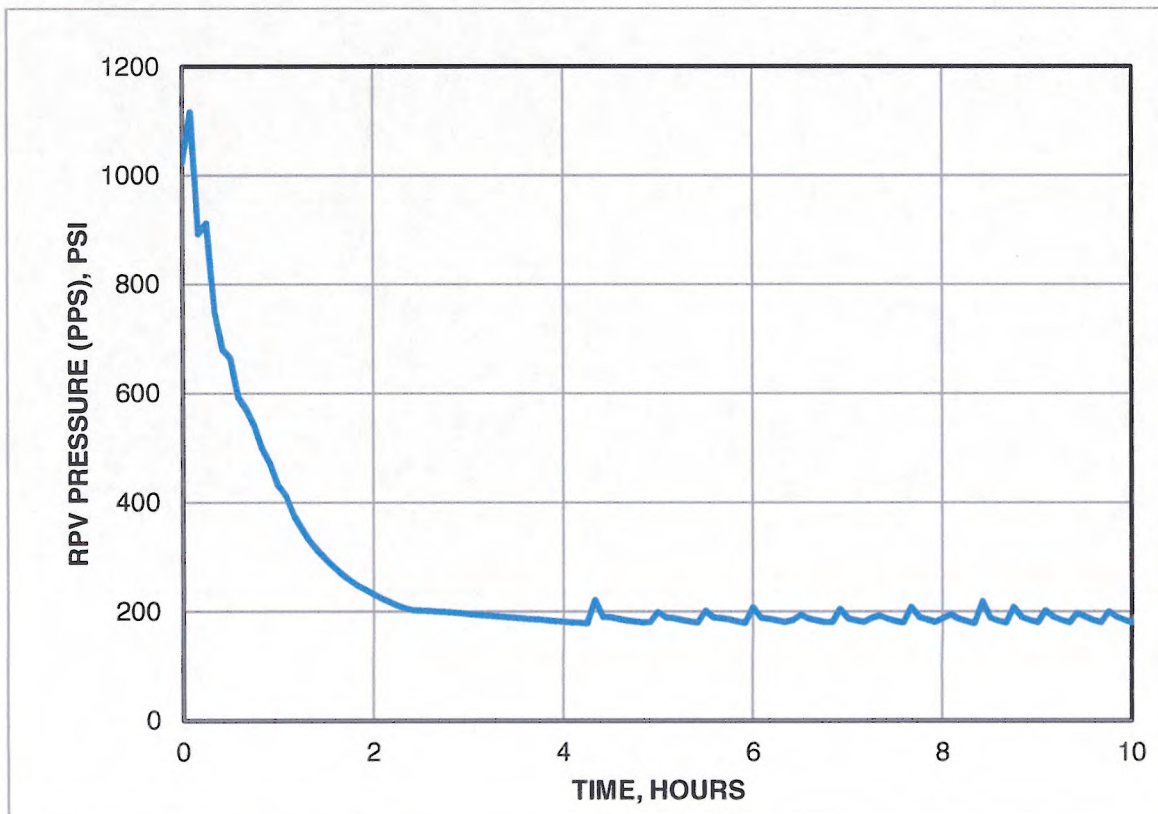
Response:

Generic response provided by EPRI BWR Roadmap "Technical Basis for Establishing Success Timelines in Extended Loss of AC Power Scenarios in Boiling Water Reactors Using MAAP4," (EPRI Product ID [3002002749](#)).

3.2.1.1.B The collapsed level must remain above Top of Active Fuel (TAF) and the cool down rate must be within technical specification limits in the MAAP4 analysis.

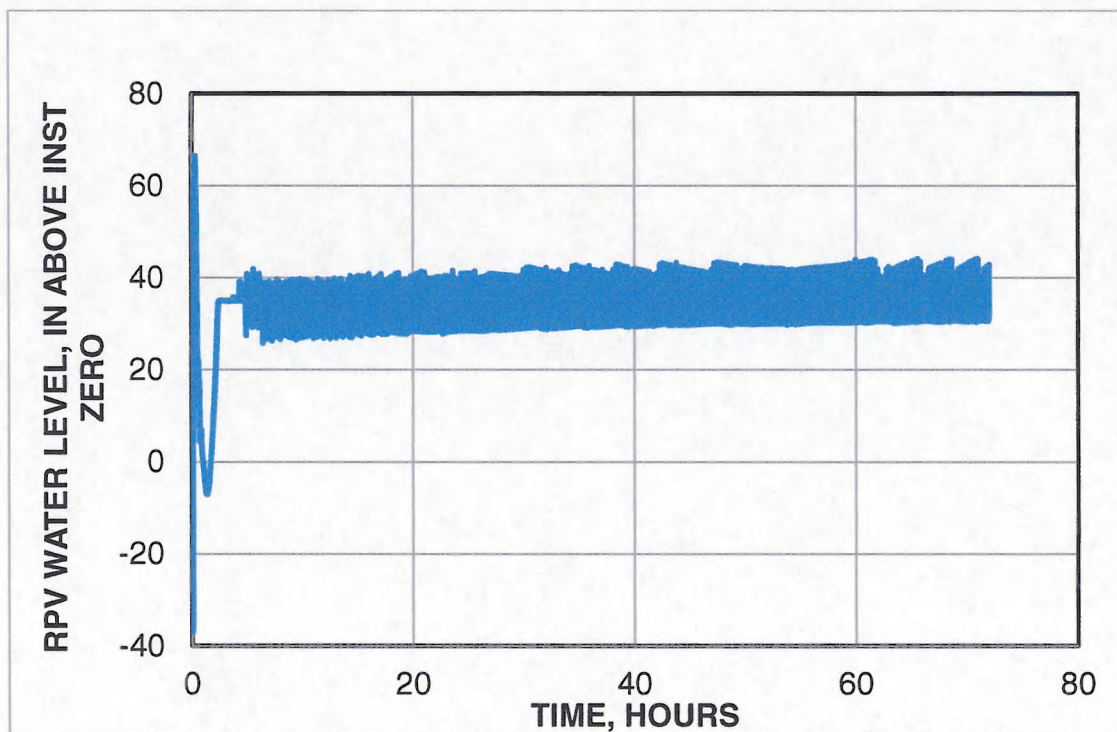
Response:

The Quad Cities Integrated Plan states that the operators would commence a cooldown of the RPV after the RPV water level reaches +40" at a rate of 80°F/hr which is within the technical specifications limit of 100°F/hr. The following plot of the RPV pressure from the MAAP analysis uses a cooldown initiation setpoint of +40" water level in the RPV.



MAAP Calculation of RPV Pressure During RPV Depressurization

For the representative MAAP run (Case 6), the collapsed RPV water level inside the shroud remains above TAF for the duration of the analysis. The plot below shows that the lowest RPV level, calculated by MAAP, was approximately -40" below instrument zero. (TAF is located at -142" relative to instrument zero, Instrument zero is at +503" above vessel zero.) As shown in the following plot, the collapsed RPV water level remains at least 8.5' above TAF for the duration of the analysis



MAAP Calculation of Collapsed RPV Water Level Inside the Shroud

3.2.1.1.C MAAP4 must be used in accordance with Sections 4.1, 4.2, 4.3, 4.4, and 4.5 of the June 2013 position paper.

Response:

MAAP analysis performed for Quad Cities was carried out in accordance with Sections 4.1, 4.2, 4.3, 4.4, and 4.5 of the June 2013 position paper, EPRI Technical Report 3002001785, "Use of Modular Accident Analysis Program (MAAP) in Support of Post-Fukushima Applications".

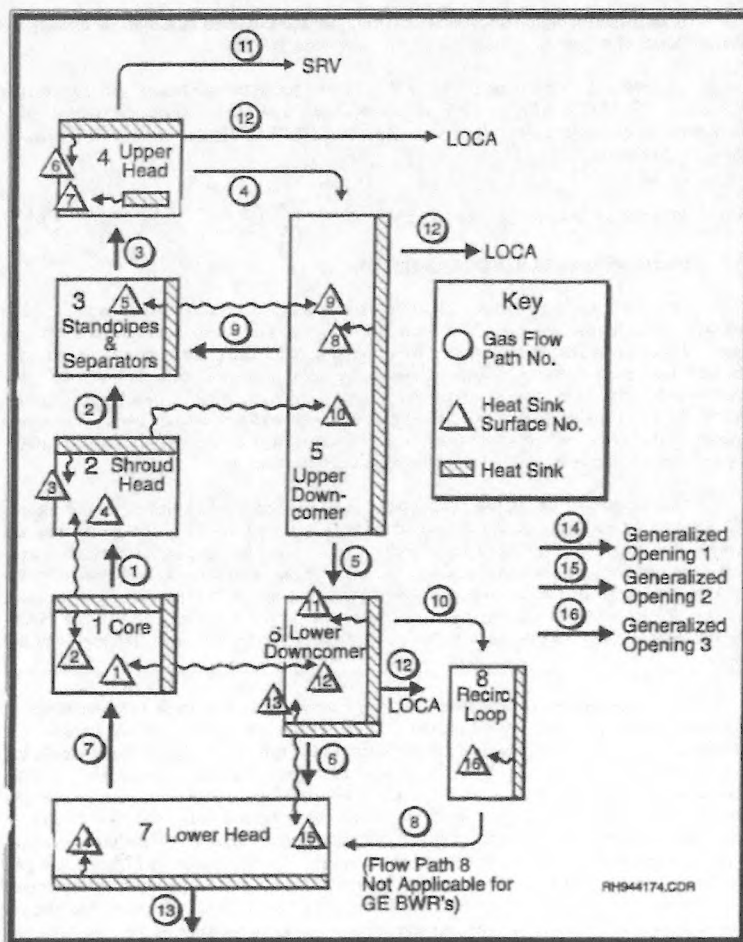
3.2.1.1.D In using MAAP4, the licensee must identify and justify the subset of key modeling parameters cited from Tables 4-1 through 4-6 of the "MAAP4 Application Guidance, Desktop Reference for Using MAAP4 Software, Revision 2" (Electric Power Research Institute Report 1 020236). *This should include response at a plant-specific level regarding specific coding options and parameter choices for key models that would be expected to substantially affect the ELAP analysis performed for that licensee's plant. Although some suggested key phenomena are identified below, other parameters considered important in the simulation of the ELAP event by the vendor / licensee should also be included.*

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- a. Nodalization
- b. General two-phase flow modeling
- c. Modeling of heat transfer and losses
- d. Choked flow
- e. Vent line pressure losses
- f. Decay heat (fission products / actinides / etc.)

Response:

- a. The reactor vessel nodalization is fixed by the MAAP code and cannot be altered by the user, with the exception of the detailed core nodalization. The Quad Cities MAAP 4.0.5 parameter file divides the core region into 5 equal volume radial regions (See NCHAN) and 13 axial regions (See NAXNOD). The axial nodalization represents 25 equal-sized fueled nodes (see NROWS), 1 unfueled node at the top (see NNFT), and 2 unfueled nodes at the bottom (see NNFB). The figure below, taken from the MAAP Users Manual, illustrates the vessel nodalization scheme.

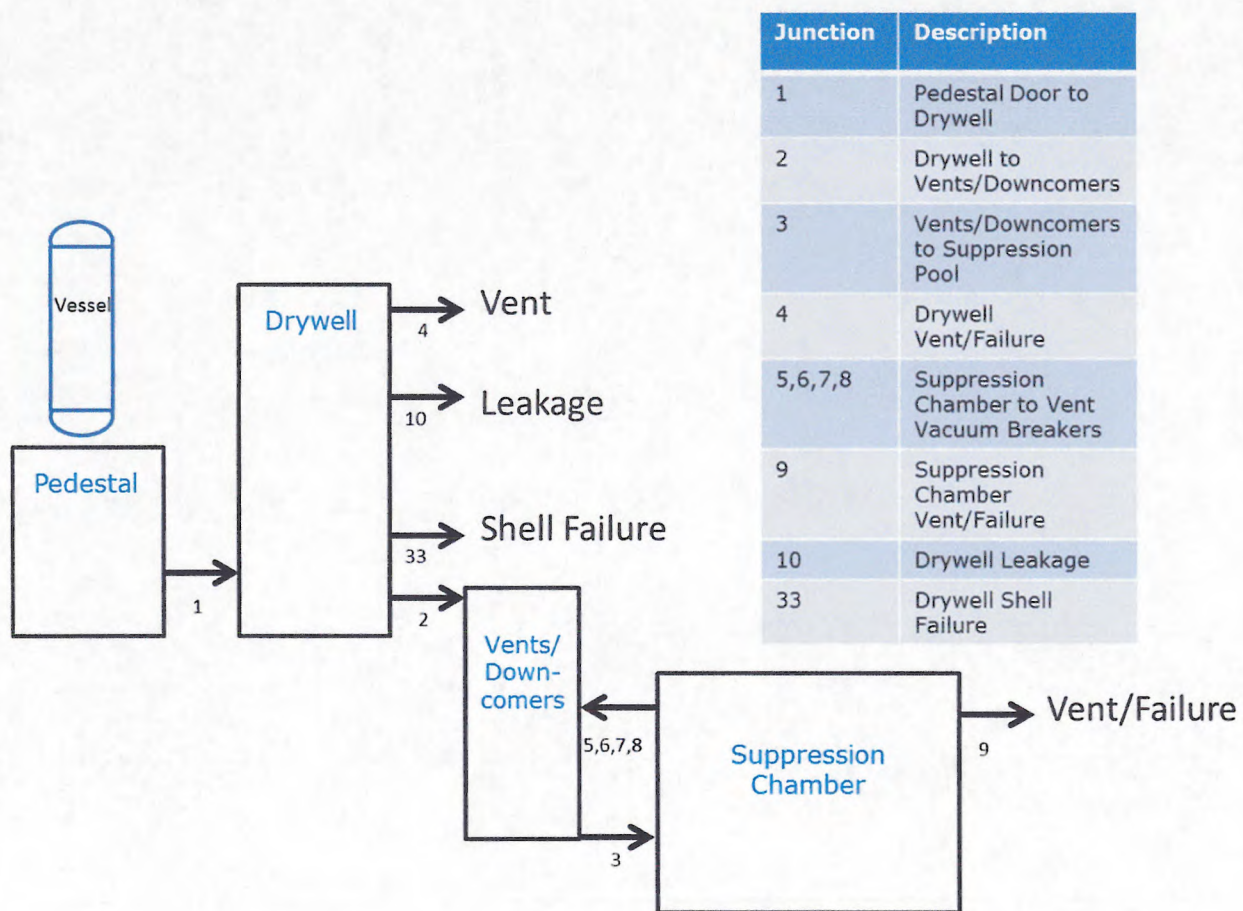


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Containment nodalization is defined by the user. The standard nodalization scheme is used in the Quad Cities MAAP 4.0.5 parameter file and represents the following individual compartments:

1. Reactor pedestal region
2. Drywell
3. Drywell vents to torus
4. Torus (Wetwell)

The figure below illustrates the Quad Cities containment nodalization along with an identification of containment flow junctions.



- b. General two-phase flow from the reactor vessel is described in the EPRI BWR Roadmap. In the case of the scenario outlined in the integrated plan, flow can exit the RPV via the open SRV(s) and from the assumed recirculation pump seal leakage. Flow from SRV will be single-phase steam and flow from the recirc pump seal or other RPV leakage will be single-phase liquid due to the location of the break low in the RPV with RPV level continued to be maintain above TAF. Upon exiting the RPV, the seal leakage will flash a portion of the flow to steam based on saturated conditions in the drywell, creating a steam source and a liquid water source to the drywell. As described in the BWR Roadmap (EPRI Product ID [3002002749](#)) there are two parameters that can

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influence the two-phase level on the RPV. The following table confirms that the parameter values match the recommended values as outlined in the roadmap.

Parameter Name	Value Used in the Quad Cities MAAP Analysis	EPRI Recommended Value
FCO	1.5248	1.5248
FCHTUR	1.53	1.53

- c. Modeling of heat transfer and losses from the RPV are described in the EPRI BWR Roadmap. The parameters that control these processes, as defined in the Roadmap, are provided below with the values selected to represent Quad Cities.

Parameter Name	Value Used in the Quad Cities MAAP Analysis	Comment
QC0 – not-thru-insulation heat transfer from RPV during normal operation.	3.90E6 BTU/hr	Plant specific value based on drywell heat removal to coolers during normal operation. Typical values range between 1-2 MW (3.4E6 to 6.8E6 BTU/hr).
FINPLT – number of plates in reflective insulation	8.0	Plant-specific value
XTINS – average reflective insulation thickness	0.2975 ft	Plant-specific value

At the request of the NRC, the following information, as used in the MAAP analysis, is provided.

Parameter Definition	Parameter Name in MAAP	Value Used in the Quad Cities MAAP Analysis
Power level, MWth	QCRO	2957 MWth
Initial CST water volume, gal	VCST0 (ft ³)	345,977 gal
Initial CST water temperature, F	HCST (enthalpy)	95°F
Initial suppression pool water mass, lbm	Calculated from input	6,908,000 lbm
Initial suppression pool water	XWRB0(i), where i is node	14.0 ft

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level, ft	number for wetwell	
Initial suppression pool water temperature, F	TWRB0(i), where i is node number for wetwell	92.5°F
Drywell free volume, ft ³	VOLRB(i), where I is node number for drywell	145,767 ft ³
Wetwell free volume, ft ³	VOLRB(i) – volume of suppression pool water from initial pool mass	236,000 ft ³
Containment vent pressure, psia	Refer to MAAP analysis document	25 psia
RCIC max flow rate, gpm	WVRCIC	400 gpm
Max FLEX pump flow rate, gpm	Refer to MAAP analysis document	88.5 gpm (into the suppression pool from 14.7 – 150 psia)
Lowest set SRV flow rate, lb/hr	Derived from SRV area, ASRV	558,000 lb/hr
Lowest set SRV pressure, psia	PSETRV	1115.7 psia
Recirc pump seal leakage, gpm	Value that was used to define LOCA area, ALOCA	36 (18 gpm per pump)
Total leakage used in the transient, gpm	Value that was used to define LOCA area, ALOCA	42 gpm

- d. Choked flow from the SRV and the recirculation pump seal leakage is discussed in the EPRI BWR Roadmap. The parameters identified that impact the flow calculation are listed below with input values identified.

Parameter Name	Value Used in the Quad Cities MAAP Analysis	EPRI Recommended Value
ASRV – effective flow area for relief valve	0.0639 ft ² (based on rated flow at pressure)	Plant-specific value
ALOCA – seal leakage area	5.8E-4 ft ² (38 gpm at normal conditions)	Plant-specific value
FCDBRK – discharge coefficient for seal leakage	0.75	0.75

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- e. Vent line pressure loss can be represented in two ways. The actual piping flow area can be input along with a discharge coefficient (FCDJ). An alternative method would be to calculate the effective flow area given the estimated piping losses, and input a loss coefficient of 1.0. For the Quad Cities analysis, the vent area is input based on a 12" diameter pipe and a discharge coefficient of 0.5 was selected.
- f. Decay heat in MAAP is discussed in the EPRI BWR Roadmap (EPRI Product ID [3002002749](#)). Input parameters used to compute the decay heat are identified in the roadmap and are listed in the following table along with their values used in the Quad Cities analysis.

Parameter Name	Value Used in the Quad Cities MAAP Analysis	EPRI Recommended Value
FENRCH – normal fuel enrichment	0.0408	Plant-specific value
EXPO – average exposure	20000 MW-day/ton	Plant-specific value
FCR – total capture rate of U-238 / total absorption rate	0.324	Plant-specific value
FFAF – total absorption rate / total fission rate	2.37	Plant-specific value
FQFR1 – fraction of fission power due to U-235 and PU-241	0.476	Plant-specific value
FQFR2 – fraction of fission power due to PU-239	0.437	Plant-specific value
FQFR3 – fraction of fission power due to U-238	0.087	Plant-specific value
TIRRAD – average effective irradiation time for entire core	26280 hours	Plant-specific value

3.2.1.1.E The specific MAAP4 analysis case that was used to validate the timing of mitigating strategies in the integrated plan must be identified and available on the Portal for NRC staff to view. Alternately, a comparable level of information may be included in the supplemental response.

Response:

The MAAP analysis performed in support of the Quad Cities Integrated Plan is documented in calculation QC-MISC-013 Rev. 2. This analysis is still in progress. The analysis will be made available to the NRC when it has been approved by the site. Case 6 was the specific MAAP run selected to represent the scenario as described in Attachment 1A of the integrated plan.