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JUN 2 6 2018

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

10 CFR 2.202

SUSQUEHANNA STEAM ELECTRIC STATION REPORT OF FULL COMPLIANCE WITH MARCH 12, 2012 COMMISSION ORDER MODIFYING LICENSES WITH REGARD TO REQUIREMENTS FOR MITIGATION STRATEGIES FOR BEYOND-DESIGN-BASIS EXTERNAL EVENTS (NRC ORDER EA-12-049)
PLA-7710

Docket No. 50-387 and No. 50-388

References:

1. *NRC Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," dated March 12, 2012*
2. *PPL Letter (PLA-6981), "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 (NRC Order EA-12-049)," dated February 28, 2013*
3. *NRC Letter from E. J. Leeds to T. S. Rausch, "Susquehanna Steam Electric 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*

On March 12, 2012, the Nuclear Regulatory Commission ("NRC" or "Commission") issued NRC Order Number EA-12-049 (Reference 1) to Susquehanna Nuclear, LLC (Susquehanna). EA-12-049 was immediately effective and directed Susquehanna 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. Susquehanna's initial mitigation strategy for compliance with EA-12-049 was submitted pursuant to Section IV, Condition C.1, in an Overall Integrated Plan (Reference 2). Susquehanna submitted status updates at six-month intervals following submittal of Reference 2 pursuant to Section IV, Condition C.2 of EA-12-049.

The purpose of this letter is to provide Susquehanna's report of full compliance with EA-12-049 pursuant to Section IV, Condition C.3 of EA-12-049. The Attachment provides a summary of EA-12-049 compliance. The Enclosure contains the Final Integrated Plan which provides the mitigation strategies to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities in the event of a beyond-design-basis external event. The timing of this report of full compliance with EA-12-049 is consistent with the schedule relaxation approved by the NRC in Reference 3. This submittal ends the need for six-month updates.

This letter contains no new or revised regulatory commitments.

If you have any questions regarding this report, please contact Mr. Jason Jennings, Manager – Nuclear Regulatory Affairs, at (570) 542-3155.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on: 6/26/2018

T. S. Rausch

Attachment: Summary of Compliance with NRC Order EA-12-049
Enclosure: Final Integrated Plan to Comply with NRC Order EA-12-049

Copy: NRC Region I
Ms. L. H. Micewski, NRC Sr. Resident Inspector
Ms. T. Hood, NRC Project Manager
Mr. B. Holian, NRR Director
Mr. M. Shields, PA DEP/BRP

Attachment to PLA-7710

Summary of Compliance with NRC Order EA-12-049

Summary of Compliance with Order EA-12-049

On March 12, 2012, the NRC issued Order EA-12-049 (Reference 1), Issuance of Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (BDBEEs). This Order was effective immediately and directed sites to develop and implement strategies and guidance to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities in the event of a BDBEE.

Susquehanna Steam Electric Station (SSES) submitted an Overall Integrated Plan (OIP) on February 28, 2013 (Reference 6). By letter dated August 28, 2013 (Reference 10), the NRC provided notification of its intent to perform audits of licensee response to EA-12-049. By letter dated January 24, 2014 (Reference 11), the NRC provided the interim staff evaluation for SSES. The NRC performed the Mitigation Strategies and Spent Fuel Pool Level Instrumentation Audit at SSES the week of December 08, 2014. During the Audit Exit meeting the NRC considered all Mitigation Strategies related items to be closed. The NRC's Audit Report dated April 13, 2015 (Reference 19) documented the closure status of the Mitigation Strategies issues.

SSES developed a Final Integrated Plan (FIP) (Enclosure), documenting the diverse and flexible (FLEX) strategies, in response to NRC Order EA-12-049. The information provided herein documents full compliance with EA-12-049.

The following table contains milestones completed since the issuance of the EA-12-049.

Milestone	Completion Date
Submit 60 Day Status Report	October 2012
Submit Overall Integrated Plan	February 2013
Submit Six-Month Updates:	
Report 1	August 2013
Report 2	February 2014
Report 3	August 2014
Report 4	February 2015
Report 5	August 2015
Report 6	February 2016
Report 7	August 2016
Report 8	February 2017
Report 9	August 2017
Report 10	February 2018
FLEX Strategy Evaluation Unit 2	May 2015
FLEX Strategy Evaluation Unit 1	April 2016
Validation by Walk-throughs or Demonstration(s):	
Walk-throughs or Demonstrations Unit 2	May 2015
Walk-throughs or Demonstrations Unit 1	April 2016
Perform Staffing Analysis	October 2014
Modifications:	
Modifications Evaluation	August 2015
Unit 2 Design Engineering Issue Unit 2 Design Change Documents (All Phases)	June 2014

Milestone	Completion Date
Unit 2 Implementation Outage	May 2015
Unit 1 Design Engineering - Issue Unit 1 Design Change Documents (All Phases)	August 2015
Unit 1 Implementation Outage	March 2016
Storage:	
Storage Design Engineering	May 2014
Storage Implementation - Equipment storage (reasonable protection) ready for operation with required FLEX equipment available for use	May 2015
FLEX Equipment:	
Procure On-Site Equipment	May 2015
Contract with Vendor for National SAFER Response Center (NSRCs) established	March 2013
Develop Strategies with NSRC	February 2015
Establish offsite staging location [Install Off-Site Delivery Station (if Necessary)]	May 2015
National SAFER Response Centers in service for Susquehanna	February 2015
Procedures:	
BWROG issue Emergency Procedure and Severe Accident Guidelines (EPGs/SAGs) Rev. 3	February 2013
Procedures Complete Unit 2 FLEX Implementation (including FSGs and maintenance, except for HCVS per Reference 14)	May 2015
Procedures Complete Unit 1 FLEX Implementation (including FSGs and maintenance, except for HCVS per Reference 14)	April 2016
Training:	
Develop Training Plan	May 2014
Training Complete	April 2016
Unit 2 FLEX Implementation, except for HCVS per Reference 14	May 2015
Unit 1 FLEX Implementation, except for HCVS per Reference 14	April 2016
Full Site FLEX Implementation, except for HCVS per Reference 14	April 2016
Unit 2 Severe Accident Capable Hardened Containment Vent System Phase 1	April 2017
Unit 1 Severe Accident Capable Hardened Containment Vent System Phase 1	April 2018
Unit 1 Severe Accident Capable Hardened Containment Vent System Phase 2	April 2018
Unit 2 Severe Accident Capable Hardened Containment Vent System Phase 2	April 2018

Order EA-12-049 Compliance Elements Summary

The elements identified below are included in the SSES FIP (Enclosure) and demonstrate compliance with Order EA-12-049.

Strategies – Complete

SSES strategies are in compliance with Order EA-12-049 and are documented in the FIP.

Staffing - Complete

The staffing assessment for SSES has been completed in accordance with 10 CFR 50.54(f), "Request for Information Pursuant to Title 10 of the Code of Federal Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force review of Insights from the Fukushima Dai-ichi Accident," Recommendation 9.3, dated March 12, 2012 (Reference 2). SSES submitted the Phase 2 staffing assessment in response to the 50.54(f) letter on October 24, 2014 (Reference 16) and February 04, 2015 (Reference 17).

Modifications – Complete

The modifications required to support the diverse and flexible strategies (FLEX) strategies documented in the FIP for SSES have been implemented in accordance with the station design control process.

Equipment – Procured and Maintenance & Testing – Complete

The equipment required to implement the FLEX strategies for SSES was procured in accordance with Nuclear Energy Institute (NEI) 12-06, Sections 11.1, Quality Attributes and 11.2, Equipment Design. This equipment was initially tested and performance was verified in accordance with NEI 12-06, Section 11.5, Maintenance and Testing, and is available for use.

As discussed in the FIP, maintenance and testing is conducted using the SSES preventive maintenance program such that equipment reliability is achieved.

Protected Storage – Complete

The storage facilities required to implement the FLEX strategies for SSES have been completed and provide protection from the applicable site hazards, as discussed in the FIP. The equipment required to implement the FLEX strategies for SSES is stored in its protected configurations.

Procedures – Complete

FLEX Support Guidelines (FSGs) for SSES have been developed and integrated with existing procedures. The FSGs and other procedures have been validated and issued for use in accordance with the site procedure control program. Susquehanna FSGs are located in procedure type Damage Control (DC).

Training – Complete

Initial compliance training has been completed in accordance with an accepted training process as recommended in NEI 12-06, Section 11.6, Training.

National SAFER Response Centers - Complete
SSES has established a contract with the Pooled Equipment Inventory Company (PEICo) and has joined the Strategic Alliance for FLEX Emergency Response (SAFER) Team Equipment Committee for offsite facility coordination. PEICo is ready to support SSES with Phase 3 equipment stored in the National SAFER Response Centers in accordance with the site specific SAFER Response Plan.

Validation - Complete

SSES has completed validation testing of the FLEX strategies in accordance with industry developed guidance. The validations assure that required tasks, manual actions, and decisions for FLEX strategies may be executed within the constraints identified in the OIP/FIP for Order EA-12-049.

FLEX Program Document – Established

The SSES FLEX Program Document has been developed and issued in accordance with the requirements of NEI 12-06.

References:

The following references represent correspondence related to EA-12-049 since issuance of this order until the submittal of the final six-month update.

1. NRC Order EA-12-049, “Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events,” dated March 12, 2012.
2. NRC Letter, “Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident,” date March 12, 2012 (ML12053A340).
3. NEI 12-06, “Diverse and Flexible Coping Strategies (FLEX) Implementation Guide,” Revision 0, dated August 2012.
4. 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 (ML12229A174).
5. PPL Letter (PLA-6923), “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 29, 2012 (ML12305A289).
6. PPL Letter (PLA-6981), “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 (NRC Order EA-12-049),” dated February 28, 2013 (ML13060A357).
7. NRC Order EA-13-109, “Order to Modify Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation under Severe Accident Conditions,” dated June 06, 2013.
8. PPL Letter (PLA-7072), “Request for Implementation Date Relief in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (NRC Order EA-12-049),” dated August 26, 2013 (ML13239A360).
9. PPL Letter (PLA-7071), “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 26, 2013 (ML13240A214).
10. NRC Letter to SSES, “Nuclear Regulatory Commission Audits of Licensee Responses to Mitigation Strategies Order EA-12-049,” dated August 28, 2013 (ML13234A503).
11. NRC Letter from J. S. Bowen to T. S. Rausch, “Susquehanna Steam Electric Station, Units 1 and 2- Interim Staff Evaluation Relating to Overall Integrated Plan in Response to Order EA-12-049 (Mitigation Strategies) (TAC NOS. MF0888 and MF0889),” dated January 24, 2014 (ML13339A764).
12. PPL Letter (PLA-7134), “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 20, 2014 (ML14052A0254).
13. PPL Letter (PLA-7137), “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 (NRC Order EA-12-049),” dated February 28, 2014 (ML14062A061).
14. NRC Letter from E. J. Leeds to T. S. Rausch, “Susquehanna Steam Electric 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 (ML14065A028).

15. PPL Letter (PLA-7204), "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 (NRC Order EA-12-049)," dated August 28, 2014 (ML14251A231).

16. PPL Letter (PLA-7246), "Susquehanna Steam Electric Station Response to March 12, 2012, Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendation of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident, Enclosure 5, Recommendation 9.3, Emergency Preparedness-Staffing, Requested Information on Items 1, 2, and 6- Phase 2 Staffing Assessment," dated October 24, 2014 (ML14297A543).

17. PPL Letter (PLA-7283), "Susquehanna Steam Electric Station Revision 1 to Fukushima Phase 2 Staffing Assessment," dated February 04, 2015 (ML15036A040).

18. PPL Letter (PLA-7295), "Fourth 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 (NRC Order EA-12-049)," dated February 25, 2015 (ML15057A228).

19. NRC Letter from John D. Hughey to T. S. Rausch, "Susquehanna Steam Electric Station, Units 1 and 2 – Report for the Audit Regarding Implementation of Mitigating Strategies and Reliable Spent Fuel Pool Instrumentation Related to Orders EA-12-049 and EA-12-12-051 (TAC NOS. MF0888, MF0889, MF0890 and MF0891)" dated April 13, 2015 (ML15089A123).

20. NRC Letter from M. K. Halter to T.S. Rausch, "Susquehanna Steam Electric Station, Units 1 and 2 – Response Regarding Phase 2 Staffing Submittals Associated with Near-Term Task Force Recommendation 9.3 Related to the Fukushima Dai-ichi Nuclear Power Plant Accident (TAC NOS. MF5139 and MF5140)," dated May 05, 2015 (ML15092A897).

21. Talen Letter (PLA-7377), "Fifth 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 (NRC Order EA-12-049)," dated August 26, 2015 (ML15238B576).

22. Talen Letter (PLA-7438), "Sixth 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 (NRC Order EA-12-049)," dated February 18, 2016 (ML16050A046).

23. Talen Letter (PLA-7513), "Seventh 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 (NRC Order EA-12-049)," dated August 19, 2016 (ML16239A011).

24. Talen Letter (PLA-7570), "Eighth 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 (NRC Order EA-12-049)," dated February 09, 2017.

25. Talen Letter (PLA-7610), "Report of Full Compliance for Unit 2 With March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (NRC Order EA-12-049)," dated May 31, 2017 (ML17151A292).

26. Talen Letter (PLA-7632), "Ninth 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 (NRC Order EA-12-049)," dated August 22, 2017 (ML17237A055).

27. Talen Letter (PLA-7669), "Tenth 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 (NRC Order EA-12-049)," dated February 21, 2018 (ML18053A774).

Enclosure to PLA-7710

Final Integrated Plan to Comply with NRC Order EA-12-049

Susquehanna Steam Electric Station

Units 1 and 2

Mitigation Strategies for Beyond Design Basis External Events (FLEX Strategies)

Final Integrated Plan

to comply with

U.S. Nuclear Regulatory Commission

Order EA-12-049

Rev. 0

June 2018

The Susquehanna Steam Electric Station Units 1 and 2 Mitigation Strategies for Beyond Design Basis External Events (FLEX Strategies) Final Integrated Plan was reviewed and approved using the NDAP-QA-0101 process.

Title	Name	Signature	Date
Preparer	John Emmett	John H. Emmett	5/30/18
Reviewer	Kevin Daly	Per NDAP-QA-0101 form on File	06/06/18
Reviewer	Jeffery Dills	Per NDAP-QA-0101 form on File	06/11/18
Reviewer	Ken Klass	Per NDAP-QA-0101 form on File	06/01/18
Final Review/QADR	Patrick Gilligan	Patrick M. Gilligan	06/20/18
Approve	James Gorman	James A. Gorman	06/21/18

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1. Background

In 2011, an earthquake-induced tsunami caused Beyond-Design-Basis (BDB) flooding at the Fukushima Dai-ichi Nuclear Power Station in Japan. The earthquake and flooding caused the emergency power supplies and electrical distribution systems to be inoperable, resulting in an extended loss of alternating current (AC) power (ELAP) in five of the six units on the site. The ELAP led to (1) the loss of core cooling, (2) loss of spent fuel pool cooling capabilities, and (3) a significant challenge to maintaining containment integrity on four of the units. All direct current (DC) power was lost early in the event on Units 1 and 2 and after some period of time at the other units. Core damage occurred in three of the units along with a loss of containment integrity resulting in a release of radioactive material to the surrounding environment.

The United States (US) Nuclear Regulatory Commission (NRC) assembled a Near-Term Task Force (NTTF) to advise the Commission on actions the US nuclear industry should take to preclude core damage and a release of radioactive material after a natural disaster such as that seen at Fukushima. The NTTF report (Reference 3.1) contained many recommendations to fulfill this charter, including assessing extreme external event hazards and strengthening station capabilities for responding to Beyond-Design-Basis External Events (BDBEEs).

Based on NTTF Recommendation 4.2, the NRC issued Order Enforcement Action EA-12-049 (Reference 3.2) on March 12, 2012 to implement mitigation strategies for BDBEEs. The order provided the following requirements for strategies to mitigate BDBEEs:

1. Licensees shall develop, implement, and maintain guidance and strategies to maintain or restore core cooling, containment integrity, and spent fuel pool (SFP) cooling capabilities following a BDBEE.

2. These strategies must be capable of mitigating a simultaneous loss of all alternating current (ac) power and loss of normal access to the ultimate heat sink and have adequate capacity to address challenges to core cooling, containment integrity and SFP cooling capabilities at all units on a site subject to the Order.

3. Licensees must provide reasonable protection for the associated equipment from external events. Such protection must demonstrate that there is adequate capacity to address challenges to core cooling, containment integrity and SFP cooling capabilities at all units on a site subject to the Order.

4. Licensees must be capable of implementing the strategies in all MODES.

5. Full compliance shall include procedures, guidance, training, and acquisition, staging or installing of equipment needed for the strategies.

The order specifies a three-phase approach for strategies to mitigate BDBEEs:

- Phase 1 - The initial phase requires the use of installed equipment and resources to maintain or restore core cooling, containment integrity and SFP cooling capabilities.

- Phase 2 - The transition phase requires providing sufficient, portable, on-site equipment and consumables to maintain or restore these functions until they can be accomplished with resources brought from off site.

- Phase 3 - The final phase requires obtaining sufficient off-site resources to sustain those functions indefinitely.

NRC Order EA-12-049 (Reference 3.2) required licensees of operating reactors to submit an overall integrated plan by February 28, 2013, that included a description of how compliance with these requirements would be achieved. The Order also required licensees to complete implementation of the requirements no later than two refueling cycles after submittal of the overall integrated plan or December 31, 2016, whichever comes first. The NRC approved the relaxation of these completion dates for Susquehanna due to the NRC required installation of Severe Accident Capable Hardened Containment Vent Systems (Reference 3.8). The revised due dates were the completion of the spring 2017 refueling outage for Unit 2 and the spring 2018 refueling outage for Unit 1. These revised due dates were met and Susquehanna was in full compliance with NRC Order EA-12-049 on April 30, 2018.

The Nuclear Energy Institute (NEI) developed NEI 12-06 (Reference 3.3), which provides guidelines for nuclear stations to assess extreme external event hazards and implement the mitigation strategies specified in NRC Order EA-12-049. The NRC issued Japan Lessons Learned Interim Staff Guidance JLD-ISG-2012-01 (Reference 3.4), dated August 29, 2012, which endorsed NEI 12-06 Rev. 0 with clarifications on determining baseline coping capability and equipment quality.

NRC Order EA-12-051 (Reference 3.5), which the NRC issued coincident with EA-12-049, required licensees to install reliable SFP instrumentation with specific design features for monitoring SFP water level. This order was prompted by NTTF Recommendation 7.1 (Reference 3.1).

NEI 12-02 (Reference 3.6) provided guidance for compliance with Order EA-12-051. The NRC determined that, with the exceptions and clarifications provided in

JLD-ISG-2012-03 (Reference 3.7), conformance with the guidance in NEI 12-02 is an acceptable method for satisfying the requirements in Order EA-12-051. Susquehanna's compliance with Order EA-12-051 for "Reliable Spent Fuel Pool Instrumentation" is documented in Reference 3.99.

This Final Integrated Plan (FIP) addresses Susquehanna's complete compliance with NRC Order EA-12-049, *Mitigation Strategies* (Reference 3.2). Susquehanna Unit 2 has been in compliance with Order EA-12-049 since completion of the Unit 2 Spring 2017 Refueling Outage per Reference 3.102.

2. NRC Order EA-12-049 – Mitigation Strategies (FLEX)

2.1 General Elements

2.1.1 Conformance to NEI 12-06

Susquehanna Steam Electric Station (SSES) has developed its FLEX strategies to conform with NEI 12-06, Revision 0 (Reference 3.3), with no exceptions.

2.1.2 General Criteria and Baseline Assumptions

The assumptions used for the evaluations of a Susquehanna ELAP / Loss of normal access to the Ultimate Heat Sink (LUHS) event and the development of diverse and flexible coping strategies (FLEX) are stated below.

The flooding and seismic re-evaluations required by the 10 CFR 50.54(f) letter of March 12, 2012 (Reference 3.13) were not completed when the original Overall Integrated Plan was developed and therefore no impacts from the re-evaluations were assumed in the original submittal. The Flooding and Seismic re-evaluations (Mitigation Strategy Assessments – MSAs) were completed with no issues affecting the strategies being identified. Refer to PLA-7559 (Reference 3.63) for the Flooding MSA and PLA-7551 (Reference 3.51) for the Seismic MSA, both of which were submitted in December 2016.

Key assumptions associated with implementation of FLEX for SSES are described below:

- The assumptions listed in NEI 12-06, Rev. 0, Section 3.2.1, General Criteria and Baseline Assumptions, are applicable to SSES.

- The applicable Boiling Water Reactor (BWR) criteria and initial plant conditions listed in NEI 12-06, Revision 0 (Reference 3.3), Sections 3.2.1.1 - 3.2.1.6, are applicable to SSES without exception.
- BDBEE hazards, when referred to in this document, are the applicable hazards from NEI 12-06, Revision 0. The applicable hazards for Susquehanna are described in Section 2.7 of this document.
- Additional staff resources are expected to begin arriving at 6 hours and the site will be fully staffed 24 hours after the event (Reference 3.88).

Boundary conditions consistent with NEI 12-06, Section 3.2.1, *General Criteria and Baseline Assumptions,* are established to support development of FLEX strategies, as follows:

– The BDB external event occurs impacting both units at the site.

– Both reactors are initially operating at full power, unless there are procedural requirements to shut down due to an impending event. The reactors have been operating at 100% power for the past 100 days.

– Each reactor is successfully shut down when required (i.e., all rods inserted, no ATWS).

– Onsite staff is at site administrative minimum shift staffing levels.

– No independent, concurrent events, e.g., no active security threat.

– All personnel onsite are available to support site response.

– The reactor and supporting plant equipment are either operating within normal ranges for pressure, temperature and water level, or available to operate, at the time of the event consistent with the design and licensing basis.

The following plant initial conditions and assumptions are established for the purpose of defining FLEX strategies and are consistent with NEI 12-06, Section 3.2.1, *General Criteria and Baseline Assumptions:*

– No specific initiating event is used. The initial condition is assumed to be a loss of offsite power (LOOP) with installed sources of emergency onsite AC power and station blackout (SBO) alternate AC power sources unavailable with no prospect for recovery.

- Cooling and makeup water inventories contained in systems or structures with designs that are robust with respect to seismic events, floods, and high winds and associated missiles are available. Permanent plant equipment that is contained in structures with designs that are robust with respect to seismic events, floods, and high winds and associated missiles, are available.
- Normal access to the ultimate heat sink is lost, but the water inventory in the ultimate heat sink (UHS) remains available and robust piping connecting the UHS to plant systems remains intact. The motive force for UHS flow, i.e., pumps, is assumed to be lost with no prospect for recovery.
- In general, all systems and components credited in the Mitigation Strategy Phase 1 plan are located in safety-related, seismic category 1 buildings, such as the Reactor Buildings, ESSW pump house, Diesel Generator (DG) buildings and are not subject to postulated severe weather external events such as hurricanes, tornados, and intense precipitation that may result in an ELAP. The building walls and penetrations are designed to prevent intrusion of water in these safety-related structures during postulated external flooding events.
- Fuel for BDB equipment stored in structures with designs that are robust with respect to seismic events, floods and high winds and associated missiles, remains available.
- Installed Class 1E electrical distribution systems (AC and DC), including DC batteries, inverters, and battery chargers, remain available since they are protected.

The following conditions exist for Susquehanna's baseline case:

- Seismically designed DC battery banks are available.
- Seismically designed AC and DC distribution equipment and systems are available.
- Plant initial response is the same as Station Blackout (SBO).

- Best estimate analysis and decay heat is used to establish operator time and action.

- No single failure of a SSC was assumed. Therefore, the Reactor Core Isolation Cooling (RCIC) will perform.

- Although the High Pressure Coolant Injection (HPCI) system is technically available, it is not credited for the baseline case, since it cannot be manually initiated locally, as required by NEI 12-06, Table C-1.

- Level switches are seismically mounted on the Condensate Storage tank (CST), which are designed to initiate a suction transfer from the CST to the Suppression pool on low CST level to support RCIC operation. The CST is not designed to withstand all ELAP events, since the CST is not missile protected and is not a fully qualified seismic structure. Consequently, the CST is not credited in the mitigation strategy plan. It is postulated that the CST fails during an ELAP event. Should the CST fail, the level switches would initiate the suction transfer from the CST to the suppression pool to support RCIC operation. If the level switches failed to initiate the suction transfer (for whatever reason), the suction transfer could be manually initiated from the Main Control Room (MCR).

- No additional accidents, events, or failures are assumed to occur immediately prior to or during the event, including security events.

- Reactor coolant inventory loss consists of unidentified leakage at the upper limit of Technical Specifications, reactor coolant system letdown flow (until isolated), and reactor recirculation pump seal leak-off at normal maximum rate.

- For the spent fuel pool, the heat load is assumed to be the maximum design basis heat load. In addition, inventory loss from sloshing during a seismic event does not preclude access to the pool area.

Additionally, key assumptions associated with implementation of FLEX strategies are as follows:

- Exceptions for the site security plan or other requirements of 10 CFR may be required.

- Deployment resources are assumed to begin arriving at hour 6 and unlimited resources available after 24 hours.

- This plan defines strategies capable of mitigating a simultaneous loss of all alternating current (AC) power and loss of normal access to the ultimate heat sink resulting from a BDB external event by providing adequate capability to maintain or restore core cooling, containment, and spent fuel pool (SFP) cooling capabilities at all units on a site. Though specific strategies have been developed, due to the inability to anticipate all possible scenarios, the strategies are also diverse and flexible to encompass a wide range of possible conditions to protect the public health and safety. Each unit's Emergency Operating Procedures (EOPs) have been revised, in accordance with established EOP change processes, to clearly reference and identify appropriate entry and exit conditions for these pre-planned strategies. The EOPs retain overall command and control of the actions responding to a BDB external event. Also, the impact of these strategies on the design basis capabilities of the unit have been evaluated under 10 CFR 50.59.

- Susquehanna's Technical Specifications contain the limiting conditions for normal unit operations to ensure that design safety features are available to respond to a design basis accident and direct the required actions to be taken when the limiting conditions are not met. The result of the BDB external event may place the plant in a condition where it cannot comply with certain Technical Specifications and/or with its Security Plan, and, as such, may warrant invocation of 10 CFR 50.54(x) and/or 10 CFR 73.55(p). This position is consistent with the previously documented *Task Interface Agreement (TIA) 2004-04, Acceptability of Proceduralized Departures from Technical Specifications (TSs) Requirements at the Surry Power Station, (TAG Nos. MC4331 and MC4332), dated September 12, 2006 (Accession No. ML060590273)* (Reference 3.9).

2.2 Strategies

2.2.1 Objective and Approach

The objective of the FLEX strategies is to establish an indefinite coping capability in order to: 1) prevent damage to the fuel in the reactors, 2) maintain the containment function, and 3) maintain cooling and prevent damage to fuel in the SFP using installed equipment, on-site portable equipment, and off-site resources. This indefinite coping capability will address an ELAP-loss of off-site power, emergency diesel generators and any alternate AC source (as defined in 10 CFR 50.2) with a simultaneous LUHS.

The plant indefinite coping capability is attained through the implementation of pre-determined mitigation strategies (FLEX strategies) that are focused on maintaining or restoring key plant safety functions. The FLEX strategies are not tied to any specific damage state or mechanistic assessment of external events. Rather, the strategies are developed to maintain the key plant safety functions based on the evaluation of plant response to the coincident ELAP / LUHS event. A safety function-based approach provides consistency with, and allows coordination with, existing plant emergency operating procedures (EOPs). FLEX strategies are implemented in support of EOPs using FLEX Support Guidelines (FSGs) that are called Damage Control procedures at Susquehanna.

The strategies for coping with the plant conditions that result from an ELAP simultaneous with a LUHS event involve a three-phase approach:

- Phase 1 – Initially cope by relying on installed plant equipment and on-site resources.
- Phase 2 – Transition from installed plant equipment to on-site FLEX equipment.
- Phase 3 – Obtain additional capability and redundancy from off-site equipment and resources until power, water, and coolant injection systems are restored or commissioned.

The duration of each phase is specific to the installed and portable equipment utilized for the particular FLEX strategy employed to mitigate the plant condition.

The FLEX strategy descriptions below are capable of mitigating an ELAP / LUHS resulting from a BDB external event by providing adequate capability to maintain or restore core cooling, containment, and SFP cooling capabilities for both of the Susquehanna units. Any differences and/or unit specific information is included where appropriate. Though specific strategies have been developed, due to the inability to anticipate all possible scenarios the FLEX strategies are also diverse and flexible enough to encompass a wide range of possible conditions. These pre-planned strategies, which have been developed to protect the public health and safety, are incorporated into the Susquehanna Emergency Operating Procedures (EOPs) in accordance with established EOP change processes, and their impact to the design basis capabilities of the unit evaluated under 10 CFR 50.59.

An overall diagram of the Susquehanna site that applies to the following FLEX strategies and shows the Site Layout, Deployment Routes, and Staging Areas that apply to the FLEX equipment is provided in Figure 1.

2.2.2 Method of Compliance with NRC Order EA-12-049

This section describes how SSES Unit 1 and Unit 2 are in compliance with NRC Order EA-12-049 to mitigate a postulated ELAP / LUHS event.

Core cooling

During Phase 1 installed plant equipment is utilized to mitigate the ELAP / LUHS event. Core decay heat is removed by using the reactor core isolation cooling (RCIC) system. The steam-driven RCIC pump will supply water to the reactor pressure vessel (RPV) from the condensate storage tank (CST), or from the suppression pool when the CST is not available. Steam from the reactor operates the RCIC pump turbine, with the steam exhaust discharging to the suppression pool. Operators will lower RPV pressure by exhausting steam through the safety relief valves (SRVs) to the suppression pool. Pressure will be controlled in a lowered specified band to enable continued RCIC operation.

During Phase 2 and Phase 3 (after RCIC ceases to be able to pump water into the RPV), a portable, diesel-driven FLEX pump will be operated to supply makeup water to the Residual Heat Removal Service Water (RHRSW) system from the UHS (Spray Pond), which will then flow to the Residual Heat Removal (RHR) system to inject water to the reactor vessel via the normal RHR system flow path.

Electrical Supply

Also during Phase 1, the installed plant batteries (125 VDC and 250 VDC) and electrical distribution system will provide power for key equipment and instrumentation. During Phase 2 and Phase 3, portable FLEX generators will be used to provide power to all four divisions of Class 1E 4160 volt alternating current (VAC). This will allow energizing Class 1E battery chargers and selected motor control centers so that power is available to critical loads such as required motor operated valves, necessary DC components and desired instrumentation.

For Phase 3, SSES will utilize the industry National SAFER Response Centers (NSRCs) for the primary supply of Phase 3 equipment. SAFER refers to the Strategic Alliance for FLEX Emergency Response (SAFER). Alternate supplies of equipment also exist and may be utilized during Phase 3 (e.g. – other power plants, commercial entities, etc.).

Containment Cooling

During an ELAP / LUHS, SSES will utilize anticipatory venting via the hardened containment vent system (HCVS) to maintain containment pressure and temperature within acceptable values. Venting is planned to be initiated in sufficient time to allow for continued RCIC operation and to maintain containment pressure below its design value. The venting strategy is consistent with the NRC endorsement of BWR Containment Venting (Anticipatory Venting) (Reference 3.38) via implementation of Boiling Water Reactor Owners Group (BWROG) Emergency Procedure Guideline (EPG)/Severe Accident Guideline (SAG), Revision 3.

Coping strategies using installed plant equipment and portable FLEX equipment can continue for greater than 72 hours. Since no time sensitive Phase 3 actions have been identified, instructions for connection and utilization of NSRC equipment for long term coping or recovery will be provided by Emergency Response Organization (ERO) personnel who will have assessed the condition of the plant and infrastructure, plant accessibility, and additional available off-site resources (both equipment and personnel) following the BDBEE.

Spent Fuel Pools

In the postulated ELAP event, the SFPs will initially heat up due to the unavailability of the normal fuel pool cooling system. During all three

Phases described below, the Spent Fuel Pool water level will be monitored by the Spent Fuel Pool level instruments installed per NRC Order EA-12-051.

During Phase 1, the normal water inventory in the SFPs is used to remove heat from and shield the irradiated fuel.

During Phases 2 and 3, a FLEX pump will be aligned and used to provide water from the Spray Pond through the RHRSW system via a standpipe and then either through portable hoses directly into the pool or through spray nozzles on the refuel floor. In addition, the FLEX pump can be connected to the RHRSW system piping, which can be cross-connected to the seismically qualified RHR system piping in the Reactor Building. The RHR piping provides an emergency fill connection to the SFP cooling system makeup piping. These methods will ensure that a sufficient volume of water remains above the top of the stored fuel assemblies at all times. The long-term strategy for SFP makeup is to continue the strategies described above, including when supplemented by portable equipment delivered from the NSRCs. However, the actions for use of the NSRC equipment are not relied upon in the FLEX strategy during the first 72 hours following an ELAP / LUHS event.

Shutdown and Refueling Modes

The strategy for core cooling for Modes 4 and 5 are, in general, similar to those for Modes 1-3, depending on what equipment is available at the time of the BDBEE. The strategy for containment protection is via the HCVS vent or containment openings during Modes 4 and 5 if containment cannot be closed. Refer to Section 2.17 of this FIP for more detail on shutdown modes. The SFP strategies are the same for Modes 1 through 5.

The specific strategies described in Sections 2.3, 2.4, 2.5 and 2.6 below are capable of mitigating an ELAP / LUHS event resulting from a BDBEE by providing adequate capability to maintain or restore core cooling, containment integrity, and SFP cooling capabilities at SSES. Though specific strategies have been developed, due to the inability to anticipate all possible scenarios, the strategies are also diverse and flexible to encompass a wide range of possible conditions. These pre-planned strategies were developed to protect the public health and safety, and were incorporated into the SSES emergency operating procedures in accordance with established change processes, and their impact to the design basis capabilities of the unit evaluated under 10 CFR 50.59.

2.3 Electric Power

2.3.1 Phase 1 Strategy

Following an ELAP / LUHS event, installed plant batteries (125 VDC and 250 VDC) would provide Main Control Room (MCR) instrumentation and required control features with power supplied from the station batteries. In order to extend battery life for all station blackout (SBO) events, operators are directed to take steps to minimize the load on the station batteries by shedding unnecessary loads in accordance with station procedures. Load shedding of all non-essential loads will be completed within 45 minutes after the start of the event. Battery calculations (References 3.34, 3.35 and 3.36) demonstrate that the minimum duration of battery capacity for the station 125 and 250 VDC is sufficient to provide power to critical loads for at least 8 hours (Table 1). The FLEX generators have been shown to be available within 6 hours from the start of a BDBEE event (Reference 3.94). This electrical power will support operation of RCIC during Phase 1 for Reactor Core Cooling.

The Hardened Containment Vent System (HCVS) has a dedicated battery system that will supply power for at least 24 hours. This electrical power will support operation of the HCVS during Phase 1 for Containment Integrity.

The EA-12-051 Spent Fuel Pool Level Instrument (SFPI) has a dedicated battery system that will supply power for at least 24 hours. This electrical power will support operation of the SFPI during Phase 1 for Spent Fuel Pool Cooling/Inventory.

Communications equipment will utilize dedicated battery capacity and sound-powered phones to allow onsite communications.

2.3.2 Phase 2 Strategy

At least two 4160 VAC FLEX generators will be connected to the 4160 VAC buses providing the ability to power the battery chargers, for the station batteries and supply DC loads at or before 6 hours into the event (time sensitive at 8 hours). The 4160 VAC FLEX generators are sized (Reference 3.37) to power all the 125 and 250 VDC battery chargers, RCIC controls, MCR lighting, RHR motor operated valves (MOVs), and other selected loads (including HCVS and SFPI). The deployment area of the 4160 VAC FLEX generators is shown on Figure 1. Cables from the generators are run via a switchgear trailer to connection boxes installed on the west wall of the “E” Diesel Generator (DG) building to support the FLEX strategies (Figure 2). The alternate strategy consists of powering the four individual 4160 VAC buses directly from the FLEX generators, via temporary cables, to FLEX connections in each of the “A” through “D” DG buildings.

Two 4160 VAC FLEX generators are transported from their protected location and positioned outside the “E” DG. The 4160 VAC FLEX generators are then cross-connected to the eight ESS 4160 VAC Buses, which supply the eight ESS load centers, which are located in the Reactor Buildings (Figure 2). This will re-power all required ESS 480 VAC loads after load shedding and re-powering selected loads to both units. Important AC and DC loads such as 125 VDC battery chargers, RCIC 250 VDC battery chargers, SRV and ADS power, vital instruments, Control Room lighting/cooling, and selected valve power to RHR, RHRSW, Reactor Recirculation, and Core Spray will be re-powered. Cables from the generators are run via a switchgear trailer to a connection point on the exterior of the ‘E’ Diesel Building (Figure 1).

The alternate electrical strategy still transports the two 4160 VAC FLEX generators from their protected location and positions them outside the “E” DG. The 4160 VAC FLEX generators are then connected to the eight ESS 4160 VAC Buses via connections in the ‘A’ through ‘D’ DG buildings (one generator powers buses A and C and the other generator powers buses B and D), which supply the eight ESS load centers, which are located in the Reactor Buildings (Figure 1). This will re-power all required ESS 480 VAC loads after load shedding and re-powering selected loads to both units. Important AC and DC loads such as 125 VDC battery chargers, RCIC 250 VDC battery chargers, SRV and ADS power, vital instruments, Control Room lighting/cooling, and selected valve power to RHR, RHRSW, Reactor Recirculation, and Core Spray will be repowered. Cables from the generators are run to a connection points inside the ‘A’ through ‘D’ Diesel Buildings.

This capability supports the Reactor Core Cooling, Containment Integrity, and Spent Fuel Pool Cooling/Inventory Functions during Phase 2.

2.3.3 Phase 3 Strategy

The long-term strategy is to continue to use 4160 VAC power, supplemented by the NSRC equipment, indefinitely. Additional 4160 VAC generators are available from the NSRC and may be used as desired but are not required for Phase 3 coping strategies. Since no time sensitive Phase 3 actions have been identified, instructions for connection and utilization of NSRC equipment for long term coping or recovery will be provided by ERO personnel who will have assessed the condition of the plant and infrastructure, plant accessibility, and additional available off-site resources (both equipment and personnel) following the BDBEE.

This capability supports the Reactor Core Cooling, Containment Integrity, and Spent Fuel Pool Cooling/Inventory Functions during Phase 3.

2.3.4 Systems, Structures and Components

2.3.4.1 Installed DC Electrical Power

The station 125 and 250 VDC systems for each unit consist of four 125 VDC and two 250 VDC independent and redundant systems. They are comprised of independent switchgear assemblies, battery chargers, and battery banks. These DC systems are credited in the Phase 1 coping strategies to maintain critical instrumentation loads until the battery chargers are repowered by the 4160 VAC FLEX generators. The station 125 and 250 VDC systems provide power to critical instruments, SRVs, RCIC system, and other required DC loads.

The safety-related batteries and associated DC distribution systems are located in the Reactor Buildings and are thus protected from BDBEE hazards (Reference 3.15).

2.3.4.2 HCVS Equipment

As part of FLEX coping strategies, the hardened containment vent systems will be powered through the entire FLEX event (see Section 2.6.4.2). Since the hardened containment vent system line has two containment isolation valves installed in series, both must open to vent containment. These valves' operator solenoids receive power from the permanently installed HCVS batteries. The HCVS battery chargers are powered from Emergency Diesel Generator and FLEX generator backed power supplies.

During an ELAP, DC power from the HCVS batteries will be used to power the HCVS equipment. The HCVS equipment is powered from permanently installed batteries and chargers. Operation of the HCVS valves will normally be controlled from the MCR panels (see Section 2.6.4.2) and can also be operated from the Remote Operating Station (ROS).

2.3.5 FLEX Connections

2.3.5.1 Primary Electrical Connection

BDBEE hazard protected 4160 VAC FLEX connection boxes, and associated conduit and cable connections to safety-related/seismically qualified breakers provide power to all the 4160 VAC and 480 VAC ESS buses from the 4160 VAC FLEX generators following an ELAP resulting from a BDBEE. Connection of the 4160 VAC FLEX generators to ESS buses provides the ability to supply DC loads and power battery chargers which charge the 125 VDC and 250 VDC batteries.

The 4160 VAC FLEX connection boxes, which serve as the primary connection points for the 4160 VAC FLEX generators, are located on the exterior west wall of the ”E” DG building. The connection boxes provide the human factored color coded connections for the 4160 VAC FLEX generators to be safely connected to the system.

The staging area for the 4160 VAC FLEX generators will be outside the east wall of the ”E” DG building.

2.3.5.2 Secondary Electrical Connection

The alternate strategy connects the 4160 VAC FLEX generators output directly to connections in each of the “A” through “D” DG buildings to provide power to the ESS buses.

2.3.6 Electrical Analysis

Battery calculations demonstrate that the limiting trains (1D610 and 1D660) of battery capacity are sufficient to provide power for critical loads for at least 8 hours following a load shed (Reference 3.35). The Class 1E battery duty cycle of 8 hours for SSES was calculated in accordance with the IEEE-485 methodology using manufacturer discharge test data applicable to the licensee's FLEX strategy as outlined in the NEI white paper on *Extended Battery Duty Cycles* (Reference 3.52) as endorsed by the NRC (Reference 3.53). According to Table 1, the minimum time margin between the calculated battery duration for the FLEX strategy and the maximum deployment time for the 4160 VAC FLEX generators to supply the DC loads is approximately 2 hours for SSES. Validation and verification has shown a time margin of greater than 2 hours.

2.3.7 4160 VAC FLEX Generators

The selected FLEX generators have sufficient capacity to supply the Phase 2 loads as determined by the 4160 VAC FLEX generator sizing calculation (Reference 3.37). The FLEX generators are 1 MW electric turbine engine powered diesel fuel consuming portable generators.

2.4 Reactor Core Cooling and Heat Removal Strategy Modes 1-3

Initially, core decay heat is removed by adding water to the RPV and releasing steam from the RPV via the SRVs to the suppression pool. Water will initially be added by the turbine-driven RCIC pump, taking suction from the seismically qualified suppression pool.

During the first hours after shutdown caused by the BDBEE, the reactor remains isolated and pressurized with RCIC providing core cooling, drawing water from the suppression pool. The SRVs are used to control reactor pressure.

The operators are directed to take steps to minimize the load on the station batteries by shedding unnecessary loads in accordance with EOP and FSG procedures; load shedding is completed within 45 minutes after the BDBEE, thus ensuring the limiting station battery trains (1D610 and 1D660) will have at least 8 hours capability and will be available until the FLEX 4160 VAC generators are placed in service at or before six hours into the event.

Using manual control of SRVs, reactor pressure is reduced as necessary to maintain a cooldown rate of < 100°F/hr and to maintain the suppression pool in the acceptable region of the Heat Capacity Temperature Limit (HCTL) curve. The revised reactor pressure band is approximately 150 to 300 psig to allow RCIC to continue operating and facilitate any future reactor depressurization needed to allow FLEX pump injection to the reactor.

At approximately hour five, the use of the HCVS is initiated for anticipatory venting to provide long term core cooling capability thru RCIC and maintain containment parameters within limits.

2.4.1 Phase 1 Strategy

Core Cooling and Heat Removal

Power Operation, Startup, and Hot Shutdown (Modes 1, 2, and 3)

After the initiation of the BDBEE induced ELAP / LUHS, the main steam isolation valves (MSIVs) automatically close, the feedwater system stops operating, and the safety relief valves (SRVs) automatically cycle to control pressure, which causes reactor water level to decrease. When reactor water level reaches -30 inches the Reactor Core Isolation Cooling (RCIC) system automatically starts with suction from the Condensate Storage Tanks (CST) if available, or the Suppression Pool (References 3.19 and References 3.26 through 3.29) and operates to inject makeup water to the reactor vessel. This injection recovers the reactor level to the normal band. The SRVs control reactor pressure (Reference 3.19). If the BDBEE causes damage to the CSTs, and level decreases to the low level setpoint, RCIC suction valves automatically swap from the CST to the suppression pool (Reference 3.19). If the CSTs are seriously damaged or destroyed, there is a potential for the CST level instruments to be impacted such that the RCIC automatic swap to the Suppression Pool may not occur, however, the operators can still manually transfer RCIC suction to the Suppression Pool from the Main Control Room. Procedural guidance currently exists for performing this manual suction transfer for RCIC. RCIC valves and controls are powered by station DC power (Reference 3.15). RCIC provides all makeup flow to the reactor vessel. Within one hour after Operation's determination that the Emergency Diesel Generators (EDGs) cannot be restarted and off-site power is unavailable, the operating crew determines the event is a beyond-design-basis ELAP event (References 3.26 and 3.27). RCIC is maintained feeding the reactor vessel with suction from the Suppression Pool (or CST if available). Additionally, the reactor pressure will be closely monitored.

This is necessary to ensure reactor pressure is not reduced to a pressure, which would prevent operation of RCIC.

As stated above, the primary method of reactor pressure control is by operation of the SRVs. Operator control of reactor pressure, using SRVs, requires DC control power and pneumatic pressure, supplied by station batteries and the drywell pneumatics system (Reference 3.15), to open. For Phase 1, the power for the SRVs is supplied by the station batteries. At event initiation, the normal pneumatic supply is lost due to loss of power; however, the Containment Instrument Gas (CIG) 90 psi system will supply a limited amount of backup pneumatic pressure for SRV operation. In addition, each ADS SRV is provided an additional accumulator, which contains enough pneumatic pressure for each ADS valve to provide two actuations (Reference 3.15). Mechanical SRV operation will also control reactor pressure. Each unit has sixteen SRVs mounted on the Main Steam lines between the Reactor Vessel and the flow restrictors to provide overpressure protection for the reactor pressure vessel. All 16 SRVs have solenoids powered from DC power sources associated with the 90-psig Containment Instrument Gas supply to provide the relief function. Control of all sixteen SRVs is available from each unit's main control room.

Placing the associated hand switch on Panel 1/2C601 in OPEN for the SRV will energize the operating solenoid associated with the valve. The ADS utilizes six of the 16 SRVs located on the four Main Steam lines between the Reactor Vessel and the inboard Main Steam Isolation Valves. These six SRVs also receive 150-psig pneumatic gas supply via independent DC solenoids, which can be controlled from the Upper or Lower Relay rooms in the main control structure. To ensure a reliable post-accident nitrogen source, each 150-psig header can be backed up by a 2,200-psig bottle bank. Each Unit has 26 bottles (13 bottles on each 150 psig header) that are normally isolated from the supply line by solenoid valves. On signals of 1.72 psig Drywell pressure or -38” Reactor Pressure Vessel water level or low pneumatic header pressure (~142 psig), the ADS supply will swap from the normal header to the bottle banks. Reserve bottle bank capacity is designed to maintain ADS valve opening for three days post-LOCA for long-term heat removal (Reference 3.15).

As part of Susquehanna’s ELAP coping strategy, Susquehanna has provided a supplemental gas supply (nitrogen bottles) and associated high pressure pneumatic hose/fittings to sustain operation of the SRVs.

The supplemental gas supply hose will be routed to existing connection points on the 150 psig ADS bottle bank on 719' elevation in the Reactor Building and/or the 90 psig Containment Instrument Gas Header located on Elevation 683' in the Reactor Building for each unit.

The baseline strategy credits RCIC for vessel make up for up to 36 hours following the ELAP event. After determining an ELAP is occurring and during the time that suppression pool temperature is increasing, operators reduce reactor pressure to a pressure range (150 to 300 psig) which provides margin to the Unsafe Region of the Heat Capacity Temperature Limit (HCTL) curve (References 3.30 and 3.15). When the suppression pool temperature reaches the Unsafe Region of the HCTL, RPV emergency depressurization is required (References 3.30 and 3.31). In accordance with EPGs and per BWR Owner's Group (BWROG) guidance, EOPs were revised to allow termination of RPV emergency depressurization at a pressure that will allow continued RCIC operation, because steam driven RCIC is the sole means of core cooling (Reference 3.22).

EOP procedure EO-000-103, *Primary Containment Control* (Reference 3.30), contains the curves for Heat Capacity Temperature Limit (HCTL), and Pressure Suppression Limit (PSL), each of which provide limits or requirements which govern or prescribe actions such as RPV emergency depressurization based on or related to level in the suppression pool. Susquehanna's EOPs were revised to direct operators to terminate RPV emergency depressurization to prevent loss of RCIC.

The primary Phase 1 strategy for core cooling is to supply higher quality water via RCIC with suction from the Suppression Pool (or CSTs if they are available).

RCIC control power is supplied by 125 VDC batteries, which have a coping time of greater than 8 hours (Reference 3.36). RCIC valve power is supplied by the 250 VDC batteries, which have a coping time of greater than 8 hours on Unit 1 by load shedding non-essential loads on Unit 1. Unit 2 RCIC 250 VDC batteries have a coping time of greater than 8 hours without load shedding (References 3.35 and 3.36).

Shutdown and Refueling Modes

Susquehanna has incorporated the supplemental guidance provided in the NRC endorsed NEI position paper entitled "Shutdown / Refueling

Modes" to enhance the shutdown risk process and procedures (Reference 3.70).

2.4.2 Phase 2 Strategy

Primary Strategy Core Cooling and Heat Removal

During Phase 2, as in Phase 1, reactor core cooling is maintained using RCIC in automatic mode (i.e., with operators controlling the RCIC flow controller) with suction from the Suppression Pool. The Suppression Pool (SP) will heat up from decay heat being transferred from the RPV to the SP. The SP will eventually reach saturated conditions at 6 hours (Reference 3.24). At ~5 hours, the Hardened Containment Vent System (HCVS) is opened to maintain containment parameters below design limits and within the limits that allow continued use of RCIC (see the Maintain Containment response for additional discussion of the HCVS). The containment design pressure is never challenged, but the MAAP calculations show that Suppression Pool temperature slightly exceeds the design temperature (228 °F calculated vs. 220 °F design value). Susquehanna has evaluated this small variance and determined that no containment structural limits are violated by this small temperature variance. FLEX makeup to the suppression pool will begin at 6 hours to maintain SP level (Reference 3.24).

As with Phase 1, the primary method of reactor pressure control during Phase 2 is by operation of the SRVs. Operator control of reactor pressure using SRVs requires DC control power and pneumatic pressure (supplied by station batteries and the drywell pneumatics system) until supplemented with FLEX equipment.

Two 4160 VAC FLEX generators are transported from the protected location and positioned outside the "E" 4160 VAC DG. The 4160 VAC FLEX generators are then cross-connected to the eight ESS 4160 VAC Buses, which supply the eight ESS load centers, which are located in the Reactor Buildings (Figure 2). This will re-power all ESS 480 VAC loads which, after load shedding and re-powering selected loads to both units, will support important AC and DC loads such as 125 VDC battery chargers, RCIC 250 VDC battery chargers, SRV and ADS power, vital instruments, Control Room lighting/cooling, and selected valve power to RHR, RHRSW, Reactor Recirculation, and Core Spray. Cables from the generators are run to connection points in tap boxes on the exterior of the 'E' Diesel Building (Figure 2).

<u>Alternate Strategy Core Cooling and Heat Removal</u>

Providing defense in depth for RCIC, a FLEX pump, capable of supplying sufficient cooling water to both units, will take suction from the Spray Pond [SSES' Ultimate Heat Sink, (UHS)] (Figures 1, 3, and 4). The FLEX pump will inject into the preferred Division II, RHRSW piping connection in the ESSW Pump House at the UHS. An alternate connection also exists on Division I of the RHRSW piping, in the ESSW Pump House. The RHRSW system is cross-connected to the RHR system in the RHR pump room, for RPV injection, as a low pressure back-up to RCIC, when RCIC is no longer able to maintain level in the RPV. In the event of a loss of RCIC, operators will depressurize the RPV in accordance with symptom based EOPs, and inject using this source of water to maintain RPV level and cooling. This source of water is also used for containment control, and spent fuel pool make-up, as described in the following sections. A hose will be routed from RHRSW to the RCIC Lube Oil cooler to supply cooling to extend RCIC operation (Figure 5, shows Unit 1 and is similar for Unit 2). This action prevents Suppression Pool heat-up from affecting RCIC turbine bearings due to high temperature (References 3.16, 3.17, 3.18, and 3.22).

The Division I and II FLEX pump connections and flow paths for core cooling are shown in Figures 3 and 4, respectively.

The alternate electrical strategy still transports the two 4160 VAC FLEX generators from the protected location and positions them outside the "E" 4160 VAC DG. The 4160 VAC FLEX generators are then connected to the eight ESS 4160 VAC Buses via connections in the 'A' through 'D' DG buildings (one generator powers buses A and C and the other generator powers buses B and D), which supply the eight ESS load centers, which are located in the Reactor Building (Figure 2). This will re-power all selected ESS 480 VAC loads which, after load shedding and re-powering selected loads to both units, will support important AC and DC loads such as 125 VDC battery chargers, RCIC 250 VDC battery chargers, SRV and ADS power, vital instruments, Control Room lighting/cooling, and selected valve power to RHR, RHRSW, Reactor Recirculation, and Core Spray. Cables from the generators are run to connection points inside the 'A' through 'D' Diesel Buildings.

2.4.3 Phase 3 Strategy

Primary Strategy

For Phase 3, the reactor core cooling strategy is the same as described in Phase 2 which relies on maintaining RCIC in operation as long as possible and aligning the FLEX pump to feed the RPV via RHRSW and RHR as a backup to RCIC, or for when RCIC is no longer able to feed the RPV. The National SAFER Response Center (NSRC) supplied pumps and generators provide backup capability to Susquehanna's FLEX equipment.

Additional capability is provided that can place one loop of RHR into the Shutdown Cooling or Suppression Pool Cooling mode. This will be accomplished by powering up a Division I or II RHR pump from the appropriate Class 1E 4160 VAC bus utilizing an additional four (4), 4160 VAC FLEX generators from the NSRC and supplying RHRSW flow to the RHR Heat Exchanger with the FLEX pump or a large portable NSRC FLEX pump (i.e., from the NSRC) at the ESSW Pump House via the RHRSW piping (Figures 3 and 4).

The 4160 VAC FLEX generators are capable of carrying all of the loads on 4160 VAC bus necessary to support the Phase 3 FLEX strategies, which include an RHR pump and its support equipment (i.e., motor operated valves (MOVs), room coolers, etc.). The FLEX pump is sized to provide sufficient flow to the RHR heat exchanger to support Shutdown Cooling (SDC) or Suppression Pool Cooling (SPC) modes of RHR. This strategy for SDC can be accomplished utilizing a FLEX pump on each unit, or single large NSRC FLEX pump or multiple NSRC FLEX pumps, depending on pump sizes available from the NSRC. The four additional 4160 VAC FLEX generators will be connected in the same manner as described in the previous Maintain Core Cooling Phase 2 discussion.

Alternate Strategy

Alternate means of core cooling can be provided by connecting to and utilizing the opposite division of RHR and RHRSW as that used for the primary function.

The Phase 3 alternate electrical strategy (for extending Phase 2 capabilities) still transports the two 4160 VAC FLEX generators from the protected location and positions them outside the "E" 4160 VAC DG.

The 4160 VAC FLEX generators are then connected to the eight ESS 4160 VAC Buses via connections in the ‘A’ through ‘D’ DG buildings (one generator powers buses A and C and the other generator powers buses B and D), which supply the eight ESS load centers located in the Reactor Buildings (Figure 2). This will re-power all selected ESS 480 VAC loads which, after load shedding and re-powering selected loads to both units, will support important AC and DC loads such as 125VDC battery chargers, RCIC 250 VDC battery chargers, SRV and ADS power, vital instruments, Control Room lighting/cooling, and selected valve power to RHR, RHRSW, Reactor Recirculation, and Core Spray. Cables from the generators are run to connection points inside the ‘A’ through ‘D’ DG buildings.

NSRC equipment is utilized to back up the Phase 2 equipment and may be used to transition to a long-term Phase 3 coping strategy.

See Table 2 for a list of equipment that will be delivered to the site by the NSRC; refer to Section 2.11 for a discussion on NSRC supplied equipment.

Since no time sensitive actions have been identified in Phase 3, instructions for connection and utilization of NSRC equipment for long term coping or recovery will be provided by Technical Support Center (TSC) personnel who will have assessed the condition of the plant and infrastructure, plant accessibility, and additional available off-site resources (both equipment and personnel) following the BDBEE.

2.4.4 Systems, Structures, Components

2.4.4.1 Reactor Core Isolation Cooling Pump

The RCIC pump is utilized to maintain the heat sink for decay heat removal following an ELAP / LUHS event, by supplying water to the RPV. The RCIC system consists of a steam-driven turbine-pump unit and associated valves and piping capable of delivering makeup water to the RPV. The steam supply to the turbine comes from the reactor vessel. The steam exhaust from the turbine discharges to the suppression pool. The pump can take suction from the CST or from the Suppression Pool. The pump discharges either to the feedwater line or to a full-flow return test line to the CST. The RCIC pump is a safety-related, seismically qualified component located in the Reactor Building, a seismically qualified structure, and therefore protected from BDBEE hazards (Reference 3.15). The BWROG performed RCIC studies (References 3.17 and 3.18) which will support operation of RCIC at lube oil temperatures > 230 °F.

2.4.4.2 RCIC Pump Discharge Isolation/Flow Control Valves

The RCIC pump discharge motor-operated isolation/flow control valves are used to modulate the flow to maintain the required RPV water level. The valves can be controlled from either the MCR or local panels. Additionally, the valves can be operated locally if DC power is lost. DC power is maintained throughout the event, initially by the safety-related station batteries and subsequently by the battery chargers once the onsite 4160 VAC FLEX generators are operating, which ensures power will be available for the valves. Refer to the SSES FSAR (Reference 3.15) for a description of the RCIC isolation/flow control valves.

The RCIC pump discharge motor-operated isolation/flow control valves and their motors are Seismic Category 1 components which are also protected from the effects due to the design basis tornado (Reference 3.15).

2.4.4.3 Safety Relief Valves

During the initial stages of the event, heat generated by the reactor is dissipated by steam release through the SRVs to the Suppression Pool. Refer to the SSES Final Safety Analysis Report (FSAR) (Reference 3.15) for a description of the SRVs. The SRVs are seismically qualified components which are also protected from BDBEE hazards (Reference 3.15).

During Phase 2, reactor pressure will be controlled manually from the MCR (or relay rooms) by the operators using the SRVs. As backup to the nitrogen tanks and the SRV accumulators, pre-staged emergency N2 bottles can supply gas to the SRVs per procedures (Reference 3.25).

2.4.4.4 Suppression Pool

The Suppression Pool is the heat sink for reactor vessel SRV discharges and RCIC turbine steam exhaust following a

BDBEE. It is also the suction source for the RCIC pump to provide core cooling. Refer to SSES FSAR (Reference 3.15) for a description of the Suppression Pool.

The Suppression Pool is a safety-related seismically qualified structure which is protected from BDBEE hazards (Reference 3.15).

2.4.4.5 Hardened Containment Vent System

The HCVS will be used to maintain the Suppression Pool temperatures below 230°F by venting steam from the Suppression Pool to the release point above the Reactor Building roof. The Suppression Pool pressure is maintained below 10 psig (Reference 3.24, Appendix D).

The HCVS is a seismically qualified system which is protected from BDBEE hazards (Reference 3.15).

2.4.4.6 Ultimate Heat Sink (Spray Pond)

The FLEX pump will be placed in service at approximately 5 hours to provide make up to the Suppression Pool from the Spray Pond. The UHS is designed to provide adequate cooling water to dissipate decay heat from the plant. Refer to SSES FSAR (Reference 3.15) for a description of the UHS.

2.4.5 FLEX Connections

2.4.5.1 FLEX Pump Connections

The discharge of the FLEX pump will be directed to the Residual Heat Removal Service Water (RHRSW) system via hose and fittings to either of two RHRSW connection points (primary and alternate) located in the Emergency Safeguards Service Water Pump House (ESSWPH) building above grade level. Permanent RHRSW piping is used to provide water flow into the Residual Heat Removal (RHR) system and then into the RPV from either path. The primary pathway connects the FLEX pump into the RHRSW permanent piping which is cross tied with the RHR system to allow RPV injection using either division of RHR. The alternate pathway utilizes temporary hose from the FLEX pump into the other division of RHRSW piping in the ESSWPH building.

2.4.5.2 FLEX Electrical Connections

Two 4160 VAC FLEX generators are transported from the protected location and positioned outside the “E” 4160 VAC Diesel Generator.

For the primary strategy, cables from the generators are run to a connection point on the exterior of the ‘E’ DG Building (Figure 2). These connections are in a connection box protected from BDBEEs.

For the alternate strategy, cables from the generators are run to connection points in the interior of the ‘A’ through ‘D’ DG Buildings (Figure 2). These connections are in buildings that provide protection from BDBEEs (Reference 3.15).

The connections are color coded quick connects that facilitate correct, smooth, safe, and quick connections. The 4160 VAC FLEX generators are then cross-connected to the eight ESS 4160 VAC Buses, which supply the eight ESS load centers, which are located in the Reactor Building (Figure 2). This will re-power all selected ESS 480 VAC loads which, after load shedding and re-powering selected loads to both units, will support important AC and DC loads such as 125VDC battery chargers, 250 VDC battery chargers, SRV and ADS power, vital instruments, Control Room lighting/cooling, and selected valve power to RHR, RHRSW, Reactor Recirculation, and Core Spray.

2.4.6 Key Reactor Parameters

The key instruments for monitoring key reactor parameters are listed in Table 3.

In addition, many local indications of these parameters will remain available (even without power) and can be used to provide indications of the key reactor parameters.

Contingencies for alternate instrumentation monitoring are provided to the MCR team following a BDBEE via procedural guidance for establishing alternate indications for essential instrumentation.

Portable FLEX equipment is supplied with the local instrumentation needed to operate the equipment. The use of these instruments is detailed in the operating procedures for each piece of FLEX equipment.

2.4.7 Thermal Hydraulic Analyses

The FLEX strategies used to implement the coping capabilities are discussed in detail in the following sections. The strategies are based on the results of a plant specific Modular Accident Analysis Program (MAAP4) analysis (Reference 3.24, Appendix D) and the GEH analysis (Reference 3.14).

These analyses demonstrate that the strategies allow SSES to successfully cope from the baseline conditions of the ELAP / LUHS event resulting from a postulated BDBEE using diverse and redundant combinations of installed and portable equipment. The analyses also demonstrate that the overall coping capabilities provide sufficient margin during each of the coping durations described above to provide defense-in-depth against the many unknowns associated with BDBEEs. The coping strategy for each essential function is evaluated and described in detail in the following sections.

2.4.7.1 Strategy Analysis

Immediately following the ELAP event, reactor core cooling (decay heat removal) will be accomplished by flow from the RPV through the SRVs to the Suppression Pool. The RCS make-up is accomplished by operation of the RCIC pump supplying water to the RPV. Suction to the RCIC pump will be from the Suppression Pool, which is also protected from tornado missiles (Reference 3.15). At approximately 1 hour, operators will begin manually depressurizing the RPV to 240 psia by opening one SRV and maintain pressure between 150 – 300 psig by cycling the SRVs. At around 5 hours, the wetwell vent is opened such that the suppression pool does not exceed ~ 230 °F.

When adequate steam pressure is no longer available to drive the RCIC pump's turbine, the alternate coping strategy for reactor core cooling requires depressurization of the RPV and connecting the FLEX pump for injection of water into the RPV.

2.4.7.2 MAAP Analysis

The MAAP4 code benchmarking for the program's use in support of post-Fukushima applications is discussed in detail in Section 5 of EPRI Report 3002001785, *Use of Modular*

Accident Analysis Program (MAAP) in Support of Post-Fukushima Applications (Reference 3.49), which includes MELCOR code result comparisons as well as direct result comparisons to actual plant pressure and temperature data from Fukushima Dai-ichi Units 1, 2, and 3. The EPRI report concludes that the MAAP4 code is acceptable for use in support of the industry response to Order EA-12-049.

The SSES MAAP4 analysis was performed 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 (Reference 3.49).

Key modeling parameters cited in Tables 4-1 through 4-6 of the "*MAAP4 Application Guidance, Desktop Reference for Using MAAP4 Software, Revision 2*" (Electric Power Research Institute Report 1020236, Reference 3.23) are specifically addressed in the SSES MAAP4 Analysis (Reference 3.24). The MAAP4 code is readily capable of analyzing the two-phase flow conditions from the RPV, and validations were performed for the key parameters that are checked for these two-phase level and flow conditions. Modeling of heat transfer and losses from the RPV, decay heat, and the plant-specific inputs are also described and followed standard practices.

2.4.8 <u>Recirculation Pump Seal Leakage</u>

The MAAP4 Analysis (Reference 3.24) assumed an initial total recirculation pump leakage of 100 gpm at full reactor pressure based on 50 gpm per recirculation pump. The primary system leakage is assumed to start at time zero and will be proportionally less at lower reactor pressures. The seal leakage that occurs during RCIC and FLEX pump operation does not challenge the RPV makeup capabilities of these systems. It is included to account for potential leakage in the drywell and the resulting temperature effects.

2.4.9 <u>Shutdown Margin Analysis</u>

Not applicable to BWRs for FLEX. All control rods are assumed to be fully inserted into the reactor core within several seconds after the ELAP and the analysis does not predict re-criticality. No soluble boron is required for BWRs like Susquehanna.

2.4.10 FLEX Pumps, FLEX Equipment, and Water Supplies

2.4.10.1 FLEX Pump

Throughout Phase 2, either the RCIC pump with suction from the Suppression Pool, or the FLEX pump, with suction from the Spray Pond (UHS), will be in operation and aligned to discharge to the RPV (Figures 3 and 4). The FLEX pump is deployed and ready for operation at approximately 3 hours into the event. The discharge of the FLEX pump will be directed to the RHRSW connection points (see Section 2.4.5.1). The FLEX pump is sized based on the strategies' flow requirements (315 gpm per RPV plus 100 gpm for recirculation pump seal leakage per unit – 830 gpm total, 500 gpm for the Spent Fuel Pools – 250 gpm per unit). This corresponds to a minimum flow rate of a 1,330 gpm (665 gpm to each unit) at ~210 pounds per square inch differential (psid) which is a discharge pressure sufficient to feed the RPV (Reference 3.20**Error! Reference source not found.**).

The bounding case used to size the FLEX pump is the FLEX pump taking suction from the Spray Pond and discharging into the RHRSW permanent piping. A minimum pump head of 485 feet is required to ensure a minimum flow rate of 1,330 gpm can be provided to the RPVs for injection and to spray the Spent Fuel Pools.

The FLEX pump includes one centrifugal diesel-driven FLEX pump (Reference 3.20). This pump is capable of pumping 2,250 gpm at 165 psig (and 1,400 gpm at 200 psig). The FLEX pump has two six-inch suction hose connections and two five-inch discharge hose connections. This FLEX pump also includes a control panel for the FLEX pump.

2.4.10.2 Spray Pond Water Quality Evaluation

Evaluation by GE Hitachi (GEH) concluded that there would not be a serious threat to the fuel from use of untreated Spray Pond Water (Reference 3.333.34). Susquehanna also evaluated this issue and reached the same conclusion. The evaluation also noted that accumulation of debris sufficient to block the coolant flow path through a fuel assembly would likely take a substantial amount of time (potentially as much as a year).

In order to help mitigate this concern, the FLEX pump suction inlets are fitted with 3/8 inch screens to filter out debris found in the Spray Pond and prevent it from reaching the RPVs or SFPs. This would limit debris injection to the RPV during an ELAP event.

BWROG-TP-14-006 (Reference 3.33) further addresses the potential consequences of fuel assembly blockage due to debris accumulation from raw water injection. This report indicates that while fuel inlet filters may clog over time, it is likely that the much larger bypass flow holes could still provide sufficient flow to flood the core. In order to assure adequate core cooling in the event the bypass holes also become clogged, procedures (References 3.26, 3.27, and 3.29) are in place to maintain the core flooded when raw water is injected to the RPV, e.g., raising downcomer level above the steam separator return elevation.

Therefore, even if a significant amount of debris reaches the RPV the fuel will remain cooled.

2.4.10.3 Water Supplies

Suppression Pool

The Suppression Pool is a safety-related seismically qualified steel lined, concrete walled vessel located below the drywell, with a major diameter of 100 feet, 0 inches and an inside diameter of 88 feet, 0 inches. A hollow pedestal and several drywell floor support steel columns consume some of the volume. The Suppression Pool is protected from all applicable hazards. The Suppression Pool at the lower limit of the normal range contains a minimum of 122,410 ft^3 (~920,000 gallons) of water and has a minimum net airspace above the pool of ~ 159,130 ft^3 (Reference 3.15). The normal suppression pool water level is maintained between 22 feet and 24 feet per Susquehanna's Technical Specifications (Reference 3.19). The initial volume of water in the

Suppression Pool provides an adequate water volume for RCIC to operate for at least 36 hours (Reference 3.24).

SSES Spray Pond

The ultimate source of water for SSES is the Spray Pond, which is located approximately 850 feet from the Unit 1 Reactor Building (Reference 3.15). The Spray Pond is also the Ultimate Heat Sink (UHS) for Susquehanna. The Spray Pond contains over 20 million gallons of water.

Other Water Sources

Other sources of water may be available to the operators depending on the type of BDBEE that occurred. Use of these sources is prioritized in existing procedures (References 3.26, 3.27, and 3.29).

2.4.11 Internal Flooding

Susquehanna does not credit any safety-related active AC powered dewatering systems for mitigating ground water intrusion into the portions of the plant which contain SSCs credited in the FLEX strategies or that require access for personnel during the BDBEE.

Susquehanna does have a strategy to repower the Reactor Building sump pumps should that become necessary.

2.5 Spent Fuel Pool (SFP) Cooling/Inventory

In an ELAP event, the SFPs will initially heat up due to the unavailability of the normal cooling system. The structures, systems and components (SSCs) for Susquehanna Unit 1 and Unit 2 associated with spent fuel pool cooling following an ELAP event are essentially identical and, therefore, the three phase strategy developed is the same for both units. The Susquehanna fuel pools are normally cross-tied, effectively making them into a single volume.

The basic FLEX strategy for maintaining SFP cooling is to monitor SFP level utilizing the SFP level instrumentation installed per NRC Order EA-12-051 (Reference 3.5), 1CB672/LE-15348 and 2CB672/LE-25348, (Reference 3.42) and initiating SFP makeup as soon as resources are available. However, makeup will be initiated prior to a decreasing SFP level reaching 10 feet above the spent fuel racks.

2.5.1 Phase 1 Strategy

The Phase 1 strategy is to use the existing plant design (i.e. – normal required water inventory) to maintain cooling of the fuel in the SFP. Water level is normally maintained at least 22 feet above the top of irradiated fuel assemblies seated in the SFP (Reference 3.19, Section 3.7.7). Analyses determined that the spent fuel pool temperatures will remain below the boiling point during Phase 1 for a minimum of 13.6 hours (References 3.19 and 3.41), assuming maximum design basis heat load. Phase 2 is entered when make-up to the SFP begins.

Operations (usually the Shift Technical Advisor (STA)) or the Emergency Response Organization will use procedure OI-TA-009, *Determination of Heat Removal Capacities and Vessel Heatup Rates* (Reference 3.106), to calculate the actual Spent Fuel Pool heatup rates during a BDBEE.

No Phase 1 actions are required for SFP cooling/inventory other than monitoring the Spent Fuel Pools' water levels in the Main Control Room using 1CB672/LE-15348 and 2CB672/LE-25348.

2.5.2 Phase 2 Strategy

The Susquehanna fuel pools are normally cross-tied, effectively making a single volume. The SFP water level at the event initiation is 22 feet above the top of the stored fuel (Reference 3.19). The Susquehanna FSAR design basis maximum heat load for one pool is based on a full core offload 250 hours after reactor shutdown and the remainder of the SFP completely filled with previously discharged assemblies (Reference 3.15, FSAR Section 9.1.3). This design basis heat load, plus the nominal decay heat from the other unit's pool, was used to conservatively calculate the time to 212 °F and the pool boil-off rate. Using this heat load, the SFP water inventory will heat up from 115 °F to 212 °F during the first 13.6 hours for the Unit 1 and Unit 2 cross-tied fuel pools. Thus, the transition from Phase 1 to Phase 2 for SFP cooling function will occur at some time > 13.6 hours (Reference 3.41). The actual time may be substantially longer than 13.6 hours based on the actual decay heat load in the SFPs.

The makeup rate needed to replace boil-off in the combined fuel pools at 13.6 hours is 93 gpm. Maintaining the SFPs at 22 feet above the spent fuel during the ELAP event is not required. The requirement is to maintain adequate level to protect the stored spent fuel and limit exposure to onsite and offsite personnel.

Heat loads for a typical Susquehanna reload are substantially less than the design basis heat load. A prior Susquehanna calculation (Reference 3.43) determined that, for a typical Susquehanna reload, the time to heat the SFP from 115 °F to 212 °F is approximately 36 hours. For a typical Susquehanna reload, the makeup rate needed to replace boil-off in the combined fuel pools at 36 hours is approximately 31 gpm.

Makeup to the SFP will be provided by one of three baseline capabilities. Section 2.4.1 provides a discussion of the Shutdown and Refueling Modes actions required if an ELAP occurs during a refueling outage.

Primary Strategy Method 1

The first method to provide water to the SFP utilizes the FLEX pump connected to the RHRSW piping at the ESSW Pump House structure to supply water to the new FLEX hose connection on Unit 2 RHRSW piping. The cooling water is routed to the refueling floor through a standpipe in the stairway of the northeast corner of the Unit 2 Reactor Building. The top of the standpipe is connected to a hose that will reach the SFPs or the hose can be connected to spray nozzles capable of making up to the SFPs. The flow and pressure provided by the FLEX pump is more than sufficient to supply the required 93 gpm makeup to the SFPs through this flow path (Reference 3.20).

Primary Strategy Method 2

The second method to provide makeup to the SFPs is with the FLEX pump connected to and providing flow to the RHRSW system piping at the ESSW Pump House Structure and cross-connecting the RHRSW system to the RHR system (i.e., opening E11-F073B and F075B), and cross-connecting the RHR divisions through the HV151F010A and B valves. The RHR to SFP cooling assist valves, 151070A and 153070B, are opened, thus providing makeup flow to the SFP through spargers via seismically qualified piping. The flow and pressure provided by the FLEX pump is more than sufficient to supply the 93 gpm makeup required to make up for maximum boil off rate to the SFPs (Reference 3.20).

Spent Fuel Pool Spray Strategy Method 3

An evaluation has been performed (Reference 3.20) which demonstrates that the FLEX pump is capable of providing the required 250 gpm spray flow to each of the SFP’s (Reference 3.3) while providing the required makeup flow to both RPV's. The SFP flow path outlined in Method 1 above is used to provide the SFP spray flow. Either the division I or division II RHRSW connections in the ESSW pump house can be used to provide the required SFP spray flow. The spray nozzles are stored near the SFPs.

The Phase 2 and 3 mitigation strategy plans require 500 gpm fuel pool spray capability for the Unit 1 and Unit 2 fuel pools throughout the ELAP event. Flow calculations EC-013-1896 (Reference 3.20) and EC-016-1043 (Reference 3.44) demonstrate the fuel pool makeup requirements will be met. Actual fuel pool makeup requirements will be determined by monitoring fuel pool levels throughout the ELAP event.

Diesel powered FLEX pumps are used to provide makeup from the safety-related spray pond to the spent fuel pools via the safety-related RHRSW system. New RHRSW distribution manifolds were installed in the Unit 2 RHR pump rooms, which will include fuel pool makeup connections. From these connection points, water will be directed to the spent fuel pools to support the fuel pool spray/makeup function, as needed, to maintain fuel pool inventory. The FLEX pumps will be re-fueled as needed to maintain the fuel pool makeup capability indefinitely or until AC power is restored.

2.5.3 Phase 3 Strategy

Fuel pool makeup will be provided via the RHRSW system in both Phase 2 and Phase 3 mitigation strategy plans. Diesel powered FLEX pumps are used to provide makeup from the safety-related spray pond to the spent fuel pools via the safety-related RHRSW system. New RHRSW distribution manifolds were installed in the Unit 2 RHR pump rooms, which include fuel pool makeup connections. From these connection points, water will be directed to the spent fuel pools to support the fuel pool spray/makeup function, as needed, to maintain fuel pool inventory. The FLEX pumps will be re-fueled as needed to maintain the fuel pool makeup capability indefinitely or until AC power is restored.

The long term strategy for SFP cooling is to continue the Phase 2 strategy supplemented by portable equipment delivered from off site. Certain NSRC supplied pumps have the capability to replace a Susquehanna FLEX pump. See Table 2 for a list of equipment that will be delivered to the site by the NSRC after notification by the plant; refer to Section 2.11 for a discussion on NSRC supplied equipment.

As resources become available, actions can be taken to transition away from extended Phase 2 coping strategies. Since no time sensitive Phase 3 actions have been identified, instructions for connection and utilization of NSRC equipment for long term coping or recovery will be provided by TSC personnel who will have assessed the condition of the plant and infrastructure, plant accessibility, and additional available off site resources (both equipment and personnel) following the BDBEE.

2.5.4 Structures, Systems, and Components

2.5.4.1 Primary Connection

Primary Strategy Method 1 (Hoses and Standpipe)

Makeup from the FLEX pump connected to the RHRSW at the ESSWPH to supply water to the RHRSW piping in the Reactor Building (see Section 2.4.5.1). Hoses will be run from the 645' elevation RHRSW piping to a seismically robust standpipe in the Unit 2 Reactor Building northeast stairwell, and then via another hose on the refueling floor. A hose long enough to reach the SFP is permanently stored and available on elevation 818' for filling the SFP or to allow connecting to the monitor spray nozzles.

Primary Strategy Method 2 (SFP Cooling Piping)

Makeup is provided with the FLEX pump connected and providing flow to the RHRSW system piping at the ESSWPH and cross-connecting the RHRSW system to the seismically qualified RHR system piping in the Reactor Building (see Section 2.4.5.1). The RHR piping provides a connection to the SFP makeup cooling piping.

Spent Fuel Spray Strategy Method 3 (Spray Nozzles)

Makeup from the FLEX pump connected to the RHRSW at the ESSWPH to supply water to the RHRSW piping in the Reactor Building (see Section 2.4.5.1). Hoses will be run from the 645' elevation RHRSW piping to a seismically robust standpipe in the northeast Unit 2 Reactor Building stairwell, and then via another hose on the refueling floor. A hose long enough to reach the SFP is permanently stored and available on elevation 818' for filling the SFP or to allow connecting to the monitor spray nozzles stored on the refueling floor elevation (818').

2.5.4.2 Alternate Connection

The alternate connection from the FLEX pump is to the alternate division of RHRSW in a separate portion of the ESSWPH.

2.5.4.3 Ventilation

Per the NEI 12-06 guidance (Reference 3.3), a baseline capability for Spent Fuel Cooling is to provide a vent pathway for steam and condensate from the SFP. The east wall of Susquehanna's reactor refueling floor is equipped with hatches that open into an equipment area for HVAC ductwork that is outside secondary containment. This equipment area has a roof hatch that opens to the atmosphere. A similar configuration exists at the west wall of the reactor refueling floor. These hatches (and a few additional doors) would be opened manually per procedural guidance to provide a vent path for spent fuel pool generated steam to be released from the refueling floor area (Reference 3.45).

2.5.4.4 Spent Fuel Pool Gate Seals

The Spent Fuel Pools (SFP) are equipped with removable gates at the transfer canals of the SFPs to the Reactor Cavities to facilitate movement of fuel during refueling operations. The gates have pneumatic seals that prevent water from leaking out of the SFP when water on the Reactor Cavity side of the gate is lower than that of the SFP. The seals are normally supplied by the instrument air system with a backup supply from nitrogen bottles stored on the refueling floor, that can be hooked up to supply the seals in accordance with procedures ON-INSTAIR-1/201, *Loss of Instrument Air* (Reference 3.107). During Phase 2, the SFP gate seals are pressurized as necessary by backup gas from the nitrogen bottles stored on elevation 799' of the Unit 2 Reactor Building, below the Refuel Floor, to ensure seal integrity can be maintained. The FSG to supply gas to the SFP seals also supports supplying gas to the reactor cavity seals and Cask Storage Pit seals, if necessary.

2.5.5 Key Spent Fuel Pool Parameters

The key parameter for the SFP makeup strategy is the SFP water level. The SFP water level is monitored by the instrumentation (1CB672/LE-15348 and 2CB672/LE-25348) that was installed in response to Order EA-12-051, *Reliable Spent Fuel Pool Instrumentation* (Reference 3.5). These instruments have dedicated batteries to provide power during an ELAP and will be repowered from the FLEX generators.

2.5.6 Thermal-Hydraulic Analyses

An analysis was performed (Reference 3.41) that determined with the maximum expected SFP heat load, the SFP will reach a bulk boiling temperature of 212 ºF in approximately 13.6 hours and boil off to a level 11 feet above the top of fuel in approximately 55 hours unless additional water is supplied to the SFP or the actual decay heat load is less than the conservatively assumed value. Total required flow to the SFPs for the most limiting case (full-core offload with full SFP) to make up for boil off is approximately 93 gpm. This can be supplied by the FLEX pump.

2.5.7 FLEX Pump and Water Supplies

2.5.7.1 FLEX Pump

One of Susquehanna's FLEX pumps was determined to be acceptable to provide all cooling water needs for both units. See Section 2.4.10.1.

2.5.7.2 Ultimate Heat Sink

Susquehanna's Spray Pond is the ultimate heat sink and it is the primary source of water to provide makeup to the SFPs.

2.5.8 Electrical Analysis

The SFP will be monitored by instrumentation (1CB672/LE-15348 and 2CB672/LE-25348) installed in response to Order EA-12-051. This equipment has a backup battery; with a minimum battery life of 24 hours to allow for power restoration from the 4160 VAC FLEX generator (References 3.42 and 3.57).

2.6 Containment Integrity

Susquehanna has a GE BWR Mark II style containment with an upper dry portion (drywell) connected to a lower portion that is partially filled with water (suppression pool or wetwell). An indefinite coping strategy has been developed to maintain containment integrity at SSES Units 1 and 2 following an ELAP with LUHS event. The SSCs of Units 1 and 2 associated with containment integrity following an ELAP event are essentially identical and, therefore, the three phase strategy developed is the same for both units

In accordance with NEI 12-06 (Reference 3.3), the containment is assumed to be isolated following the event. As the suppression pool heats up and begins to boil, the containment will begin to heat up and pressurize. Additionally, because it is necessary to ensure the capability of SRVs to perform the pressure relief function, and it is necessary to maintain containment integrity, the containment will be vented to reduce suppression pool inventory and containment pressure. A Hardened Containment Vent System (HCVS) has been installed in each unit at Susquehanna to ensure that the required vent operations will occur. Susquehanna installed Hardened Containment Wetwell Vents in response to NRC Order EA-13-109, under Plant Modifications EC1881050, EC1881053, EC1881047, and EC1672825 for Unit 1 and EC1881014, EC1881029, EC1881034, and EC1672802 for Unit 2 (References 3.46 through 3.48 and 3.50 for Unit 1, and References 3.54 through 3.56 and 3.59 for Unit 2). The HCVS will be operated from the primary operating controls in the Main Control Room (MCR).

The suppression pool temperature is also a limiting factor for implementation of the ELAP strategy. It is controlled by venting and does not exceed 230°F (Reference 3.24).

At approximately hour five, the use of the HCVS is initiated to provide long term core cooling capability thru RCIC and maintain containment parameters within limits. The containment design pressure is 53 psig. Containment pressure limits are not reached during the event (Reference 3.24) because the HCVS is opened prior to exceeding any containment pressure limits.

Thus, containment integrity is not challenged and remains functional throughout the event. Monitoring of containment (drywell) pressure and temperature is available via permanently installed plant instrumentation using the coping strategy described below for instrumentation and controls.

2.6.1 Phase 1 Strategy

The Suppression Pool (SP) level rises due to the transfer of energy and inventory from the RPV to the Suppression Pool via RCIC, and from the RPV to the Suppression Pool via the SRVs. According to the MAAP analysis (Reference 3.24) the drywell and the suppression pool pressures are controlled by opening the HCVS wetwell vent (at approximately 5 hours and as needed thereafter) to prevent initially entering the unsafe regions of the HCTL or SRV tail pipe limit. During the initial coping period, installed plant equipment is used to maintain the essential function of containment integrity.

All containment parameters are expected to remain within design values during the Phase 1 coping period.

The MAAP analysis (Reference 3.24) shows that the Heat Capacity Temperature Limit (HCTL) is not expected to be exceeded prior to the installation of Phase 2 equipment. The MAAP analysis also shows that the pressure suppression pressure (PSP) is not expected to be exceeded prior to the installation of Phase 2 equipment. If either limit were to be exceeded, this would require the operators to reduce reactor pressure in accordance with the EOPs.

The Maintain Core Cooling Phase 1 Strategy uses the SRVs to stabilize reactor pressure and begin a < 100 ˚F/hr. cooldown rate within 1 hour from the start of the ELAP. This cooldown will be performed using EO-000-103, *Primary Containment Control* guidance (Reference 3.30), by opening SRVs to stay within the HCTL and PSP limits. EPG/SAG's Rev. 3 allows the early venting strategy. Operations will perform venting from the Suppression Chamber (SC) using the Hardened Containment Vent System (HCVS) in accordance with EO-000-103 (Reference 3.30). This is done to maintain SP temperature < 230 ˚F, as part of the Maintain Core Cooling Phase 1 Strategy, to maintain core cooling (RCIC) in service. Peak suppression pool temperature is not expected to exceed 230 ˚F per the MAAP analysis (Reference 3.24).

Calculation EC-050-1032 (Reference 3.16) evaluated RCIC NPSH conditions during the ELAP event, as defined in the baseline coping strategy. The calculation demonstrates that there would be adequate NPSH available to support RCIC operation under the conditions described in the baseline coping strategy (References 3.16 and 3.24).

During Phase 1, containment integrity is maintained by normal design features of the containment, such as the containment isolation valves and HCVS. In accordance with NEI 12-06 (Reference 3.3), the containment is assumed to be isolated following the event. As the suppression pool heats up and the water begins to boil, the containment will begin to heat up and pressurize. The HCVS will be used to maintain containment temperature and pressure within acceptable limits.

According to the MAAP analysis (Reference 3.24) the limiting containment parameter will be the HCTL. After approximately 7 hours, the suppression pool will reach the Emergency Operating Procedure (EOP) Heat Capacity Temperature Limit (HCTL). Plant procedures for addressing SBO conditions will instruct the operator not to depressurize below the point where RCIC would isolate on low pressure, therefore operators will continue to rely upon RCIC to provide core cooling. If a reactor depressurization was initiated that reduced reactor pressure too low to provide motive steam to RCIC, the only available high pressure make up system would be eliminated. The suppression pool temperature is also a limiting factor for implementation of the ELAP strategy (Reference 3.18). As discussed in the Phase 1 Core Cooling section above, RCIC suction temperature will be allowed to go as high as 230°F. By opening the HCVS at approximately 5 hours, the temperature peaks at 226°F at approximately 16.1 hours with a second peak of 228ºF at 37.2 hours (Reference 3.24).

The containment design pressure is 53 psig (Reference 3.15). Containment pressure limits are not expected to be reached during the event as indicated by MAAP analysis, because the HCVS is opened prior to exceeding any containment pressure limits.

Thus, containment integrity is not challenged and remains functional throughout the event. As indicated by MAAP analysis, the containment will be vented with the Hardened Containment Vent System at approximately 5 hours after event initiation. Monitoring of containment (drywell) pressure and temperature will be available via normal plant instrumentation.

Phase 1 (i.e., the use of permanently installed plant equipment/features) of containment integrity is maintained throughout the duration of the event; no non-permanently installed equipment is required to maintain containment integrity. Therefore, there is no defined end time for the Phase 1 coping period for maintaining containment integrity. An alternative strategy for containment integrity during Phase 1 is not required, because containment integrity is maintained by the plant's design features.

Procedural guidance for venting the Primary Containment was developed as part of the EOP revisions developed by the BWROG Emergency Procedures Committee (EPC). As part of this Emergency Operating procedure revision, specific guidance related to the parameter values and instrument inputs to the decision will be clearly identified. Further detail regarding the HCVS and venting is provided to the NRC in Susquehanna's response to NRC Order EA-13-109.

2.6.2 Phase 2 Strategy

Use of the HCVS is continued throughout the event with the FLEX generator providing power to the HCVS.

The Maintain Containment Phase 1 Strategy discusses opening the HCVS to limit suppression chamber pressure. This action, as indicated by the MAAP analysis (Reference 3.24), will cause Suppression Pool (SP) level to decrease slightly due to boil off. SP level will be maintained by EO-000-103, Primary Containment Control (Reference 3.30) actions by making up to the SP using the RHR SP return flow path. RHR is being supplied by the FLEX pump staged at the UHS, discussed as part of the Maintain Core Cooling Phase 2 Strategy. The Maintain Core Cooling Phase 1 Strategy has the RPV depressurized to achieve between 300 to 150 psig and controlled in that band. From this state, when RCIC is no longer able to feed the RPV, RPV pressure will be further reduced using SRVs to allow make up from the RHR system supplied by the FLEX pump, to maintain RPV level. The MAAP analysis (Reference 3.24) calculated that peak SP temperature will be 228° F during this transition.

Another adverse effect on the containment, due to the loss of cooling to the reactor recirculation pump seals, is an assumed 100 gpm seal leakage into the containment (50 gpm /pump at rated RPV pressure). Actions can be taken to isolate this leak by energizing and closing the reactor recirculation pump discharge, discharge bypass, and suction valves to isolate the leakage into the containment. Power to the valves can be supplied by the two 4160 VAC FLEX generators used to re-power ESS 480 VAC loads as discussed in the Maintain Core Cooling Phase 2 Strategy. The MAAP analysis did not credit isolation of this leakage.

The RPV will continue to boil off through open SRVs to the SP. The SP will boil off through the open HCVS. The FLEX pump injection through the RHR system will be used to make up to the RPV and SP until supplemental long-term Phase 3 actions are implemented to place RHR in Shutdown Cooling or Suppression Pool Cooling to remove decay heat from the RPV and Primary Containment.

The FLEX pump flow paths to the Suppression Pool (SP) are shown in Figures 3 and 4.

Containment integrity is maintained by permanently installed equipment and FLEX equipment for Phase 2. Portable equipment required to support Phase 2 of containment control is the 4160 VAC FLEX generators and FLEX pumps and connections described in the previous Phase 2 of the Maintain Core Cooling section. See Phase 1 description for discussion of containment integrity applicable throughout the event.

2.6.3 Phase 3 Strategy

As resources become available, actions can be taken to transition away from extended Phase 2 coping strategies. Since no time sensitive Phase 3 actions have been identified, instructions for connection and utilization of NSRC equipment for long term coping or recovery will be provided by TSC personnel, who will have assessed the condition of the plant and infrastructure, plant accessibility, and additional available off-site resources (both equipment and personnel) following the BDBEE.

Primary Phase 3 Strategy

As described in Phase 2, the RPV will continue to boil off through open SRVs to the SP. The SP will boil off through the open HCVS. The FLEX pump injection through the RHRSW and RHR systems will be used to make up to the RPV and SP or an appropriate SAFER NSRC pump can be used.

Additional capability is being provided that can place one loop of RHR into the Shutdown Cooling or Suppression Pool cooling modes of operation. Shutdown Cooling will remove heat from the RPV, which ultimately reduces heat input to the containment. This will be accomplished by powering up a Division I or II RHR pump from the Class 1E 4160 V bus utilizing four additional 4160 VAC FLEX generators from the NSRC and supplying the RHR Heat Exchanger cooling flow with the FLEX pump or a large portable NSRC FLEX pump (i.e., from the NSRC) at the ESSW Pump House via the RHRSW piping (Figures 3 and 4), if permanent RHRSW pumps are unavailable.

The 4160 VAC FLEX generators are capable of carrying all of the loads on 4160 V bus necessary to support the Phase 3 FLEX strategies, which include the battery chargers for SRV control, RHR MOV control, an RHR pump and its support equipment (i.e., MOVs, room coolers, etc.). The

FLEX pump is sized to provide sufficient flow to the RHR heat exchanger to support Shutdown Cooling (SDC) or Suppression Pool Cooling (SPC) modes of RHR during an ELAP. This strategy for SDC can be accomplished utilizing a FLEX pump on each unit.

The four additional 4160 VAC FLEX generators from the NSRCs will be connected in the same manner as described in the Maintain Core Cooling Phase 2 earlier discussion.

Alternate Phase 3 Strategy

Alternate means of containment cooling can be provided by connecting to and using the opposite division of RHR and RHRSW as that used for the primary function.

2.6.4 Structures, Systems, Components

2.6.4.1 Containment

During the BDBEE which results in an ELAP / LUHS event, containment integrity is maintained by normal design features of the containment. The containment design pressure is 53 psig and the containment design temperature is 340 °F (Reference 3.15, Section 6.2.1.1.3). Refer to the SSES FSAR (Reference 3.15) for a description and discussion of design capabilities of the containment.

2.6.4.2 Hardened Containment Vent System (HCVS)

The HCVS is a reliable, severe accident capable, wetwell venting system that complies with the requirements of NRC Order EA-13-109. During a BDBEE which results in an ELAP / LUHS event, the HCVS provides a means of relieving excessive containment pressure directly to the environment via a dedicated vent pipe with a release point above the Reactor Building roof. The two primary containment isolation valves (PCIVs) within the HCVS system are provided with a dedicated air supply (adequate for at least 7 days) and a dedicated electrical power system (dedicated batteries that can be recharged by the FLEX generators).

The HCVS is normally operated from the Main Control Room (MCR) and can also be operated from the Remote Operating Station (ROS).

2.6.5 Key Containment Parameters

The instruments monitoring containment (drywell and suppression pool) pressure and temperature and suppression pool level remain available following specified load shed actions outlined in plant procedures. Analyses (References 3.34 through 3.36) indicate this strategy provides critical instrumentation relying on the station batteries (for at least 8 hours) until supplied by a 4160 VAC FLEX generator (by 6 hours after the ELAP).

The containment pressure and temperature and suppression pool level instrumentation credited in the strategy are listed in Table 3, as cited in Section 2.4.6.

Contingencies for alternate instrumentation monitoring are provided to the control room team following a BDBEE. Procedural guidance is provided for establishing alternate indications for essential instrumentation.

2.6.6 Thermal-Hydraulic Analyses

A Susquehanna specific MAAP analysis (Reference 3.24) demonstrates that containment response following a postulated ELAP event does not challenge containment design limits until after availability of off-site equipment and implementation of strategies to control pressure and temperature.

MAAP BWR Version 4.0.5 analysis software was utilized for the containment analysis (Reference 3.24). The MAAP BWR Version 4.0.5 analysis software was employed to analyze the specified FLEX scenarios during an ELAP / LUHS event. MAAP4 is an EPRI sponsored computer code that simulates the response of light water nuclear power plants during severe accident sequences, including actions taken as part of the severe accidents. MAAP4 can predict the progression of hypothetical accident sequences from a set of initiating events to either a safe, stable, coolable state or to an impaired containment and depressurization. The guidance provided in the EPRI position paper entitled "*Use of Modular Accident Analysis Program (MAAP) in Support of Post-Fukushima Applications*" (Reference 3.49) as endorsed by the NRC (Reference 3.97) was used to support the performance of ELAP containment analyses

2.6.7 FLEX Pump and Water Supplies

The FLEX Pump will provide make-up water to maintain the containment below design limits by cooling the RPV through providing direct injection into the RPV or the Suppression Pool from the Spray Pond.

2.6.8 Electrical Analysis

Power requirements for the HCVS and containment critical instrumentation is provided by the dedicated HCVS batteries and the station batteries, respectively. The 4160 VAC FLEX generators are used to repower the HCVS and station battery chargers. See additional discussion in Section 2.3.2.

2.7 Characterization of External Hazards

In accordance with NEI 12-06, Sections 4 through 9, the applicable extreme external hazards at SSES Unit 1 and 2 are seismic, external flooding, severe storms with high winds (hurricanes and tornados), snow, ice, extreme cold and high temperature (References 3.3 and 3.32). These hazards (except seismic) are bounded by the current design basis hazards as described in the FSAR (Reference 3.15). Seismic is discussed below

2.7.1 Seismic Hazards

Per the SSES Unit 1 and 2 FSAR (Reference 3.15), the seismic criteria for SSES include two design basis earthquake spectra: Operating Basis Earthquake (OBE) and the Design Basis Earthquake (DBE). The OBE and the DBE are 0.05 g and 0.10 g, respectively; these values constitute the design basis of SSES.

For FLEX strategies, an earthquake is assumed to occur without warning and result in damage to non-seismically designed structures and equipment. A debris assessment for the site was performed, including debris generated by seismic events, to determine debris removal tool requirements; see Section 2.9.1 for a discussion of debris removal capability.

As part of Susquehanna's response to the NRC's March 12, 2012 Request For Information 50.54(f) letter (Reference 3.13), a new Ground Motion Response Spectrum (GMRS) was developed for Susquehanna. This new GMRS was not fully bounded by the OBE nor the DBE. Using NRC accepted methodologies Susquehanna performed a *Seismic Hazard Mitigation Strategies Assessment (SHMSA)* (Reference 3.51) that demonstrated the Susquehanna *Individual Plant Examination of*

External Events (IPEEE) evaluated Alternate Mitigating Strategy was acceptable. The NRC reviewed and accepted SHMSA for Susquehanna (Reference 3.58).

The SHMSA (Reference 3.51) evaluated and demonstrated that Susquehanna can mitigate the effects of the reevaluated seismic hazard. Susquehanna's IPEEE formed the basis of the Alternate Mitigating Strategy. The SHMSA also addressed Indefinite Coping, IPEEE Upgrade to Full Scope (which includes Relay Chatter and Soil Failure Analysis), Spent Fuel Pool Cooling, a High Frequency Evaluation, and the availability of FLEX equipment.

Seismic events will not impact the availability of the UHS water inventory at Susquehanna. In addition, there are no downstream dams required to contain water in the UHS. Susquehanna cannot be impacted by the failure of a non- seismically robust downstream dam and does not have to address the deployment of FLEX for such an event.

FLEX equipment is stored in a structure that meets one or more of the configurations identified in NEI 12-06 (Reference 3.3), Section 5.3.1.1(a), (b) and (c). The final FLEX Building seismic design requirement is specified to be 2 times the Safe Shutdown Earthquake (SSE). Large portable FLEX equipment, such as pumps and power supplies, are arranged to protect them from damage during a seismic event (SSE). Stored equipment is protected from seismic interactions to ensure that unsecured and/or non-seismic components do not damage the equipment.

Per Section 2.5 of the Susquehanna FSAR (Reference 3.15), the soil liquefaction analysis determined that adequate safety margin against liquefaction is present. Therefore, soil liquefaction does not need to be considered for deployment of FLEX equipment.

At least one connection point for FLEX equipment is accessed through a seismically robust structure (e.g. – ESSW Pump house and Diesel Generator buildings).

Susquehanna relies on a water source that is seismically qualified (UHS), which will be available during Extended Loss of AC Power (ELAP) conditions.

If power is required to move or deploy FLEX equipment (e.g. – open the door from a storage location), then power supplies are provided as part of FLEX deployment. Means to move equipment are provided and are reasonably protected from the event.

SSES compiled a reference source for the plant operators that provides approaches to obtaining necessary instrument readings to support the implementation of the event response strategy. This reference source includes control room and non-control room readouts and provides guidance on how and where to measure key instrument readings. The guidance to operators also identifies appropriate operations to perform until the alternate indications can be connected and the guidance includes how to control selected equipment without control power. Susquehanna complies with NEI 12-06 section 5.3.3.1.

There are no known seismic hazards associated with migration of ground water. SSES does not use ac power to mitigate ground water in critical locations.

Alternate routes to the station have been established to ensure off-site resources can be obtained. These are described in the SAFER Response Plan.

2.7.2 External Flooding

As part of Susquehanna's response to the NRC's March 12, 2012 Request For Information 50.54(f) letter (Reference 3.13), a new *Flood Hazard Reevaluation Report* was prepared (Reference 3.60). After reviewing the Flood Hazard Reevaluation Report the NRC concluded that "All the reevaluated flood hazard mechanisms for Susquehanna were bounded by the current design basis of the site, and it was appropriate to evaluate the mitigating strategies against the current design-basis flood hazard mechanisms." (Reference 3.61).

The NRC concluded that Susquehanna has adequately responded to the Flooding hazard sections of the NRC's March 12, 2012 Request For Information 50.54(f) letter (Reference 3.13) and that those actions are complete (Reference 3.62).

Susquehanna developed a *Flooding Hazard Mitigating Strategies Assessment (FHMSA)* report and submitted the report to the NRC (Reference 3.63). The FHMSA concluded that the Mitigating Strategies could be implemented as designed while considering the reevaluated flood hazards. The NRC concluded that the FHMSA was adequate in Reference 3.64.

The evaluation of external flood-induced challenges has three parts, which include determining whether the site is susceptible to external flooding, characterization of the applicable external flooding threat, and application of the flood characterization to the protection and deployment of FLEX strategies (Reference 3.3, Section 6.2 of NEI 12-06). Based on the NEI 12-06 guidance document (Reference 3.3), Section 6.2.1, Susquehanna Steam Electric Station (SSES) is susceptible to external flooding events. A discussion of the relevant SSES external flood hazards is provided below, along with applicable FLEX equipment protection and deployment strategies. Due to Susquehanna's site location, which is over 150 feet above the normal elevation of the Susquehanna river, SSES is not subject to external flooding from river flooding, upstream dam failures, high tides or Tsunami events. SSES is classified as a "dry site" as discussed in the FSAR, Section 2.4 (Reference 3.15). The most significant long-term external flooding event (24 hours or greater) at Susquehanna is the Probable Maximum Precipitation (PMP) flooding event. This postulated external flooding event results in approximately 30 inches of rain in a 24-hour period. This external flooding event results in some local ponding around safety-related buildings or structures, with no significant water accumulation against any safety-related buildings. This conservative PMP flooding event bounds any postulated severe weather external flooding event at the station, such as from a hurricane. As a result, no external flood mitigating actions are required in response to these external flooding events.

SSES is also subject to short term external flooding from postulated external flooding events such as a cooling tower basin rupture or a site storage tank rupture. These external flooding events could result in a short duration buildup of water around safety-related buildings. Due to the short duration of these external flooding events, no mitigating actions could be initiated in response to these events. In addition, no mitigating actions are required in response to these short-term external flooding events.

The station's flood protection features (doors and penetrations within the exterior flood barriers) are designed to prevent water from entering safety-related buildings during all postulated external flooding events. Although flooding protection requirements are not required for these external flooding events, FLEX equipment must be located outside the flow path of these on-site water sources. It is not anticipated that deployment of FLEX equipment would be required during these short-term external flooding events. However, deployment of FLEX equipment during or after a PMP flooding event may be required.

Procedures are in place to prepare the station for severe weather operation that may coincide with external flooding (such as hurricanes). Actions include, but are not limited to establishing manpower needs, topping off vehicles with fuel, completing station button down actions, tying-down equipment, setting up sleeping accommodations, and ensuring storm drains are clear. Although actions to prepare for severe weather operation are necessary, there are no credited time dependent actions associated with external flooding events at SSES, and there are no specific mitigating actions required to protect against the ingress of water into SSCs important to safety during any PMP flooding event.

Susquehanna reviewed site access routes to determine the best means to obtain resources from off-site during or following a worst-case site flooding event (PMP). Staging areas are established to support deployment of Phase 3 equipment. These are described in the SAFER Response Plan.

2.7.3 Severe Storms with High Winds

Susquehanna's current plant design bases address the storm hazards of hurricanes, high winds and tornadoes.

The NEI FLEX Implementation Guide (Reference 3.3) Figures 7-1 and 7-2 were used for this assessment. It was determined that the Susquehanna Steam Electric Station (SSES) could experience hurricane winds in excess of 130 mph based on Figure 7-1. It was also determined that SSES is in Region 2 and could experience tornado force winds exceeding 160 mph based on Figure 7-2. Therefore, the high wind hazard is applicable to SSES.

High winds may delay deployment of FLEX equipment. Consequently, the FLEX strategy includes consideration for deployment of equipment prior to the high wind event, since for a high wind event (such as a hurricane) significant warning time would typically be available. It is noted that for tornados there may not be significant warning time available. Since tornados are typically short-term events, deployment of equipment during a tornado would not be anticipated. Appropriate station procedures were revised to include provisions for deployment of FLEX equipment.

Protection of FLEX equipment is guaranteed by ensuring that the characteristics of the storage locations meet the requirements in NEI 12-06. At SSES the storage location is inside the vehicle barrier system (VBS) and in the owner controlled area (OCA). By providing a storage building designed to withstand hurricane and tornado high wind hazards, sufficient FLEX equipment to supply both units is protected from BDBEEs from all high wind hazards including high wind missiles.

Following a hurricane or tornado, debris removal may be required to deploy FLEX equipment. Path clearing equipment is available to support deployment of equipment. This path clearing equipment is also protected in the FLEX Building which was designed to withstand the severe storm and high wind hazards.

The tow vehicles for the FLEX equipment are also stored in the FLEX storage building; see Section 2.9.1 for additional discussion of debris removal capability.

2.7.4 Ice, Snow and Extreme Cold

Based on the NEI guidance document (Reference 3.3), Section 8.2.1, SSES must address impact of Snow, Ice, and Extreme Cold on protection and deployment of FLEX equipment.

Snow, Ice, and Extreme Cold considerations include protection of FLEX equipment, deployment of FLEX equipment, procedural interfaces, and considerations in using off-site resources. These considerations are discussed in Section 8.3.1, 8.3.2, 8.3.3, and 8.3.4 of the guidance document (Reference 3.3), respectively.

The storage of FLEX equipment, including transport equipment, has been designed to protect it from extreme weather. The design criteria for the FLEX Storage building meet the site design basis weather effects. Debris removal equipment is stored in the FLEX storage building; see Section 2.9.1 for additional discussion of debris removal capability. Because advance warning of freezing weather would be available, actions will be taken per procedural guidance in advance to prepare for adverse conditions (including personnel actions).

Snow/ice removal may be required to deploy FLEX equipment. Path clearing equipment is available to support deployment of FLEX equipment. Since the UHS may be affected by extreme low temperatures due to ice buildup, the FLEX strategy includes provisions for creating access to the UHS water for the FLEX pump suction or minimizing ice buildup in the UHS when sufficiently cold weather conditions are forecast to ensure the FLEX equipment can utilize the UHS inventory. FLEX equipment is stored in a structure that meets the requirements identified in Section 8.3.1.1 of the guidance document (Reference 3.3). The equipment is maintained at a temperature within the range to ensure its likely function when called upon.

Susquehanna reviewed site access routes to determine the best means to obtain resources from off-site under Snow, Ice, and/or Extreme Cold conditions. Staging areas are established to support receipt of equipment under these adverse weather conditions. These are described in the SAFER Response Plan.

2.7.5 <u>High Temperatures</u>

Based on the NEI guidance document (Reference 3.3), Section 9, all sites will address the impact of high temperatures on protection and deployment of FLEX equipment. FLEX equipment must be capable of functioning under high temperature conditions. For Susquehanna, the maximum outside air temperature is 101˚F (Reference 3.15, Section 2.3.1.1).

High Temperature considerations include protection of FLEX equipment, deployment of FLEX equipment, procedural interfaces, and considerations in using off-site resources. These considerations are discussed in section 9.3.1, 9.3.2, 9.3.3, and 9.3.4 of the guidance document (Reference 3.3), respectively.

The equipment is maintained at a temperature within the range to ensure its likely function when called upon.

The FLEX equipment was procured to function in extreme high temperature conditions applicable to Susquehanna. The potential impact on storage of equipment due to high temperatures was also considered.

The FLEX pumps can operate in hot weather, including the 101 °F extreme. Similarly, the FLEX generators can operate in these temperatures based on information from the equipment vendor.

Extreme high temperatures are not expected to impact the ability of personnel to implement the required FLEX strategies. Site industrial safety procedures currently address activities with a potential for heat stress to prevent adverse impacts on personnel. (Refer to section 2.13 for more detail).

Extreme high temperatures are not expected to impact the utilization of off-site resources.

2.8 Protection of FLEX Equipment

Susquehanna's FLEX equipment is stored in a single ~ 10,000 ft^2 steel reinforced concrete FLEX Building that provides tornado-missile protection and was designed to 2x the Safe Shutdown Earthquake (which bounds the new GMRS between 1 and 10 hertz). This FLEX Building also satisfies all the External Hazard considerations evaluated in Section 2.7. The SSES FLEX storage building is located within the Owner Controlled Area and the Protected Area (see Figure 1). This location is significantly above any flooding issue elevation (even Local Intense precipitation is not an issue at the FLEX Building due to being located near the high point on-site). The FLEX storage building was designed and constructed to prevent water intrusion and built to protect the equipment from all the BDBEE hazards identified in Section 2.7 above.

Large portable FLEX equipment such as the FLEX pumps and FLEX generators are positioned inside the FLEX storage building to protect them during a seismic event. Additionally, fire suppression piping and ventilation ductwork were designed and installed to meet the FLEX storage building specifications (seismic, wind, etc.). The lighting, conduits, electrical, and fire detection/suppression components were seismically installed to ensure they remain functional before, during, and after a BDBEE and to preclude damage to the FLEX equipment.

Debris removal equipment is also stored inside the FLEX storage building to reasonably protect it from the applicable external events such that the equipment remains functional and deployable to clear obstructions from the pathway between the FLEX equipment's storage location and its deployment location(s). See Section 2.9.1 for additional discussion of debris removal capability.

Deployment of the FLEX and debris removal equipment from the FLEX storage building is not dependent on off-site power. The FLEX Building has an internal permanently installed dedicated diesel generator to provide power if off-site power is lost (automatic start on loss of external power with a 24-hour capacity fuel tank). In addition, the personnel access and main access doors can be opened manually.

The logistics of equipment removal after a BDBEE was considered in the design of the building and the arrangement of the equipment inside the building. The door opening size provides adequate clearance for equipment to enter and exit the building. The design also includes two personnel entry/exit doors. The doors are designed to survive the design basis tornado and wind loading and will remain operational after tornado wind pressure loads and tornado-missile loads. The ventilation systems are designed to maintain the following indoor conditions: Heating: minimum indoor temperature of 50°F; cooling: maximum indoor temperature of 100°F.

2.9 Deployment of FLEX Equipment

2.9.1 Haul Paths and Accessibility

Multiple haul routes are available from the FLEX storage building to any staging area. The appropriate haul routes have been evaluated for access per NEI 12-06, Section 5.3.2 (including liquefaction).

The equipment being transported for Phase 2 strategies will be towed by heavy duty pickup trucks. The FLEX Pump vehicle (pumper truck) can also be used to tow equipment (if the N+1 pumper truck is available). The tires on the frontend loader/backhoe are designed to withstand small debris punctures and razor wire cuts/penetration (i.e., large commercial/military grade, run-flat, non-pneumatic tires). Debris clearing equipment is also stored in the FLEX storage building. This will provide the equipment with direct access to the critical travel paths providing timely debris removal. Any transmission lines that may be brought down by an external hazard are assumed to be electrically charged until verified otherwise. Equipment is available to address downed power lines (e.g. - v-watch proximity meters).

It was determined through walk downs that all haul paths can support a minimum of two lanes of normal vehicular traffic. This decreases the likelihood of a path being completely blocked, as well as reduces the time it will take to clear any debris adequately to deploy the FLEX equipment. The possibility exists to move off of the roadway onto firm level roadway shoulders to avoid debris along a portion of the deployment route paths.

Based on the results of a liquefaction potential assessment, the overall liquefaction potential at the FLEX storage building and across the designated travel paths is deemed low for the postulated seismic ground motions. The risk of surface displacement due to faulting or lateral spreading is also deemed low (Reference 3.15, Section 2.5).

A debris assessment for the site was performed to determine debris removal equipment requirements. It was determined that the debris removal equipment should be capable of moving large debris such as automobiles, trees, pieces of buildings, switchyard structures, and concrete barriers, in addition to general assorted small debris such as tree limbs. Based on this assessment, it was determined that a medium size wheeled frontend loader/backhoe with appropriate bucket and horsepower can move the postulated debris in a single maneuver which simplifies and speeds the debris removal effort. Two large diesel powered pickup trucks with large steel snowplow blades are also available for clearing debris from the roadways. A variety of hand tools is also available to facilitate debris removal.

2.10 Deployment of Strategies

This section of the Final Integrated Plan describes how the equipment used for implementing the strategies described in Sections 2.3, 2.4, 2.5, and 2.6 will be deployed. Susquehanna uses a common electrical strategy and a common hydraulic (water supply) strategy for the three strategy sections described below. The Electrical supply strategy is described in Section 2.3 (Phase 2 in Section 2.3.2 and Phase 3 in Section 2.3.3).

2.10.1 Core cooling Strategy

During Phase 1 installed plant equipment is used (RCIC and station batteries). For Phase 2, the water supply equipment (FLEX pump and hoses) and electrical supply equipment (generators, cables, and switchgear trailer) will be transported from the FLEX Building to the appropriate staging areas (FLEX Pump near the Spray Pond and electrical equipment near the ‘E’ Diesel Generator) as shown on Figures 1, 3, and 4.

During Phase 1 the RCIC system pumps water from the Suppression Pool to the RPV and the water returns to the Suppression Pool as steam via the SRVs and RCIC turbine exhaust. For Phase 2, water is pumped from the Spray Pond through the FLEX pump into the RHRSW system. The RHRSW system connects to the RHR system and provides flow through permanently installed piping connections. The RHR system is used to direct water into the RPV.

For Phase 3 the same basic strategies are used, but the on-site FLEX equipment is augmented by the off-site NSRC (or other source) equipment.

2.10.2 Containment Integrity Strategy

During Phase 1 installed plant equipment is used (RCIC, station batteries, and HCVS). For Phase 2, the water supply equipment (FLEX pump and hoses) and electrical supply equipment (generators, cables, and switchgear trailer) will be transported from the FLEX Building to the appropriate staging areas (FLEX Pump near the Spray Pond and electrical equipment near the 'E' Diesel Generator) as shown on Figures 1, 3, and 4.

During Phase 1 the RCIC system pumps water from the Suppression Pool to the RPV and the water returns to the Suppression Pool as steam via the SRVs and RCIC turbine exhaust. For Phase 2, water is pumped from the Spray Pond through the FLEX pump into the RHRSW system. The RHRSW system connects to the RHR system and provides flow through permanently installed piping connections. The RHR system is used to direct water into the Primary Containment. The HCVS system is used in all 3 Phases to maintain the Primary Containment pressure within limits and in a desired operating range.

For Phase 3 the same basic strategies are used, but the on-site FLEX equipment is augmented by the off-site NSRC (or other source) equipment.

2.10.3 Spent Fuel Pool Cooling (SFP) Strategy

During Phase 1 installed plant equipment is used (the spent fuel pool water volume). For Phase 2, the water supply equipment (FLEX pump and hoses) and electrical supply equipment (generators, cables, and switchgear trailer) will be transported from the FLEX Building to the appropriate staging areas (FLEX Pump near the Spray Pond and electrical equipment near the 'E' Diesel Generator) as shown on Figures 1, 3, and 4.

During Phase 1 the spent fuel pool water volume is allowed to heat up. For Phase 2, water is pumped from the Spray Pond through the FLEX pump into the RHRSW system. Flow from the RHRSW system can be directed through a hose to a standpipe and then from the standpipe into another hose to the SFPs (either water flow into the

SFPs or a spray onto the SFPs). The RHRSW system could also be connected to the RHR system which can provide flow into the SFPs through permanently installed piping connections.

For Phase 3 the same basic strategies are used, but the on-site FLEX equipment is augmented by the off-site NSRC (or other source) equipment.

2.10.4 Fueling of Equipment

The Fuel Oil Storage Tank (FOST) associated with the 'E' Emergency Diesel Generator contains approximately 80,000 gallons of ultra-low sulfur diesel fuel. The 'E' FOST is the preferred source of diesel fuel for Susquehanna's FLEX equipment. This FOST can provide diesel fuel to the Phase 2 FLEX equipment for greater than 72 hours (References 3.65 through 3.67).

The FOSTs for the "A' through 'D' Emergency Diesel Generators each contain approximately 50,000 gallons of low sulfur fuel and are not the preferred source of diesel fuel for the FLEX equipment. All five of the FOSTs are seismically designed and protected from all the BDBEE hazards (References 3.65 through 3.67).

As part of the FLEX mitigating strategy developed in response to NRC order EA-12-049, diesel fuel will be deployed to support temporary equipment operation. Equipment such as tow vehicles, tank trucks, pumper trucks, turbine generators, and debris removal equipment will require diesel fuel during ELAP events. The equipment will be stored with the fuel tank for the engine full of diesel fuel except for the turbine generators (no onboard fuel tanks). The onboard storage capacity will be sufficient for operation during the early stages of the ELAP event.

During ELAP events, fuel will be drawn out of the Diesel Generator (DG) E FOST using a lift pump. The lift pump will be connected to the DG E FOST using the existing dipstick connection and a lift assembly. A check valve is used in the lift pump suction assembly to minimize priming time required for the lift pump after each use. The fuel will be transferred to two tank trucks. One of the tank trucks will be stationary and function as a fuel tank for the turbine generators (Turbine Generator Tank Truck (TGTT)) and other FLEX equipment. The turbine generators will be connected to the TGTT through a network of hoses (References 3.65 through 3.67). The second tank truck will be mobile and deploy fuel to various equipment (Mobile Tank Truck (MTT)), including the FLEX pumper trucks.

The lift pump could be used up to 72 hours into the event using fuel oil in the DG E storage tank. On site fuel supply tank trucks would be used, if available, to supplement the fuel deployment strategy. In addition, during ELAP events, local fuel suppliers will be contacted to obtain supplemental fuel required to support operation of the FLEX equipment during both ELAP events, as applicable. During extended ELAP events, fuel will be brought onsite to support continued operation.

If during the ELAP, the pumper truck is hooked up and running 4.5 hours into the event, it would be appropriate to fill the MTT first, to support pumper truck operation. The pumper truck must continue to function and provide cooling to the core. Fuel for the lift pump will be supplied using a one of two 5-gallon diesel fuel cans stored in the FLEX Storage Building.

2.11 Off-site Resources

2.11.1 National SAFER Response Centers

The commercial nuclear power industry has established two National SAFER Response Centers (NSRCs) to support utilities during BDBEEs. Susquehanna has established contracts with the Pooled Equipment Inventory Company (PEICo) to participate in the process for support of the NSRCs as required.

Each NSRC holds five (5) sets of equipment, four (4) of which will be available for deployment when requested, the fifth set will have equipment in a maintenance cycle. In addition, on-site FLEX equipment hose and cable end fittings are standardized with the equipment supplied from the NSRC.

In the event of a BDBEE and subsequent ELAP / LUHS event, equipment will be moved from an NSRC to a local staging area established by the Strategic Alliance for FLEX Emergency Response (SAFER) team. FLEX strategy requests to the NSRC are directed by Susquehanna procedures.

The *SAFER Response Plan for SSES* (Reference 3.91) has been approved by SAFER and Susquehanna. Staging areas, travel paths and congested area flight plans have all been walked down and approved by NSRC personnel. The SAFER Response Plan can have up to four (4) Staging Areas (A through D). Staging Area 'A' is where the equipment will be used on-site to perform a FLEX function. Staging Area 'B' is a near-site location to stage equipment before moving it to Staging Area 'A' (the South Gate House Parking Lot at SSES and a Helicopter Landing Zone is the helipad next to the main site access road off Route 11). Staging Area 'C" is an off-site location selected to be between 25 to 35 miles from the site (outside the postulated 25 mile damage radius and inside the flight range of a loaded cargo helicopter). Staging Area 'D' is an optional alternate off-site location that Susquehanna has chosen not to utilize.

Susquehanna's Staging Area "C" is at the Wilkes-Barre/ Scranton International airport (referred to as AVP). Communications will be established between the SSES plant site and the SAFER team via satellite phones (or other available methods) and required equipment moved to the site as needed. First arriving equipment will be delivered to the site within 24 hours from the initial request. The order in which equipment is delivered is identified in the SSES SAFER Response Plan (Reference 3.91).

NSRC personnel will commence delivery of a pre-selected equipment set from the NSRC upon notification. Plans are to deliver equipment from off-site sources via truck or air lift. Typically, deliveries will go by truck using preselected routes and with any necessary escort capabilities to ensure timely arrival at the plant site staging area "B" or to staging area "C" approximately 27 miles from the site. The delivery of equipment from the intermediate staging area will use the same methodology. The "B" staging area is a large hard-surfaced area of approximately 2 to 3 acres in size. Helicopter landing considerations are accounted for in selection of the areas. These areas are designed to accommodate the equipment being delivered from the NSRC.

Depending on time constraints, equipment can be flown commercially to a major airport near the plant site and trucked or air lifted from there to the staging areas. The use of helicopter delivery is typically considered when routes to the plant are impassable and time considerations for delivery will not be met with ground transportation. Multiple pre-selected routes are one method to circumvent the effects of seismic events, floods, etc. and these routes take into account potentially impassible areas such as bridges, rivers, heavily wooded areas and towns. The drivers will have the routes marked and will be in communication with the NSRC to ensure that the equipment arrives on time.

2.11.2 Equipment List

The equipment stored and maintained at the NSRC for transportation to the local assembly area to support the response to a BDBEE at SSES is listed in Table 2.

See Reference 3.100 for descriptions and capabilities of equipment maintained by the NSRC.

2.12 Habitability and Operations

2.12.1 Equipment Operating Conditions

Following a BDBEE and subsequent ELAP / LUHS event at SSES, ventilation providing cooling to occupied areas and areas containing FLEX strategy equipment will be lost. Per the guidance given in NEI 12-06, FLEX strategies must be capable of execution under the adverse conditions (unavailability of installed plant lighting, ventilation, etc.) possible following a BDBEE resulting in an ELAP / LUHS event. The primary concern with regard to the loss of ventilation is the heat buildup which could occur with the loss of forced ventilation in areas that continue to have heat loads. Loss of ventilation analyses were performed to quantify the maximum steady state temperatures expected in specific areas related to FLEX implementation to ensure the environmental conditions remain acceptable for personnel habitability or accessibility and within equipment limits.

The key areas identified for all phases of execution of the FLEX strategy activities are the Main Control Room (MCR), RCIC pump room, battery rooms in the Control Structure, switchgear rooms in the Reactor Buildings, Refuel Floor (Spent Fuel Pool area), ESSW Pump House, RHR rooms and Containment areas.

2.12.1.1 Main Control Room Habitability

The primary strategy for maintaining the environment of the control room during Phase 1 is to open doors and to use a portable fan during the worst case warm weather conditions. Control Room temperature could potentially exceed 110 °F at 36 hours after the loss of Control Structure HVAC (Reference 3.72, Computer Case Number 95-148). NUMARC 87-00 Rev.

1 (Reference 3.71), page 2-14 indicates that light work at 110°F is tolerable for limited times (4-hour intervals). During warm weather conditions, actions could be taken to provide natural circulation and forced cooling of the Control Room by opening Control Structure Doors and using a portable fan to prevent exceeding the 110°F habitability limit (Reference 3.72). Report GENSTP3-001 (Reference 3.74) indicates electrical equipment can experience temperature excursions up to 120°F for an indefinite period of time, therefore, no adverse impacts on control room equipment is anticipated.

For cold weather conditions, lighting and equipment heat loads are expected to maintain control room temperatures well above freezing and the minimum temperature in the control room is not expected to drop below 60°F after 72 hours (Reference 3.72); therefore, no specific mitigating actions are required for the control room under these conditions.

For long-term cooling of the Control Room during an ELAP (Extended Loss of AC Power) scenario, supplementary actions are proceduralized to enhance circulation through the Control Room. These consist of using a portable fan and opening the Control Structure doors identified in Reference 3.72.

Opening these doors and using a portable fan creates a circulation pathway from Elevation 670' of the Plant Yard on east side of Reactor Buildings up Stair No. 120 on north side of Control Structure to the north end of the Control Room. Outside air entering the Control Room from Stair No. 120 will flow through the Control Room from north to south to Stair No. 221, where it will then flow up the stairs to the Turbine Building roof.

The primary strategy for maintaining the environment of the control room during Phase 2 is to open Control Structure doors and use a portable fan during worst case warm weather conditions. Control Room temperature could potentially exceed 110 °F at 36 hours after the loss of Control Structure HVAC (Reference 3.72, Computer Case Number 95-148). NUMARC 87-00 Rev. 1 (Reference 3.71), page 2-14 indicates that light work at 110 °F is tolerable for limited times (4-hour intervals). During warm weather conditions, actions would be taken to provide circulation cooling of the Control Room by using a portable fan and opening Control Structure Doors to prevent exceeding the 110 °F habitability limit (Reference 3.72). Report GENSTP3-001 (Reference 3.74) indicates electrical equipment can experience temperature excursions up to 120 °F for an indefinite period of time, therefore, no adverse impacts on control room equipment is anticipated.

Use of a portable fan and opening Control Structure doors as described in Reference 3.72, creates a circulation pathway from Elevation 670’ of the Plant Yard on east side of Reactor Buildings up Stair No. 120 on north side of Control Structure to the north end of the Control Room. Outside air entering the Control Room from Stair No. 120 will flow through the Control Room from north to south to Stair No. 221, where it will then flow up the stairs to the Turbine Building roof. A FLEX procedure was developed to implement the cooling strategy.

For cold weather conditions, lighting and equipment heat loads are expected to maintain control room temperatures well above freezing; therefore, no specific mitigating actions are required for the control room under these conditions.

The Phase 3 strategy for MCR cooling is to continue the Phase 2 strategy supplemented by portable equipment delivered from off-site. See Table 2 for a list of equipment that will be delivered to the site by the NSRC after notification by the plant; refer to Section 2.11 for a discussion on NSRC supplied equipment.

As resources become available, actions can be taken to transition away from extended Phase 2 coping strategies. Since no time sensitive Phase 3 actions have been identified, instructions for connection and utilization of NSRC equipment for long term coping or recovery will be provided by TSC personnel who will have assessed the condition of the plant and infrastructure, plant accessibility, and additional available off-site resources (both equipment and personnel) following the BDBEE.

2.12.1.2 RCIC Pump Room

The primary strategy for maintaining the environment of the RCIC room during both Phases 1 and 2 is to open Reactor Building doors to provide natural circulation cooling to the RCIC room during worst case ambient conditions. A Susquehanna specific calculation (Reference 3.73) shows RCIC room temperature reaches approximately 120 °F after 5 hours assuming an initial room temperature of 104 °F. As discussed in the Maintain Core Cooling Phase 2 discussion, Susquehanna plans on providing cooling water to the RCIC lube oil cooler when suppression pool temperature reaches approximately 200 °F, which occurs at about 5 hours into the event. If the specified Reactor Building doors are opened at 5 hours as described in Reference 3.73 Appendix P, room temperature would drop quickly to about 110 °F, which would allow plant personnel to enter the pump room and connect FLEX cooling water supply to the RCIC lube oil cooler. Report GENSTP3-001 (Reference 3.74) indicates electrical equipment can experience temperature excursions up to 120 °F for an indefinite period of time and temperature excursions up to 135 °F for up to 100 days; therefore, RCIC electrical components would not be adversely impacted by this worst-case temperature excursion.

Another Susquehanna specific calculation (Reference 3.75, Appendix N) shows that RCIC room remains above 60 °F for greater than 72 hours during “worst case” cold weather conditions, therefore no manual actions are required to maintain RCIC room environment during cold weather conditions.

FLEX procedures were developed to open RCIC pump room doors and other Reactor Building doors early in the event to facilitate natural circulation cooling of the RCIC room. If environmental conditions allow, operators would enter the RCIC room and establish the cooling water connection. In the event high temperature and humidity prevent room entry, the system would be operated for as long as possible without cooling of the lube oil. Upon failure of RCIC, the reactor vessel would be depressurized and makeup would be provided by the FLEX pump with suction from the spray pond.

Note that cooling water for the RCIC lube oil cooler would only be available after the FLEX pump is aligned and ready for vessel injection. Therefore, success of the Mitigation Strategy is not dependent on this Operator action, and opening of the RCIC pump room door is not a time sensitive action.

Since no time sensitive Phase 3 actions have been identified, instructions for connection and utilization of NSRC equipment for long term coping or recovery will be provided by TSC personnel who will have assessed the condition of the plant and infrastructure, plant accessibility, and additional available off-site resources (both equipment and personnel) following the BDBEE.

2.12.1.3 Engineered Safety Feature (ESF) Switchgear Rooms

Emergency switchgear and load center rooms were analyzed in Calculation EC-SBOR-0504 (Reference 3.75). Peak temperatures at 72 hours were found to be less than 120 °F. As discussed on page 218 of EC-SBOR-0504, temperatures less than 120 °F are acceptable for 100 days of switchgear operation. For time greater than 72 hours, emergency switchgear and load center room doors can be opened to provide natural circulation cooling of the equipment (Reference 3.75, Appendix O). Susquehanna developed proceduralized actions for opening doors during an ELAP event.

Under station blackout conditions, both units' switchgear is de-energized at the onset of the station blackout. The switchgear rooms remain de-energized until Phase 2 when portions of the switchgear are reenergized by the 4160 VAC FLEX generators. The rooms containing the 4160 VAC ESF switchgear will begin to heat up as the switchgear is energized by the 4160 VAC FLEX generators; therefore, they were evaluated for limiting temperatures for equipment survivability. The calculations performed for station blackout conditions (Reference 3.75) indicate that switchgear rooms will remain below 120 °F for greater than 72 hours. Therefore, the strategy for maintaining the environment in the switchgear rooms will be to open doors to the rooms, which will further reduce maximum switchgear room temperatures. Report

GENSTP3-001 (Reference 3.74) indicates that electrical equipment can experience temperature excursions up to 120 °F for an indefinite period of time, therefore, no adverse impacts on control room equipment is anticipated.

For cold weather conditions, the minimum temperature in the switchgear rooms is greater than 60 °F after 72 hours (Reference 3.75); therefore, no manual actions are required to maintain switchgear rooms under these conditions.

2.12.1.4 Battery Rooms

Susquehanna performed a calculation to evaluate hydrogen concentration versus time for the 125 VDC battery rooms and determined that hydrogen levels remain below 2% for up to 102 hours (Reference 3.76). The Phase 2 and Phase 3 mitigation strategy is to restore the normal battery room ventilation system using the onsite FLEX 4160 VAC generators. This will be accomplished well within 24 hours. The calculation for hydrogen generation in the 250 VDC battery rooms determined that hydrogen levels remain below 2% for up to 54 hours (Reference 3.76). Again, the mitigation strategy is to restore the normal ventilation system for Phase 2 and Phase 3 well within 24 hours.

Restarting the battery room exhaust fans removes hydrogen from the battery rooms and prevents extreme battery room temperatures during summer and winter conditions.

The Phase 2 and Phase 3 strategy for ventilation of the 125 VDC and 250 VDC Battery Rooms located in the Control Structure is to restart one of the two redundant Battery Room exhaust fans (0V116A/B) during Phase 2 of the Mitigation Strategy. These fans draw air from the battery rooms and discharge directly to the Standby Gas Treatment System vent stack (Reference 3.77). Makeup air to the battery rooms is supplied from the general area of the Control Structure through dampers located in the battery room walls near the floor. Therefore, under summer and winter conditions, battery room temperatures are maintained consistent with the ambient Control Structure temperature, and general ambient building temperatures are expected to preclude extreme battery room temperatures under summer and winter temperatures.

Since no time sensitive Phase 3 actions have been identified, instructions for connection and utilization of NSRC equipment for long term coping or recovery will be provided by TSC personnel who will have assessed the condition of the plant and infrastructure, plant accessibility, and additional available off-site resources (both equipment and personnel) following the BDBEE.

2.12.1.5 Refuel Floor/Spent Fuel Pool Area

Per the NEI 12-06 guidance, a baseline capability for Spent Fuel Cooling is to provide a vent pathway for steam and condensate from the SFP. The east wall of the reactor refueling floor is equipped with hatches that open into an equipment area for HVAC ductwork that is outside secondary containment. This equipment area has a roof hatch that opens to the atmosphere. A similar configuration exists at the west wall of the reactor refueling floor. These hatches would be opened manually to provide a vent path for spent fuel pool steam (Reference 3.45). Procedures are in place to perform these actions and the appropriate equipment is staged.

At ~9.8 hours after the start of the ELAP, Operations with Station support establishes air flow on the refuel floor by opening the Reactor Building doors and roof vents to remove steam generated from boil-off. This time sensitivity is based on the design basis heat load time to boil calculation (Reference 3.41) and a Refuel Floor habitability limit of 110 °F (Reference 3.45). Actual time sensitivity will be based on the actual heat load. This could substantially lengthen the time at which this action is required. The parameters will be monitored and the decision to perform this action will be made based on the actual conditions during the event.

2.12.1.6 ESSW Pump House

Under worst case extreme cold conditions, the pump house will need heaters powered from FLEX generators to maintain temperatures above freezing conditions. The pump house is normally maintained at or above 60 °F during winter conditions. As part of the FLEX strategy, a hose is routed into the pump house and connected to a RHRSW connection inside the building, therefore, a pump house door will be propped open during ELAP conditions. In the event of extreme cold, the portable 4160 VAC FLEX generators would be used to repower the existing heaters in the ESSW pump house to maintain the temperatures above 32 °F. Cooldown of the ESSW pump house under extreme winter conditions and heating requirements are evaluated in Reference 3.78, Appendix C.

SSES has not identified any potential for freezing of piping or instrument lines (currently installed) required for the FLEX strategies at this time (except the ESSW pump house). The modifications performed for FLEX ensured that freezing is not a concern.

2.12.1.7 Residual Heat Removal (RHR) Rooms

RHR room temperature will be controlled by repowering a RHR room cooler when Shutdown Cooling or Suppression Pool Cooling is placed in service during Phase 3. Portable 4160 VAC FLEX generators will be used to repower one RHR pump and one RHR room cooler on each Unit during Phase 3 of the Mitigation Strategy.

2.12.1.8 Containment

Containment conditions during the event are below the design limits of the containment, except Suppression Pool water temperature. During Phase 2, as in Phase 1, reactor core cooling is maintained using RCIC in automatic mode (i.e., with operators controlling the RCIC flow controller) with suction from the Suppression Pool. The Suppression Pool (SP) will heat up from decay heat being transferred from the RPV to the SP by RCIC and the use of SRVs for RPV pressure control. The SP will eventually reach saturated conditions at ~6 hours (Reference 3.24). At ~5 hours, the Hardened Containment Vent System (HCVS) is opened to maintain containment parameters below design limits and within the limits that allow continued use of RCIC (see the Maintain Containment response for additional discussion of the HCVS, Section 2.6). The containment design pressure is never challenged, but the MAAP calculations show that Suppression Pool temperature slightly exceeds the design temperature (228 °F calculated vs. 220 °F design value). Susquehanna has evaluated this small variance and determined that no containment structural limits are violated by this small temperature variance. FLEX makeup to the suppression pool will begin at 6 hours to maintain SP level (Reference 3.24). It is expected that drywell temperature will remain below the containment design basis temperatures during the ELAP / LUHS due to the actions of containment venting and injection of cool water from the spray pond via FLEX pumps.

A limited number of instruments in containment are required to remain operable for post-accident monitoring as specified in Technical Specification 3.3.3.1, *Post Accident Monitoring Instrumentation* (Reference 3.19). These instruments meet Regulatory Guide 1.97 Category I design and qualification requirements for seismic and environmental qualification, single failure criterion, utilization of emergency standby power, immediately accessible display, continuous readout, and recording of display (Reference 3.103). Additionally, refer to NTTF Tier 3 item closure plan for Instrument Enhancements for BDB Events (white paper, Joint steering committee presentation 10/20/2015, and SECY-15-0137, Notation Vote Request on Tier 2 and 3 Plans in ADAMS Package ML15254A006, SECY-15-0137 is ML15254A008 and there are 9 additional enclosures.). Containment entry is not required following an ELAP; therefore, personnel habitability/accessibility is not applicable.

Because all the drywell parameters are staying within their applicable design basis limits qualified components in the drywell, such as the SRVs and post-accident instrumentation are expected to be available during this type of event.

Since no time sensitive Phase 3 actions have been identified, instructions for connection and utilization of NSRC equipment for long term containment cooling will be provided by TSC personnel who will have assessed the condition of the plant and infrastructure, plant accessibility, and additional available off-site resources (both equipment and personnel) following the BDBEE.

2.12.2 Heat Tracing

For the SSES site, the FLEX strategies developed to respond to an ELAP / LUHS do not require any heat tracing to be functional. All hydraulic connections are made inside buildings that are expected to be well above freezing. The FLEX pumps and associated hose layouts have freeze protection considerations in place, if the weather is cold enough to warrant their use.

The storage of FLEX equipment is inside buildings that are expected to be well above freezing.

2.13 Personnel Habitability

Operators are trained on recognizing the symptoms of heat stress and on proper hydration methods to combat heat stress. Guidance derived from current site industrial safety procedures and passive cooling technologies already used by response personnel will be applied as deemed necessary to minimize impacts of heat stress. Continued accessibility will be assured by evaluation of room environments, application of heat stress countermeasures, and rotation of personnel to the extent feasible.

Personnel habitability for MCR was evaluated in Section 2.12.1.1 and determined to be acceptable.

2.14 Lighting

Immediately after the ELAP / LUHS begins the installed plant Emergency Lighting equipment will be put into use (Phase 1). At Susquehanna, the emergency lighting system is comprised of two subsystems. The first subsystem is the 125 VDC Station Battery Lighting System. This subsystem provides emergency lighting throughout the plant. However, in remote areas not served by the station battery subsystem, emergency lighting is provided by self-contained battery powered units of which there are four types: Exit lights which are 2-1/2-hour rated, emergency lighting centers which are 8- hour rated, emergency lighting units which are 8-hour rated, and stair lights which are 2-1/2-hour rated.

The emergency lighting units provide emergency lighting instantaneously and automatically upon the failure or interruption of the essential lighting power supply. Each emergency lighting unit consists of a battery, a charger, control and monitoring circuits, and devices enclosed as a self-contained unit. Each emergency lighting unit will supply 2 locally mounted sealed beam lamps for 8 hours without the charger. Emergency lighting units exist in the Control Room, Operating Areas (Reactor Building, Turbine Building, and Diesel Generator Buildings, Control Structure, and ESSW Pump house), stairways and major walkways, building exits, and the TSC.

During Phase 2 the FLEX generators will be used to repower the Main Control Room lighting and selected Reactor Building lighting equipment. The FLEX vehicles (two pickup trucks, two fuel trucks, two FLEX pump pumper trucks, and the frontend loader/backhoe all have lights that can be used to provide general area lighting where people are working. There are also lights on the switchgear trailer. Additional general area outdoor lighting may be available from the Security lighting system.

Flashlights are another means of lighting for an individual or team to accomplish FLEX actions in low light situations. In addition, members of the operating staff are equipped with flashlights.

During Phase 3, six portable lighting towers will be provided by the NSRCs that can be used around the plant site.

2.15 Communications

Susquehanna's communications equipment that can be used during an ELAP consists of the plant Public Address system, the Site Radio system, the plant Sound Powered phone system, and Satellite Phones (both installed and hand held).

The portable FLEX generators will provide power to charge hand held radios and satellite phone batteries during the event. The installed plant radio and PA systems will be repowered from FLEX 4160 VAC generators feeding normal 480 VAC Load Centers. The sound powered phones do not require external power. Communications assessments revealed the need for satellite phones. Satellite phones will be used as an alternate means to normal communications equipment to communicate with selected on-site personnel and off-site Susquehanna Emergency Response facilities and off-site agencies. There are both installed and hand held satellite phones available on-site to facilitate communications. Susquehanna will meet the requirements of NEI 12-01 (Reference 3.11, Section 4).

Susquehanna has previously transmitted information regarding communications to the NRC in 6 separate letters (References 3.68, 3.69, 3.89, 3.90, 3.92, and 3.93).

The plant Public Address (PA) system will assist with initial notifications and directions to on-site personnel, the on-shift Emergency Response Organization (ERO) personnel, and in-plant response personnel. Battery operated handheld and permanently installed satellite phones will assist with initial notifications and directions to off-site ERO personnel and other personnel. Following a BDBEE, the SSES plant PA system will be available as an alternate method for on-site communications. Susquehanna currently has a 5-channel page-party system (Public Address) with a normal power supply and a back-up supply. Some plant areas are not on the backup supply. Communications to individuals in these areas will need to be via the plant radio and messengers. The Plant PA is powered from the Vital AC power system which is backed up by station batteries, and is expected to last At least 4 hours, following the loss of all AC power. Therefore, the plant PA system will allow the initial plant emergency announcements (event classification, site accountability, etc.) to be made before the UPS battery is lost. The FLEX portable generators will restore power to the PA system.

Sound Powered Phones are available in specific site locations and would be mainly used for operational functions. Sound Powered Phones are located in certain safety-related structures and headsets are stored inside the control room and other locations protected from flooding, wind, and seismic effects around site. Sound Powered Phones do not require power and are separate from radio and phone with regard to location, pathway, and power.

The Plant Radio System (including antenna amplifiers) normal power supply is offsite power from a Turbine Building Motor Control Center. Upon failure of the normal power supply, the Radio system UPS battery is expected to last 8-16 hours depending on usage. When the battery is no longer available, radio (Line of sight- Talk around mode) would still be available to communicate outdoors by security staff and operators, and to a limited degree, inside plant buildings. The Radio (Plantwide system) would become available to communicate in all areas when power is restored to the battery charger utilizing the FLEX portable generators. Handheld radios have 10-hour batteries. Spare batteries are stored in the control room and other locations protected from flooding, wind, and seismic effects around site. Spare batteries are available to extend power beyond 24 hours and are separate from sound powered and satellite communications methods. To provide a continuing source of charged radio batteries, battery charging stations will be strategically located based on the event to recharge batteries needed for radios (primary location is in the Control Structure).

The FLEX communications equipment is located in the Control Structure, the Reactor Buildings, and the Turbine Building which are seismically robust structures.

2.16 Water sources

Susquehanna relies on the Suppression Pools and the Spray Pond (the Ultimate Heat Sink - UHS), which is a seismically qualified water source, to be available during Extended Loss of AC Power (ELAP) conditions. The Spray Pond meets the requirements of NEI 12-06 (Reference 3.3) for a long-term water source.

There are numerous other water sources that may be available for the operators to use in response to a BDBEE. Depending on the BDB event, all, some, or none of these sources may be available. During Phase 3 water could be pumped from the Cooling Tower basins or the Susquehanna river to replenish the Spray Pond. In addition, water could be trucked into the site.

The Emergency Operating Procedures (EOPs) at Susquehanna provide water source and injection system information to the operators.

Table 4 provides an expanded list of on-site water sources considered for core cooling and SFP cooling coping strategies. This table considers each source's design robustness with respect to seismic events, floods, high winds, and associated missiles. The Suppression Pools and Spray Pond meet the qualification guidelines of NEI 12-06 for an injection source that can be credited for the ELAP / LUHS event. Other tanks and basins are included in the table to provide a comprehensive list of site water sources. These non-creditable water sources may be available for injection, depending on the cause of the event, and although these are not credited, they could be considered for use during an actual event.

2.17 Shutdown and Refueling Modes

SSES has implemented the guidance in the Nuclear Energy Institute position paper entitled "*Shutdown/Refueling Modes*" (Reference 3.70) addressing mitigating strategies in shutdown and refueling Modes. This paper has been endorsed by the NRC Staff (Reference 3.10).

All modes were considered, and the FLEX strategies are applicable in the same manner for all modes. The strategies for core cooling during Modes 4 and 5 are similar to those for Modes 1-3.

2.17.1 <u>FLEX Mode 4</u>

If an ELAP occurs during Mode 4 (cold shutdown), water in the reactor vessel will heat up. When temperature reaches 212 °F, (Mode 3, hot shutdown) the vessel will begin to pressurize. The turbine driven systems (RCIC and HPCI) are generally available for emergency use at the beginning and end of an outage, thus during the pressure rise RCIC can be returned to service with suction from the Suppression Pool to provide injection flow. When pressure rises to the SRV setpoints then pressure will be controlled by SRVs. The primary and alternate strategies for Mode 4 are the same as those for Modes 1 – 3 as discussed for core cooling (Sections 2.4.1 through 2.4.3). It should be noted that the heatup from cold shutdown conditions through vessel pressurization will provide a significant amount of time to obtain FLEX water sources for makeup and cooling and FLEX generators for electrical power.

2.17.2 <u>FLEX Mode 5</u>

During Mode 5, many variables exist which impact the ability to cool the core. To accommodate the activities of vessel disassembly and refueling, water levels in the reactor vessel and the reactor cavity are often changed. The most limiting condition is the case in which the reactor head is detensioned and water level in the vessel is at or below the reactor vessel flange. If an ELAP / LUHS event occurs during this condition, then (depending on the actual decay heat load based on the current time after shutdown) boiling in the core could occur fairly rapidly.

To mitigate the consequences of this scenario, a FLEX pump could be pre-staged near the Spray Pond and hoses could be routed similar to the flow path using the tie-ins described in Sections 2.4.2 or 2.5.2. The pre-staged pump would provide the water for core cooling while other equipment is being staged. In addition, another option would be to retension the reactor head, allow the reactor to repressurize, and use RCIC to pump water from the Suppression Pool into the reactor vessel.

With the reactor head removed and SFP gates removed in Mode 5, makeup to the RPV can also be accomplished via the SFP makeup strategy utilizing the FLEX pump.

Modes 4 and 5 SFP Cooling Strategy

For SFP considerations refer to Section 2.5.

Modes 4 and 5 Containment Strategies

Except for the specific containment closure requirements of Technical Specifications, equipment hatches and airlocks are often opened during refueling outages. Each breach of containment integrity is administratively controlled.

The containment may or may not initially be intact in operating Modes 4 and 5 during an outage if an ELAP occurs. Closure of large hatches and penetrations will not be possible until power is restored. If the penetrations are all intact and closed, then the Phase 1 and 2 FLEX strategy will be employed (i.e. use of HCVS) if containment limits should be approached. These coping strategies for maintaining containment integrity include monitoring containment pressure. If the containment is not intact the containment pressure limits will not be challenged.

2.18 Sequence of Events

Table 5 presents a sequence of events timeline for an ELAP / LUHS event at SSES. Validation of each of the FLEX time sensitive actions has been completed in accordance with the FLEX Validation Process document issued by NEI (Ref. 3.101) and includes consideration for staffing (Reference 3.101 and 3.88). Time to clear debris to allow equipment deployment is assumed to be up to 2 hours from the start of the event (Reference **Error! Reference source not found.**). This time is considered to be conservative based on site reviews and the location of the FLEX storage building. The deployment routes are fairly short, can be partially shared and are not adjacent to many significant sources of debris. The debris removal equipment is stored in the hardened FLEX storage building which is inside the protected area (Figure 1).

Additional technical basis details regarding the identified time sensitive actions (i.e., actions which have a “Y” in the ELAP Event Time Constraint column of Table 5) is provided below. These time sensitive actions were validated prior to partial implementation (before HCVS installation was completed) and the validation was completed prior to Unit 1 and Unit 2 full implementation (Reference 3.94), which now includes the use of the recently installed HCVS equipment.

1. 45 minutes, Operations completes DC Load shedding per procedure (References 3.26 and 3.27) to extend 125 VDC and 250 VDC battery

lives. This increases Phase 1 coping time by increasing the availability of Reactor Core Isolation Cooling (RCIC) and other equipment powered by the batteries.

2. 50 minutes, After all attempts to start Emergency Diesel Generators (EDGs) have been unsuccessful and off-site power has not been restored, Operations declares an ELAP and enters appropriate procedures. FLEX equipment is directed to be connected to plant systems. This is time sensitive at a time greater than 1 hour. The time required to connect the 4160 VAC FLEX generators and a FLEX pumper truck and place them in service has been validated to ensure they are adequate to support the transition to Phase 2 (Reference 3.94).

3. 1.0 hr., Using manual control of SRVs to begin depressurizing the RPV in accordance with EOPs (References 3.26 through 3.30) at less than 100° F/hr into a range of 150 – 300 psig. This is time sensitive to support the base strategy to partially depressurize the RPV to stay above the pressures that would isolate RCIC and place the RPV at lower pressure to facilitate transition to the use of the FLEX pumper truck injection on loss of steam driven feed systems.

4. 5.0 hr., Operators begin venting the Suppression Chamber using the Hardened Containment Vent System per EOPs to maintain containment parameters within limits. Per the MAAP case (Reference 3.24), Suppression Pool temperature reaches approximately 200 °F at 5 hours. Peak suppression pool parameters are:
    a. Peak Suppression Pool Pressure: 22 psia at 4.9 hours; and,

    b. Peak Suppression Pool temperature: 226° F at 16.1 hours and 228° F at 37.2 hours.

5. 5.0 hr., Station Personnel align the FLEX Pumper truck to feed Residual Heat Removal Service Water (RHRSW) at the ESSW pump house, which cross-ties to Residual Heat Removal (RHR), and is capable of supporting all Phase 2 safety function needs (FLEX pumper truck water injected through RHR to the RPV is the back-up, when RCIC is no longer available). The FLEX pumper truck supplying RHRSW and cross-tied to RHR is capable of supplying cooling water to both units. (Reference 3.20). When steam flow from the RPV is insufficient to support RCIC operation, due to the decrease in decay heat, transition to FLEX pumper truck injection to the RPV will be used.

6. 5.0 hr., Operations cross-ties RHRSW to supply cooling flow to the RCIC lube oil coolers. This action assists in maintaining RCIC functional by preserving the RCIC Turbine bearings and barometric condenser per the GEH report (Reference 3.18). Susquehanna plans on providing cooling water to the RCIC lube oil cooler when suppression pool temperatures reach approximately 200˚F. The GEH Report (Reference 3.18) indicates that this approach will prolong the life of RCIC turbine bearings and the barometric condenser. In addition, Susquehanna Calculation EC-050-1032 (Reference 3.16) evaluated RCIC NPSH conditions during the ELAP event, as defined in the baseline coping strategy. The calculation demonstrates that there would be adequate NPSH available to support RCIC operation under the conditions described in the baseline coping strategy (Reference 3.24).

7. 6.0 hr., Operations completes AC load shedding/re-alignment and the 4160 VAC FLEX generators are energized and feeding the 4160 VAC Buses, load centers, and selected important loads (References 3.26 and 3.27). This repowers the 125 VDC and 250 VDC RCIC battery chargers, and other important loads required for FLEX mitigation strategy. Evaluations were performed that determined battery life is greater than 8.0 hours without the chargers. (Reference 3.36). The switching moves and time required to complete this action item were evaluated and validated to try to shorten the time frame to power essential loads. The time frame for Item 7 is readily achievable in less than 6 hours as was validated, which provides margin for unanticipated complications (Reference 3.94).

8. 6.0 hr., Operations begins makeup to the Suppression pool (SP) with continuous feed to make-up for boil-off out the Reliable Hardened Containment Vent System (HCVS) as directed by the EOPs (References 3.26 through 3.30). The MAAP analysis (Reference 3.24) demonstrates that the SP will begin boiling after 6 hours, and two SP temperature peaks will occur - 226˚F at 16.1 hours and 228˚F at 37.2 hours. Makeup to the SP adds cooler water to the SP, which helps lower peak suppression pool temperature. Peak suppression chamber pressure reaches 22 psia.

9. 9.8 hr., Operations with Station support establishes air flow on the refuel floor by opening the Reactor Building doors and roof vents to remove steam generated from boil-off. This time sensitivity is based on the

design basis heat load time to boil calculation (Reference 3.41) and a Refuel Floor habitability limit of 110°F (Reference 3.45). Actual time sensitivity will be based on the actual heat load. This could substantially lengthen the time at which this action is required.

2.19 Programmatic Elements

2.19.1 Overall Program Document

Susquehanna's program for FLEX in response to a BDBEE is described in two documents; the Program Description - for Roles and Responsibilities (Reference 3.80), and a Program Document that specifies the strategies for Susquehanna (Reference 3.79). Together, the two documents describe the FLEX program for SSES.

The key program elements provided in the Program Document and Program Description include:

- Description of the FLEX strategies and basis
- Provisions for documentation of the historical record of previous strategies and the basis for changes
- The basis for the ongoing maintenance and testing programs chosen for the FLEX equipment
- Designation of the minimum set of parameters necessary to support strategy implementation

In addition, the program description includes a list of the FLEX basis documents that are kept up to date for facility and procedure changes.

Existing design control procedures have been revised to ensure that changes to the plant design, physical plant layout, roads, buildings, and miscellaneous structures will not adversely impact the approved FLEX strategies.

Future changes to the FLEX strategies may be made without prior NRC approval provided 1) the revised FLEX strategies meet the requirements of NEI12-06 (Reference 3.3), and 2) a basis is documented that ensures that the change in FLEX strategies continues to ensure the key safety functions (core and SFP cooling, Containment integrity) are met.

2.19.2 Procedural Guidance

The overall plant response to an ELAP / LUHS event is accomplished through normal plant command and control procedures and practices. The plant emergency operating procedures (EOPs) or abnormal operating procedures (AOPs) will govern the operational response. The FLEX strategies will be deployed in support of the AOPs/EOPs using separate FLEX Support Guidelines (FSGs, which at Susquehanna are in the DC class of procedures)), which will provide direction for using FLEX equipment in maintaining or restoring key safety functions. The inability to predict plant conditions following an extreme external event has prompted the creation of a new set of procedures. These procedures, FLEX Support Guidelines (FSGs, DC-FLEX and DC-B5B at Susquehanna), provide guidance for deployment of FLEX equipment. FSGs are written such that they can be implemented during a variety of post event conditions. When the use of FLEX equipment is required for response to a FLEX stylized BDBEE, EOPs or AOPs will direct the entry into and exit from the appropriate FSG. This procedure approach conforms to NEI 12-06 (Reference 3.3), Section 11.4 guidance for the relationship between FLEX procedures and other relevant plant procedures.

FSGs at SSES were developed to provide pre-planned strategies for accomplishing specific tasks associated with implementation of FLEX strategies.

Changes to plant procedures including FSGs are screened using existing procedural guidance which incorporates aspects of NEI 96-07 (Reference 3.81) and NEI 97-04 (Reference 3.82).

2.19.3 Staffing

Using the methodology of NEI 12-01, *Guideline for Assessing beyond Design Basis Accident Response Staffing and Communications Capabilities* (Reference 3.83), assessments of the capability of the SSES 1 and 2 on-shift staff and ERO to respond to a BDBEE were performed for Phase 1 and for Phase 2 (Reference 3.88).

Section 11.7 of NEI 12-06 (Reference 3.3) provides the following assumptions for evaluating staffing for FLEX strategies:

- On-site staff are at the site administrative minimum shift staffing levels (minimum staffing may include additional staffing that is procedurally brought on-site in advance of a predicted external event, e.g., a hurricane),

- No independent, current events are ongoing (e.g., active security threats), and

- All personnel on-site are available to support the site response.

The Staffing Assessment (Reference 3.88) documents the results of an assessment of the capability of the Susquehanna (SSES) minimum staffing as defined in the Emergency Plan, supplemental staff allowed by administrative staffing procedures, and augmented Emergency Response Organization (ERO) to respond to a Beyond Design Basis External Event (BDBEE). The staffing assessment report contains the results of the analyses used to determine the staffing needed to respond to the BDBEE at Susquehanna.

The assumptions for the scenario are based on accepted industry guidance and postulate that the BDBEE involves a large-scale external event that results in:

A. an extended loss of AC power (ELAP)

B. an extended loss of ultimate heat sink (UHS)

C. impact on all units (all units are in operation at the time of the event)

D. impeded access to the units by off-site responders as follows:

- 0 to 6 Hours Post Event – No site access. (Initial Phase)

- 6 to 24 Hours Post Event – Limited site access. Individuals may access the site by walking, personal vehicle or via alternate transportation capabilities (e.g., private resource providers or public sector support). (Transition Phase)

- 24+ Hours Post Event – Improved site access. Site access is restored to a near-normal status and/or augmented transportation resources are available to deliver equipment, supplies and large numbers of personnel. (Final Phase)

The assessment of the minimum on-shift staffing was performed by a team of subject matter experts from Operations, Maintenance, Radiation

Protection, Chemistry, Security, Effluents, Emergency Preparedness and industry consultants. This team performed the Staffing Assessment in July 2014, with subsequent minor revisions being made. The participants reviewed the assumptions and applied existing procedural guidance and included applicable draft FLEX implementation strategies for coping with a BDBEE using minimum on-shift staffing. Particular attention was given to the sequence and timing of each procedural step, its duration, and the on-shift individual performing the step to account for both the task and time motion analyses of NEI 10-05, *Assessment of On-Shift Emergency Response Organization Staffing and Capabilities* (Reference 3.12).

The on-shift staffing task timing analysis concluded that there were no task overlaps for the activities that were assigned to the on-shift personnel.

The on-shift staffing task performance analysis determined that the available on-shift resource and supplemental staff complement from Operations, Security, Chemistry, Effluents and Health Physics can be expected to accomplish all identified tasks during the Initial Phase of an ELAP.

The expanded ERO function analysis concluded that sufficient personnel resources exist in the current SSES augmented ERO to fill positions for the expanded ERO functions during the Transition Phase of an ELAP. Thus, adequate ERO resources and capabilities necessary to implement the Transition Phase activities exist in the current program.

Revision 1 modified this Staffing Assessment in response to NRC questions regarding usage of Security personnel.

Revision 2 modified this Staffing Assessment to support manual operation of the ADS SRVs from the relay rooms starting at Hour 2 for NPOs 3 and 4, to connect hoses and establish RCIC cooling by Hour 5 for PCO3 and NPOs 1 and 2, to start operation of FLEX generators from Hour 4 to Hour 5, and to initiate pump house heating at Hour 8.

2.19.4 <u>Training</u>

Training has been developed and delivered to the target populations (Operations, Maintenance, Chemistry, Radiation Protection, Security, and ERO staff) using the Systematic Approach to Training (SAT) process. The training conducted Susquehanna the requirements of NEI 12-06 (Reference 3.3), Section 11.6.

The general population is trained using NANTeL courses provided by the Emergency Response Training Development (ERTD) Working Group (INPO facilitated). The ERTD conducted a job analysis to identify common training topics and coordinated the design and development of common training materials.

Susquehanna's staff that is responsible for the implementation of the FSGs also complete additional NANTeL training provided by the ERTD working group.

ERO decision makers receive additional training on directing actions and implementing strategies following a BDBEE.

2.19.5 FLEX Equipment List

The equipment necessary for the implementation of the FLEX strategies in response to a BDBEE at SSES is listed in Table 2. The table includes the quantity and equipment performance criteria for the required FLEX equipment. FLEX equipment is primarily stored in the FLEX storage building. Some equipment (e.g. - spray nozzles for SFP makeup) are stored near their staging areas in the Reactor Buildings and Control Structure. Specific details regarding fittings, tools, hose lengths, consumable supplies, etc. are not provided in Table 2.

2.19.6 N+1 Equipment Requirement

NEI 12-06 (Reference 3.3) invokes an N+1 requirement for the major BDB FLEX equipment that directly performs a FLEX mitigation strategy for core cooling, containment, or SFP cooling in order to assure reliability and availability of the FLEX equipment required to meet the FLEX strategies. Susquehanna meets this requirement.

Sufficient equipment is available to address all functions at all units on-site, plus one additional spare, i.e., an N+1 capability, where "N" is the number of pieces of equipment required by the FLEX strategies for all units on-site. Where a single resource is sized to support the required function of both units a second resource is available to meet the +1 capability.

In addition, where multiple strategies to accomplish a function have been developed, the equipment associated with each strategy does not require N+1 capability (e.g. – Spent Fuel Pool Cooling).

NEI submitted a letter to the NRC (Reference 3.104) that defined the quantities of spare hoses and cables to be stored on site consistent with NEI 12-06 (Reference 3.3). The definition stated that either: (a) 10 percent additional lengths of each size and type of hoses and cabling necessary for the “N” capability plus at least one spare of the longest single section/length of hose or cable be provided; or, (b) that spare cabling and hose of sufficient length and sizing to replace the longest single run needed to support any FLEX strategy. The NRC endorsed this approach as documented in Reference 3.105. These hoses and cables are passive components being stored in a protected facility. It is postulated the most probable cause for degradation/damage of these components would occur during deployment of the equipment. Therefore, for Susquehanna, the +1 capability is accomplished by having sufficient hoses and cables to satisfy the N capability +10% spares or at least 1 length of hose and cable. Susquehanna has provided additional hoses or cables equivalent to 10% of the total length of each type/size of hose or cable (or at least one length of hose or cable) necessary for the “N” capability as described in References 3.104 and 3.105 to establish the quantities of N+1 hose and cable. This 10% margin capability ensures that failure of any one of these passive components would not prevent the successful deployment of a FLEX strategy. The additional hoses and cables are of the same type and capability as the N hoses and cables. Therefore, there is no change in voltage drops or flow resistance.

The N+1 requirement does not apply to the FLEX support equipment, vehicles, and tools. However, these items are subject to inventory checks, requirements, and any associated maintenance and testing.

2.19.7 Equipment Maintenance and Testing

The portable FLEX equipment that directly performs a FLEX mitigation strategy for the core cooling, containment integrity, or spent fuel pool cooling is subjected to initial acceptance testing and to subsequent periodic maintenance and testing utilizing the guidance provided in INPO AP 913, *Equipment Reliability Process* (Reference 3.98), to verify proper function.

The standard EPRI industry PM process (similar to the Preventive Maintenance Basis Database) is used to establish the maintenance and testing actions for FLEX equipment. EPRI has completed and issued the *Preventive Maintenance Basis for FLEX Equipment – Project Overview Report* (Reference 3.95). This provides assurance that stored or pre-staged FLEX equipment is being properly maintained and tested.

EPRI FLEX maintenance templates (where provided) were used to develop the specific maintenance and testing guidance for the associated FLEX equipment. In the absence of an EPRI FLEX template, existing maintenance templates (where available) were used to develop the specific maintenance and testing guidance. For all other equipment not covered by a maintenance template, manufacturer OEM or industry standards were used to determine the recommended maintenance and testing.

The PM Templates include activities such as:

- Periodic Static Inspections
- Periodic Fluid Filter Replacements
- Periodic Fluid Analysis
- Periodic Generator Load Tests
- Periodic Component Operational verifications
- Periodic Walkdowns

2.19.8 FLEX Equipment Unavailability Tracking

The unavailability of FLEX equipment and applicable connections that directly perform a FLEX mitigation strategy for core, containment, and SFP is managed such that risk to mitigating strategy capability is minimized. Maintenance/risk guidance conforms to the guidance of NEI 12-06. Changes were made to NDAP-QA-1902 (Reference 3.85), OI-013-001 (Reference 3.86), and the '*Equipment Important To Emergency Response*' procedure, EP-115 (Reference 3.87), to provide assurance that adequate availability of equipment and connections is maintained. The FLEX equipment can be used for other than emergency response, as long as compliance with the out of storage requirements are met. Emergency response use will always take precedence over other uses.

The unavailability of FLEX equipment and applicable connections is managed such that risk to mitigating strategy capability is minimized and the maintenance/risk guidance conforms to the guidance of NEI 12-06 (Reference 3.3) as follows:

- Portable FLEX equipment may be unavailable for 90 days provided that the site FLEX capability (N) is available.
- If portable equipment becomes unavailable such that the site FLEX capability (N) is not maintained, initiate actions within 24 hours to restore the site FLEX capability (N) and implement compensatory measures (e.g., repair equipment, use of alternate suitable equipment or supplemental personnel) within 72 hours.

FLEX equipment and connections will not normally be used for purposes other than emergency response. It is permissible, however, to pre-stage and/or use FLEX equipment and connections provided the following requirements are met:

- Permission is received from the Shift Manager or Emergency Director.
- The proper action to restore the equipment to an available status is determined and the status of the affected equipment and/or connection is tracked per EP-115, *Equipment Important To Emergency Response* (Reference 3.87).

FLEX equipment and resources may be released to another plant when requested to support a beyond design basis emergency event at another nuclear site provided the following requirements are met:

- Permission is received from the Plant Manager or designee per NDAP-QA-0201, *Material Control Activities* (Reference 3.96).
- The status of the allocated equipment is tracked and unavailability actions implemented per EP-115, *Equipment Important To Emergency Response* (Reference 3.87).

3. References

3.1 SECY-11-0093, "Near-Term Report and Recommendations for Agency Actions Following the Events in Japan," dated July 12, 2012 (ADAMS Accession No. ML11186A950)

3.2 NRC Order Number EA-12-049, Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for BDBEEs, dated March 12, 2012 (ADAMS Accession No. ML12056A045)

3.3 Nuclear Energy Institute, NEI 12-06, Diverse and Flexible Coping Strategies (FLEX) Implementation Guide, Revision 0, dated August 2012 (ADAMS Accession No. ML12242A378)

3.4 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 BDBEEs, Revision 0, dated August 29, 2012 (ADAMS Accession No. ML12229A174)

3.5 NRC Order Number, EA-12-051, Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation, dated March 12, 2012 (ADAMS Accession No. ML12054A682)

3.6 Nuclear Energy Institute, NEI 12-02, Industry Guidance for Compliance with NRC Order EA-12-051, To Modify Licenses with Regard to Reliable SFP Instrumentation, Revision 1, dated August 2012 (ADAMS Accession No. ML12240A307)

3.7 NRC Interim Staff Guidance JLD-ISG-2012-03, Compliance with Order EA-12-051, Reliable SFP Instrumentation, Revision 0, dated August 29, 2012 (ADAMS Accession No. ML12221A339)

3.8 NRC Letter to Susquehanna dated April 15, 2014, Susquehanna Steam Electric 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" (ADAMS Accession No. ML14065A028)

3.9 Task Interface Agreement (TIA) 2004-04, "Acceptability of Proceduralized Departures from Technical Specifications (TSs) Requirements at the Surry Power Station," (TAC Nos. MC4331 and MC4332)," dated September 12, 2006 (ADAMS Accession No. ML060590273)

3.10 United States NRC Endorsement Letter of the Nuclear Energy Institute (NEI) Position Paper entitled “Position Paper: Shutdown/ Refueling Modes,” dated September 30, 2013 (ADAMS Accession No. ML13267A382)

3.11 Nuclear Energy Institute, NEI 12-01, Guideline for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities, Revision 0, dated May 3, 2012 (ADAMS Accession No. ML12125A410)

3.12 Nuclear Energy Institute, NEI 10-05, Assessment of On-Shift Emergency Response Organization Staffing and Capabilities, Revision 0, dated June 2011

3.13 NRC Letter "Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident", dated March 12, 2012 (ADAMS Accession No. ML12053A340)

3.14 NEDC-33771P, Project Task Report BWROG GEH Evaluation of FLEX Implementation Guidelines, Revision 1

3.15 Susquehanna Steam Electric Station Final Safety Analysis Report

3.16 EC-050-1032, Evaluate RCIC pump Operation during Extended Station Blackout conditions, as defined in the Baseline Coping Strategy for NRC Order EA-12-049 Mitigating Strategies

3.17 GEH Report, 0000-0143-0382-R0 (proprietary), GEH Feasibility Study of RCIC System Operation in Prolonged Station Blackout

3.18 GEH Report, 0000-0155-1545 Rev 0 BWROG RCIC Pump and Turbine Durability Evaluation – Pinch Point Study

3.19 Susquehanna Steam Electric Station Technical Specifications and Bases

3.20 EC-013-1896, Performance Requirements for the Portable Diesel Driven pump in support of FLEX Mitigation Strategies

3.21 EC-050-1034, RCIC Pump Seal Leakage During Extended Loss of AC Power Scenario

3.22 BWROG EPG Issue Number 1103, 3/1/12

3.23 EPRI MAAP4 Applications Guidance, Desktop Reference for Using MAAP4 Software, Revision 2, 1020236, Final Report, July 2010

3.24 Westinghouse Report LTR-AEO-12-0004, Rev. 2, Susquehanna Steam Electric Station FLEX Coping Time Evaluation

3.25 DC-FLEX-1/205, Back Up Gas Supply to Unit 1 CIG Header/Back Up Gas Supply to Unit 2 CIG Header

3.26 EO-100-030, Unit 1 Response to Station Blackout

3.27 EO-200-030, Unit 2 Response to Station Blackout

3.28 EO-000-100, Cautions

3.29 EO-000-102, RPV Control

3.30 EO-000-103, Primary Containment Control

3.31 EO-000-112, Rapid Depressurization

3.32 PLA-7669, Tenth 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 (NRC ORDER EA-12-049), dated February 21, 2018, (ADAMS Accession No. ML18053A774)

3.33 BWROG-TP-14-006, Fukushima Response Committee, Raw Water Issue: Fuel Inlet blockage from debris, March 2014

3.34 EC-SBOR-0501, Coping Assessment for the SSES Station Blackout

3.35 EC-088-0524, 250 VDC Battery 2D650 Station Blackout Discharge Calculation

3.36 EC-FLEX-0001 through EC-FLEX-0012, Fukushima-Battery (1D620 through 2D660, respectively) Coping Time for ELAP (Extended Loss of AC Power)

3.37 EC-FLEX-0015, Fukushima FLEX Generators - Phase 2 Load Flow Analysis

3.38 NRC endorsement of BWR Containment Venting (Anticipatory Venting), (ADAMS Accession No. ML13358A206)

3.39 ES-150-001, RCIC TURBINE ISOLATION AND TRIP BYPASS

3.40 ES-250-001, RCIC TURBINE ISOLATION AND TRIP BYPASS

3.41 EC-FUEL-1771, Rev. 1, Fukushima Spent Fuel Pool Heatup w/ Design Basis Heat Load

3.42 PLA-7321, “Completion of Actions Required by NRC Order EA-12-051, “Reliable Spent Fuel Pool Instrumentation”, dated July 2, 2015, (ADAMS Accession No. ML15211A138)

3.43 EC-035-1026, Loss of Fuel Pool Cooling Evaluation in response to INPO IER 11-2, Recommendation 3

3.44 EC-016-1043, Flow Model of UHS Cooling Water Supply to Support Phase 2 and 3 FLEX Mitigation Strategy Plan

3.45 EC-012-6122, Refuel Floor Venting during Extended Loss of AC Power Event

3.46 Plant Modification EC1881050, U1 Reliable Hardened Containment Vent - Piping and Vent Stack Installation - Non-Outage Modification

3.47 Plant Modification EC1881053, U1 Reliable Hardened Containment Vent - Remote Operation Station - Non-Outage Modification

3.48 Plant Modification EC1881047, Unit 1 Reliable Hardened Containment Vent Main Control Room Outage Work

3.49 EPRI Technical Report 3002001785, Use of Modular Accident Analysis Program (MAAP) in Support of Post-Fukushima Applications, June 2013

3.50 Plant Modification, EC1672825, Unit 1 Reliable Hardened Containment Vent X201B Piping Tie-In Work

3.51 PLA-7551, Susquehanna Steam Electric Station (SSES) NEI 12-06, APPENDIX H, REVISION 2, H.4.3 PATH 3: GMRS >SSE but< IHS, Mitigating Strategies Assessment (MSA) Report for the New Seismic Hazard Information, dated December 19, 2016, ML 16355A338

3.52 Nuclear Energy Institute, NEI White Paper entitled “Battery Life Issue,” dated August 27, 2013 (ADAMS Accession No. ML13241A186)

3.53 United States NRC Endorsement Letter of the Nuclear Energy Institute (NEI) White Paper entitled “Battery Life Issue,” dated September 16, 2013 (ADAMS Accession No. ML13241A188)

3.54 Plant Modification EC1881014, U2 Reliable Hardened Containment Vent - Piping and Vent Stack Installation - Non-Outage Work

3.55 Plant Modification EC1881029, Unit 2 Reliable Hardened Containment Vent Remote Operating Station Non-Outage Work

3.56 Plant Modification EC1881034, U2 Reliable Hardened Containment Vent - Main Control Room - Outage Work

3.57 PLA-6980, Susquehanna Steam Electric Station Overall Integrated Plan In Response to March 12,2012 Commission Order Modifying Licenses with Regard to Requirements for Reliable Spent Fuel Pool Instrumentation (Order EA-12-051), dated February 28, 2013 (ADAMS Accession No. ML13064A276)

3.58 NRC letter to Susquehanna Nuclear, LLC, “Susquehanna Steam Electric Station, Units 1 and 2 – Staff Review of Mitigation Strategies Assessment Report of the Impact of the Reevaluated Seismic Hazard Developed in Response to the March 12, 2012, 50.54(f) letter (CAC NOS.MF7883 and MF7884), dated April 13, 2017, (ADAMS Accession No. ML17096A255)

3.59 Plant Modification EC1672802, Unit 2 Reliable Hardened Containment Vent X201B Piping Tie-In Work Outage Modification

3.60 PLA-7287, Susquehanna Steam Electric Station Flood Hazard Reevaluation Report, letter dated March 3, 2015 (ADAMS Accession No. ML 15063A319)

3.61 NRC letter to Susquehanna Nuclear, LLC, Susquehanna Steam Electric Station, Units 1 and 2 – Correction to Interim Staff Response to Reevaluated Flood Hazards Submitted in Response to 10 CFR 50.54(f) Information Request - Flood-Causing Mechanism Reevaluation (TAC NOS. MF6037 AND MF6038), dated November 12, 2015 (ADAMS Accession No. ML 15314A747)

3.62 NRC letter to Susquehanna Nuclear, LLC, Susquehanna Steam Electric Station, Units 1 and 2 – Staff Assessment of Response to 10 CFR 50.54(f) Information Request - Flood-Causing Mechanism Reevaluation (CAC NOS. MF6037 AND MF6038), dated September 8, 2016, (ADAMS Accession No. ML16231A517)

3.63 PLA-7559, Susquehanna Steam Electric Station Flooding Mitigating Strategies Assessment (MSA) Report, dated December 19, 2016, (ADAMS Accession No. ML16355A339)

3.64 NRC letter to Susquehanna Nuclear, LLC, Susquehanna Steam Electric Station, Units 1 and 2 – Flood Hazard Mitigation Strategies Assessment (CAC NOS. MF6037 AND MF6038), dated January 19, 2017, (ADAMS Accession No. ML17017A318)

3.65 EC-023-1004, Flow rate and NPSH for Diesel Fuel Deployment Strategy

3.66 DC-FLEX-011, “Fuel Oil Deployment Strategy”

3.67 EC 1687567, Mitigation strategy documentation and implementation package – Unit 2, Attachment 13 Fuel Oil Deployment Strategy

3.68 PLA-6852, Susquehanna Steam Electric Station 60-day Response To NRC Letter, Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force review of Insights from the Fukushima Dai-Ichi Accident, Dated March 12, 2012, PLA-6852 sent May 11, 2012

3.69 PLA-6866 - Susquehanna Steam Electric Station Units 1 and 2 Emergency Preparedness Information Requested by NRC Letter Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(F) Regarding Recommendations 2.1, 2.3, and 9.3 of the Near-Term Task Force Review of Insights from the Fukushima Daichi Accident, Dated March 12, 2012, PLA-6866 sent June 11, 2012

3.70 Nuclear Energy Institute position paper entitled "Position Paper: Shutdown/ Refueling Modes," dated September 18, 2013 (ADAMS Accession No. ML13273A514)

3.71 NUMARC 87-00, Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors, Revision 1

3.72 EC-030-1006, Control Structure Temperature Response to a Station Blackout or Fire Induced Loss of Control Structure HVAC, and implementation documentation in AR-2013-04843

3.73 EC-SBOR-0505 Evaluation of HPCI and RCIC Room Temperatures During Station Blackout

3.74 GENSTP3-001 – Upper Boundary Temperature For Mild Environments Related To Environmental Qualification Of Electrical Equipment

3.75 EC-SBOR-0504, Reactor Building Heatup Analysis During Station Blackout

3.76 EC-088-0526, Battery Room Hydrogen Generation

3.77 M-178, Sheet 1, UNIT 1 P&ID Control Structure Air Flow Diagram

3.78 EC-028-0009, Emergency Safeguard Service Water Pump Structure Heat Loss

3.79 Diverse and Flexible Coping Strategies (FLEX) and Spent Fuel Pool

Instrumentation (SFPI) Program Document, Revision 1 (AR-2015-21229) and Revision 0 (ACT-1748734)

3.80 EP-11, Susquehanna Steam Electric Station Diverse and Flexible Coping Strategies (FLEX) Program Description

3.81 Nuclear Energy Institute (NEI) 96-07, Revision 1, Guidelines For 10 CFR 50.59 Implementation, dated November 2000

3.82 Nuclear Energy Institute (NEI) 97-04, Revision 1, Design Bases Program Guidelines, dated February 2001

3.83 Nuclear Energy Institute (NEI) 12-01, Guideline for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities, Revision 0, dated May 3, 2012 (ADAMS Accession No. ML12125A410)

3.84 Nuclear Energy Institute, NEI 10-05, Assessment of On-Shift Emergency Response Organization Staffing and Capabilities, Revision 0, dated June 2011

3.85 NDAP-QA-1902, Integrated Risk Management

3.86 OI-013-001, Fire Protection Component Technical Data

3.87 EP-115, Equipment Important To Emergency Response EITER

3.88 Susquehanna SES Response to NRC Request For Information 50.54(f) letter Staffing Assessment History; Phase 2 Staffing Assessment Revision 2 (AR-2015-26012), Phase 2 Staffing Assessment Revision 1 (PLA-7283), Phase 2 Staffing Assessment Revision 0 (PLA-7246), and Phase 1 Staffing Assessment (PLA-6996)

3.89 PLA-7034, Susquehanna Steam Electric Station Commitment Change Notification Regarding Recommendation 9.3, dated June 23, 2014

3.90 PLA-6927, Susquehanna Steam Electric Station Requested Communications Assessment Results and Implementation Schedule per References 1 and 2, sent October 21, 2012

3.91 SAFER Response Plan 38-9233766-000 for Susquehanna Steam Electric Station, Revision 1 Jan 23, 2015

3.92 PLA-6978, Susquehanna Steam Electric Station Response to Follow-Up Letter on Technical Issues for Resolution Regarding Licensees Communication Submittals, sent February 22, 2013

3.93 PLA-7091, Susquehanna Steam Electric Station Change in Completion Date for the Installation of Satellite Phone Base Stations and Antennas, dated November 14, 2013

3.94 Susquehanna SES FLEX Implementation Validation Process History; Unit 2 and Common FLEX Procedures (AR-2015-04750), Unit 1 FLEX Procedures (AR-2015-06409 and AR-2016-04506), Unit 2 HCVS Initiation Validation (AR-2015-06407), and Unit 1 HCVS Initiation Validation (AR-2017-06915)

3.95 EPRI Report 3002000623, Preventive Maintenance Basis for FLEX Equipment – Project Overview Report, September 2013

3.96 NDAP-QA-0201, Material Control Activities

3.97 United States NRC Endorsement Letter of the Nuclear Energy Institute (NEI) position paper “Use of Modular Accident Analysis Program (MAAP) in Support of Post-Fukushima Application” dated October 3, 2013 (ADAMS Accession No. ML13275A318)

3.98 INPO AP 913, Equipment Reliability Process

3.99 PLA-7321, Completion of Actions Required by NRC Order EA-12-051, “Reliable Spent Fuel Pool Level Instrumentation” (ADAMS Accession No. ML15211A378)

3.100 AREVA Document No. 51-9199717-015, National SAFER Response Center Equipment Technical Requirements

3.101 Nuclear Energy Institute letter to Administrative Points of Contact (APC 14-17), Validation Document for FLEX Strategies, dated July 18, 2014.

3.102 PLA-7610, Susquehanna Steam Electric Station Report Of Full Compliance For Unit 2 With March 12, 2012 Commission Order Modifying Licenses With Regard To Requirements For Mitigation Strategies For Beyond-Design Basis External Events (NRC Order EA-12-049), letter dated May 31, 2017 (ADAMS Accession No. ML17151A292)

3.103 U.S. Nuclear Regulatory Commission, "Criteria For Accident Monitoring Instrumentation For Nuclear Power Plants" Regulatory Guide 1.97

3.104 Letter from Nicholas Pappas (NEI) to Jack R. Davis (NRC) regarding alternate approach to NEI 12-06 guidance for hoses and cables, May 1, 2015 (ADAMS Accession No. ML 15126A135)

3.105 Letter from Jack R. Davis (NRC) to Joseph E. Pollock (NEI), regarding NRC endorsement of NEI's alternative approach to NEI 12-06 guidance for hoses and cables, May 18, 2015 (ADAMS Accession No. ML 15125A442)

3.106 OI-TA-009, *Determination of Heat Removal Capacities and Vessel Heatup Rates*

3.107 ON-INSTAIR-1/201, *Loss of Instrument Air*

4. Figures

Figure 1 - Site Layout, Deployment Routes, and Staging Areas

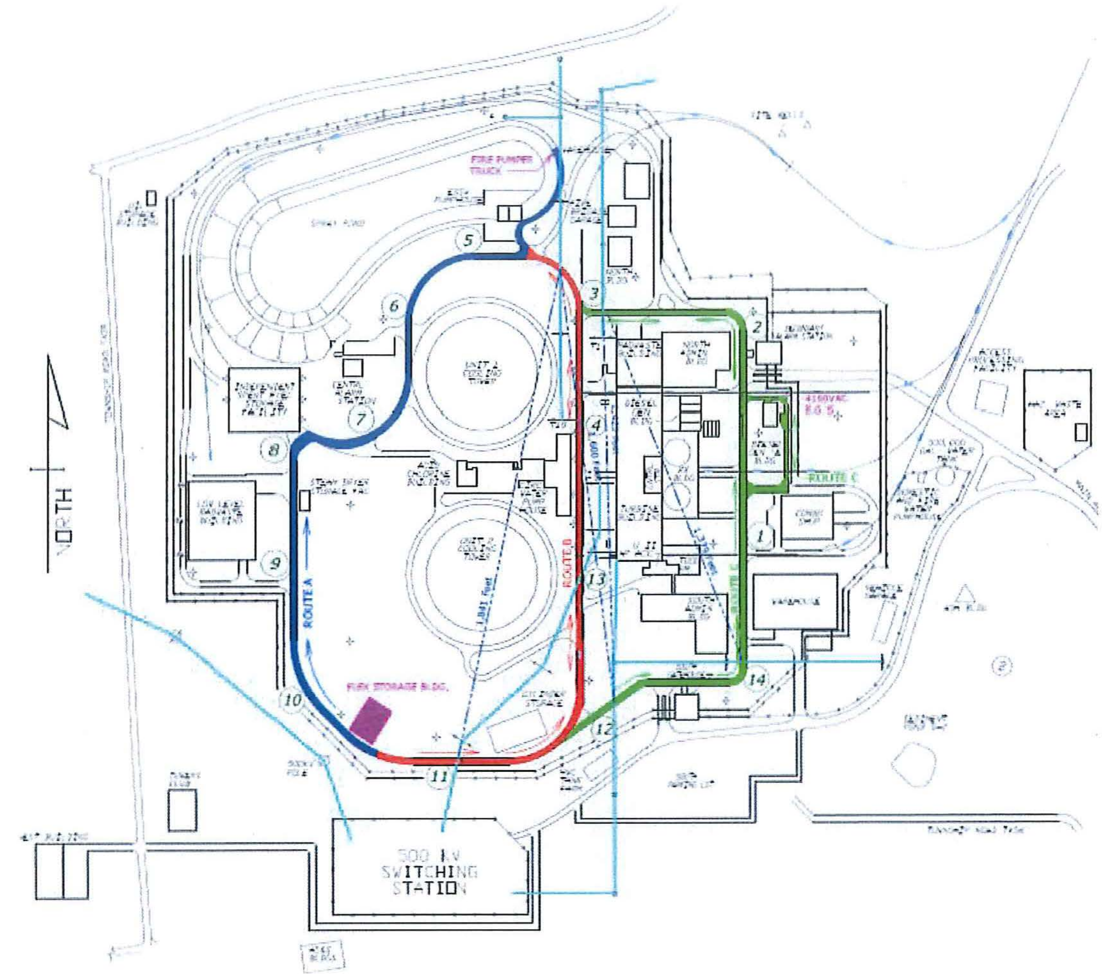


Figure 2 - 4160 VAC FLEX Generators and Distribution

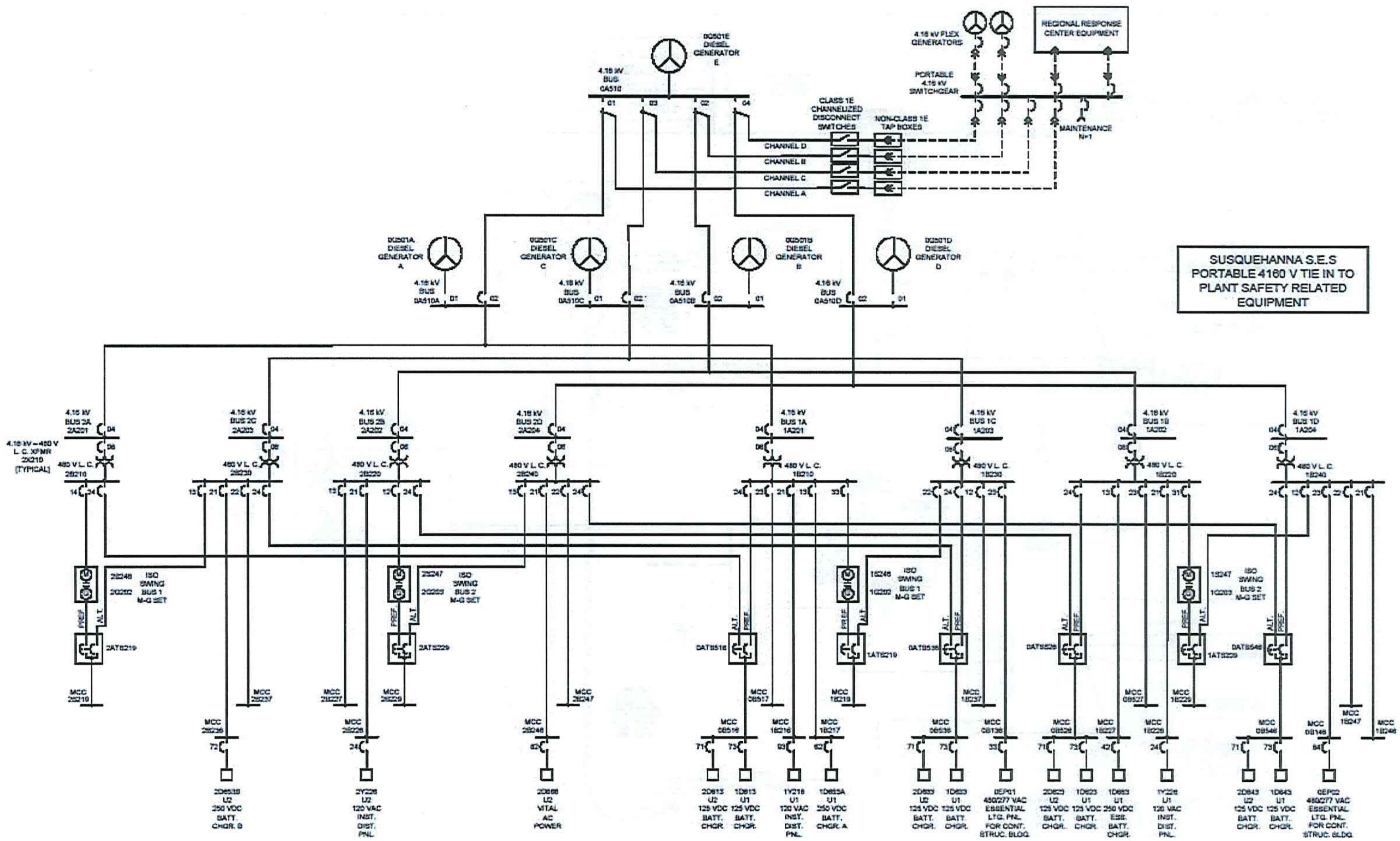


Figure 3 – Unit 1 and Unit 2 Division I RHRSW FLEX Connections

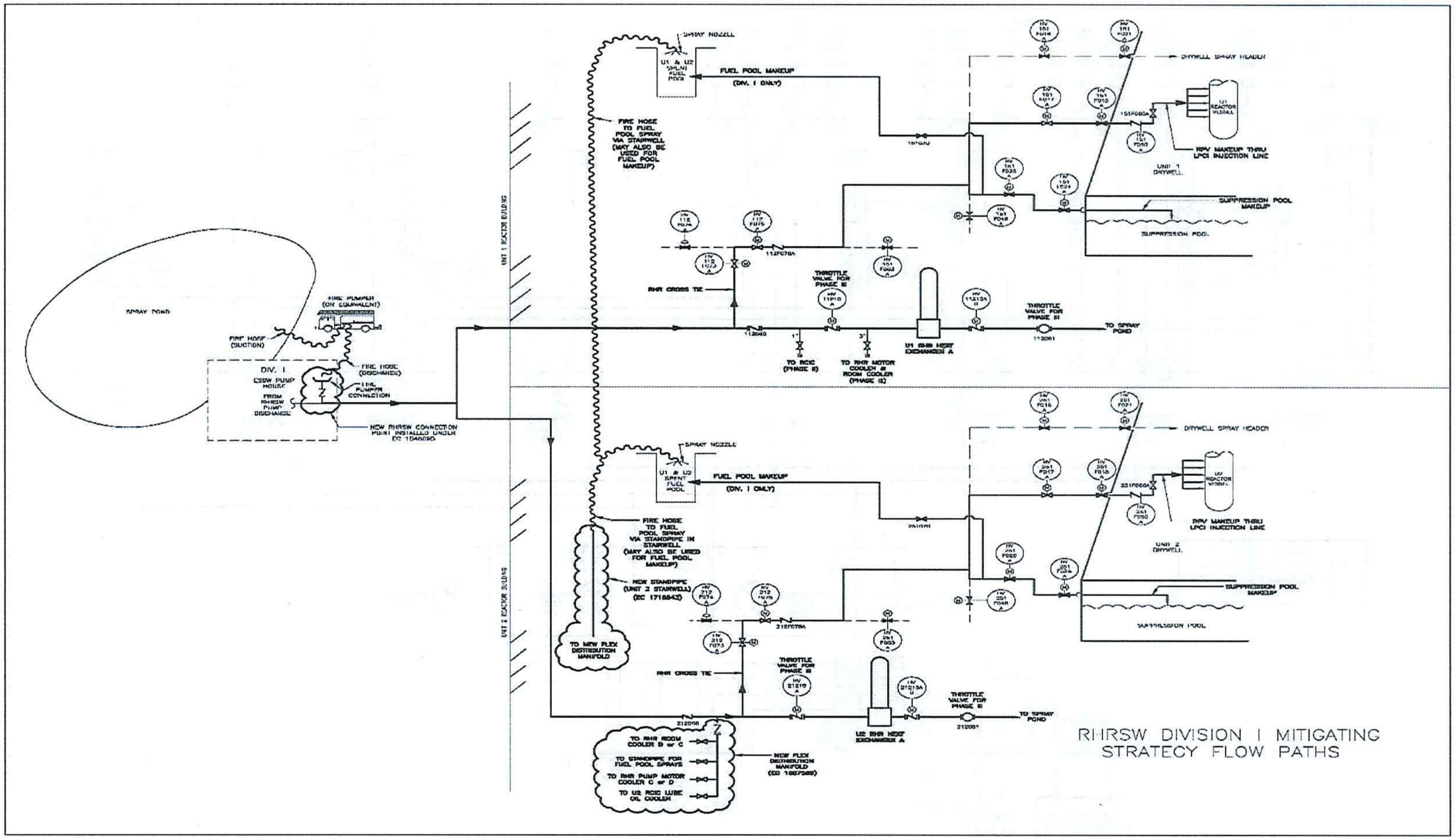


Figure 4 – Unit 1 and Unit 2 Division II RHRSW FLEX Connections

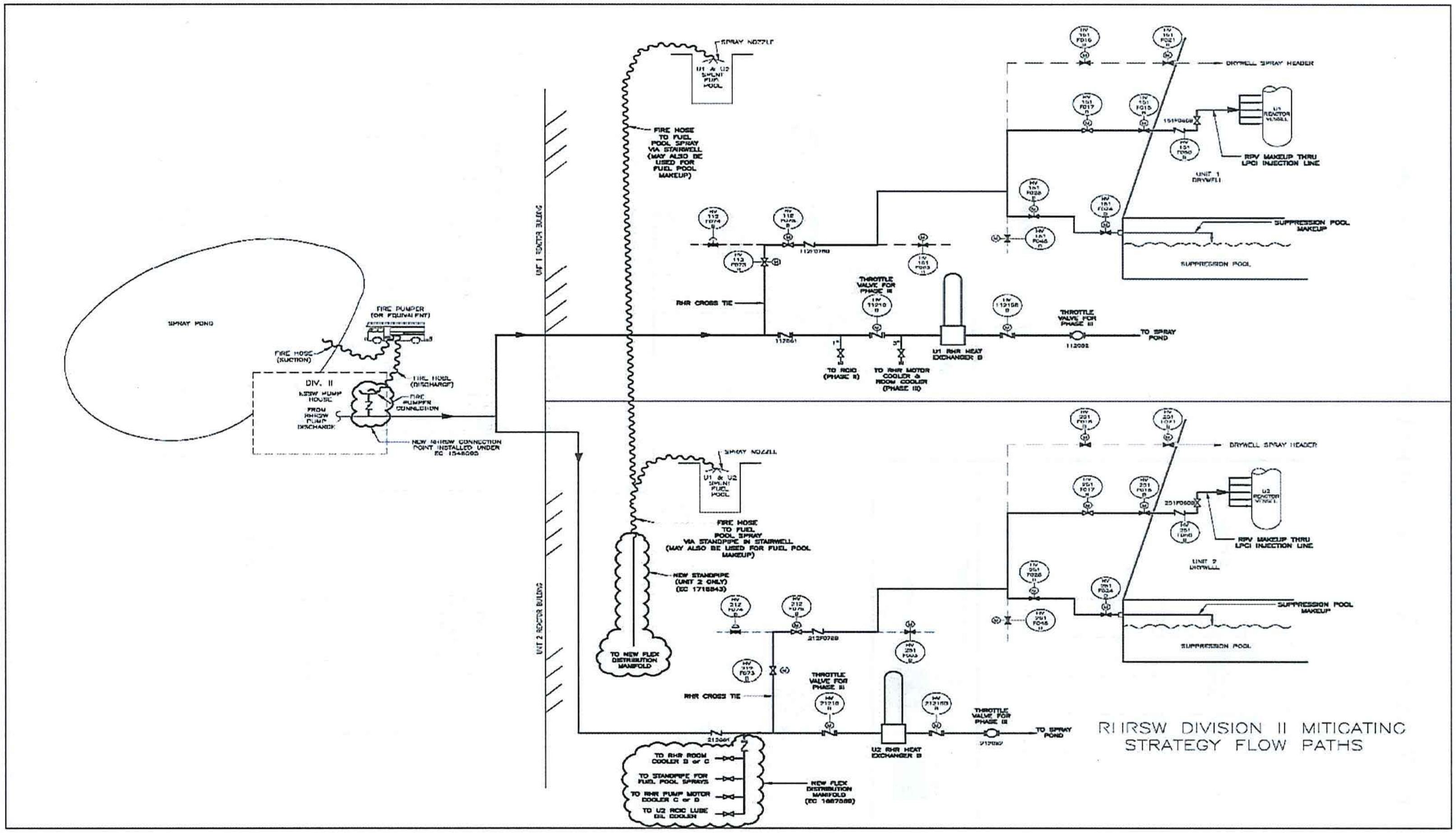
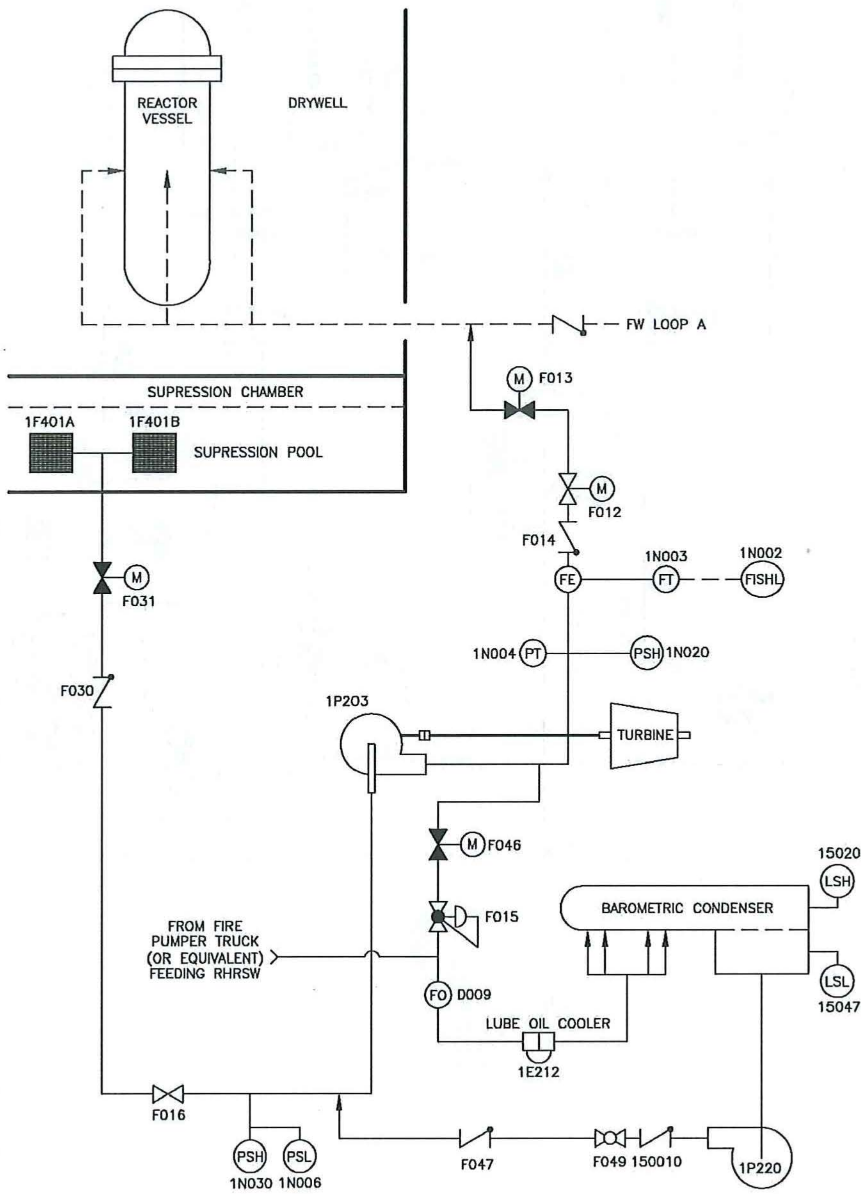


Figure 5 - RCIC System RHRSW Connection to RCIC LO cooler



REACTOR CORE ISOLATION COOLING SYSTEM
RHRSW CONNECTION TO RCIC LUBE OIL COOLER

5. Tables

Table 1 – Summary of 8 hour DC Battery Coping Evaluations

Summary of 8 hour DC Battery Coping Evaluations

Unit 1						
Battery	1D610	1D620	1D630	1D640	1D650	1D660
Nominal Voltage	125VDC	125VDC	125VDC	125VDC	250VDC	250VDC
Coping time	8h	8h 15m	8h 50m	11h 44m	>24h	8h

Unit 2						
Battery	2D610	2D620	2D630	2D640	2D650	2D660
Nominal Voltage	125VDC	125VDC	125VDC	125VDC	250VDC	250VDC
Coping time	8h 15m	8h 27m	> 12h	11h 58m	>24h	>24h

Based on References 3.34, 3.35, and 3.36

Table 2 – FLEX Phase 2 (SSES) and Phase 3 (NSRC) Portable Equipment List

BWR Portable Equipment Phase 2							
Use and (potential / flexibility) diverse uses						*Performance Criteria*	*Maintenance*
List portable equipment [(1)]	Core	Containment	SFP	Instrumentation	Accessibility		Maintenance / PM requirements
Two (2) FLEX pumps	X	X	X			The spray pond is used as the ultimate heat sink in support of the phase 2 and 3 mitigation strategy plan. Calculation EC-013-1896 establishes performance requirements for the portable FLEX pump to be used in support of the Phase 2 mitigation strategy plan. This calculation establishes makeup requirements to the reactor vessel, the suppression pool, the RCIC lube oil coolers, and the fuel pools in support of phase 2 strategy for both Units 1 and 2. This calculation demonstrates that the portable FLEX pump, which takes suction from the spray pond and discharges into a division of the RHRSW system via an ESSW pump house connection, is capable of providing adequate makeup flow to both units to support these mitigation strategy functions for Phase 2.	Per manufacturer's recommendation.

BWR Portable Equipment Phase 2							
Use and (potential / flexibility) diverse uses						*Performance Criteria*	*Maintenance*
List portable equipment [(1)]	Core	Containment	SFP	Instrumentation	Accessibility		Maintenance / PM requirements
Two (2) tow-along fuel tankers for FLEX pump s and generators	X	X	X			Store up to 600 gallons of fuel.	
1500 feet of 5 inch hose for each FLEX pump	X	X	X			Provide adequate hose for required flow paths.	
Three (3) 4160 VAC (1MW) generators	X	X	X	X		Generate up to 1 MW of 4160 VAC power per generator.	Per IOM.
Diesel fuel transfer lift pumps	X	X	X	X	X	Pump diesel fuel from the 'E' DG Fuel Oil Storage Tank into a Fuel Tank Truck.	Per vendor guidance.
Explosion proof portable ventilation fan	X	X	X	X		Safely support building ventilation strategies.	
Three (3) days' supply of MREs (meals ready to eat) and drinking water for 200 personnel					X	Sustain the on-site staff until regular travel routes are established.	
Debris removal Equipment					X	Safely and efficiently clear deployment routes for the FLEX equipment.	Per vendor guidance.

Notes:

BWR Portable Equipment Phase 3 (from the NSRCs)							
	Use and (potential / flexibility) diverse uses					*Performance Criteria*	*Notes*
List portable equipment	Core	Containment	SFP	Instrumentation	Accessibility		
NOTE: Phase 3 Equipment below is in addition to the Phase 2 Equipment noted above.							
Four (4) 4160VAC (1 MW) generators (SAFER-NSRC)	X	X	X	X		Generate up to 1 MW of 4160 VAC power per generator.	To power RHR, etc. (cables and Distribution Centers supplied also).
Two (2) low pressure, high flow, self-powered pumps (SAFER-NSRC)	X		X			Per the SAFER Response Plan.	Back-up water supply to Spray Pond. (hoses supplied also)
Two (2) low pressure, medium flow, self-powered pumps (SAFER-NSRC)	X		X			Per the SAFER Response Plan.	Back-up for FLEX pumps. (hoses supplied also)
Two (2) 480 VAC FLEX generators (SAFER-NSRC)	X	X	X	X		Per the SAFER Response Plan.	Cables supplied also.
Six (6) Mobile Lighting Towers (SAFER-NSRC)					X	Per the SAFER Response Plan.	
Two (2) Diesel Fuel Transfer Pumps (SAFER-NSRC)	X	X	X			Per the SAFER Response Plan.	
Two (2) Diesel Fuel Tanks with Pumps (SAFER-NSRC)	X	X	X			Per the SAFER Response Plan.	

Phase 3 Response Equipment/Commodities	
Item	Notes
Radiation Protection Equipment • Survey instruments • Dosimetry • Off-site monitoring/sampling	
Commodities • Food • Potable water	Three (3) days' supply of MREs (Meals Ready to Eat) and drinking water for 200 personnel.
Fuel Requirements • Diesel Fuel	Mitigating Strategies – a Fuel Oil Deployment Strategy is complete.
Heavy Equipment • Transportation equipment	Two (2) Pick-up trucks Front End Loader/Backhoe
Portable Lighting	Six (6) Mobile Lighting Towers (SAFER-NSRC)
Portable Toilets	Four (4) Porta-Pottys

Table 3 – Key Monitoring Instrumentation

Key Instrumentation from EO-100-030 Revision 38 (Unit 1, similar for Unit 2)

Reactor Pressure Vessel (RPV) Parameters

Parameter	**Range**	**Instrument / Indicator**	**Instrument / Indicator Location**	**Power Supply**
RPV LEVEL				
RPV Level - Div 1(2) (Wide Range (WR)	-150 to +60 in	LI-14201A(B) (Indications	12-729', C-409, 1C601	1Y11501/1Y11505
RPV Level - Div 1(2) (Wide Range (WR)	-150 to +60 in	LI-14203A(B) (Indications	12-729', C-409, 1C601	1Y11501/1Y11505
RPV - Div 1 (Fuel Zone Level (FZL))	-310 to -110 in	UR-14201A	12-729', C-409, 1C601	1Y11501/1Y11505
RPV - Div 2 (Fuel Zone Level (FZL))	-310 to -110 in	UR-14201B	12-729', C-409, 1C601	1Y12501/1Y12505
RPV PRESSURE				
RPV Pressure - Div 1 (Wide Range)	0 to 1500 psig	PI-14202A PI-14204A	12-729', C-409, 1C601	1Y11501/1Y11505
RPV Pressure - Div 2 (Wide Range)	0 to 1500 psig	PI-14202B PI-14204B	12-729', C-409, 1C601	1Y12501/1Y12505
RPV Pressure - RCIC Steam (Requires RCIC steam supply valves HV149007 and HV149F008 open)	0 to 1500 psig	PI-E51-1R602	12-729', C-409, 1C601	1D61407

RCIC Parameters

Parameter	**Range**	**Instrument / Indicator**	**Instrument / Indicator Location**	**Power Supply**
RCIC				
Rx Steam Sup Press to RCIC Turb (Same as RPV Pressure - RCIC Steam above)	0 to 1500 psig	PI-E51-1R602	12-729', C-409, 1C601	1D61407
RCIC Turbine Exhaust Pressure	0 to 200 psig	PI-E51-1R603	12-729', C-409, 1C601	1D61407
RCIC Pump Suction Pressure	30" Hg Vac to 85 psig	PI-E51-1R604	12-729', C-409, 1C601	1D61407
RCIC Pump Discharge Pressure	0 to 1500 psig	PI-E51-1R601	12-729', C-409, 1C601	1D61407
RCIC Flow	0 to 700 gpm	FI-E51-1R600-1	12-729', C-409, 1C601	1D61407
RCIC Turbine Speed	0 - 6000 rpm	SI-15001A	12-729', C-409, 1C601	1D61407

Containment Parameters

Parameter	Range	Instrument / Indicator	Instrument / Indicator Location	Power Supply
CONTAINMENT PARAMETERS				
Containment Pressure (DW) 27-719', I-401 Adj Equip Hatch (SC) 27-683', I-203 Adj South SP Hatch (need 6 ft ladder)	-3 to +3 psig	PI-15702 (HSS)	12-729', C-409, 1C601	1Y629 Fuse Bkr 25
Containment Pressure	-15 to 65 psig (G) 0 to 250 psig (B) -15 to 65 psig (R)	UR-15701A Supp-Chr LOCA (Green) Drwl Hi Accident (Blue) Drwl LOCA (Red)	12-729', C-409, 1C601	1Y11501
Containment Pressure	-15 to 65 psig (G) 0 to 250 psig (B) -15 to 65 psig (R)	UR-15701B Supp-Chr LOCA (Green) Drwl Hi Accident (Blue) Drwl LOCA (Red)	12-729', C-409, 1C601	1Y12501
Supp Pool Level - Div 1 (Narrow Range)	18 to 26.5 ft	LI-15775A	12-729', C-409, 1C601	1Y11501
Supp Pool Level - Div 2 (Narrow Range)	18 to 26.5 ft	LI-15775B	12-729', C-409, 1C601	1Y12501
Supp Pool Level - Div 1 (Narrow Range - NR) (Wide Range - WR)	18 to 26.5 ft 4.5 to 49 ft	UR-15776A (Indications from LT-15775A (NR) and LT-15776A (WR))	12-729', C-409, 1C601	1Y11501
Supp Pool Level - Div 2 (Narrow Range - NR) (Wide Range - WR)	18 to 26.5 ft 4.5 to 49 ft	UR-15776B (Indications from LT-15775B (NR) and LT-15776B (WR))	12-729', C-409 1C601	1Y12501
Containment Temperature	40 to 440°F	UR-15701A(B)	12-729', C-409, 1C601	1Y11501(1Y12501)
Supp Pool Temperature Div 1 (SPOTMOS)	°F	TX-15751 (Main)	12-729', C-409, 1C690A (Main)	Primary/Alternate 1Y11502/1Y21626
Supp Pool Temperature Div 2 (SPOTMOS)	°F	TX-15752 (Main)	12-729', C-409, 1C690B (Main)	Primary/Alternate 1Y12502/1Y22626

Spent Fuel Pool Level Parameter

Parameter	Range	Instrument / Indicator	Instrument / Indicator Location	Power Supply
SPENT FUEL POOL				
Spent Fuel Pool Level	0 to -23.67 ft	LIS-15348	12-729', C-409, 1CB672	1D697, 1Y21610

Table 4 - On-site Water Sources

On-site Water Sources			
Water Source	Available Volume (gallons)	Cleanliness[1]	Seismic
Suppression Pool	>950,000 per reactor	Clean	Seismic
Spray Pond	~25 million	Unclean	Seismic
Condenser Hotwell	>100,000	Clean	Non-seismic
Condensate Storage Tanks	>135,000, up to 300,000	Clean	Non-seismic
Cooling Tower Basin	>6 million	Unclean	Non-seismic
Demin Water Tank	~50,000	Clean	Non-seismic
Refuel Water Storage Tank	~680,000	Clean	Non-seismic
Fire Protection System[2]	>300,000	Unclean	Non-seismic
Susquehanna River	Continuous source	Unclean	Undefined

1. Water normally ready for injection to the reactor is considered clean.
2. Fire Protection water normally comes from the Clarified Water Storage Tank (CWST).

1
2

Table 5 – Sequence of Events Timeline

Action item	**Elapsed Time**	**Action**	**ELAP Event Time Constraint Y/N [1]**	**Remarks / Applicability**
	0	**Event Starts**	NA	Plants @100% power
1	60 sec	RCIC starts.	N	Reactor operator initiates or verifies initiation of reactor water level restoration with steam driven high pressure injection
2	30 min	Initiate deployment of Flex mitigation equipment.	N	Debris will be removed, the Pumper Truck and 4160 VAC FLEX generators will be deployed and staged, but not connected.
3	45 min	DC Load shed complete.	Y	DC buses are readily available for operator access and breakers are appropriately identified to show which are required to be opened.
4	50 min	All attempts to start EDGs have been unsuccessful and off-site power has not been restored, enter ELAP Procedure. Direct FLEX equipment to be connected to plant systems.	Y	Time sensitive at a time greater than 1 hour. Entry into ELAP provides guidance to operators to perform ELAP actions.

[1] Instructions: Provide justification if No or NA is selected in the remark column.
If yes include technical basis discussion as requires by NEI 12-06 section 3.2.1.7

Action item	Elapsed Time	Action	ELAP Event Time Constraint Y/N [1]	Remarks / Applicability
5	1 hr.	Using manual control of SRVs depressurize the RPV IAW EOPs (100°F/hr. to approximately 150 – 300 psig).	Y	Time sensitive to support base strategy to partially depressurize the RPV to stay above the pressures that would isolate RCIC and place the RPV at lower pressure to facilitate transition to the use of pumper truck injection on loss of steam driven feed systems.
6	2.8 hr.	The RPV has depressurized to <300 psig and being controlled in a band of 150 to 300 psig.	N	Lower pressure facilitates smooth transition to feed from the pumper truck and maintains steam available for RCIC.
7	*5.0 hr.	Initiate use of Hardened Containment Vents per EOPs (to be revised) to maintain containment parameters within limits.	Y	Per MAAP analysis, Suppression Pool temperature is approximately 200°F at 5 hours. Peak containment parameters: DW Press: 24.6 psia at 15 hrs. DW Temp: 252°F at 36 hrs. SP Pressure: 22 psia at 4.9 hrs. SP Temp: 228°F at 37.2 hrs. When steam flow from the RPV is insufficient to support RCIC operation, due to the decrease in decay heat, transition to pumper truck injection to the RPV will be used.

Action item	Elapsed Time	Action	ELAP Event Time Constraint Y/N [1]	Remarks / Applicability
8	5.0 hr.	Pumper truck feeding RHRSW at the ESSW pump house, cross-tied to RHR, and capable of supporting all Phase 2 safety function needs (Pumper truck water injected through RHR to the RPV is the back-up, when RCIC is no longer available.)	Y	The pumper truck supplying RHRSW and cross-tied to RHR is capable of supplying both units' safety function needs simultaneously.
9	5.0 hr.	Cross tie RHRSW to supply cooling flow to the RCIC lube oil coolers. Note: When RCIC cooling water is supplied from the pumper truck via RHRSW, transition from phase 1 to phase 2 occurs.	Y	Assists in maintaining RCIC functional by preserving RCIC Turbine bearings and barometric condenser.
10	**6.0 hr.	AC load shedding complete, 4160 VAC FLEX generators are energized and feeding the 4160 VAC Essential Buses, 480 VAC Essential load centers, and selected important loads.	Y	Repower 125 VDC and 250 VDC RCIC battery chargers, and other important loads required for FLEX mitigation strategy.
11	6.0 hr.	Suppression pool (SP) make-up commences and continues with continuous feed to make-up for boil-off out the HCVS as directed by EOPs.	Y	MAAP runs indicate that, for base case conditions, the SP will begin boiling beyond 6 hours, and SP temperature will peak at 228°F with a continuous make-up to maintain level. Makeup to the SP adds cooler water to the SP, which helps lower peak suppression pool temperature.

Action item	Elapsed Time	Action	ELAP Event Time Constraint Y/N [1]	Remarks / Applicability
12	9.8	Operations with Station Support align refuel floor for natural circulation by opening the Reactor Building roof vents to remove steam generated from boil-off. (This was an open item, see attachment 4, item 9)	Y	Time sensitivity is based on the design basis heat load time to boil calculation and the time to reach 110°F. Time sensitivity will be based on the actual heat load. This could substantially increase the time at which this action is required.
13	13.6 hr.	Begin makeup to SFP as necessary to maintain adequate level in the SFP. (Boiling under design basis conditions begins at ~13.6 hours and requires ~100 gpm makeup to cross-tied SFPs based on the Design Basis heat load).	N	Boil-off rate is slow with a large volume of water in the cross-tied SFPs. The SFPs are normally cross-tied. Since the Design Basis heat load consists of a full core offload for one of the two Susquehanna units, FLEX flow to that RPV is not required for this case.
14	30-72 hr.	Transition from Phase 2 to Phase 3 for Core Cooling function maintaining Pumper Truck feeding RHRSW at the ESSW pump house, cross-tied to RHR once RCIC becomes unavailable. Additional actions will be implemented to place RHR Pumps in Suppression Pool Cooling or Shutdown Cooling to cool the plant down to cold shutdown. Additional actions require staging and operation of NSRC Portable 4160 VAC FLEX generators.	N	If RHR pumps are not available or some other reason prevents going to cold shutdown, then the plant can be maintained in a stable condition with RCIC or make-up from RHR from the Pumper Truck.

* Susquehanna submitted a relief request on 08/26/2013 in PLA-7072. The Request for Relief described in the letter was based on NRC mandated changes to the Hardened Containment Vent System implementation dates that impact the Mitigation Strategy Overall Integrated Plan. Specifically, the change in implementation dates for the Hardened Containment Vent Order (NRC Order EA-12-050 was rescinded and superseded by NRC Order EA-13-109) impacts the Mitigation Strategy Overall Integrated Plan and implementation timeline. Susquehanna has submitted a Request for Relaxation in PLA-7134 on 02/20/14 that supersedes PLA-7072. This Request for Relaxation was approved by the NRC (ML14065A028).

* * The switching moves and time required to complete this action item were evaluated and validated to try to shorten the time frame to power essential loads. The time frame for Action Item 10 is readily achievable in less than 6 hours as was validated, which provides margin for unanticipated complications.