Exelon Generation.

Order No. EA-12-049

RS-16-223

December 7, 2016

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

Braidwood Station, Unit 1
Renewed Facility Operating License No. NPF-72
NRC Docket No. STN 50-456

Subject: 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 (Order Number EA-12-049)

References:

1. NRC Order Number EA-12-049, "Issuance of Order to Modify Licenses with Regard to Requirements For Mitigation Strategies For Beyond-Design-Basis External Events," dated March 12, 2012
2. NRC Interim Staff Guidance JLD-ISG-2012-01, "Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," Revision 0, dated August 29, 2012
3. NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," Revision 0, dated August 2012
4. Exelon Generation Company, LLC's Initial Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049), dated October 25, 2012
5. Exelon Generation Company, LLC Overall Integrated Plan in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049), dated February 28, 2013 (RS-13-017)
6. Exelon Generation Company, LLC First Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049), dated August 28, 2013 (RS-13-113)
7. Exelon Generation Company, LLC Second Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049), dated February 28, 2014 (RS-14-007)

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8. Exelon Generation Company, LLC Third Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049), dated August 28, 2014 (RS-14-205)
9. Exelon Generation Company, LLC 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 (Order Number EA-12-049), dated February 27, 2015 (RS-15-016)
10. Exelon Generation Company, LLC 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 (Order Number EA-12-049), dated August 28, 2015 (RS-15-208)
11. Exelon Generation Company, LLC 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 (Order Number EA-12-049), dated February 26, 2016 (RS-16-020)
12. Exelon Generation Company, LLC 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 (Order Number EA-12-049), dated August 26, 2016 (RS-16-145)
13. NRC letter to Exelon Generation Company, LLC, Braidwood Station, Units 1 and 2 – Interim Staff Evaluation Relating to Overall Integrated Plan in Response to Order EA-12-049, (Mitigation Strategies) (TAC Nos. MF0895 and MF0896), dated December 17, 2013
14. 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
15. Exelon Generation Company, LLC letter to USNRC, Response to March 12, 2012, Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 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 Items 1, 2, and 6 - Phase 2 Staffing Assessment, dated November 26, 2014 (RS-14-320)
16. NRC letter to Exelon Generation Company, LLC, Braidwood Station, Unit Nos. 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-12-051 (TAC Nos. MF0895, MF0896), dated May 27, 2015

On March 12, 2012, the Nuclear Regulatory Commission ("NRC" or "Commission") issued Order EA-12-049, "Order Modifying Licenses with Regard to Requirements For Mitigation Strategies For Beyond-Design-Basis External Events," (Reference 1) to Exelon Generation Company, LLC (EGC). Reference 1 was immediately effective and directed EGC to develop, implement, and maintain guidance and strategies to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities in the event of a beyond-design-basis external event. Specific requirements are outlined in Attachment 2 of Reference 1.

Reference 1 required submission of an initial status report 60 days following issuance of the final interim staff guidance (Reference 2) and an Overall Integrated Plan (OIP) pursuant to Section IV, Condition C. Reference 2 endorsed industry guidance document NEI 12-06, Revision 0 (Reference 3) with clarifications and exceptions identified in Reference 2. Reference 4 provided the EGC initial status report regarding mitigation strategies. Reference 5 provided the Braidwood Station, Unit 1 OIP.

Reference 1 required submission of a status report at six-month intervals following submittal of the OIP. References 6, 7, 8, 9, 10, 11, and 12 provided the first, second, third, fourth, fifth, sixth, and seventh six-month status reports, respectively, pursuant to Section IV, Condition C.2, of Reference 1 for Braidwood Station, Unit 1.

The purpose of this letter is to provide the report of full compliance with the 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) (Reference 1) pursuant to Section IV, Condition C.3 of the Order for Braidwood Station, Unit 1.

Braidwood Station, Unit 1 has developed, implemented, and will maintain the 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 in response to Order EA-12-049. The information provided herein documents full compliance for Braidwood Station, Unit 1 with Reference 1.

OIP open items have been addressed and closed as documented in References 6, 7, 8, 9, 10, 11, and 12, and are considered complete pending NRC closure. EGC's response to the NRC Interim Staff Evaluation (ISE) open and confirmatory items identified in Reference 13 have been addressed and closed as documented in References 7, 8, 9, 10, 11, and 12, and are considered closed as documented in Reference 16. EGC's response to the NRC ISE confirmatory items identified as open in Reference 16 are addressed and closed as documented in References 10 and 11, and are considered complete pending NRC closure. EGC's response to the NRC audit questions and additional audit open items have been addressed and closed as documented in References 10, 11, 12, and 16, and are considered complete pending NRC closure. The following tables provide completion references for each OIP open item and NRC ISE open or confirmatory item, and NRC Audit Report open item.

Overall Integrated Plan Open Items

OIP Open Item		**Completion Response Reference**
Key Site assumptions (p.4)	Primary and secondary storage locations have not been selected yet; once locations are finalized implementation strategies and routes will be assessed for hazard impact.	Reference 10
Sequence of events (p.5)	The final timeline will be time validated once detailed designs are completed and procedures are developed.	Reference 11
Identify how strategies will be deployed (p.7)	Identification of storage area and creation of the administrative program.	Reference 10

OIP Open Item		**Completion Response Reference**
Programmatic controls (p.8)	Develop an administrative program for FLEX responsibilities, and testing & maintenance.	Reference 10
National SAFER Response Center plan (p.9)	Development of Braidwood Station's playbook.	Reference 10
Key Reactor Parameters (p. multiple)	Identify additional parameters that are needed in order to support key actions identified in the plant procedures/guidance or to indicate imminent or actual core damage.	Reference 8
Deployment Conceptual Design (p. multiple)	Develop the storage structure conceptual design.	Reference 9
Maintain RCS Inventory Control, Phase 2 (p.23)	A calculation will be required for the timing of the boration and quantity required.	Reference 11
Maintain Containment, Phase 1 (p.31)	Additional calculations will be performed to evaluate containment response.	Reference 10
Maintain Spent Fuel Pool Cooling, Phase 1 (p.39)	Procedure development for Initial Spent fuel pool make-up with gravity drain from the RWST.	Reference 8
Maintain Spent Fuel Pool Cooling, Phase 1 (p.39)	Initial calculations were used to determine the fuel pool timelines. Formal calculations will be performed to validate this information during development of the spent fuel pool cooling strategy detailed design.	Reference 8
Maintain Spent Fuel Pool Cooling, Phase 1, (p.39 and p.42)	Evaluation of the spent fuel pool area for steam and condensation will be performed and used to determine if vent path strategy is needed.	Reference 8
Safety Functions Support, Phase 2 (p.51)	Habitability conditions will be evaluated and a strategy will be developed to maintain Main Control Room.	Reference 8
Safety Functions Support, Phase 2 (p.51)	Critical ventilation assets may be required to support DDAF pumps, station battery rooms, miscellaneous electric equipment rooms, and fuel handling building personnel habitability and/or component survivability. Specific analyses of these rooms will be performed.	Reference 9

Interim Staff Evaluation Open Items

ISE Open Item	Completion Response Reference
Item No. 3.2.1.8.A	Reference 11

Interim Staff Evaluation Confirmatory Items

ISE Confirmatory Item	Completion Response Reference
Item No. 3.1.1.1.A	Reference 10
Item No. 3.1.1.3.A	Reference 9
Item No. 3.1.1.4.A	Reference 10
Item No. 3.1.5.1.A	Reference 9
Item No. 3.1.5.3.A	Reference 9
Item No. 3.2.1.A	Reference 10
Item No. 3.2.1.1.A	Reference 10
Item No. 3.2.1.1.B	Reference 9
Item No. 3.2.1.1.C	Reference 9
Item No. 3.2.1.1.D	Reference 9
Item No. 3.2.1.2.B	Reference 11
Item No. 3.2.1.2.E	Reference 10
Item No. 3.2.1.3.A	Reference 10
Item No. 3.2.1.4.A	Reference 10
Item No. 3.2.1.4.B	Reference 9
Item No. 3.2.1.5.A	Reference 8
Item No. 3.2.1.6.A	Reference 11
Item No. 3.2.1.6.B	Reference 9
Item No. 3.2.1.9.A	Reference 9
Item No. 3.2.2.A	Reference 9
Item No. 3.2.3.A	Reference 10
Item No. 3.2.3.B	Reference 10
Item No. 3.2.4.1.A	Reference 9
Item No. 3.2.4.2.A	Reference 9
Item No. 3.2.4.2.B	Reference 9
Item No. 3.2.4.3.A	Reference 9
Item No. 3.2.4.4.A	Reference 10
Item No. 3.2.4.6.A	Reference 8
Item No. 3.2.4.7.A	Reference 11
Item No. 3.2.4.8.A	Reference 9
Item No. 3.2.4.9.A	Reference 10
Item No. 3.2.4.10.A	Reference 9

NRC Audit Report Open Items

Audit Open Item	Completion Response Reference
SE # 9	Reference 10
SE # 10	Reference 10

MILESTONE SCHEDULE – ITEMS COMPLETE

Milestone	Completion Date
Submit 60 Day Status Report	October 25, 2012
Submit Overall Integrated Plan	February 28, 2013
Contract with National SAFER Response Center	April 30, 2015
Submit 6 Month Updates:	
Update 1	August 28, 2013
Update 2	February 28, 2014
Update 3	August 28, 2014
Update 4	February 27, 2015
Update 5	August 28, 2015
Update 6	February 26, 2016
Update 7	August 26, 2016
Modification Development:	
Phases 1 and 2 modifications	October 16, 2016
National SAFER Response Center Operational	September 11, 2014
Procedure Development:	
Strategy procedures	October 16, 2016
Validate Procedures (NEI 12-06, Sect. 11.4.3)	October 16, 2016
Maintenance procedures	October 16, 2016
Staffing analysis	May 29, 2014
Modification Implementation	
Phases 1 and 2 modifications	April 16, 2015
Storage plan and construction	April 16, 2015
FLEX equipment acquisition	April 16, 2015
Training completion	September 16, 2015
Unit 1 implementation date	October 25, 2016

ORDER EA-12-049 COMPLIANCE ELEMENTS SUMMARY

The elements identified below for Braidwood Station, Unit 1 as well as the site OIP response submittal (Reference 5), the 6-Month Status Reports (References 6, 7, 8, 9, 10, 11, and 12), and any additional docketed correspondence, demonstrate compliance with Order EA-12-049.

Strategies - Complete

Braidwood Station, Unit 1 strategies are in compliance with Order EA-12-049. There are no strategy related Open Items, Confirmatory Items, or Audit Questions/Audit Report Open Items. The Braidwood Station, Units 1 and 2, Final Integrated Plan for mitigating strategies is provided in the enclosure to this letter.

Modifications - Complete

The modifications required to support the FLEX strategies for Braidwood Station, Unit 1 have been fully implemented in accordance with the station design control process.

Equipment – Procured and Maintenance & Testing – Complete

The equipment required to implement the FLEX strategies for Braidwood Station, Unit 1 has been procured in accordance with NEI 12-06, Sections 11.1 and 11.2, received at Braidwood Station, Unit 1, initially tested/performance verified as identified in NEI 12-06, Section 11.5, and is available for use.

Maintenance and testing will be conducted through the use of the Braidwood Station, Unit 1 Preventative Maintenance program such that equipment reliability is achieved.

Protected Storage – Complete

The storage facilities required to implement the FLEX strategies for Braidwood Station, Unit 1 have been completed and provide protection from the applicable site hazards. The equipment required to implement the FLEX strategies for Braidwood Station, Unit 1 is stored in its protected configuration.

Procedures – Complete

FLEX Support Guidelines (FSGs) for Braidwood Station, Unit 1 have been developed and integrated with existing procedures. The FSGs and affected existing procedures have been verified and are available for use in accordance with the site procedure control program.

Training – Complete

Training for Braidwood Station, Unit 1 has been completed in accordance with an accepted training process as recommended in NEI 12-06, Section 11.6.

Staffing – Complete

The Phase 2 staffing study for Braidwood Station has been completed in accordance with 10CFR50.54(f), "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," Recommendation 9.3, dated March 12, 2012 (Reference 14), as documented in Reference 15.

National SAFER Response Center – Complete

EGC has established a contract with Pooled Equipment Inventory Company (PEICo) and has joined the Strategic Alliance for FLEX Emergency Response (SAFER) Team Equipment Committee for off-site facility coordination. It has been confirmed that PEICo is ready to support Braidwood Station, Unit 1 with Phase 3 equipment stored in the National SAFER Response Centers in accordance with the site specific SAFER Response Plan.

Validation – Complete

EGC has completed performance of validation in accordance with industry developed guidance to assure required tasks, manual actions and decisions for FLEX strategies are feasible and may be executed within the constraints identified in the Overall Integrated Plan (OIP) for Order EA-12-049.

FLEX Program Document - Complete

The Braidwood Station, Unit 1 FLEX Program Document has been developed in accordance with the requirements of NEI 12-06.

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

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 7th day of December 2016.

Respectfully submitted,

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

Enclosure: Braidwood Station Units 1 and 2 Final Integrated Plan Document – Mitigation Strategies for a Beyond-Design-Basis Event (NRC Order EA-12-049)

cc: Director, Office of Nuclear Reactor Regulation
NRC Regional Administrator - Region III
NRC Senior Resident Inspector – Braidwood Station
NRC Project Manager, NRR – Braidwood Station
Mr. John D. Hughey, NRR/JLD/JOMB, NRC
Illinois Emergency Management Agency - Division of Nuclear Safety

Enclosure

Braidwood Station Units 1 and 2

Final Integrated Plan Document – Mitigation Strategies for a Beyond-Design-Basis External Event (NRC Order EA-12-049)

(106 pages)

Exelon Generation®

Braidwood Station
Units 1 & 2

Final Integrated Plan Document

Mitigation Strategies for a Beyond-Design-Basis External Event

(NRC Order EA-12-049)

December 2016

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1. Background

On March 11, 2011, an earthquake-induced tsunami caused Beyond-Design-Basis (BDB) flooding at the Fukushima Dai-ichi Nuclear Power Station in Japan. The flooding caused by the tsunami rendered 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. All direct current (DC) power was lost early in the event on Units 1 & 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.

Nuclear Regulatory Commission (NRC) Order EA-12-049, Issuance of Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (BDBEE) (Reference 1), requires a three-phase approach for mitigating beyond-design-basis external events. The initial phase requires the use of installed equipment and resources to maintain or restore core cooling, containment and spent fuel pool (SFP) cooling capabilities. The transition phase requires providing sufficient, portable, onsite equipment and consumables to maintain or restore these functions until they can be accomplished with resources brought from off site. The final phase requires obtaining sufficient offsite resources to sustain those functions indefinitely.

These strategies must be capable of mitigating a simultaneous loss of all AC power and loss of normal access to the ultimate heat sink (LUHS) and have adequate capacity to address challenges to core cooling, containment, and SFP cooling capabilities following a beyond-design-basis external event. Reasonable protection must be provided for the associated equipment from external events. Such protection must demonstrate that there is adequate capacity to address challenges to core cooling, containment, and SFP cooling capabilities. The strategies must be implementable in all Modes.

NRC Interim Staff Guidance (ISG) 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, (Reference 3) provides guidance to assist nuclear power reactor applicants and licensees with the identification of measures needed to comply with the requirements to mitigate challenges to key safety functions contained in Order EA-12-049. This ISG endorses, with clarifications, the methodologies described in Nuclear Energy Institute (NEI) 12-06 Revision 0, Diverse and Flexible Coping Strategies (FLEX) Implementation Guide (Reference 2).

NEI 12-06 outlines the process to be used by individual licensees to define and implement site-specific diverse and flexible mitigation strategies that reduce the risks associated with beyond-design-basis conditions. NEI 12-06 requires that each plant establish the ability to cope with the baseline conditions for a simultaneous ELAP and loss of normal access to the UHS (LUHS) event and then evaluate the FLEX protection and deployment strategies in consideration of the challenges of the external hazards applicable to the site.

This final integrated plan provides the Braidwood Station Units 1 & 2 (Braidwood Station) approach to comply with Order EA-12-049 using the methods described in NRC JLD-ISG-2012-01. The Braidwood Station Final Integrated Plan is based on our design information and engineering analyses, completed modifications, developed guidelines, and procurement of material.

2. NRC Order EA-12-049 – Diverse and Flexible Mitigation Capability (FLEX)

The primary FLEX objective is to develop the capability for coping with a simultaneous ELAP and LUHS event for an indefinite period through a combination of installed plant equipment, portable onsite equipment, and offsite resources. The baseline assumptions have been established on the presumption that other than the loss of normal and alternate AC power sources, and normal access to the UHS, installed equipment that is designed to be robust with respect to design basis external events is assumed to be fully available. Installed equipment that is not robust is assumed to be unavailable. Permanent plant equipment, cooling and makeup water inventories, and fuel for FLEX equipment contained in systems or structures with designs that are robust with respect to seismic events, floods, high winds and associated missiles are available. Other equipment, such as portable AC power sources, portable back up DC power supplies, spare batteries, and equipment for Title 10 of the Code of Federal Regulations (10 CFR) Section 50.54(hh)(2), may be used provided it is reasonably protected from the applicable external hazards and has predetermined hookup strategies with appropriate procedures/guidance and the equipment is stored in a relative close vicinity of the site. Installed electrical distribution systems, including inverters and battery chargers, remain available provided they are protected consistent with current station design.

The FLEX strategy relies upon the following principles:

- Initially cope by relying on installed plant equipment (Phase 1).
- Transition from installed plant equipment to onsite FLEX equipment (Phase 2).

- Obtain additional capability and redundancy from offsite resources until power, water, and coolant injection systems are restored or commissioned. (Phase 3).
- Response actions will be prioritized based on available equipment, resources, and time constraints. The initial coping response actions can be performed by available site personnel post-event.
- Transition from installed plant equipment to onsite FLEX equipment may involve onsite, offsite, or recalled personnel as justified by evaluation.
- Strategies that have a time constraint to be successful are identified and a basis provided that the time can reasonably be met.

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

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

NRC Order EA-12-051, Issuance of Order to Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation, (Reference 4) required licensees to install reliable SFP instrumentation with specific design features for monitoring SFP water level.

NEI 12-02, Industry Guidance for Compliance with NRC Order EA-12-051, "To modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation," (Reference 8) provided guidance for compliance with Order EA-12-051. The NRC determined that, with the exceptions and clarifications provided in JLD-ISG-2012-03, Compliance with Order EA-12-051, Reliable Spent Fuel Pool Instrumentation, (Reference 5), conformance with the guidance in NEI 12-02 is an acceptable method for satisfying the requirements in Order EA-12-051.

2.1 General Elements - Assumptions

The assumptions used for the evaluations of a Braidwood Station ELAP/LUHS event and the development of FLEX strategies are stated below.

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 (Reference 2):

- The BDBEE occurs impacting both units at the site.

- Both reactors are initially operating at power, unless there are procedural requirements to shut down due to the 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 control rods inserted, no Anticipated Transient Without SCRAM (ATWS)). Steam release to maintain decay heat removal upon shutdown functions normally, and reactor coolant system overpressure protection valves respond normally, if required by plant conditions, and reseat.

- 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, for Braidwood Station:

- 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 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. The portion of the fire protection system that is robust with respect to seismic events, floods, and high winds and associated missiles is available as a water source.

- Normal access to the Ultimate Heat Sink (UHS) is lost, but the water inventory in the 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.
- Fuel for FLEX 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, including inverters and battery chargers, remain available since they are protected.
- 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 and identified leakage at the upper limit of Technical Specifications and reactor coolant pump seal leak-off at normal rates at rated pressure.
- 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 (license/site specific) requirements of 10 CFR's may be required.
- Site access is impeded for the first 6 hours, consistent with NEI 12-01, Guideline for Assessing Beyond-Design-Basis Accident Response Staffing and Communications Capabilities (Reference 7). Additional resources are assumed to begin arriving at hour 6 with limited site access up to 24 hours. By 24 hours and beyond, near-normal site access is restored allowing augmented resources to deliver supplies and personnel to the site.

The plant 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 BDBEE 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 Specification (TSs) Requirements at the Surry Power Station", (TAC Nos. MC42331 and MC4332) (Reference 6).

2.2 Strategies

The FLEX strategies described below are capable of mitigating an ELAP/LUHS resulting from a BDBEE by providing adequate capability to maintain or restore core cooling, containment, and SFP cooling capabilities at both units at Braidwood Station. Though specific strategies have been developed, due to the inability to anticipate all possible scenarios the FLEX strategies are also diverse and flexible 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 Braidwood Station 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.

NOTE: All strategies described below are the same for Braidwood Station Units 1 & 2. Any differences and/or unit specific information is included where appropriate.

A simplified design / hookup diagram of the following FLEX strategies showing the general hose routing is provided in Figure 1. FLEX equipment staging areas are shown in Figure 20.

2.3 Reactor Core Cooling Strategy

Reactor core cooling involves the removal of decay heat through the secondary side of the Nuclear Steam Supply System (NSSS) and maintaining sufficient RCS inventory to ensure the continuation of natural circulation in the primary side of the NSSS. The FLEX strategy for reactor core cooling and decay heat removal is to release steam from the Steam Generators (SG) using the SG Power Operated Relief Valves (PORVs) and the addition of a corresponding amount of Auxiliary Feedwater (AF) to the SGs via the Diesel Driven AF (DDAF) pump. The AF system includes the Condensate Storage Tank (CST) as the primary initial water supply to the DDAF pump. However the Essential Service Water (SX) system is the safety related backup supply.

RCS cooldown, using this AF flow/SG steam release balance, will be initiated as soon as time and resources permit and in all cases within 8 hours following a BDBEE that initiates an ELAP/LUHS event (Reference 31).

DC bus load stripping will be initiated within 35 minutes following a BDBEE to ensure Class 1E battery life is extended to eight (8) hours. Portable generators will be used to repower instrumentation prior to battery depletion (Reference 24).

As the plant cools down and RCS inventory shrinks as expected, initial RCS inventory and boration addition will accomplished through the injection from the safety-related, passive Safety Injection Accumulators. Subsequent longer term inventory and boration makeup will be accomplished through the use of a high head FLEX pump, connected from the borated Refueling Water Storage Tank (RWST) and a primary or alternate RCS injection connection. RCS makeup and boron addition will be initiated within 16 hours following a BDBEE to ensure natural circulation, reactivity control, and boron mixing is maintained in the Reactor Coolant System (RCS) (Reference 33).

2.3.1 Phase 1 Strategy

Following the occurrence of an ELAP/LUHS event, the reactor will trip and the plant will initially stabilize at no-load RCS temperature and pressure conditions, with reactor decay heat removal via steam release to the atmosphere through the Main Steam Safety Valves (MSSVs) and/or the SG PORVs. Natural circulation of the RCS will develop to provide core cooling and the Diesel Driven Auxiliary Feedwater (DDAF) pump will provide flow from the Condensate Storage Tank (CST) to the SGs to make up for steam release.

Operators will respond to the ELAP/LUHS event in accordance with emergency operating procedures (EOPs) to confirm RCS, secondary system, and Containment conditions. A transition to 1/2BwCA-0.0, Loss of All AC Power Unit 1/2, will be made upon the diagnosis of the total loss of AC power. This procedure directs isolation of RCS letdown pathways, verification of Containment isolation, reduction of DC loads on the station Class 1E batteries, and establishes electrical equipment alignment in preparation for eventual power restoration. The operators verify AFW flow to all steam generators, establish manual control of the safety-related, missile protected, seismically qualified SG PORVs and initiate a rapid cooldown of the RCS to minimize inventory loss through the Reactor Coolant Pump (RCP) seals. 1/2BwCA-0.0 also directs local manual control of AFW flow to the SGs and manual control of the SG PORVs to control steam release and the RCS cooldown rate, as necessary.

Safety Injection (SI) accumulator injection will provide the initial boration for reactivity control and RCS inventory addition. Inventory and shutdown margin calculations require the addition of 6000 gallons of RWST water to the RCS to commence before 16 hours. The inventory portion is not required prior to the bounding time of 58 hours to prevent an end of single phase natural circulation (Reference 31).

Other actions and/or expected responses include:

- Verify Diesel Driven Auxiliary Feedwater (DDAF) pump is providing feedwater to the Steam Generators. The initial and preferred suction source will be the CST. In the event the CST is not available, actions will be taken to align the UHS, which is a safety-related water source, to the DDAF pump. Action will also be taken to align the alternate cooling water supply from the discharge of the Essential Service Water (SX) pump to the DDAF pump engine driven booster pump to ensure adequate cooling water supply is available for continued operation of the pump. This alignment will occur within two (2) hours of pump start to prevent overheating from the short cycle of the cooling water (Reference 14). Guidance is provided in 1/2BwFSG-2, Alternate AFW/EFW Suction Source Unit 1/2.

- In the event one or more steam generators (SG) are unavailable for cooldown, asymmetric cooldown rate limits are established to prevent loop stagnation and allow for boron mixing of the active loops. The cooldown rates for the initial cooldown are 11°F/hour for Unit 1 and 25°F/hour for Unit 2 (Reference 32).

- Following the cooldown, Reactor Coolant System temperature will be maintained at approximately 410°F by controlling SG pressure at approximately 260 psig in order to ensure maximum SI accumulator injection while preventing nitrogen injection (Reference 13).

- SI accumulators will be isolated by powering their discharge valves from the FX DG. In the event the SI accumulator isolation valves cannot be closed, venting of the cover gas to reduce pressure and prevent nitrogen injection will be performed.

- Braidwood Station has installed the Westinghouse reactor coolant pump (RCP) SHIELD® Passive Thermal Shutdown Seals (SDS) (Generation III) on Unit 1 and on Unit 2. Braidwood Station has Westinghouse RCP Model 93A. Section 2.3.6 contains additional detail.

- Division 12/22 instrumentation will be maintained available by performing DC and AC Bus load shedding. Load shedding will be completed within 65 minutes of event initiation. Load shedding is expected to extend 125V DC battery life to eight (8) hours (Reference 24).

- Core reactivity monitoring will be performed using the installed _Div. 2 nuclear instrumentation or the Post Accident Neutron Monitoring (PANM) instrumentation.

2.3.2 Phase 2 Strategy

Secondary Side

The Phase 2 FLEX Strategy for reactor core cooling provides an indefinite supply of water for feeding the SGs using the installed DDAF pump.

The site will also deploy a FLEX strategy utilizing primary and alternate connection points capable of providing SG make-up. To accomplish this, the Low head FLEX pump will be moved from the storage building to the Lake Screen House. Its suction will be from the UHS via a strainer. The medium pressure FLEX pump will be moved from the storage building to the deployment area near the RWST tunnel hatch. The Low head FLEX pump discharge will be routed from the LSH to the Medium head FLEX pump to provide a source of water to the Medium head FLEX pump. The Medium head FLEX pump discharge will be directed to the primary or alternate plant connections. These connections are contained within the B/C and A/D MSSV rooms. The UHS will serve as the long term source of water to the SGs via the SX and DDAF pump or via the Medium head FLEX pump.

Other actions and/or expected responses include:

- The medium pressure FLEX pump will be maintained in a standby condition as this is a backup to the DDAF pump. An alternate source of feedwater must be supplied within sixty-two (62) minutes for Unit 1 and forty-five (45) minutes for Unit 2 of a failure of the DDAF pump to prevent SG dry out assuming the 1/2C and 1/2D SG PORVs are isolated within five (5) minutes of the loss of feedwater (Reference 34).

- DDAF pump diesel fuel oil level will be monitored and the tank refilled using the installed diesel oil (DO) transfer pumps that are powered from the FLEX diesel generator (FX DG). The DDAP has 420 gallons of diesel fuel stored within it day tank. This amount of fuel is adequate to provide seven (7) hours of operation. Refilling this tank can be performed by re-energizing the fuel transfer pump with a FLEX generator outlined in 0BwFSG-50, FLEX Support Equipment Operation (Reference 13).

- RCS temperature will be maintained at approximately 410°F by controlling SG pressure at approximately 260 psig.

- DDAF pump battery charger will be energized from the FX DG. Division 2 instrumentation will be maintained available by performing DC and AC bus load shedding as well as providing power to the battery chargers from the FX DG. It is expected that power will be restored to the battery charger within six (6) hours (Table 4).

- In the event a battery charger cannot be energized, the DC bus may be cross-tied to the opposite unit provided its battery charger is energized.

<u>Primary Side</u>

The Phase 2 FLEX strategy for RCS Inventory and Reactivity Control provides a reliable supply of Borated water. The high pressure FLEX pump will be moved from the storage building to the deployment area near the RWST tunnel hatch. The pumps borated water suction source is the Refueling Water Storage Tank (RWST) provided by a connection on the B Safety Injection (SI) pump suction line. The pumps discharge will be routed to the FLEX primary connection on the B Safety Injection (SI) system, downstream of the B SI pump. The alternate connection is on the B Chemical and Volume Control (CV) system, downstream of the B CV pump.

Other actions and/or expected responses include:

- The High head FLEX pump will be maintained in a standby condition and operated as required to provide RCS makeup and boration.
- A second RCS cooldown is initiated following isolation of the SI accumulators and after completion of the minimum RCS boration. In the event one or more SGs are not available for cooldown the asymmetric cooldown rates of 8°F/hour (Unit 1) and 20°F/hour (Unit 2) will be implemented (Reference 32).
- RCS boration will be initiated in 16 hours to ensure the reactor is maintained in a subcritical condition. A minimum volume of 6,000 gallons of borated water from the RWST will be injected (Reference 33).
- Div. _2 instrumentation will be maintained available by performing DC and AC bus load shedding as well as providing power to the battery chargers from the FX DG. It is expected that power will be restored to the battery charger within six (6) hours.
- In the event a battery charger cannot be energized, the DC bus may be cross-tied to the opposite unit provided its battery charger is energized.
- Core reactivity monitoring will be performed using the installed _Div. 2 nuclear instrumentation or the Post-Accident Neutron Monitoring (PANM) instrumentation.

2.3.3 Phase 3 Strategy

The Phase 3 strategy for Reactor Core Cooling and Heat Removal utilizes Phase 2 connections and includes additional equipment available from the National SAFER Response Center (NSRC) to provide backup as necessary.

Water treatment skid from the NSRC will be used to treat site makeup water used for core cooling. Boration skid from the NSRC will be used for long term borated water make-up source. Phase 3 equipment will also provide Operations and the TSC/ERO flexibility in addressing plant issues relating to the BDBEE.

If any FLEX equipment from the NSRC is required, the transition is provided in Attachment L of 1/2BwFSG-13, Transition from FLEX Equipment. Figure 12 and 13 show simplified Medium and High head FLEX pump replacement layout.

2.3.4 Systems, Structures, Components

2.3.4.1 Diesel Driven Auxiliary Feedwater Pump

Each unit has one Diesel Driven Auxiliary Feedwater (DDAF) pump. It provides 100% of the required AF capacity to the four (4) Steam Generators, as assumed in the accident analysis. The pump is equipped with an independent recirculation line to prevent pump operation against a closed system. The DDAF pump is supported by a diesel engine, an independent battery system, an essential service water booster pump, and a fuel oil day tank all safety related systems located in the robust Auxiliary building. The diesel is a 16 cylinder engine which produces a nominal 1500 HP and is cooled by the Essential Service Water (SX) system. It has two sets of 100% capacity 24VDC batteries (nickel cadmium). One battery bank is required for starting duty and half of the other bank is used for control power. The fuel system consists of a 500 gallon Day Tank which is maintained with at least 420 gallons of fuel as required by Technical Specifications. Pump design capacity is 990 gpm at 1450 psig. This ensures at least 740 gpm total flow (160 gpm per Steam Generator plus 100 gpm recirculation flow) with all SGs intact (UFSAR Section 10.4). Normal suction is from the Condensate Storage Tank with the SX System as the safety-related backup (Reference 52).

The DDAF pump logic has been modified to lock-out the pump after unsuccessful starting attempts prior to draining the battery. This scenario could occur in a BDBEE if the units Condensate Storage Tank were to fail. This lockout will be manually reset after the DDAF pump suction is realigned to SX. 1/2BwFSG-2, Alternate AFW

Suction Source, provides operators with the necessary direction to manually reset the DDAF pump lockout.

Analysis confirms the DDAF pump batteries can operate for > 8 hour following ELAP event (Reference 20).

2.3.4.2 <u>DDAF pump alternate cooling</u>

In a BDBEE the DDAF pump is subject to overheating due to cooling water recirculation within the SX system. As a result, Braidwood Station has installed an alternate SX cooling supply line to 1/2SX04P suction. The alternate SX supply is safety related and contained within the Safety related auxiliary building. 1/2BwFSG-2, Alternate AFW/EFW Suction Source, provides operators with the necessary guidance to align the alternate SX supply.

2.3.4.3 <u>Steam Generator Power Operated Relief Valves (PORVs)</u>

During an ELAP/LUHS event decay heat will be removed from the SGs for an indefinite time period by manually opening/throttling the safety related SG PORVs. The S/G PORV's are hydraulically operated relief valves that can be manually operated via a locally operated hydraulic hand pump. Two SG PORV's are in each robust MSSV room. The SG PORV's are manually operated within the MSSV room next to an outside access door.

Braidwood is taking an alternate approach to NEI 12-06 Sections 3.2 and 3.2.1.3. The alternate approach is for the method of protecting the permanently installed power operated relief valve (PORV) manual hand pumps from all design basis external events. The PORV manual operators are within robust structures with a non-robust access door. The PORV hand pumps are relied upon for symmetric cool down following a beyond design basis external event (BDBEE).

<u>Basis for alternate approach</u>:

> NEI 12-06, Rev. 0, Section 3.2 states, "Installed equipment that is designed to be robust with respect to design basis external events is assumed to be fully available. Installed equipment that is not robust is assumed to be unavailable." Also, Section 3.2.1.3 states, "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." Robust is defined in Appendix A as, "the design of an SSC either meets the current plant design basis for the applicable external hazards or has been shown by analysis or test to meet or exceed the current design basis."

Braidwood's PORV hand pumps do not meet all of the plant robust requirements for all design basis external events, due to the location behind a non-robust door. Specifically, the door is designed for high winds, but not tornado winds or wind driven missiles.

The PORV operators are within the Category I, robust main steam safety valve (MSSV) room concrete structures at grade elevation, surrounding the containment building. The rooms are protected from tornado missiles and wind by robust concrete labyrinth vestibules with entry via steel Category II doors. The non-safety related PORV manual operators are seismically-mounted within the labyrinth vestibules, but the components are subject to tornado winds and wind generated missiles through the non-robust door.

Per Braidwood UFSAR Section 2.3.1.2.2, the predominant tornado path is southwest to northeast. These doors are located on the east side of the site. As a result, the turbine building, auxiliary building, containment and transformer yards provide a shield protecting these doors from tornado winds and wind driven missiles traveling in the predominant tornado direction.

The Unit 1 and Unit 2 A/D MSSV rooms are located back, closer to the turbine building, and protected by the turbine building structure and transformer yard firewalls. These structures provide reasonable assurance that tornado winds or wind driven missiles will not strike or damage the outer door and prevent access or disable the PORV manual controllers.

The Unit 1 and Unit 2 B/C MSSV rooms are exposed to the environment facing east. Large concrete blocks will be placed in front of the two (2) B/C MSSV room doors to protect the PORV operators from design basis horizontal missiles. The blocks also limit the amount of possible large debris build-up in front of the doors, since the blocks are placed approximately four (4) feet from the entrance.

This configuration ensures all four sets of permanently installed PORV hand pumps have "reasonable protection" and will survive all BDBEEs.

2.3.4.4 Auxiliary Feedwater (AF) flow control valves

The AF flow control valves (AF005's) are AOV's with manual override. The _AF005 valve(s) fail open on a loss of air. These valves can be mechanically positioned by using the local hand wheels. The AF005 valves are safety related and located in the safety related auxiliary building on the 364 elevation.

2.3.4.5 Batteries

The safety-related Class 1E batteries and associated DC distribution systems are located within safety-related structures designed to meet applicable design basis external hazards and will be used to initially power required key instrumentation and applicable DC components. Load stripping of non-essential equipment has been conservatively calculated to provide a total service time of eight (8) hours of operations.

2.3.4.6 Condensate Storage Tank

The 650,000 gallon Condensate Storage Tank (CST) provides a non-safety grade source of water to the Steam Generators for removing decay and sensible heat from the Reactor Coolant System (RCS). The CST provides a passive flow of water, by gravity, to the Auxiliary Feedwater (AF) System (LCO 3.7.5) which feeds the Steam Generators. The steam produced is released to the atmosphere by the Main Steam Safety Valves (MSSVs) or the Steam Generator Power Operated Relief Valves when the condenser is not available. The AF pumps normally operate with recirculation to the CST. The specified LCO level assures the required useable volume of approximately 212,000 gallons is met.

2.3.4.7 Essential Service Water

If the CST is not available, AF can be supplied by the Essential Service Water (SX) system. The SX system provides a safety related, Seismic Category I backup to the CST. The SX system is automatically aligned to provide AF based on system conditions and pump start signals. The UHS consists of an excavated essential cooling pond integral with the main cooling pond, and the piping and valves connecting the pond with the SX system pumps. The UHS is described in UFSAR, Section 9.2.5. The UHS is sufficiently oversized to permit a minimum of 30 days of operation with no makeup.

2.3.5 FLEX Strategy Connections

The site FLEX connections are above or protected from the probable maximum precipitation (PMP) flood level (Section 2.6.2). FLEX connections are made using standard FLEX connections.

2.3.5.1 Primary AF FLEX Connection

The primary SG connection is located in the B/C Main Steam Safety Valve (MSSV) on the 401' elevation. A flexible hose will be routed from the Medium head FLEX pump discharge to the B/C MSSV room and attached to the FLEX connection on the B and C Auxiliary Feedwater (AF) lines.

2.3.5.2 Alternate AF FLEX Connection

The primary SG connection is located in the A/D Main Steam Safety Valve (MSSV) on the 401' elevation. A flexible hose will be routed from the Medium head FLEX pump discharge to the A/D MSSV room and attached to the FLEX connection on the A and D Auxiliary Feedwater (AF) lines.

Additionally, both the B/C and A/D Auxiliary Feedwater (AF) lines have flanges in the Main Steam tunnel on the 377' elevation. Routing a hose through the Main Steam tunnel, between these two flanges, allows for one FLEX pump to feed all four (4) SG's. Temporary hoses are stored within the robust Main Steam Tunnel to provide this connection.

The Main Steam Safety Valve (MSSV) room and the Main Steam tunnel are seismic Category I, tornado missile protected areas. These connections are protected from the external hazards described in Section 2.6.

2.3.5.3 Primary RCS Connection

The primary connection for RCS make-up is located in the RWST tunnel. The High head FLEX pump discharge hose will be routed from the pump through the RWST tunnel hatch to a FLEX connection on the B Safety Injection (SI) system downstream of the B SI pump.

The RWST tunnel, B SI pump room and CV pump rooms connections are protected from the external hazards described in Section 2.6.

2.3.5.4 Alternate RCS Connection

The alternate connection for RCS make-up is located in the B Chemical Volume and Control (CV) system pump room. The High head FLEX pump discharge hose will be routed from the pump through the RWST tunnel hatch, through the RWST tunnel to a FLEX connection on the B CV system downstream of the B CV pump. The High Head pump discharge hose can also be routed through the Fuel Handling Building (FHB) or the opposite unit RWST tunnel to make this connection. The alternate connection provides the physical and train separation required per NEI 12-06 from the primary connection.

2.3.5.5 RWST Suction Connection

The primary supply of water to the High head FLEX pump is through a suction connection from the units RWST. The connection is installed in the RWST tunnel on the suction piping of the B SI pump. A suction hose is routed from this connection, through the RWST tunnel, to the High head FLEX pump suction manifold.

In the event that one unit's RWST is not available, the suction hose to that unit's High head FLEX pump can be routed from the opposite units RWST via, the opposite unit High head FLEX pump suction manifold.

2.3.5.6 Primary Electrical Connection

The primary 480VAC connection is to a modified breaker Bus Connection Device (BCD) installed in a cubicle of BUS _32X in the 4KV ESF switchgear room. The BCD will have the line side connections extending through the breaker frame to standard temporary power cable (TPC) FLEX electrical connections. Temporary cables will be routed from the TPC connections to the associated units FLEX generator at the 401' turbine building track way entrance. The BCD and cables will be stored within the associated 4KV switchgear room to improve operator response time. Once the bus is energized, appropriate breakers will be closed to provide power to the safety related batteries.

The primary and alternate electrical connections are protected from the external hazards described in Section 2.6.

2.3.5.7 Alternate Electrical Connection

In the event either unit primary FLEX strategy is unable to be implemented, DC busses 112 and 212 will be crosstied to provide power to the site B train safety related batteries. Critical 480VAC electrical loads will be powered from a temporary power unit (TPU) staged within the Auxiliary Building (AB). Cables will be routed from the FLEX generator located by the turbine building track way door to the TPU. Cables will then be routed from the TPU to predesigned MCC buckets modified with a new feed breaker and fitted with a short pig tail type connector allowing back feeding of the MCC.

2.3.5.8 Diesel Fuel Oil Connection

The site diesel fuel oil supply is located with the site safety related Diesel Generator Fuel Oil Storage Tanks. The tanks are below ground elevation and cannot be accessed in all BDBEE. As a result, a FLEX connection has been installed on the 401 elevation in both B Diesel Generator rooms. The FLEX connections are on the discharge of the Diesel Generator Fuel Oil Storage Tank transfer pumps. Hoses will be routed from this connection to the turbine building track way door to a fuel transport vehicle. The Diesel Generator Fuel Oil Storage Tank transfer pumps will be re-energized as part the site electrical strategy.

2.3.6 Key Reactor Parameters

Instrumentation providing the following key parameters is credited for all phases of the reactor core cooling and decay heat removal strategy:

- SG Pressure.
- SG Level Narrow Range (NR).
- SG Level Wide Range (WR).

- RCS Pressure Wide Range (WR).
- RCS Cold Leg Temperature.
- RCS Hot Leg Temperature.
- Auxiliary Feedwater (AF) Flow.
- Auxiliary Feedwater (AF) Suction pressure.
- Condensate Storage Tank (CST) Level.
- Core Exit Thermocouple (CETC).
- Reactor Vessel Level Indication System (RVLIS).
- Post-Accident Neutron Monitor (PANM).
- DC Bus Voltage.

Additionally, CETC, RVLIS, and PANM will be energized from the FX DG and Instrumentation will be maintained available from the FX DG or Cross-tie to the opposite unit DC Bus with an energized charger. The use of alternate indication for vital information is described in 1/2BwFSG-7, Loss of Vital Instrumentation or Control Power.

2.3.7 Thermal Hydraulic Analyses

2.3.7.1 Secondary Makeup Water Requirements

The 650,000 gallon Condensate Storage Tank (CST) provides a non-safety grade source of water to the Steam Generators for removing decay and sensible heat from the Reactor Coolant System (RCS). The CST provides a passive flow of water, by gravity, to the Auxiliary Feedwater (AF) system (LCO 3.7.5) which feeds the Steam Generators. The specified LCO level assures the required useable volume of approximately 212,000 gallons is met.

If the CST is not available, AF can be supplied by the Essential Service Water (SX) system. The SX system provides a safety related, Seismic Category I backup to the CST. The SX system is automatically aligned to provide AF based on system conditions and pump start signals. The UHS consists of an excavated essential cooling pond integral with the main cooling pond, and the piping and valves connecting the pond with the SX system pumps. The UHS is described in UFSAR, Section 9.2.5. The UHS is sufficiently oversized to permit a minimum of 30 days of operation with no makeup.

2.3.7.2 RCS Response

A cooldown and depressurization will be performed at < 100 °F/hour to approximately 410°F (saturation for 260 psig) with manual/local operation of the Steam Generator (SG) Power Operated Relief Valves (PORVs). SG feed will be controlled with local operation of the Auxiliary Feedwater (AF) flow control (1/2AF005) valves. The cooldown will be initiated as soon as possible, resource permitting, but no later than 8 hours after event initiation (Reference 31).

After an ELAP occurs, nominal RCP seal leakage occurs for the first 30 minutes followed by significantly reduced leakage due to SHIELD seal actuation. As a result of the cooldown and depressurization, the accumulators inject a significant amount of liquid and the RCS inventory partially recovers, although not enough to refill to the initial level. The SHIELD seals allow for a single-phase natural circulation to continue until 58 hours after the event initiation. Two-phase natural circulation is expected to continue until 71 hours after the event initiation with core uncover in 186 hours without operator intervention (Reference 31).

In the event one or more Steam Generators (SGs) are unavailable for the initial cooldown, asymmetric cooldown rate limits are established to prevent loop stagnation and allow for boron mixing of RCS loop(s). The cooldown rate limits for an asymmetric alignment during the first phase cooldown are 11°F/hour for Unit 1 and 25°F/hour for Unit 2 (Reference 32).

2.3.8 Reactor Coolant Pump Seals

Braidwood Station has installed the Westinghouse Reactor Coolant Pump (RCP) SHIELD® Passive Thermal Shutdown Seals (SDS) (Generation III) in all 4 RCPs on Unit 1 and Unit 2. The NRC has concluded that the use of the Westinghouse SHIELD® Passive Thermal SDS is acceptable for use in ELAP evaluation for Order EA-12-049 as documented in ADAMS Accession No. ML 14132A128 (Reference 42).

The qualification testing of the shutdown seal was performed at conditions based on a cold leg temperature of 571°F. The maximum shutdown seal temperature remains below the shutdown seal temperatures experienced during qualification testing. Following a loss of AC power, it is possible for the RCS cold leg temperature to exceed 571°F for short periods of time without the shutdown seal heating up beyond the temperatures experienced during qualification testing. This is due to the significant thermal inertia of the massive reactor coolant pump internals and pressure boundary. The evaluation documented in Westinghouse Letter LTR-CDA-15-11 concludes that even if the cold leg temperature is 581°F for the first 3000 seconds (50 minutes) following ELAP initiation, the maximum fluid temperature at the reactor coolant pump seal inlet remains below the temperatures experienced during shutdown seal qualification testing. Auxiliary Feedwater flow to the Steam Generators will be initiated at approximately 30 minutes into the ELAP event. Following the restoration of Auxiliary Feedwater flow to the Steam Generators and prior to initiating plant cooldown, cold leg temperature will be dictated by the Main Steam Safety Valves. Cold leg temperature will remain less than 571°F during this period based on the lowest Main Steam Safety Valve setting of 1175 psig adjusted for setting tolerance and lift setpoint testing uncertainty.

Westinghouse LTR-RES-13-153, Documentation of 7228C Compound O-Rings at ELAP Conditions, concludes, with a high level of confidence, that the integrity of the RCS O-rings will be maintained at the temperature conditions experienced during the ELAP event (Reference 59).

2.3.9 Shutdown Margin Analysis

Braidwood Station will abide by the position expressed by the Nuclear Regulatory Commission (NRC) staff in the letter dated January 8, 2014 regarding the boron mixing issue for Pressurized Water Reactors (PWRs) (Reference 41).

Braidwood Station determined the timing and quantity of borated water required to maintain the reactor subcritical. Boration will need to start within 16 hours of the event initiation and require approximately 6,000 gallons of 2300 ppm water injected into the RCS (Reference 33). This analysis determines the amount of boric acid injection required to maintain the reactor 1% subcritical (Keff of 0.99) for various postulated scenarios. One hour of boron mixing time was accounted for before the boration was credited in the results. All of the required boration occurs before the time of the end of single phase natural circulation.

The results were utilized to develop a setpoint to determine the time after shutdown when boration is required from the High head FLEX pump. A process has been developed to verify the setpoint remains conservative for each Braidwood Station future fuel cycles.

If it is necessary to reduce RCS pressure to support boration and makeup, 1/2BwFSG-8 will direct venting the RCS. The primary vent path is via the reactor head vents 1/2RC014B/D. The motive power for these valves is 125 VDC. The alternate vent path is via the pressurizer PORVs. Attachment B of 1/2BwFSG-8 verifies that both the PORV and its block valve are available prior to using this path for venting.

The Spent fuel pool makeup could be from a borated or a non-borated water source. The criticality analyses for the spent fuel assembly storage racks confirm that keff remains $\leq$ 0.95 for the Holtec spent fuel pool storage racks (including uncertainties and tolerances) at a 95% probability with a 95% confidence level (95/95 basis), based on the accident condition of the pool being flooded with unborated water. Thus, the design of both regions assumes the use of unborated water while maintaining stored fuel in a subcritical condition (LCO 3.7.15)

2.3.10 FLEX Pumps and Water Supplies

2.3.10.1 Beyond-Design-Basis Low Head FLEX Pump

The Low head FLEX pump is rated at 1500 gpm at 150 psig that is shared between several functions. The pump is sized to provide a water supply of 300 gpm to each unit and 500 gpm Spent Fuel Pool makeup simultaneously. The Low head FLEX pump is a trailer-mounted, diesel driven centrifugal pump that is stored in the BDB Storage Building. The pump is deployed by towing the trailer to a designated draft location near the UHS. One Low head FLEX pump is required to implement the reactor core cooling and SFP make-up strategy for both units. Two high capacity pumps are available to satisfy the N+1 requirement. FLEX pump sizing and hydraulic analysis establishes the design basis of the FLEX pumps and the ability of FLEX to perform as required (Reference 15).

The Low head FLEX pump will take draft suction from the Ultimate Heat Sink (UHS). Hydraulic analysis has shown the pump has sufficient suction capabilities to perform its FLEX design function (Reference 26).

2.3.10.2 Beyond-Design-Basis Medium Head FLEX Pump

Consistent with NEI 12-06, Appendix D, core cooling and head removal capability is provided using a portable pump through a primary and alternate connection. This function is satisfied with the sites Medium head FLEX pump rating is a nominal 409 psig at 500 gpm and is sized to provide adequate cooling water flow for reactor core cooling and heat removal. The Medium head FLEX pump is a trailer-mounted, diesel engine driven centrifugal pump that is stored in the FLEX Storage Building. The portable, diesel-driven Medium head FLEX pump will provide a back-up method for SG make-up in the event that the DDAF pump can no longer perform its function. Three Medium head FLEX pumps are available to satisfy the N+1 requirement. FLEX pump sizing and hydraulic analysis, establishes the design basis of the FLEX pumps and the ability of FLEX to perform as required (Reference 15).

2.3.10.3 Beyond-Design-Basis High Head FLEX Pump

Consistent with NEI 12-06, Appendix D, RCS inventory and reactivity control capability is provided using a portable pump through a primary and alternate connection. This function is satisfied with the sites High head FLEX pump rating is a nominal 1522 psig at 40 gpm and is sized to provide the service required for RCS inventory and reactivity control. The High head FLEX pump is a trailer-mounted, diesel engine driven positive displacement pump that is stored in the FLEX Storage Building. Three High head FLEX pumps are available to satisfy the N+1 requirement. FLEX pump sizing and hydraulic analysis, establishes the design basis of the FLEX pumps and the ability of FLEX to perform as required (Reference 15).

2.3.10.4 Core Cooling Water Supplies

Ultimate Heat Sink (UHS) is a safety related, Seismic Category I non-borated water supply for the FLEX strategy. The UHS consists of an excavated essential cooling pond integral with the main cooling pond. The UHS is described in UFSAR, Section 9.2.5. The UHS is sufficiently oversized to permit a minimum of 30 days of operation with no makeup.

2.3.10.5 Borated Water Supplies

Braidwood Stations Refueling Water Storage Tank (RWST) is robust and is the main supply of borated water for a BDBEE. Each operating unit has their dedicated RWST. Each RWST contains a minimum of 320,600 of useable water volume. This volume is maintained at a nominal boron concentration of 2400 ppm and at a temperature between 35°F and 100°F. Calculations have shown that in the most demanding scenario of usage, each RWST alone will provide at least 33.6 hours of borated water with a unit in mode 5 and SG's isolated. When both units are on-line, which is the most likely scenario, and an alternate water supply is provided to the SFP, a single RWST is not depleted for 1060 hours (Reference 27).

2.3.11 Electrical Analysis

The general site electrical BDBEE strategy is to repower safety related Division 2 480 volt loads and 120VDC batteries. DC load shedding will be performed starting approximately 35 minutes after the start of an ELAP event and complete within 65 minutes. With the appropriate load shedding, the Division 2 DC batteries will last at least 8 hours (Reference 24).

The primary electrical strategy will be to power 480V Bus 132X/232X by running temporary cables using a downhill deployment method from Division 12/22 switchgear rooms to a portable FLEX diesel generator staged at the affected unit's turbine building track way. Connection of the temporary cables is accomplished using a Bus Connection Device (BCD) that will be racked in to Bus 132X/232X. Among the loads, the FX DG will power includes:

- DDAF pump battery chargers.
- Train B diesel oil fuel transfer pumps.
- Safety Injection accumulator isolation valves.
- Main Control Room (MCR) lighting.
- Lights and ventilation for DDAF pumps and valve operating areas.

- SFP level instrumentation.
- Alternate SFP cooling (0A Refueling Water Purification Pump).
- Post-Accident Neutron Monitors (PANM).
- CETCs/RVLIS.
- Division 12/22 Battery Charger and associated Battery Room Exhaust Fans.

Figure 2, Braidwood Station FLEX Electrical Strategy, provides a basic block diagram of the electrical strategy.

The alternate electrical strategy will be implemented in the event Bus 132X/232X is unavailable. Temporary cables will be routed from the patch panel to provide power directly to Motor Control Centers (MCCs) to provide power to needed equipment. A FLEX diesel generator will be tied into the opposite unit's Bus 132X/232X with a Bus Connection Device to energize the opposite unit's Division 12/22 Battery Charger and allow powering the unit's DC Bus through DC breaker crosstie. Figure 3 and 4, provides a basic block diagram of the unit 1 and 2 alternate electrical strategies.

The primary and alternate electrical supply strategies were put together under the loading premise that one unit would be implementing the primary strategy while the opposite unit would be implementing the alternate strategy. Braidwood Station calculation BRW-13-0182-E, and its supporting documents, supply the basis for electrical equipment sizing (cables, breakers, portable generators, etc.) that support these strategies (Reference 25).

Braidwood Station has three FX DG s with the same capacity. As required, one of the three is considered a spare (N+1) unit. The FX DG s have sufficient capacity to power their associated busses. Loads associated with Busses 132X and 232X are also documented in Braidwood Station Calculation BRW-13-0182-E. The Unit 1 primary strategy calls for a loading of 191.8 KW at 316.3 Amps. The Unit 1 alternate strategy calls for a loading of 83.8 KW at 117.6 Amps. The Unit 2 primary strategy calls for a loading of 180.7 KW at 298.1 Amps. The Unit 2 alternate strategy calls for a loading of 72.7 KW at 99.4 Amps.

Each FX DG has a nominal rating of 350KW/438KVA and is trailer-mounted. Each FX DG has sufficient capacity to deliver the bounding load current, with consideration of all load drops, including margin. Each FX DG has sufficient motor starting volt-amp capacity to start the largest required motor (1/2SI8808A-D). The standby rating of each diesel generator is adequate for energizing a 1000KVA transformer. Each FX DG has the capability of adjusting the output +/- from a nominal 480V (456V – 504V). Therefore, the capability of the FLEX diesel generators supports the strategies.

Load shedding and battery conservation are described in 1/2BwFSG-4, ELAP DC BUS Load Shed/Management Unit. The alternate DC electrical strategy will be to cross-tie DC Busses to one with an energized battery charger.

FX DG alignment to supply 480V AC power to Bus132X/232X is described in 1/2BwFSG-5, Initial Assessment and FLEX Equipment Staging Unit 1/2. This procedure also provides electrical bus isolation and ensures multiple sources are not simultaneously connected to buses. The FX DG circuit breakers are sized to provide over-current protection downstream of the circuit breakers.

The FX DG phase rotation was verified to be compatible with Braidwood Station equipment. Standard color-coded cables will be used to ensure the FX DG is properly connected.

The use of alternate indication for vital information is described in 1/2BwFSG-7, Loss of Vital Instrumentation or Control Power.

Additional replacement 480 VAC diesel powered generators are available from the National SAFER Response Center (NSRC) for the Phase 3 strategy. The specifications and ratings for this equipment are listed in Table 2.

2.4 Spent Fuel Pool Cooling/Inventory

The Braidwood Station Spent Fuel Pool (SFP) is a common pool designed for both Unit 1 and Unit 2. The basic FLEX strategy for maintaining SFP cooling is to monitor SFP level and provide sufficient makeup water to the SFP to maintain the normal SFP level. Evaluations estimate that with no operator action following a loss of Spent Fuel Pool (SFP) cooling at the maximum design heat load, the SFP will reach 212°F in approximately 10.94 hours. 1/2BwCA 0.0, Loss of All

AC, directs spent fuel pool make-up at 420' elevations which will occur 24.8 hours into the event (Reference 22).

2.4.1 Phase 1 Strategy

The Phase 1 coping strategy for spent fuel pool cooling is to monitor spent fuel pool level using instrumentation installed as required by NRC Order EA-12-051 (Reference 5).

Other actions and/or expected responses include:

- SFP level will be monitored using Spent Fuel Pool Level Instrumentation – 0LI-FC001B and 0LI-FC002B. The instrumentation will initially be powered from an Uninterruptible Power Supply (UPS) that will provide power to the instrumentation for 72 hours. Prior to the UPS exhaustion, a FLEX diesel generator (FX DG) will be connected to provide a continuing source of power.
- A Spent Fuel Pool vent path will be provided by opening the Fuel Handling Building track way roll-up door. The site has manual actions within the Fuel Handling Building, which include aligning the alternate SFP make-up flow path. The site will perform these manual actions prior to the onset of SFP boiling and prior to reaching an adverse environment in the area. The actions are directed by 0BwFSG-5, Initial Assessment and FLEX Equipment Strategy.
- For all SFP heat loads, procedure guidance directs the FHB vent path and alternate FLEX SFP makeup hose placement to assure safe access and task completion.

2.4.2 Phase 2 Strategy

The primary Phase 2 strategy will be repowering the installed safety related 0A Refueling Water Purification Pump, utilizing the site plan to re-energize safety related 480V buses with a FLEX DG. The RWST with the installed safety related piping will be used as the suction source. The discharge will use the existing 0A Refueling Water Purification Pump safety related discharge piping directly to the SFP. Use of this strategy does not require entry into the Fuel Handling Building. Actions are directed through 0BwFSG-11, Alternate SFP Makeup and Cooling Unit 0. FX DG electrical strategy deployment is described in section 2.9.4.

The alternate Phase 2 strategy will be achieved with a portable low head FLEX diesel pump stage at the ultimate Heat Sink (UHS). Discharge hoses will be routed to the SFP via the Medium head FLEX pump suction header. The discharge will consist of spray flow as required by NEI 12-06. Spray monitor guns and sufficient hose length required for the SFP spray option are located in the FLEX Storage Building. Actions are directed through 0BwFSG-11, Alternate SFP Makeup and Cooling Unit 0.

Other actions and/or expected responses include:

- The medium pressure FLEX pump will be moved from the storage building to the deployment area near the RWST tunnel hatch.
- The Phase 2 deployment activities in the Fuel Handling Building will be completed prior to boiling occurring in the Spent Fuel Pool.
- SFP level will be monitored using Spent Fuel Pool level instrumentation.

2.4.3 Phase 3 Strategy

The Phase 3 strategy for Spent Fuel Pool Cooling/Inventory utilizes Phase 2 strategy and includes additional equipment available from the National SAFER Response Center (NSRC) to provide backup as necessary.

Phase 3 equipment will also provide Operations and the TSC/ERO flexibility in addressing plant issues relating to the BDBEE.

In case any FLEX equipment from the NSRC is required, the transition is provided in Attachment L of 1/2BwFSG-13, Transition from FLEX Equipment.

2.4.4 Structures, Systems, and Components

2.4.4.1 Primary Connection

The primary Phase 2 strategy will be repowering the installed safety related 0A Refueling Water Purification Pump utilizing the site plan to re-energize safety related 480V buses with a FLEX diesel generator. The RWST with the installed safety related piping will be used as the suction source. The discharge will use the existing 0A Refueling Water Purification Pump safety related discharge piping directly to the

SFP. The FLEX connection required to execute this strategy are associated with the FLEX diesel generator strategy discussed in section 2.3.5.6 and 2.3.5.7.

2.4.4.2 Alternate Connection

The alternate Phase 2 strategy will be achieved with a portable low head FLEX diesel pump stage at the ultimate Heat Sink (UHS). Discharge hoses will be routed to the SFP via the Medium head FLEX pump suction header. The discharge will consist of spray flow as required by NEI 12-06. Spray monitor guns and sufficient hose length required for the SFP spray option are located in the FLEX storage building. The execution of this strategy does not require FLEX connections to plant systems.

2.4.4.3 Spray Option Connection

The site alternate strategy described in section 2.4.4.2 utilizes a spray flow to achieve SFP makeup. The spray strategy, as required by NEI 12-06 Table D-3, provides 500 gpm flow through portable spray monitor guns located in different corners of the fuel pool (Figure 10).

2.4.4.4 Fuel Building Ventilation

A Spent Fuel Pool (SFP) vent path will be provided by opening the Fuel Handling Building track way roll-up door. The site has manual actions within the Fuel Handling Building to align the alternate SFP make-up flow path. The site plans to perform these manual actions prior to the onset of SFP boiling. The actions will be directed by 0BwFSG-5, Initial Assessment and FLEX Equipment Staging.

The SFP environment has the potential to communicate with the Aux Building via the FHB supply ducting, because the FHB supply dampers fail open on a loss of AC. It is reasonable to assume this flow path will be isolated by fire damper 0VA413Y. The fire damper will close when its fusible link melts shortly after reaching a set point of 165°F. Due to this damper arrangement and lack of motive force, minimal FHB atmosphere should be dispersed in to the Auxiliary Building (AB).

2.4.5 Key Reactor Parameters

The key parameter for the SFP makeup strategy is the SFP water level. The SFP water level is monitored by the instrumentation 0LI-FC001B and 0LI-FC002B installed in response to Order EA-12-051, Reliable Spent Fuel Pool Level Instrumentation (Reference 4).

The instrumentation will initially be powered from an Uninterruptible Power Supply (UPS) that will provide power to the instrumentation for 72 hours. Prior to the UPS exhaustion, a FLEX diesel generator (FX DG) will be connected to provide a continuing source of power.

2.4.6 Thermal-Hydraulic Analyses

The worst case SFP Heat Load during non-outage conditions is 32.5 Mbtu/hour Loss of SFP cooling with this heat load results in a time to boil of 10.94 hours and 90.98 hours to the top of active fuel. 1/2BwCA 0.0, Loss of All AC, directs spent fuel pool make-up at 420' elevations which will occur 24.8 hours into the event. The equipment line-up for initiating SFP make-up needs to be completed prior to the SFP Boil time of 10.94 hours into the event to ensure adequate cooling of the spent fuel is maintained. The worst case SFP heat load during an outage is 62.9 Mbtu/hr. Loss of SFP cooling with this heat load results in a time to boil of 2.72 hours and 43.96 hours to the top of active fuel. With the entire core being located in the SFP, manpower resources normally allocated to aligning core cooling along with the Operations outage shift manpower can be allocated to aligning SFP make-up.1/2 BwCA 0.0, Loss of All AC, directs spent fuel pool make-up at 420' elevations which will occur 9.8 hours into the event. Therefore, completing the equipment line-up for initiating SFP make-up 2.72 hours into the event ensures adequate cooling of the spent fuel is maintained (Reference 22).

2.4.7 FLEX Pump and Water Supplies

2.4.7.1 0A Refueling Water Purification Pump

The safety related 0A Refueling Water Purification Pump will be used for the primary method for Spent Fuel Pool cooling and makeup. The pump rating is a nominal 150 psig at 150 gpm and will provide the service required for SFP makeup (UFSAR 9.1.3).

2.4.7.2 Low Head FLEX Pump

The Low head FLEX pump is rated at 1500 gpm at 150 psig that is shared between several functions. The pump is sized to provide a water supply of 300 gpm to each unit and 500 gpm Spent Fuel Pool makeup simultaneously. The Low head FLEX pump is a trailer-mounted, diesel driven centrifugal pump that is stored in the BDB Storage Building. The pump is deployed by towing the trailer to a designated draft location near the UHS. One Low head FLEX pump is required to implement the reactor core cooling and SFP make-up strategy for both units. Two high capacity pumps are available to satisfy the N+1 requirement. FLEX pump sizing and hydraulic analysis establishes the design basis of the FLEX pumps and the ability of FLEX to perform as required (Reference 15).

2.4.7.3 Water Sources

Braidwood Station Ultimate Heat Sink and the Unit Refueling Water Storage Tanks are the water source for the Spent Fuel Pool. Section 2.15 contains additional detail.

2.4.8 Electrical Analysis

The SFP will be monitored by instrumentation installed in response to Order EA-12-051. The power for this equipment has backup battery capacity for 72 hours. Alternative power will be provided within 72 hours using onsite portable generators, if necessary, to provide power to the instrumentation and display panels and to recharge the backup battery. Section 2.3.11 contains additional detail.

2.5 Containment Integrity

With an extended loss of all alternating current power (ELAP) initiated while either Braidwood Station unit is in Modes 1-4, Containment cooling for that unit is also lost for an extended period of time. Therefore, Containment temperature and pressure will slowly increase. With the installation of the Westinghouse Reactor Coolant Pump (RCP) SHIELD® Passive Thermal Shutdown Seals (SDS) (Generation III), the amount of leakage into containment will be reduced, resulting in additional margin to reaching design basis temperature and pressure. As part of the Containment integrity strategy, Containment status will be monitored by the Main Control Room operators. Containment temperature and pressure design limits are not expected to be approached.

2.5.1 Phase I

Following the occurrence of an ELAP/LUHS event, the reactor will trip and the plant will initially stabilize at no-load Reactor Coolant System (RCS) temperature and pressure conditions. Operators will respond to the ELAP/LUHS event in accordance with emergency operating procedures (EOPs) to confirm RCS, secondary system, and Containment conditions. A transition to 1/2BwCA-0.0, Loss of All AC Power Unit 1/2, will be made upon the diagnosis of the total loss of AC power. Among the actions directed by this procedure is verification of Containment isolation and monitor containment status.

Other actions and/or expected responses include:

- Monitor Containment status.

- Division 12/22 instrumentation will be maintained available by performing DC and AC bus load shedding as well as providing power to the battery chargers from the FLEX diesel generator (FX DG). It is expected that power will be restored to the battery charger within six (6) hours (Table 4).

- In the event a battery charger cannot be energized, the DC bus may be cross-tied to the opposite unit provided its battery charger is energized.

2.5.2 Phase 2

The Phase 2 coping strategy is to continue monitoring Containment temperature and pressure using installed instrumentation.

Other actions and/or expected responses include:

- Monitor Containment status.

- Division 12/22 instrumentation will be maintained available by performing DC and AC bus load shedding as well as providing power to the battery chargers from the FLEX diesel generator (FX DG). It is expected that power will be restored to the battery charger within six (6) hours (Table 4).

2.5.3 Phase 3

The Phase 3 coping strategy is to continue monitoring Containment temperature and pressure using installed instrumentation.

1/2BwFSG-12, Containment Cooling, provides operators with options for restoring containment cooling to reduce containment temperature and pressure. These options utilize existing plant systems and/or FLEX equipment, if needed. Section 2.5.4 contains additional detail.

The Phase 3 strategy for Containment Integrity utilizes Phase 2 strategy and includes equipment available from the National SAFER Response Center (NSRC) to provide backup as necessary.

Phase 3 equipment will also provide Operations and the TSC/ERO flexibility in addressing plant issues relating to the BDBEE.

2.5.4 Structures, Systems, Components

2.5.4.1 Ventilation Cooling Strategy

If ventilation Cooling strategy is necessary, 1/2BwFSG-12, Containment Cooling, provides operator with the guidance to perform the following:

- Attachment C: Venting Containment using the mini purge exhaust system.
- Attachment D: Alternate Containment Fan Cooling, using the Reactor Containment Fan Cooling (RCFC) system.
- Attachment E: Containment Purge for Containment Cooling, using the mini purge exhaust, supply and installed fans.

2.5.4.2 Spray Strategy

If spray strategy is necessary, 1/2BwFSG-12, Containment Cooling, provides operator with the guidance to perform the following:

- Attachment A: Alternate Containment Spray, using the Containment Spray system and FLEX water source.
- Attachment B: Alternate Power to Containment Spray, which restores the 4 KV bus and re-energizes the existing Containment Spray system.

- Attachment F: External Containment Cooling, utilizing the Fire Protection system or a FLEX pump to spray the containment exterior.

2.5.5 Key Containment Parameters

Instrumentation providing the following key parameters is credited for all phases of the Containment integrity strategy:

- Containment Pressure.
- Containment Wide Range Temperature.

Instrumentation will be powered from the FLEX diesel generator (FX DG). The use of alternate indication for vital information is described in 1/2BwFSG-7, Loss of Vital Instrumentation or Control Power.

2.5.6 Thermal-Hydraulic Analyses

Calculation BYR13-235/BRW-13-0217-M, Containment Pressure and Temperature Response during an ELAP Event shows it will take >30 days for containment pressure to exceed 40 psig and 13.7 days for the containment temperature to exceed 200°F. The 40 psig and 200°F values are FSG setpoint limits.

The data also shows it would take > 30 days for the containment pressure to exceed 50 psig and > 30 days for the containment temperature to exceed 280°F. The 50 psig and 280°F values are design base limits (Reference 17).

2.5.7 FLEX Pump and Water Supplies

The NSRC is providing different sized FLEX pumps which can be used to provide water as described in 1/2BwFSG-12, if needed. The NSRC pumps are described in Table 2. Water sources are as described in Section 2.15.

2.5.8 Electrical Analysis

Instrumentation will be powered from the FLEX diesel generator (FX DG). Section 2.3.11 contains additional electrical strategy details. In addition, the NSRC will be supplying generators are described in Table 2.

2.6 Characterization of External Hazards

The applicable extreme external hazards for Braidwood Station are seismic, external flooding, high winds, ice, snow, and extreme cold, and extreme high temperatures.

2.6.1 Seismic

The original investigation of historical seismic activity in the Braidwood Station region determined a design safe shutdown earthquake (SSE) which is defined as the occurrence of a Modified Mercalli Intensity of VIII originating at the bedrock-till interface at the site. Per Section 2.5 of the Updated Final Safety Analysis Report (UFSAR), Braidwood Station determined the corresponding ground surface acceleration to be 0.26 g for the postulated Safe Shutdown Earthquake (Reference 52).

In addition to the NEI 12-06 guidance, Near-Term Task Force (NTTF) Recommendation 2.1, Seismic, required that facilities re-evaluate the site's seismic hazard. Braidwood Station subsequently re-evaluated the seismic hazard and developed a Ground Motion Response Spectra (GMRS) for the site based upon the most recent seismic data and methodologies, and has found that the existing SSE does not bound the new GMRS over the entire frequency range, specifically the high frequency range (greater than 10Hz). As a result, Braidwood Station completed the evaluation of this frequency range and confirmed that the FLEX strategies can be implemented as designed and no further seismic evaluations are necessary (Reference 61).

For FLEX strategies, the earthquake is assumed to occur without warning and results in damage to non-seismic designed structures and equipment. Non-seismic structures and equipment may fail in a manner that would seemingly challenge accomplishment of FLEX-related activities (i.e., normal access to plant equipment, functionality of non-seismic plant equipment, deployment of FLEX equipment, and restoration of normal plant services, etc.). The ability to clear haul routes, along with the diverse FLEX strategies, facilitates Braidwood Station success should a BDB seismic event occur.

2.6.2 External Flooding

Braidwood Station is located in Illinois, about 4 miles southwest of the Kankakee River near the town of Braidwood, in Will County. External flooding for Braidwood Station site is not applicable per NEI 12-06 (Section 6.2.1), since Braidwood Station is considered a dry site per Braidwood Station UFSAR. Braidwood Station plant grade elevation is at 600.0 feet and the grade floor of the safety related buildings are at elevation 601.0 feet. The site is not subject to significant river or tsunami type flooding based on the site elevation compared to nearby rivers. The probable maximum flood (PMF) along the Kankakee River, Mason River and Granary Creek do not affect the site, since the maximum water surface elevations are 561.3, 582, and 576 feet respectively: the peak elevations are a minimum of 18 feet below the plant grade of 600 feet (Reference 52).

There are no dams upstream on nearby rivers whose failure could cause flooding at the site.

The probable maximum precipitation (PMP) falling on the plant area was considered in the analysis of local intense precipitation on the plant site. The maximum water level is elevation 601.91 feet at the plant safety related facilities due to PMP (Reference 36).

To prevent this water from entering areas where essential equipment/systems are located, reinforced concrete curbs or steel barriers are provided at the following locations:

- External hatches to the RWST tunnel.
- Radwaste building access to the transfer tunnel.
- MSIV rooms adjacent to 401' elevation exterior access doors.
- Personnel access locations to the Auxiliary Building from the FHB 401' elevation.

Braidwood Station has flood doors associated with the Diesel Oil (DO) Storage Tank Rooms below the 401' elevation. Therefore, the DO Transfer Pumps are protected from external and internal flooding. The DO FLEX connections in the 1/2B Emergency Diesel Generator Rooms are at the 402' elevation. This is slightly above the expected flood level. The 401' level of the Turbine building is utilized to access the 1/2B Emergency Diesel Generators Rooms, but flooding is not expected since external water would cascade to the lower elevations of the turbine building as opposed to pooling on the 401' elevation.

The site BDBEE strategy does not required FLEX equipment to remove ground water. The site does have 3 trash pumps listed in Table 1, in the event water removal from an area is needed.

Since the original submittal of the Overall Integrated Plan, Braidwood has completed and submitted the Flood Hazard Reevaluation Report for Braidwood Station as requested by the 10 CFR 50.54(f) letter dated March 12, 2012. The reevaluation represents the most current flooding analysis for Braidwood Station Units 1 and 2 using present-day methodologies and guidance. The reevaluation results were bounded by the current Braidwood Station site flooding design basis (Reference 37).

Braidwood Station UFSAR (Section 2.4.4 through 2.4.7) addresses additional flooding mechanisms that are either not critical or not bounding for Braidwood Station.

2.6.3 <u>Severe Storms with High Wind</u>

Braidwood Station's longitude and latitude are 41 degrees 14' N and 88 degrees 13' W.

NEI 12-06 (Reference 2) identifies Braidwood Station in a region which would not experience severe winds from hurricanes. However, NEI 12-06 identified Braidwood Station in Region 1 and is susceptible to tornado winds of 200 mph. Braidwood Station UFSAR Section 2.3.1.2.2, identifies the predominant tornado path is southwest to northeast.

Braidwood Station has existing abnormal procedures 0/1/2 BwOA ENV-1, Adverse Weather Conditions, addresses high wind conditions. These procedures direct operators to check plant equipment and assess damage. Plant administrative procedure MA-AA-716-026, Station housekeeping and Material Condition Program exist for addressing the elimination of potential tornado-generated missiles within the area of the Main and Auxiliary power transformers. The Braidwood Station FLEX implementation procedure (Reference 54) provides locations for staging equipment delivered from offsite through the Strategic Alliance for FLEX Emergency Response (SAFER) response procedure (Reference 55).

2.6.4 Ice, Snow and Extreme Cold

For Braidwood Station, per UFSAR Section 2.3.1.2.3, Heavy Snow and Severe Glaze Storms, severe winter storms which usually produce snowfall in excess of six (6) inches and are often accompanied by damaging glaze in Illinois. These storms occur on an average of five times per year.

NEI 12-06 (Figure 8-1) identifies Braidwood Station in an area in which it could receive 25 inches of snow over three (3) days. NEI 12-06 (Figure 8-2) identifies Braidwood Station in a region, of ice severity level 5, catastrophic destruction to power lines and/or existence of extreme amount of ice.

Braidwood Stations UFSAR Section 2.3.1.1, General Climate, list the annual average temperature in the Braidwood Station area as represented by Peoria Illinois is 50.8°F, while extreme low temperatures is -20°F. Minimum temperatures are less than or equal to 32°F about 130 times per year.

2.6.5 High Temperatures

For Braidwood Station, UFSAR Section 2.3.1.1, General Climate, the annual average temperature in the Braidwood Station area as represented by Peoria Illinois is 50.8°F, with an extreme high of 102°F. Maximum temperatures equal or exceed 90°F about 20 times per year.

Extreme high temperatures are not expected to impact the utilization of onsite or offsite resources, or the ability of personnel to implement the required FLEX strategies. Provisions have been made to hydrate personnel working in extreme high temperatures.

2.7 Protection of FLEX Equipment

The site FLEX storage building will consist of one robust building and one commercial building. The robust and commercial buildings will be located adjacent to each other outside the protected area, southeast of the main parking lot. The site FLEX robust storage structure is designed to withstand design basis wind, tornado, and seismic events as outlined in NEI 12-06. The commercial building is constructed to American Society of Civil Engineers (ASCE) 7-10 standards. In general, the robust building will contain the sites "N" FLEX equipment and the commercial building will contain the sites "N+1" FLEX equipment. For Braidwood Station, some of the +1 equipment will be stored in a fully robust building. These buildings do not meet the axis of separation described in NEI 12-06. As a result, Braidwood Station is taking an alternate approach to NEI 12-06, Revision 0 for protection of FLEX equipment as stated in Section 5.3.1 (seismic,) Section 7.3.1 (severe storms with high winds), and Section 8.3.1 (impact of snow, ice and extreme cold). This alternate approach will be to store "N" sets of equipment in a fully robust building and the +1 set of equipment in a commercial building. Note that, for Braidwood Station, some of the +1 equipment will be stored in a fully robust building.

Basis for the alternate approach:

For all hazards scoped in for the site, the FLEX equipment will be stored in a configuration such that no one external event can reasonably fail the site FLEX capability (N).

To ensure that no one external event will reasonably fail the site FLEX capability (N), Exelon will ensure that N equipment is protected in the robust building. To accomplish this, Exelon will develop procedures to address the unavailability allowance as stated in NEI 12-06, Revision 0 Section 11.5.3., (see Maintenance and Testing section below for further details). This section allows for a 90-day period of unavailability. If a piece of FLEX equipment stored in the robust building were to become or found to be unavailable, Exelon will impose a shorter allowed outage time of 45 days. For portable equipment that is expected to be unavailable for more than 45 days, actions will be initiated within 24 hours of this determination to restore the site FLEX capability (N) in the robust storage location and implement compensatory measures (e.g., move the +1 piece of equipment into the robust building) within 72 hours where the total unavailability time is not to exceed 45 days. Once the site FLEX capability (N) is restored in the robust storage location, Exelon will enter the 90-day allowed out of service time for the unavailable piece of equipment with an entry date and time from the discovery date and time.

Maintenance and Testing:

1. The unavailability of equipment and applicable connections that directly performs a FLEX mitigation strategy for core, containment, and SFP should be managed such that risk to mitigating strategy capability is minimized.

a. The unavailability of plant equipment is controlled by existing plant processes such as the Technical Specifications. When plant equipment which supports FLEX strategies becomes unavailable, then the FLEX strategy affected by this unavailability does not need to be maintained during the unavailability.

b. The required FLEX equipment may be unavailable for 90 days provided that the site FLEX capability (N) is met. If the site FLEX (N) capability is met but not protected for all of the site's applicable hazards, then the allowed unavailability is reduced to 45 days.[1]

c. The duration of FLEX equipment unavailability, discussed above, does not constitute a loss of reasonable protection from a diverse storage location protection strategy perspective.

d. If FLEX equipment or connections become 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., use of alternate suitable equipment or supplemental personnel) within 72 hours.

e. If FLEX equipment or connections to permanent plant equipment required for FLEX strategies are unavailable for greater than 45/90 days, restore the FLEX capability or implement compensatory measures (e.g., use of alternate suitable equipment or supplemental personnel) prior to exceedance of the 45/90 days.

For Section 5, seismic hazard, Exelon will also incorporate these actions:

1. Large portable FLEX equipment such as pumps and power supplies should be secured as appropriate to protect them during a seismic event (i.e., Safe Shutdown Earthquake (SSE) level).

[1] The spare FLEX equipment is not required for the FLEX capability to be met. The allowance of 90- day unavailability is based on a normal plant work cycle of 12 weeks. In cases where the remaining N equipment is not fully protected for the applicable site hazards, the unavailability allowance is reduced to 45 days to match a 6-week short cycle work period. Aligning the unavailability to the site work management program is important to keep maintenance of spare FLEX equipment from inappropriately superseding other more risk-significant work activities.

2. Stored equipment and structures will be evaluated and protected from seismic interactions to ensure that unsecured and/or non-seismic components do not damage the equipment.

For Section 7, severe storms with high winds, Exelon will also incorporate this action:

- To meet Section 7.3.1.1.a, either of the following are acceptable:
  - All equipment (N+1) in a structure(s) that meets the plant's design basis for high wind hazards, or
  - (N) equipment in a structure(s) that meets the plant's design basis for high wind hazards and (+1) equipment stored in a location not protected for a high wind hazard.

For Section 8, impact of snow, ice and extreme cold, Exelon will also incorporate this action:

- Storage of FLEX equipment should account for the fact that the equipment will need to function in a timely manner. The equipment should be maintained at a temperature within a range to ensure its likely function when called upon. For example, by storage in a heated enclosure or by direct heating (e.g., jacket water, battery, engine block heater, etc.).

Braidwood will meet all of the requirements in NEI 12-06, Revision 0 for Section 6.2.3.1 for external flood hazard and Section 9.3.1 for impact of high temperatures.

The robust and commercial buildings have been constructed with 5000 pound capacity tie-downs for large portable equipment stored within the buildings. This equipment is secured during a seismic event to preclude seismic interaction that could cause damage to the equipment. Equipment is secured using a minimum of 2 tie-down points per piece of equipment. In situations where this cannot be achieved, then Engineering has evaluated the tie down to ensure the equipment is properly restrained to prevent interaction with surrounding equipment. Storage cabinets are located a sufficient distance for any piece of equipment such that if the cabinet were to fall over during a seismic event, it would not make contact with any equipment. Miscellaneous items are stored on shelves in the FLEX building. Equipment is located a sufficient distance away from shelves to ensure items stored on shelves will not contact and result in damage affecting availability if they fall from the shelves during a seismic event.

The site maximum flood water level is at elevation 601.91 feet resulting from a probable maximum precipitation (PMP) event. The FLEX Storage Buildings are constructed above the flood level to an elevation of 602 feet.

The FLEX storage robust building and the commercial building will house the dedicated FLEX Equipment. The interior temperature of the building is designed to maintain between 40°F and 100°F (Reference 46). The both buildings are designed to withstand the snow loading as required per NEI 12-06.

The FLEX equipment is qualified to operate in extreme conditions, including high temperatures. FLEX pumps were procured with operational specification for ambient temperatures as high as a nominal 110°F. FLEX hoses were procured with similar operational specification. FLEX diesel generators were procured with operational specification for ambient temperatures as high as a nominal 122°F.

FLEX Pumps were procured with operational specification for ambient temperatures as low as a nominal (–) 20° F. FLEX hoses were procured with similar operational specification. FLEX Diesel Generators were procured with operational specification for ambient temperatures as low as a nominal (–) 25°F and capable of operating in rain, snow, and sleet. The procured, large FLEX truck is equipped with a plow for snow removal to clear a path for deployment. In addition, the Braidwood Station FLEX Plan CC-AA-118-1001 Attachment 7 provides a diagram for FLEX equipment deployment locations and snow/ice removal paths from FLEX Buildings to deployment location.

The site FLEX strategy has been evaluated for potential freezing due to loss of heat trace or other heat sources. Susceptible equipment includes the borated RWST, temporary hoses and pumps deployed outside.

- Refueling Water Storage Tank (RWST) could potentially reach 32°F in 82.3 hours. Precipitation of boron in solution should not occur before this time (Reference 28).
- The RWST vent header is heat traced and contains a vacuum relief device. 0BwFSG-5, Initial Assessment and FLEX Equipment Staging, provides the necessary direction to open the RWST hatch ensuring the vent path is maintained.

- The FLEX temporary hoses, routed outside, will be protected from freezing by maintaining positive flow or by draining when not in use. Operator guidance has been added to various FSG's to alert the operators to the potential freezing concern. Additional sections of FLEX hose are also available as a replacement in the event a section of the hose freezes.

In-plant storage areas are established to ensure required equipment is available to support the FLEX strategies:

- Main Control Room alternate ventilation support equipment will be stored near the deployment areas described in 0BwFSG-51, Alternate MCR Ventilation.
- Division 12/22 4KV ESF switchgear rooms to support alignment of the FLEX diesel generator to Bus 132X/232X.
- Main steam tunnel to support the ability to provide feedwater to all four (4) Steam Generators.
- Aux Building 383' elevation to support Auxiliary Feedwater and other Aux Building requirements.

2.8 Planned Deployment of FLEX Equipment

2.8.1 Haul Paths

Pre-determined primary and alternate deployment routes for Phase 2 portable FLEX equipment are identified in CC-BR-118-1001 Attachment 7 (Reference 55).

The deployment of onsite FLEX equipment in Phase 2 requires that pathways between the FLEX storage building(s) and various deployment locations be clear of debris resulting from beyond design basis seismic, high wind (tornado), or flooding events. The stored FLEX debris removal equipment includes a F750 truck with plow and two T5.115 New Holland tractors. One of the tractors is equipped with a bucket and the other with forks to assist in debris removal. These vehicles will be stored within the robust FLEX building. The robust building has three vehicle access doors. The 2 New Holland tractors and the F750 truck will be staged behind these doors ready to deploy. The deployment of the debris removal equipment and the Phase 2 FLEX equipment from the storage building is not dependent on offsite power. The building equipment doors can be manually opened, if needed.

Downed power lines affecting the primary route will be assessed and de-energized, as necessary, or a secondary route will be used.

Deployment paths and staging areas are contained in the snow/ice removal plan. These areas will be maintained as a priority after site safety concerns are addressed. Post event snow/ice removal will be accomplished by a FLEX truck with snow plow or FLEX tractor with bucket. Additionally, the main road salt storage facility contains a large amount of salt and smaller amounts are strategically located throughout the site for winter use.

The site maximum flood water level is at elevation 601.91 feet resulting from a probable maximum precipitation (PMP) event. Braidwood Station plant grade elevation is at 600.0 feet and does not vary significantly across the site. The FLEX storage building floor will be constructed above the flood level to an elevation of 602 feet. A majority of the travel path elevations are between elevation 600 feet and 601 feet (Reference 47). Some travel path location maybe covered by a small amount of water. Since the FLEX pumps and generators are trailer mounted, they should be maintained available when being deployed to different locations at the site.

Extreme hot and cold temperatures should have little impact on the site travel paths.

Evaluation of the site for soil liquefaction potential concludes there is a potential for liquefaction at intermittent depths between about 6 feet to 16 feet. The induced ground settlement for the Braidwood Station FLEX equipment paths outside the main plant area is about 1 inch. The induced ground settlement for the Braidwood Station equipment paths in the main plant area is about 2 inches. Considering the size of the haul vehicles and the trailer loads, 1 inch to 2 inch settlement should not impose a significant impediment to FLEX equipment deployment (Reference 30).

Phase 3 of the FLEX strategies involves the receipt of equipment from offsite sources including the NSRC and various commodities such as fuel and supplies. Delivery of this equipment can be through airlift or via ground transportation. Primary and alternate deployment routes for Phase 3 portable FLEX equipment as well as staging areas are described in CC-BR-118-1002, SAFER Response Plan for Braidwood Station (Reference 56).

Memorandums of Understandings (MOU) for Pontiac Municipal Airport and LaSalle Station are validated annually to ensure they are in place, accurate, and renewed for the next annual period.

2.8.2 Accessibility

The potential impairments to required access are: 1) doors and gates, and 2) site debris blocking personnel or equipment access. The coping strategy to maintain site accessibility through doors and gates is applicable to all phases of the FLEX coping strategies, but is essential as part of the immediate activities required during Phase 1.

Doors and gates serve a variety of barrier functions on the site. One primary function, security, is discussed below. However, other barrier functions include fire, flood, radiation, ventilation, tornado, and HELB. These doors and gates are typically administratively controlled to maintain their function as barriers during normal operations. Following a BDBEE and subsequent ELAP event, FLEX coping strategies require the routing of hoses and cables through various barriers in order to connect portable FLEX equipment to station fluid and electric systems. For this reason, certain barriers (gates and doors) will be opened and remain open. This departure from normal administrative controls is acknowledged and is acceptable during the implementation of FLEX coping strategies.

During the BDBEE with an ELAP, the site security doors electronic latches will fail in the latched position. The operators have ample security keys within the Main Control Room that will be used to open these doors to ensure the overall integrated FLEX strategy can be successfully executed. In addition Site Security will be available to assist in allowing access to the required vital areas.

Vehicle access to the Protected Area is via the vehicle access area. As part of the Security access contingency, the access gates will be manually controlled to allow delivery of FLEX equipment (e.g., generators, pumps) and other vehicles such as debris removal equipment into the Protected Area. Manual operation of security equipment is contained in site specific procedures which are non-SGI and non-SUNSI. They are SY-BR-101-115, Operation of Active Vehicle Barriers (AVB), and SY-BR-101-115-1001, Operation of Power Operated Gates. Security gates can be placed in the manual mode by dropping the motor chain. The bollards and patriots can also be manually lowered by security. If the checkpoint canopy or other debris sources create too great a hindrance for equipment passage through the normal vehicle access route, an alternate route can be made available to the east of this location. The process would be covered by our compensatory measures procedure. Manual tracking of individual access would be performed if the servers were unavailable.

2.9 Deployment of Strategies

FLEX equipment staging areas are shown in Figure 20. The FX DG, Medium head FLEX pump and High head FLEX pump have additional cable or hose sections to allow for flexible laydown locations. The additional cable and hoses lengths have been included in the strategy electrical and hydraulic analysis.

2.9.1 AF Makeup Strategy

Braidwood Station Ultimate Heat Sink (UHS) provides a long term supply of water to the Steam Generators. The UHS is a safety-related, seismic Category I structure that will remain available for any of the external hazards listed in Section 2.6.

The Low head FLEX pump and hose trailer will be moved from the FLEX storage building to the deployment area at the lake screen house (LSH), adjacent to the UHS. The Low Head Pump suction hose and strainer will be lowered into the Ultimate Head Sink (UHS). Typically the strainer will be submerged and not susceptible to surface debris, but the strainer could still pick up debris from other sources. If this occurs, it can be removed and cleaned or replaced as needed.

The site consists of two reactors with alternate refueling outages (spring and fall) maintaining at least one heat source for the lake, typically both units during the winter. The lake temperature tends for the last 3,600 days shows the temperature has been maintained above freezing. The SX suction in the UHS is well below the surface to protect it from surface ice blockage. The low head portable FLEX pump suction is from a temporary hose / strainer lowered into the UHS. It will also be below the below the surface to protect it from ice blockage. Additionally, a set of fire irons (Axe and halligan bar) will be available to breakup surface ice, if necessary.

Discharge hoses will be routed from the LSH to the Medium head FLEX pump deployment area to provide a source of water to the Medium head FLEX pump. Figure 11 shows the hose routing for the Low head FLEX pump.

The Medium head FLEX pump and hose trailer will be moved from the storage building to the deployment area near the RWST tunnel hatch. Hoses will be routed from the medium pressure FLEX pump to the primary SG connection in the B/C Main Steam Safety Valve (MSSV) room to provide a backup source of feedwater to the SGs. Hoses will also be routed to connections in the Main Steam (MS) tunnel to allow feedwater to be provided to the A/D SGs. This will allow all four SGs to be used to provide symmetric cooling of the RCS and Reactor Coolant Pump (RCP) seals to maintain their integrity.

An alternate connection for feedwater to the SGs will be available in the A/D MSSV room for use in the event the primary connection is not available or the MS tunnel is inaccessible.

A simplified design / hookup diagram of the following FLEX strategies showing the general hose routing is provided in Figure 1.

2.9.2 <u>RCS Makeup Strategy</u>

The Braidwood Station refueling water storage tanks (RWST) are safety-related, seismic Category I structures providing the main borated water source for the site.

The High head FLEX pump and hose trailer will be moved from the storage building to the deployment area near the RWST tunnel hatch. The primary supply of borated water to the High head FLEX pump is through a suction connection from the units RWST. The connection is installed in the RWST tunnel on the suction piping of the B SI pump. A suction hose is routed from this connection, through the RWST tunnel, to the High head FLEX pump suction manifold. In the event a unit's RWST is not available, the suction hose to that unit's High head FLEX pump can be routed from the opposite units RWST via, the opposite unit High head FLEX pump suction manifold.

The primary connection for RCS make-up is located in the RWST tunnel. The High head FLEX pump discharge hose will be routed from the pump through the RWST tunnel hatch to a FLEX connection on the B Safety Injection (SI) system downstream of the B SI pump.

The alternate connection for RCS make-up is located in the B Chemical Volume and Control (CV) system pump room. The High head FLEX pump discharge hose will be routed from the pump through the RWST tunnel hatch, through the RWST tunnel to a FLEX connection on the B CV system downstream of the B CV pump. The high head pump discharge hose can also be routed through the Fuel Handling Building (FHB) or the opposite unit RWST tunnel to make this connection.

If the RWST tunnel hatch access is blocked, FLEX tools can be used to gain access / remove debris. Additionally, the opposite unit RWST can be used to support both units high head injection strategy.

A simplified design / hookup diagram of the following FLEX strategies showing the general hose routing is provided in Figure 1.

2.9.3 Spent Fuel Pool Makeup Strategy

The primary Phase 2 strategy will be repowering the installed safety related 0A Refueling Water Purification Pump utilizing the site plan to re-energize safety related 480V buses with a FLEX generator. The RWST with the installed safety related piping will be used as the suction source. The discharge will use the existing 0A Refueling Water Purification Pump safety related discharge piping directly to the SFP. Use of this strategy does not require entry into the Fuel Handling Building. Actions are directed through 0BwFSG-11, Alternate SFP Makeup and Cooling Unit 0. FX DG electrical strategy deployment is described in section 2.9.4. Figure 9 shows the primary SFP makeup strategy.

The alternate Phase 2 strategy will be achieved with a portable FLEX diesel pump and temporary hoses routed to the Spent Fuel Pool (SFP). The strategy utilizes the deployment of the low head and Medium head FLEX pumps described in section 2.9.1. The discharge of the Medium head FLEX pump will be routed thought the Unit 1 Fuel Handling Building track way. In the FH building, the 5" discharge hose will be connected to a wye and separated into two 3" discharge hoses. These hoses will be routed to spray monitor guns located in different corners of the fuel pool. The spray monitor guns will provide make-up and spray flow to the SFP to maintain water level. Actions are directed through 0BwFSG-11, Alternate SFP Makeup and Cooling Unit 0. Figure 10 shows the alternate SFP makeup strategy hose routing.

Fuel Handling Building track way door is a non-robust structure. This door is opened to provide a vent path for the spent fuel pool area and to provide the SPF makeup hose deployment path. If damaged such that its integrity is intact, it can be opened by using available FLEX tools and/or vehicles. If the door integrity is breached, the door breach can be used to fulfill the needed function.

2.9.4 Electrical Strategy

The 480VAC FLEX generator and cable trailer will be moved from the FLEX storage building to the deployment area at the respective unit turbine building track way. Staged cables are downhill deployed from the 480V ESF bus in the Auxiliary Building, through the Turbine Building, to a FLEX diesel generator. Figure 6, 7 and 8 provides a diagram of the unit 1 or 2 electrical cable routing.

The alternate AC electrical strategy will utilize a second connection on the available FLEX diesel generator to provide power to a Power Connection Panel (PCP) that is staged on the 401 elevation of the Auxiliary Building (AB). Temporary cables will then be routed from the patch panel to provide power directly to various Motor Control Centers (MCCs) within the AB to repower needed equipment. The alternate DC electrical strategy will be to cross-tie unit DC busses using existing electrical switchgear with an energized battery charger. Figure 5 provides a basic block diagram of the unit 1 or 2 PCP cable routing.

The FLEX generator primary and alternate electrical connections are protected from the external hazards described in Section 2.6. The cables from the FLEX generator are routed through the non-robust turbine building. The turbine building has been evaluated as an acceptable routing path (Reference 21).

2.9.5 Fueling of Equipment

The Braidwood Station FLEX response strategy is to ensure all of the Phase 2 and Phase 3 equipment can continue to operate for the indefinite coping time required. The fuel credited is the fuel stored in the

Unit 1/2 "A" and "B" train DG Fuel Oil Storage Tanks. These diesel fuel oil storage tanks typically contain at least 191,400 gallons of fuel.

Braidwood Station installed a modification in the Unit 1/2 "B" Diesel Oil system allowing the transfer of the fuel into a refuel vehicle for refuel operations from a repowered "B" DG Fuel Oil Transfer Pump

FLEX equipment that has been purchased will operate on the same type of fuel, Ultra Low Sulfur (ULS) diesel fuel. All fuel onsite meets the ULS requirements and the future orders of fuel will meet the same requirements.

Filling portable diesel fuel tanks is described in 0BwFSG-50, FLEX Support Equipment Operation Unit 0. This procedure will be used to fill the fuel tank installed on the F-750 (or equivalent) which will then be used to fill tanks on the portable FLEX equipment. The F 750 contains two (2) 118 gallon tanks and a fuel pump.

Based on a fuel consumption study, the fuel transfer truck has sufficient capacity to support continuous operation of the major FLEX equipment expected to be deployed and placed into service following a BDBEE. The fuel supply capacity contained in the DG Fuel Oil Storage Tanks is adequate to provide the onsite FLEX equipment with diesel fuel for >30 days. Fuel consumption and refuel strategy is documented in CC-BR-118-1001, Attachment 9 (Reference 55).

The site also has 125,000 gallon and 50,000 gallons storage tanks that are not robust and must be assumed unavailable, but would be used if available.

Sufficient time is available to ensure emergency supplies of diesel fuel oil can be delivered from Braidwood's long term supplier. A business continuity plan is in effect with the long term supplier which stipulates services during catastrophic events.

National SAFER Resource Center resources, in the form of additional tanks and fuel transfer pumps, may also be used for fueling FLEX equipment.

2.10 Offsite Resources

2.10.1 National SAFER Response Center

The industry has established two (2) National SAFER Response Centers (NSRCs) to support utilities during BDB events. Exelon Braidwood Station has contractual agreements in place with the Strategic Alliance for FLEX Emergency Response (SAFER) to participate in the process for support of the NSRCs as required. Each NSRC will hold five (5) sets of equipment, four (4) of which will be able to be fully deployed when requested, the fifth set will have equipment in a maintenance cycle. In addition, onsite FLEX equipment hose and cable end fittings are standardized with the equipment supplied from the NSRC.

Equipment will be moved from an NSRC to a local assembly area, established by the SAFER team and the utility. Site primary staging area (Area C) location is the Pontiac Municipal Airport in Pontiac Illinois. The alternate staging area (Area D) location is LaSalle Nuclear Station near Marseilles Illinois. The site has approved memorandum of understanding (MOU) with Pontiac Municipal Airport and LaSalle Nuclear Station. Primary and alternate transportation routes have been identified between these locations and the site. These routes are detailed within the sites response plan (playbook). The main transportation method will be by a heavy haul vehicle. If an accessible transportation route cannot be identified, helicopter transportation will be utilized. Communications will be established between the affected nuclear site and the SAFER team and required equipment moved to the site as needed. First arriving equipment, as established during development of the nuclear site's playbook will be delivered to the site within 24 hours from the initial request. Braidwood Station's response plan (playbook) CC-BR-101-1002 has been developed and approved (Reference 56).

2.10.2 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 Braidwood Station is listed in Table 2. Table 2 identifies the equipment that is specifically credited in the FLEX strategies for Braidwood Station, but also lists the equipment that will be available for backup/replacement should onsite equipment be unavailable. Since all the equipment will be located at the local assembly area, the time needed for the replacement of a failed component will be minimal.

2.11 Equipment Operating Conditions

2.11.1 Ventilation

Following a BDBEE and subsequent ELAP/LUHS event at Braidwood Station, ventilation providing cooling to occupied areas and areas containing FLEX strategy equipment will be lost. Per the guidance in NEI 12-06, FLEX strategies must be capable of execution under the adverse conditions (unavailability of installed plant lighting, ventilation, etc.) expected following a BDBEE resulting in an ELAP/LUHS. The primary concern with regard to ventilation is the heat buildup which occurs when forced ventilation is lost in areas that continue to have heat loads. A loss of ventilation analysis was performed to quantify the temperatures expected in specific areas related to FLEX implementation to ensure the environmental conditions remain acceptable for equipment qualification limits.

The key areas identified for all phases of execution of the FLEX strategy activities are the Main Control Room (MCR), Auxiliary Electric Equipment Room (AEER), Diesel Driven Auxiliary Feedwater (DDAF) pump room, Miscellaneous Electric Equipment Room (MEER) and the DC battery room.

As a result of the loss of ventilation, the following calculations were performed to ensure the loss of ventilation would not significantly affect equipment operation:

- The Diesel Driven Auxiliary Feedwater Pump room temperature analysis during and ELAP Event shows room temperature is maintained within acceptable limits and supplemental room cooling is not required (Reference 16). Procedure guidance for the setup of alternate cooling was developed to provide additional options to the operators and is controlled by 0BwFSG-5, Initial Assessment and FLEX Equipment Staging Unit 0. Figure 15 shows the general ventilation layout for the DDAF pump rooms.
- MEER and Battery Room Conditions following ELAP shows battery room can reach 2% hydrogen concentration within 2.52 hours of re-energizing the battery changer. Hydrogen generation begins when

the battery chargers are re-energized. When power is re-established to the battery charger, power is also returned to the battery room vent fan. Operation of the battery room vent fan will prevent hydrogen generation from becoming a concern. 1/2BwFSG-5, Initial Assessment and FLEX Equipment Staging Unit 1/2, provides operators with the necessary guidance to establish forced ventilation within the battery room. Additionally, this calculation shows the MEER room will require forced ventilation to preserve component availability within 8 hours of re-energizing the battery chargers. 0BwFSG-5, Initial Assessment and FLEX Equipment Staging Unit 0, provides operators with the necessary guidance to establish alternate ventilation. This calculation also assumes a battery room maximum temperature of 138°F and a minimum temperature of 60°F during an ELAP event. The temperature effects on the battery capacity were incorporated into this calculation (Reference 19). Figure 18 and 19 show the general ventilation layout for the MEER.

- The Main Control Room and Auxiliary Electric Equipment Room (AEER) heat up during an ELAP shows the Unit 2 AEER portion of the MCR boundary reaching temperature limits first within approximately 4.75 hours. 0BwFSG-51, Alternate MCR Ventilation Unit 0, provides operators the necessary guidance to establish alternate ventilation for the MCR, the Unit 1 AEER, and the Unit 2 AEER (Reference 18). Figure 17 shows the general ventilation layout for the MCR and AEER.

In addition, a Spent Fuel Pool (SFP) vent path will be provided by opening the Fuel Handling (FH) building track way roll-up door per 0BwFSG-11, Alternate SFP Makeup and Cooling. The site plans to perform required manual actions within the FH building prior to the onset of SFP boiling.

2.11.2 Heat Tracing

The site FLEX strategy has been evaluated for potential freezing due to loss of heat trace or other heat sources. Susceptible equipment includes the RWST, temporary hoses, and pumps deployed outside. BRW-14-0211-M, Evaluation of Tank and Hose Freezing during an ELAP, has been completed (Reference 28). It shows the RWST could potentially reach 32°F in 83.7 hours. Precipitation of boron in solution should not occur before this time. The RWST vent header is heat traced and contains a vacuum relief device. 0BwFSG-5, Initial Assessment and FLEX Equipment Staging, provides the necessary direction to open the RWST hatch ensuring the vent path is maintained.

The FLEX temporary hoses, routed outside, will be protected from freezing by maintaining positive flow or by draining when not in use. Operator guidance has been added to various FSG's to alert the operators to the potential freezing concern. Additional sections of FLEX hose are also available as a replacement in the event a section of the hose freezes.

2.12 Habitability

Habitability conditions within the MCR and other areas of the plant will be maintained with a tool box approach limiting the impact of high temperatures with methods such as supplemental cooling, personnel rotation and/or availability of fluids.

Local manual actions will be occurring in multiple areas of the plant to execute the FLEX strategy. The action will provide for control of the plant equipment as well as connecting and controlling FLEX equipment. Local manual actions will be occurring in:

- Main Steam Safety Valve (MSSV) room (PORV's).
- Main Steam (MS) tunnel.
- Diesel Driven Auxiliary Feedwater (DDAF) pump room.
- Main Control Room (including the Unit 1 and 2 Auxiliary Electric Equipment room).
- Miscellaneous Electric Equipment Room (MEER) / DC battery room.
- Fuel Handling Building.
- Diesel Driven Auxiliary Feedwater Pump discharge valve area (AF005s).

Braidwood's UFSAR indicates the site extreme outside temperature range of 102°F to -20°F. It is considered acceptable for operators to perform actions outside the plant under these conditions as they do on a day by day basis today. Area temperatures inside the plant are maintained with forced ventilation prior to the event. Post event, some areas contain components that will continue to generate heat.

Local area evaluation:

- Local PORV operation is accomplished adjacent to an outside door, which can be opened to providing a cooler staging area for the operators. Sound power phone headsets are provided to ensure communications are acceptable and available outside the rooms. Entry would only be required to make small adjustments in the PORV position.
- DDAF pump room initial actions will be aligning the suction source and alternate SX cooling. Ongoing manual actions include filling day tank (valve operation), monitoring pump performance and setting up temp ventilation. Continuous occupancy is not required.
- MEER / battery room's initial actions include DC load shedding and verifying aligning the battery charger to the DC bus. Ongoing actions include area / equipment checks and temporary ventilation setup. Continuous occupancy is not required.
- Main Control room (MCR) initial actions include emergency procedures and plant operations. Ongoing actions will require continuous occupancy. The AEER does not have initial operator actions. Execution of BwFSG-7 would require entry for alternate instrument readings, but continuous occupancy is not required. Temporary ventilation will be setup to provide cooling in both the MCR and AEER.
- The Spent fuel pool area initial actions include setting up temporary hoses and spray nozzles. These actions are performed prior to the onset of SFP boiling. Occupancy after this initial setup in not required.
- MS tunnel initial actions include routing a temporary hose between the A/D and B/C MSSV rooms. This area is the supply air for the MSSV rooms. Natural ventilation will draw air from the Turbine Building, through the tunnel and out the MSSV rooms. Continuous occupancy is not required.
- The DDAF pump discharge valves will need to be throttle periodically to control SG level. The valves are located on the 364 elevation of the Auxiliary Building. This area is relatively cool and does not contain components that will generate significant heat.

Operators have been provided procedure guidance to setup temporary ventilation in the MCR, AEER room, MEER room, DC battery room and in the DDAF pump room to alleviate continued heat buildup. 1/2BwFSG-5 / 0BwFSG-5, Initial Assessment of FLEX Equipment and 0BwFSG-51, Alternate Control Room Ventilation, provides operators with the necessary guidance to establish alternate ventilation.

2.13 Lighting

Appendix R lights are available in many locations within the plant, including the DDAF pump room, AF005 valve area, Main Control Room, Auxiliary Building, and Containment Penetration areas. These lights are not robust, but may provide general area lighting that will assist the operators in execution of the site FLEX strategy. Flashlights are available to Operators and will be used to illuminate specific areas or components, as needed. Temporary lighting is established in the following areas by 0BwFSG-5, Initial Equipment and FLEX Equipment Staging Unit 0:

- Main Control Room.
- DDAF pump rooms.
- AF005 flow control valve operating area.
- FLEX equipment deployment areas.

MCCs 132X2 and 232X2 will be powered from a FLEX diesel generator. When energized, MCR lighting is restored as one of the vital loads.

Figure 14, 15 and 16 shows the general lighting layout for the AF005 valve area, the DDAF pump room, and the MCR.

In addition, the High and Medium head FLEX pumps are equipped with external lighting that can be operated to illuminate the deployment area.

2.14 Communications

In the event of a BDBEE and subsequent ELAP, communications systems functionality could be significantly limited. Communications necessary to provide onsite command and control of the FLEX strategies and offsite notifications at Braidwood Station can be effectively implemented with a combination of sound powered phones, satellite phones, and hand-held radios.

Onsite:

Onsite communications will be performed using either the installed sound powered headset system or the 900 Mhz radios in the talk around mode. If the Security diesel generator is in operation then the normal onsite telephone and radio system may be functional. Additional hand-held radios for use on talk around, with batteries, are staged in the robust FLEX storage building. The operation of this sound-powered phone subsystem is not dependent on the availability of the electric power system.

For high noise areas such as manual SG PORV operation, the sound power phone headsets are equipped with shielded microphones designed for extremely noisy environments. Additionally, sufficient cable is being provided to allow the operator to be outside the MSSV room and still communicate with the control room.

Offsite:

Satellite phones are the only reasonable means to communicate offsite when the telecommunications infrastructure surrounding the nuclear site is non-functional.

The design of the NARS Communication upgrade for Braidwood Station is one (1), installed dish, permanently mounted, that provides primary satellite communication for the MCR. As backup emergency communication in BDBEE, two trailer mounted satellite communications system are staged in the Robust FLEX building. One of the trailer satellite systems is designated for MCR backup use and the other for TSC & OSC. Each trailer has its own small portable diesel generator unit for emergency power. Each is rated at 5500W, able to carry the small expected load. The trailers are compact and can be deployed via any small vehicle with a trailer hitch. The trailers have automatically deploying dish, satellite communications terminal box, remote satellite terminals as well as necessary cable and miscellaneous items to establish communications from a remote satellite deployment location.

Three (3) satellite phones (e.g., Iridium®) and three (3) Bull Horns are available for the Shift Manager/Site Emergency Director in the Main Control Room area.

Battery chargers for portable communications equipment will be powered from a portable diesel generator or a FX DG.

2.15 Water Sources

2.15.1 Water Sources – Secondary Side

The 650,000 gallon Condensate Storage Tank (CST) provides a non-safety grade source of water to the Steam Generators for removing decay and sensible heat from the Reactor Coolant System (RCS). The CST provides a passive flow of water, by gravity, to the Auxiliary Feedwater (AF) system (LCO 3.7.5) which feeds the Steam Generators. The steam produced is released to the atmosphere by the Main Steam Safety Valves (MSSVs) or the Steam Generator Power Operated Relief

Valves when the condenser is not available. The AF pumps normally operate with recirculation to the CST. The specified LCO level assures the required useable volume of approximately 212,000 gallons is met.

If the CST is not available, AF can be supplied by the Essential Service Water (SX) system. The SX system provides a safety related, Seismic Category I backup to the CST. The SX system is automatically aligned to provide AF based on system conditions and pump start signals. The UHS consists of an excavated essential cooling pond integral with the main cooling pond, and the piping and valves connecting the pond with the SX system pumps. The UHS is described in UFSAR, Section 9.2.5. The UHS is sufficiently oversized to permit a minimum of 30 days of operation with no makeup.

Potential debris at the suction of the SX system would not prevent an adequate flow to the DDFP. The normal flow path is from the Ultimate Heat Sink through the Lake Screen House trash bars and traveling screens to the suction piping for the Essential Service Water pumps. The intake area and screens at the Lake Screen House are designed to accommodate all the pumps (Fire Protection, Nonessential Service Water and Circulating Water pumps) located in the Lake Screen House. Therefore, under the ELAP scenario, the flow rate is insignificant (thousands of gpm) compared to the design basis flow rate (hundreds of thousands of gpm) providing significant margin in the event of screen clogging (Reference 11).

These water sources have a wide range of associated chemical compositions. Therefore, extended periods of operation with addition of these various water sources to the SGs will have an impact on their material. Use of the available clean water sources, condenser and CST, are limited only by their quantity. The water supply from the UHS has an essentially unlimited quantity, but is limited in quality. Calculations have shown that Unit 1 Steam Generators (SG) heat transfer capabilities will be reduced by 1.4% (Unit 2 by 2.3%) through the first 72 hours when using UHS as the water supply. Additionally, based on calculated heat removal requirements over this time, the SGs could lose 67% of their heat transfer capabilities and still meet the heat removal requirement over the first 72 hours, with adequate subsequent margin (Reference 29). This assures acceptable and adequate site water sources until the delivery and deployment of the Phase 3 NSRC water treatment equipment. Procedural guidance has been developed which follows the industry approach of prioritizing the cleanest to dirtiest water sources. The first choice for makeup to the DDAF pump is the Condensate Storage Tank (CST). If the CST is not available the UHS will be used. Additionally, lakes adjacent to the site, such as Monster Lake, can be used as make-up water source for the UHS.

2.15.2 Water Sources – Primary Side

The Safety Injection Accumulators (4 per unit) will provide the initial source of borated water for reactivity control and RCS inventory makeup. The SI Accumulators are passive components, since no operator or control action are required for them to perform their function. Each SI Accumulator contains a nominal volume of 7106 gallons of water with a boron concentration of 2300 ppm, and a pressurized nitrogen cover gas of 624.5 psig (LCO 3.5.1). The gas is the motive force for RCS addition. This internal tank pressure is sufficient to discharge each borated accumulator contents into their respective cold leg of the RCS, as RCS pressure decreases below the accumulator pressure.

The Refueling Water Storage Tank (RWST) supplies borated water to the Chemical and Volume Control System (CVCS) during abnormal operating conditions, to the refueling pool during refueling, and to the ECCS and Containment Spray system during accident conditions. Each operating unit has their dedicated RWST. Each RWST contains a minimum of 320,600 gallons of useable water volume. This volume is maintained at a nominal boron concentration of 2400 ppm and at a temperature between 35°F and 100°F. Calculations have shown that in the most demanding scenario of usage, each RWST alone will provide at least 33.6 hours of borated water with a unit in mode 5 and SG's isolated. When both units are on-line, which is the most likely scenario, and an alternate water supply is provided to the SFP, a single RWST is not depleted until 1060 hours (Reference 27).

The RWST and the SI accumulators are designed to withstand the extreme hazards discussed in section 6.2.

The sites long term borated water supply will rely on additional site sources and/or off site assistance. 0BwFSG-50, FLEX Support Equipment Operation, provides operators with direction for filling the RWST from the Boric Acid Storage Tanks (BAST), portable makeup skid or by cross tying RWST's. In addition, a boration skid is requested from the NSRC to provide a long term borated water make-up source.

2.15.3 Spent Fuel Pool (SFP)

At Braidwood Station the RWST and the Ultimate Heat Sink are the main two make-up water sources that will survive in a BDBEE. Either of these water sources is acceptable for use as makeup to the SFP. Boration is not a concern since boron is not being removed from the SFP when boiling. These sources are discussed in section 2.15.1 and 2.15.2.

2.16 Shutdown and Refueling Modes Analysis

Braidwood Station is complying with the Nuclear Energy Institute position paper entitled, "Shutdown/Refueling Modes," dated September 18, 2013, addressing mitigation strategies in shutdown and refueling modes (Reference 9). This position paper has been endorsed by the NRC staff (Reference 40). Further clarification has been provided in an internal position paper EXC-WP-03 (Reference 62). Braidwood Station will incorporate the supplemental Guidance provided in the NEI position paper titled, "Shutdown/Refueling Modes" to enhance the shutdown risk process and procedures.

For planned outages and early in an unplanned outage, an outage risk profile is developed (Reference 57). These risk assessments is updated on a daily basis, and as changes are made to the outage schedule. Contingency actions are developed for high risk evolutions and the time needed for such evolutions is minimized. These contingency plans consider time to core boil/damage, decay heat loads, time to implement the contingency plan, and use of installed or temporary equipment. Contingency plans are distributed to the appropriate work groups and briefed, as appropriate. During the outage, additional resources are available on site, and during the high risk evolutions individuals are assigned specific response actions (e.g., response team assigned to close the containment equipment hatch). The risk assessment accounts for, among other things, environmental conditions and the condition of the grid.

In order to effectively manage risk and maintain safety during outages, Braidwood Station develops contingencies to address the precautions and response actions for a loss of cooling, among other Key Safety Functions. These contingencies not only direct actions to minimize the likelihood of a challenge to a key safety function, such as loss of cooling, but also direct the actions to be taken to respond to such an event. For example, the initial response for a loss of cooling could be to perform a gravity drain from the

RWST to the RCS using installed plant equipment to maintain core cooling. Should a contingency plan used to support shutdown risk identify the need for FLEX equipment, consideration will be given to pre-staging the equipment to a location that will not become inaccessible due to external hazards. The N+1 equipment will be used as the pre-staged equipment, such that the N set of equipment remains protected from external hazards and remains available (Reference 57).

When in Cold Shutdown and Refueling, many variables exist which impact the ability to cool the core. In the event of an ELAP during these Modes, installed plant systems cannot be relied upon to cool the core, thus transition to Phase 2 will required sooner. All efforts will be made to expeditiously provide core cooling and minimize heat-up and repressurization. Braidwood Station has programs in place (References 57 and Reference 58) to determine the time to boil for all conditions during shutdown periods.

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 removed and water level in the vessel is at or below the reactor vessel flange. If an ELAP/LUHS occurs during this condition, then (depending on the time after shutdown) boiling in the core may occur quite rapidly. 1/2 BwOA Elec-8, Loss of All AC Power While on Shutdown Cooling is in place to provide guidance for addressing a Loss of all AC Power while on shutdown cooling.

Missile barriers have been placed outside of the 1/2B and 1/2C Main Steam Safety Valve (MSSV) rooms to protect the local controls for 1/2B and 1/2C Main Steam PORV's. This assures that the 1/2B and 1/2C Main Steam PORV's remain available as a steam release path for cooldown. In Modes 1-3, this allows for symmetric cooling of the RCP seals during the cooldown following an ELAP. In lower modes, the availability of these PORV's allows for RCS heat removal to keep the core cooled and remove energy that would otherwise have to be released to the Containment. These barriers should remain in place to support the FLEX strategy. These barriers should only be removed when the 1/2B and 1/2C Main Steam PORV's are no longer required to be available.

Deploying and implementation of portable FLEX pumps and equipment to supply injection flow must commence immediately from the time direction is provided in the Site Emergency Procedures and/or Abnormal Procedures. This should be plausible because more personnel are on site during outages to provide the necessary resources. Strategies for makeup water include deploying of a FLEX pump to take suction from the RWST and /or Ultimate Heat Sink as described in the Phase 2 Core Cooling section. Guidance has been provided to ensure that sufficient area is available for deployment and that haul paths remain accessible without interference from outage equipment during refueling outages.

2.17 Sequence of Events

The Table 4 presents a Sequence of Events (SOE) Timeline for an ELAP/LUHS event at Braidwood Station.

The validation of FLEX strategies and procedures has been performed using a series of simulator scenarios, plant walk-downs, and table-top discussions. The process used was similar to the one that was used for the validation of the Emergency Operating Procedures (EOP) as described in AD-BR-101-1003, EOP Maintenance Program Guideline. The validation process included Phase 1 and Phase 2 strategies. Since Phase 3 strategies utilize the same connection with NSRC components, the validation was applicable/bounding to Phase 3 strategies.

Time to clear debris to allow equipment deployment is assumed to be 2 hours. This time is considered to be reasonable based on site reviews and the location of the BDB storage building. Debris removal equipment is stored inside the BDB storage building and is, therefore, protected from the external hazards described in Section 2.6.

The FLEX related procedures were walked down for accuracy and will be walked down at least once every five (5) years to ensure the ability to perform the strategy remains unchanged. Among the items to be considered in the walkdown are: 1) current configuration of the plant, 2) location and legibility of labels, and 3) viability of the referenced procedures credited in this site specific Final Integrated Plan (FIP).

Snow and Ice plans, which adequately address FLEX deployment travel routes, have been validated and will be validated at least once every five (5) years.

Assessments will be performed in accordance with LS-AA-126-1005, Check-In Self Assessments, at least once every five (5) years. The assessment should focus on the ability to implement the FLEX strategies.

2.18 Programmatic Elements

2.18.1 Overall Program Document

Program Document CC-AA-118, Diverse and Flexible Coping Strategies (FLEX) and Spent Fuel Pool Instrumentation Program Document (Reference 54), provides Exelon fleet governance and procedure guidelines to ensure readiness in the event of a Beyond-Design-Basis External Event.

Braidwood Station procedure CC-BW-118-1001 (Reference 55) provides a description of the Site Implementation of Diverse and Flexible Coping Strategies (FLEX) and Spent Fuel Pool Instrumentation Program. This procedure implements the Exelon fleet program document CC-AA-118 by outlining Braidwood Station site-specific details. The key elements of this procedure include:

- Summary of the Braidwood Station FLEX Strategies.
- Validation of FLEX Strategies.
- Portable FLEX Equipment and Commodities design, control, and identification.
- Maintenance and Testing Procedures, including Spent Fuel Pool Instrumentation.
- Availability of Equipment and Connections.
- FLEX Equipment Storage.
- Deployment of FLEX Equipment.
- Procedures and Guidelines.
- Plant Configuration Control.
- Staffing and Training to Support FLEX Strategies.
- Tracking of Commitments.
- Snow/ice removal routes.

Existing design control procedures CC-AA-309-101, Engineering Technical Evaluations, has 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 NEI 12-06, and 2) an engineering basis is documented that ensures that the change in FLEX strategies continues to ensure the key safety functions (Core cooling, SFP cooling, and Containment integrity) are met.

2.18.2 Procedural Guidance

The inability to predict actual plant conditions that require the use of FLEX equipment makes it impossible to provide specific procedural guidance. As such, the Braidwood Station FLEX Strategy Guidelines (FSGs) provide guidance that can be employed for a variety of conditions. Clear criteria for entry into FSGs will ensure that FLEX strategies are used only as directed for BDBEE conditions, and are not used inappropriately in lieu of existing procedures. When FLEX equipment is needed to supplement Emergency Operating Procedure (EOPs), Contingency Action Procedures (CAs), or Abnormal Operating Procedures (AOPs) strategies, the EOP, CA or AOP, as well as Severe Accident Mitigation Guidelines (SAMGs), or Extreme Damage Mitigation Guidelines (EDGMs), direct the entry into and exit from the appropriate FSG procedure.

FLEX Strategy Guidelines have been developed in accordance with Pressurized Water Reactors Owners Group (PWROG) guidelines. FLEX Strategy Guidelines provide available, pre-planned FLEX strategies for accomplishing specific tasks in EOPs, CAs or AOPs. FSGs are used to supplement (not replace) the existing procedure structure that establishes command and control for the event.

Procedural interfaces have been incorporated into 1/2BwCA 0.0, Loss of all AC Power, and 1/2BwOA ELEC-8, Loss of All AC Power While on Shutdown Cooling, to the extent necessary to include appropriate reference to FSGs and provide command and control for the ELAP.

FLEX Equipment guidelines have been created to support proper operation of specific equipment, i.e., High head FLEX pump operation guideline, FLEX diesel generator operation guideline. These guidelines are contained in the OP-BR-FX series of Braidwood Station procedures.

Changes to FSGs are controlled by Exelon fleet procedure AD-AA-101, Processing of Procedures and T&RMs (Reference 53). FSG changes will be reviewed and validated by the involved groups to the extent necessary to ensure the strategy remains feasible. Validation for existing FSGs have been accomplished in accordance with the guidelines provided in NEI APC14-17, FLEX Validation Process, issued July 18, 2014 (Reference 10).

2.18.3 Staffing

The staffing requirements were assessed utilizing the methodology of NEI 12-01, Guideline for Assessing Beyond-Design-Basis Accident Response Staffing and Communications Capabilities, and an assessment of the capability of Braidwood Station on-shift staff and augmented Emergency Response Organization (ERO) to respond to a BDBEE.

The assumptions for the NEI 12-01 Phase 2 scenario postulate that the BDBEE involves a large-scale external event that results in:

- An extended loss of AC power (ELAP).
- An extended loss of access to the Ultimate Heat Sink (UHS).
- Impact on units (all units are in operation at the time of the event).
- Impeded access to the units by offsite responders as follows:
  - 0 to 6 Hours Post Event – No site access.
  - 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).
  - 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.

Braidwood Station Operations, Security, Chemistry, Radiation Protection and FLEX Project personnel conducted a table-top review of the on-shift response to the postulated BDBEE and extended loss of AC power for the Initial and Transition Phases using the FLEX mitigating strategies. Resources needed to perform initial event response actions were identified from the Emergency Operating Procedures (EOPs). 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.

This Phase 2 Staffing Assessment concluded that the current minimum on-shift staffing as defined in the Emergency Response Plan for Braidwood Station, as augmented by site auxiliary personnel, is sufficient to support the implementation of the FLEX strategies on both units, as well as the required Emergency Plan actions, with no unacceptable collateral duties. The Phase 2 Staffing Assessment also identified the staffing necessary to support the Expanded Response Capability for the BDBEE as defined for the Phase 2 Staffing Assessment. This staffing will be provided by the current Braidwood site resources, supplemented by Exelon fleet resources, as necessary.

A Phase 2 Staffing Assessment was performed to verify and validate minimum staffing requirements to implement Phase 2 FLEX mitigation strategies with conclusions documented in RS-14-320, Response to NRC March 12, 2012 Request for Information Pursuant to 10 CFR 50.54(f), Enclosure 5, Recommendation 9.3, Emergency Preparedness – Staffing, Requested Information Items 1, 2, and 6 – Phase 2 Staffing Assessment (Reference 49).

Security personnel shall only be deployed to support FLEX procedure actions after all other available site personnel have been assigned to FLEX tasks. Security personnel would be relieved from duties associated with the implementation of mitigating strategies upon the earlier of two conditions:

- Availability of other plant personnel

  or

- Task completion

Once dismissed, security personnel may resume their normal duties, as necessary.

2.18.4 Training

Braidwood's Nuclear Training Program has been revised to assure personnel proficiency in the mitigation of BDBEE is adequate and maintained. These programs and controls were developed and have been implemented in accordance with the Systematic Approach to Training (SAT) Process. Refer to CC-AA-118, Diverse and Flexible Coping Strategies (FLEX) and Spent Fuel Pool Instrumentation Program Document for staffing and training requirements. Using the Systematic Approach to Training (SAT), Operations and other appropriate personnel received initial and will receive continuing training on FLEX related procedures and strategies.

Personnel assigned to direct the execution of mitigation strategies for BDBEEs have received the necessary training to ensure familiarity with the associated tasks, considering available job aids, instructions, and mitigating strategy time constraints. Upon SAFER equipment deployment and connection in an event, turnover and familiarization training on each piece of SAFER equipment will be provided to station operators by the SAFER deployment/operating staff.

Emergency Response Organization (ERO) members have completed NANTEL Basic FLEX Certification. New ERO members will complete NANTEL Basic FLEX Certification. ERO decision makers have completed NANTEL Generic Advanced FLEX Certification. New ERO Decision makers will complete NANTEL Generic Advanced FLEX Certification.

2.18.5 Equipment List

The equipment stored and maintained at the Braidwood Station FLEX storage building necessary for the implementation of the FLEX strategies in response to a BDBEE is listed in Table 1. Table 1 identifies the quantity, applicable strategy, and capacity/rating for the major BDB equipment components only. Specific details regarding fittings, tools, hose lengths, consumable supplies, etc. are not provided in Table 1.

Portable FLEX equipment shall have unique plant equipment numbers. If a unique plant equipment number does not exist, then the major equipment is clearly labeled with a noun name and designated as FLEX equipment.

FLEX storage areas is marked as FLEX or Emergency Response Storage Areas.

Non-control room equipment that requires manipulation or verification as part of a FLEX mitigation strategy are clearly identified by plant labelling.

Infrequently operated or difficult to locate components are clearly identified by one of the following methods:

- The plant label has FLEX (FX) equipment listed on it.
- The plant label will be color coded or contain orange reflective tape so Operations personnel can easily identify it as FLEX/FSG or Emergency Response Equipment.

FLEX equipment availability will be administratively controlled to ensure that the N equipment is available at all times, or appropriate contingency actions are taken until restored. 0BwOS FX-1a, Administrative Action Requirement (AAR) FLEX Support Equipment, is in place to track the unavailability of portable Phase 2 equipment, connections, and the allowed unavailability period.

Refer to CC-AA-118, Diverse and Flexible Coping Strategies (FLEX) and Spent Fuel Pool Instrumentation Program Document, for governance on equipment design and quality requirements (Reference 54).

2.18.6 N+1 Equipment Requirement

In order to assure reliability and availability of the FLEX equipment, the site should have sufficient equipment 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 units on-site. It is also acceptable to have a single resource that is sized to support the required functions for multiple units at a site (e.g., a single pump capable of all water supply functions for a dual unit site). In this case, the N+1 could simply involve a second pump of equivalent capability. In addition, it is also acceptable to have multiple strategies to accomplish a function (e.g., two separate means to repower instrumentation). In this case the equipment associated with each strategy does not require N+1.

The N+1 capability applies to the portable FLEX equipment described in Tables 3-2 (i.e., that equipment that directly supports maintenance of the key safety functions). Other FLEX support equipment only requires an N capability.

In the case of hoses and cables associated with FLEX equipment required for FLEX strategies, an alternate approach to meet the N+1 capability stated in Section 3.2.2 of NEI 12-06 has been selected.

Basis for the alternate approach:

NEI 12-06, Section 3.2.2 specifically states that a site will have FLEX equipment to meet the needs of each unit on a site plus one additional spare. This is commonly known as N+1 where N is the number of units at a given site. The relevant text from NEI 12-06 is as follows:

NEI 12-06, Section 3.2.2 states: "In order to assure reliability and availability of the FLEX equipment required to meet these capabilities, the site should have sufficient equipment 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 units on-site. Thus, a two-unit site would nominally have at least three portable pumps, three sets of portable ac/dc power supplies, three sets of hoses & cables, etc."

NEI 12-06, Section 11.3.3 states: "FLEX mitigation equipment should be stored in a location or locations informed by evaluations performed per Sections 5 through 9 such that no one external event can reasonably fail the site FLEX capability (N)."

Typically the hoses utilized to implement a FLEX strategy are not a single continuous hose but are composed of individual sections of a smaller length joined together to form a sufficient length. In the case of cables, multiple individual lengths are used to construct a circuit such as in the case of 3-phase power.

Proposed Alternative:

NEI 12-06 currently requires N+1 sets of hoses and cables. As an alternative, the spare quantity of hose and cable is adequate if it meets either of the two methods described below:

Method 1: Provide additional hose or cable equivalent to 10% of the total length of each type/size of hose or cable necessary for the "N" capability. For each type/size of hose or cable needed for the "N" capability, at least 1 spare of the longest single section/length must be provided.

- Example 1-1: An installation requiring 5,000 ft. of 5 in. diameter fire hose consisting of 100 50 ft. sections would require 500 ft. of 5 in. diameter spare fire hose (i.e., ten 50 ft. sections).

- Example 1-2: A pump requires a single 20 ft. suction hose of 4 in. diameter, its discharge is connected to a flanged hard pipe connection. One spare 4 in. diameter 20 ft. suction hose would be required.

- Example 1-3: An electrical strategy requires 350 ft. cable runs of 4/0 cable to support 480 volt loads. The cable runs are made up of 50 ft. sections coupled together. Eight cable runs (2 cables runs per phase and 2 cable runs for the neutral) totaling 2800 ft. of cable (56 sections) are required. A minimum of 280 ft. spare cable would be required or 6 spare 50 ft. sections.

- Example 1-4: An electrical strategy requires 100 ft. of 4/0 cable (4 cables, 100 ft. each) to support one set of 4 KV loads and 50 ft. of 4/0 (4 cables, 50 ft. each) to support another section of 4 kv loads. The total length of 4/0 cable is 600 ft. (100 ft. x 4 plus 50 ft. x 4). One spare 100' 4/0 cable would be required representing the longest single section/length.

Method 2: Provide spare cabling and hose of sufficient length and sizing to replace the single longest run needed to support any single FLEX strategy.

- Example 2-1 – A FLEX strategy for a two unit site requires 8 runs each of 500 ft. of 5 in. diameter hose (4000 ft. per unit). The total length of 5 in. diameter hose required for the site is 8000 ft. with the longest run of 500 ft. Using this method, 500 ft. of 5 in. diameter spare hose would be required.

For either alternative method, both the N sets of hoses or cables and the spare set of hoses or cables would all be kept in a location that meets the reasonable protection requirements for the site.

The NRC has endorsed (ML15125A442) the NEI position paper (ML15126A135) for the above stated alternate approach. If using Method 2, per the endorsement letter, Exelon will ensure that the FLEX pumps and portable generators are confirmed to have sufficient capability to meet flow and electrical requirements when a longer spare hose/cable is substituted for a shorter length. Exelon acknowledges that the NRC staff has not reviewed and is not endorsing the specific examples included in the NEI endorsement request dated May 1, 2015. If necessary, Exelon will provide additional justification regarding the acceptability of various cable and hose lengths with respect to voltage drops, and fluid flow resistance, rather than merely relying on the additional, longest length cable/hose as implied by Example 1-4 in the subject letter.

Hoses and cables are passive devices unlikely to fail provided they are appropriately inspected and maintained. The most likely cause of failure is mechanical damage during handling provided that the hoses and cables are stored in areas with suitable environmental conditions (e.g., cables stored in a dry condition and not subject to chemical or petroleum products). The hoses and cables for the FLEX strategies will be stored and maintained in accordance with manufacturers' recommendations including any shelf life requirements. Initial inspections and periodic inspections or testing will be incorporated into the site's maintenance and testing program implemented in accordance with Section 11.5 of NEI 12-06.

Therefore, the probability of a failure occurring during storage is minimal, resulting in the only likely failure occurring during implementation. Mechanical damage will likely occur in a single section versus a complete set of hose or cable. Therefore, the N+1 alternative addresses the longest individual section/length of hose or cable.

Providing either a spare cable or hose of a length of 10% of the total length necessary for the "N" capability or alternatively providing spare cabling or hose of sufficient length and sizing to replace the single longest run needed to support any single FLEX strategy is sufficient to ensure that a strategy can be implemented. Mechanical damage during implementation can be compensated for by having enough spares to replace any damaged sections with margin. It is reasonable to expect that an entire set of hoses or cables would not be damaged provided they have been reasonably protected.

The N+1 requirement does not apply to the FLEX support equipment, vehicles, and tools. However, these items are covered by a fleet administrative procedure and are subject to inventory checks, unavailability requirements, and any maintenance and testing that are needed to ensure they can perform their required functions.

2.18.7 Equipment Maintenance and Testing

FLEX mitigation equipment is subject to initial acceptance testing and subsequent periodic maintenance and testing to verify proper function.

Portable FLEX equipment is maintained under the site's Preventative Maintenance (PM) program. Preventive maintenance (PM) procedures and test procedures are based on the templates contained within the EPRI Preventive Maintenance Basis Database. FLEX support equipment will be maintained as necessary to ensure continued reliability. The performance of the PMs and test procedures are controlled through the site work control process.

Identified equipment deficiencies shall be entered into the corrective action program. Equipment deficiencies that would prevent FLEX equipment from performing the intended function shall be worked under the priority list in accordance with the work management process. Equipment that cannot perform its intended functions shall be declared unavailable. Unavailability shall be tracked in accordance with 0BwOS FX-1a, Administrative Action Requirement (AAR) FLEX Support Equipment. For example, it provides the following guidance:

- The required FLEX equipment may be unavailable for 90 days provided that the site FLEX capability (N) is met. If the site FLEX (N) capability is met but not protected for all of the site's applicable hazards, then the allowed unavailability is reduced to 45 days.

- If FLEX equipment or connections become 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., use of alternate suitable equipment or supplemental personnel) within 72 hours.

- If FLEX equipment or connections to permanent plant equipment required for FLEX strategies are unavailable for greater than 45/90 days, restore the FLEX capability or implement compensatory measures (e.g., use of alternate suitable equipment or supplemental personnel) prior to exceedance of the 45/90 days.

Unavailability of the Spent Fuel Pool instrumentation is tracked in accordance with 0BwOS FX-2a, AAR Spent Fuel Pool (SFP) Level Instruments.

3. References

1. NRC Order Number EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," dated March 12, 2012.
2. NEI 12-06 Rev. 0, Diverse and Flexible Coping Strategies (FLEX) Implementation Guide, dated August 2012.
3. NRC ISG 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, dated August 29, 2012.
4. NRC Order EA-12-051, Issuance of Order to Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation, dated March 12, 2012.
5. NRC ISG JLD-ISG-2012-03 Compliance with Order EA-12-051, Reliable Spent Fuel Pool Instrumentation, dated August 29, 2012.
6. Task Interface Agreement (TIA) 2004-04, "Acceptability of Proceduralized Departures from Technical Specification (TSs) Requirements at the Surry Power Station", (TAC Nos. MC42331 and MC4332), dated September 12, 2006.
7. NEI 12-01 Rev. 0, Guideline for Assessing Beyond-Design-Basis Accident Response Staffing and Communications Capabilities, dated May 2012.
8. NEI 12-02 Rev. 1, Industry Guidance for Compliance with NRC Order EA-12-051, "To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation," dated August 2012.
9. NEI Position Paper: "Shutdown/Refueling Modes," (ML 13273A514), dated September 18, 2013.
10. NEI APC14-17, FLEX Validation Process, dated July 18, 2014.
11. Exelon Position Paper, EXC-WP-04, Debris Clogging at Suction Point for FLEX Water Source, dated April 2015.
12. Braidwood Station, Units 1 and 2 – Interim Staff Evaluation Relating to Overall Integrated Plan in Response to Order EA-12-049 (Mitigating Strategies) (TAC NOS. MF0895 AND MF0896), dated December 17, 2013.
13. BYR99-010/BRW-99-0017-I Rev. 2, Documentation of the Basis of the Emergency Operating Procedures (EOP) Setpoints, dated September 2014.
14. BYR13-026/BRW-13-0031-M Rev. 0, Transient Analysis of SX System Following Loss of A-C Power, dated August 2013.

15. BYR13-144/BRW-13-0160-M Rev. 2, FLEX Pump Sizing and Hydraulic Analysis, dated December 2014.

16. BYR13-234/BRW-13-0216-M Rev. 0, Auxiliary FW Pump Room Temperature Analysis during and ELAP Event, dated April 2014.

17. BYR13-235/BRW-13-0217-M Rev. 0, Containment Pressure and Temperature Response during an ELAP Event, dated September 2014.

18. BYR13-236/BRW-13-0218-M Rev. 0, Control Room and Auxiliary Electric Equipment Room heat up and Ventilation during an ELAP, dated June 2014.

19. BYR13-237/BRW-13-0219-M Rev. 0, MEER and Battery Room Conditions Flowing ELAP, dated July 2014.

20. BRW-97-0340-E Rev. 3, Battery Duty Cycle and Sizing for the Braidwood Diesel Driven Auxiliary Feedwater Pumps, dated August 2014.

21. EC Evaluation 399726 Rev. 0, Turbine Building Robustness Post-Seismic Event, dated December 2014.

22. BYR13-240/BRW-13-0222-M Rev. 0, Spent Fuel Pool Boil Off Analysis during an ELAP Event, dated April 2014.

23. BYR14-046/BRW-14-0058-M Rev. 0, Containment Environment Following an Extended Loss of AC Power During Shutdown, dated September 2014.

24. BYR14-060/BRW-14-0080-E Rev. 0, Unit 1(2) 125 VDC Battery FLEX Coping Calculation – Common Calc – Beyond Design Basis, dated September 2014.

25. BRW-13-0182-E Rev. 2, FLEX 480V Bus Connection Equipment Sizing, dated April 2015.

26. BRW-14-0030-M Rev. 0, Godwin Pump Suction Line Hydraulic Analysis to Support FLEX, dated August 2014.

27. BYR14-129 / BRW-14-0212-M Rev. 1, RWST Usage During FLEX Scenarios, dated February 2016.

28. BYR14-130/BRW-14-0211-M Rev. 0, Evaluation of Tank and Hose Freezing during an ELAP, dated September 2014.

29. BRW-14-0255-M Rev.1, Braidwood Units 1 and 2 FLEX Steam Generator Degraded Heat Transfer Analysis through 72 hours, dated December 2014.

30. BRW-15-0002-S Rev.0, Evaluation of FLEX Equipment Haul Paths for Soil Liquefaction Potential, dated March 2015.

31. CN-LIS-15-34 Rev. 0, Exelon Byron and Braidwood Stations Reactor Coolant System ELAP Inventory Control Analysis SHIELD Reactor Coolant Pump Seal Packages, dated July 13, 2015.

32. CN-LIS-15-38 Rev. 0, Calculation of Asymmetric Natural Circulation Cooldown Rate Limits for the Byron and Braidwood Units in Support of the FLEX Program, dated September 2015.

33. CN-LIS-15-39, Rev.0, Exelon Byron and Braidwood Stations Reactor Coolant System ELAP Long-Term Subcriticality Analysis with Low-Leakage Reactor Coolant Pump Seal Packages, dated September 2015.

34. CN-LIS-15-40, Rev. 0, Exelon Byron and Braidwood Stations Delayed AFW FLEX Studies, dated September 2015.

35. CN-LIS-15-48 Rev. 0, Byron and Braidwood Condensate Consumption/Auxiliary Feedwater Usage Evaluation in Support of the FLEX Program, dated September 2015.

36. WR-BR-PF-10 Rev 16, Effect of Local PMP at Plant Site, dated November 14, 2014.

37. Braidwood Station, Units 1 And 2 - Interim Staff Response To Reevaluated Flood Hazards Submitted in Response to 10 CFR 50.54(F) Information Request- Flood-Causing Mechanism Reevaluation (Tac Nos. Mf3895 And Mf3896), dated September 3, 2015.

38. PWROG-14027-P Rev. 3, No.1 Seal Flow Rate for Westinghouse Reactor Coolant Pumps Following Loss of All AC Power. Task 3: Evaluation of Revised Seal Flow Rate on Time to Enter Reflux Cooling and Time at which the Core Uncovers.

39. PWROG-14064-P Rev. 0, Application of NOTRUMP Code Results for Westinghouse Designed PWRs in Extended Loss of AC Power Circumstances, dated September 2014.

40. Letter to Mr. J.E. Pollack (NEI) from Mr. J.R. Davis (NRC) endorsing NEI Shutdown/Refueling Modes Position Paper (ML 13267A382), dated September 30, 2013.

41. Letter to Mr. Jack Stringfellow requesting endorsement of Westinghouse position paper entitled "Westinghouse Response to NRC Generic Request for Additional Information (RAI) on Boron Mixing in support of the Pressurized Water Reactor Owners Group (PWROG)", Accession Number ML13276A183, date January 8, 2014.

42. Letter to Mr. James A. Gresham titled "Use of Westinghouse SHIELD Passive Shutdown Seal for FLEX Strategies," May 28, 2014. (Agency wide Documents Access and Management System (ADAMS) Accession Number ML14132A128).

43. Letter to David Flahive, of Westinghouse, titled "Exelon Generation Company, LLC Mitigation Strategies Order (EA-12-049) Open and Confirmatory Item Responses," Letter LTR-FSE-14-61 Rev.0-A, dated July 17, 2014.

44. Letter to Mr. Jack Stringfellow titled "Application of NOTRUMP Code Results for Westinghouse Designed PWRs in Extended Loss of AC Power Circumstances". (Agency wide Documents Access and Management System (ADAMS) Accession Number ML15061A442), dated June 16, 2015.

45. Westinghouse Correspondence LTR-FSE-14-43, Revision 0, "Exelon Generation Company, LLC Mitigation Strategies Order (EA-12-049) Design ELAP Simulation Parameters," dated June 15, 2015.

46. EC398039, FLEX Robust Building Construction and EC398040, FLEX Buildings – Commercial Buildings, dated October, 2015.

47. Exelon Structural Drawing S-183 Rev. AF, Roadway Plan Plant and Construction Laydown Area, dated May 20, 2014.

48. WCAP 17601-P Rev. 1, Reactor Coolant System Response to the Extended Loss of AC Power Event for Westinghouse, Combustion Engineering and Babcock & Wilcox NSSS Designs, dated January 2013.

49. Braidwood Station, Units 1 and 2 - Response Regarding Phase 2 Staffing Submittals Associated With Near-term Task Force Recommendation 9.3 Related to the Fukushima Dal-ichi Nuclear Power Plant Accident (ADAMS Accession No.: ML 151568260), dated June 2015.

50. Exelon Generation Company, LLC letter to the NRC, "Braidwood Station, Unit 2, 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 (Order Number EA-12-049) (RS-15-276), dated December 16, 2015.

51. Braidwood Station, Units 1 and 2 – NRC Report for the Audit Regarding Implementation of Mitigating Strategies and Reliable Spent Fuel Pool Instrumentation Related to Orders EA-12-049 and EA-12-051 (TAC Nos. MF0895 and MF0896), dated May 27, 2015 (ADAMS Accession No. ML15134A459).

52. Braidwood Station Updated Final Safety Analysis Report.

53. AD-AA-101 Rev. 28, Processing of Procedures and T&RMs, dated August 2016,

54. CC-AA-118 Rev. 1, Diverse and Flexible Coping Strategies (FLEX) and Spent Fuel Pool Instrumentation Program Document, dated July 2016.
55. CC-BR-118-1001 Rev. 1, Site Implementation of Diverse and Flexible Coping Strategies (FLEX) and Spent Fuel Pool Instrumentation Program, dated October 2015.
56. CC-BY-118-1002 Rev. 1, SAFER Response Plan for Braidwood Station, dated April 2015.
57. OU-AA-103 Rev. 15, Shutdown Safety Management Program, dated September 2014.
58. OU-AP-104 Rev. 22 Shutdown Safety Management Program Byron Braidwood Annex, dated August 2016.
59. Westinghouse Correspondence LTR-RES-13-153, "Documentation of 7228C O-Rings at ELAP Conditions," dated October 31, 2013.
60. NRC letter, Braidwood Station, Unit 1 – Relaxation of the schedule requirements for Order EA-12-049 "Order modifying licenses with regard to requirements for mitigation strategies for Beyond-Design-Basis External Events" (TAC NO. MF0895), (ADAMS Accession No. ML 15068A215), dated April 15, 2015
61. Braidwood Station Seismic Path 2 MSA Submittal, RS-16-168 and Seismic High Frequency Submittal, RS-16-174.
62. Exelon Position Paper, EXC-WP-03, FLEX Guidance for Shutdown / Refueling Modes, dated July 2014.

Table 1 – PWR Portable Equipment Stored Onsite

List Portable Equipment	Use and (Potential / Flexibility) Diverse Uses					Performance Criteria
	Core	Containment	SFP	Instrumentation	Accessibility	
Three (3) 480V AC diesel generators and associated cables, connectors and switchgear				X	X	350 KW
Three (3) Godwin L1618 High Head FLEX Pumps and associated hoses and fittings	X					40 GPM 1522 PSIG
Three (3) Godwin 3393 Medium Head FLEX Pumps and associated hoses and fittings	X		X			500 GPM 409 PSIG
Two (2) Godwin HL 130 Self Priming Pumps and associated hoses and fittings	X		X			1500 GPM 150 PSIG
Portable instrumentation power supply (Fluke 707 or equivalent)	X	X		X		N/A
Six (6) Portable diesel generators	X	X	X	X	X	5500 WATT

Table 1 – PWR Portable Equipment Stored Onsite

List Portable Equipment	Use and (Potential / Flexibility) Diverse Uses					Performance Criteria
	Core	Containment	SFP	Instrumentation	Accessibility	
One (1) F-750 (or equivalent) truck with snow plow	X	X	X	X	X	N/A
Two (2) tractors, one with a bucket and one with forks	X	X	X	X	X	N/A
Three (3) diesel trash pumps	X	X	X	X	X	300 GPM 110 FT. HEAD
Three (3) satellite phones	X	X	X	X	X	N/A
Two (2) satellite trailers with self-aligning satellite dishes, communications boxes, cables, and Yanmar diesel generators.	X	X	X	X	X	N/A
Four (4) portable vent fans			X	X	X	N/A

Table 2 – PWR Portable Equipment From NSRC											
List Portable Equipment	Quantity Req'd /Unit	Quantity Provided / Unit	Power	Use and (Potential / Flexibility) Diverse Uses					Performance Criteria		Notes
				Core Cooling	Cont. Cooling/ Integrity	Access	Instrumentation	RCS Inventory			
Medium Voltage Generators	0	2	Jet Turb.	X		X	X	X	4160 VAC	1 MW	1
Low Voltage Three Phase Generators	0	2	Jet Turb.	X		X	X	X	480 VAC	1100 KW	1
High Pressure Injection pump	0	2	Diesel	X				X	2000 PSI	60 GPM	1
S/G RPV Makeup pump	0	2	Diesel	X					500 PSI	500 GPM	1
Low Pressure / Medium Flow pump	0	2	Diesel	X					300 PSI	2500 GPM	1
Low Pressure / High Flow	0	2	Diesel	X					150 PSI	5000 GPM	1

Table 2 – PWR Portable Equipment From NSRC

List Portable Equipment	Quantity Req'd /Unit	Quantity Provided / Unit	Power	Use and (Potential / Flexibility) Diverse Uses					Performance Criteria	Notes
				Core Cooling	Cont. Cooling/ Integrity	Access	Instrumentation	RCS Inventory		
(Dewatering) pump										
Lighting Towers	0	1	Diesel			X			40,000 Lumens	1
Diesel Fuel Transfer	0	2	N/A	X	X	X	X	X	264 Gal.	1
Water Treatment	1	2	Diesel	X				X	250 GPM	2
Mobile Boration	1	2	N/A	X				X	1000 Gal.	3

Notes:

1. Support equipment to provide backup as necessary and provide Operations and the TSC/ERO flexibility in addressing plant issues relating to the BDBEE. Not required to meet N+1.
2. Water treatment skid will be used to treat site makeup water used for core cooling.
3. Boration skid will be used for long term borated water make-up source.

Table 3 – Water Sources

Water Sources and Associated Piping that Fully Meet All BDB Hazards and Are Credited in FLEX Strategies

Water Sources	Usable Volume (Gallons)	Applicable Hazard					Time Based on Decay Heat	Cumulative Time Based on Decay Heat
		Satisfies Seismic	Satisfies Flooding	Satisfies High Winds	Satisfies Low Temp	Satisfies High Temp		
Refueling Water Storage Tanks	320,600	Y	Y	Y	Y	Y	n/a	1060 hours Reference 27
Braidwood Station Lake (Ultimate Heat Sink)	149,000,000	Y	Y	Y	Y	Y	n/a	> 30 days UFSAR
Condensate Storage Tanks	212,000	N	Y	N	Y	Y	Note 1	Note 1

Notes:

1. This volume is sufficient to maintain the RCS in MODE 3 at normal operating pressure and temperature for 2 hours, followed by a cooldown to residual heat removal (RHR) entry conditions at 50F/hour, followed by a period not longer than one-hour to allow warmup of the RHR pumps prior to placing the RHR system into service in shutdown cooling mode (LCO 3.5.1 bases).

Table 4 – Sequence of Events Timeline

Action Item	Elapsed Time	Action	Time Constraint Y/N	Remarks / Applicability
1	0	Event Starts, BDBEE occurs, Unit 1 and Unit 2 reactors automatically trip and all rods are inserted. Loss of off-site power (LOOP) affecting both units occurs.	NA	Unit 1 and Unit 2 @100% power
2	1 minutes	Emergency Operating Procedures, (EOPs) and Station Black Out, (SBO), Procedures are entered.	NA	_BwCA 0.0, Loss of All AC Power, action.
3	3-5 minutes	MCR closes C & D S/G PORVs to conserve inventory.	Y – 5 minutes	_BwCA 0.0, Loss of All AC Power, action. CN-LIS-15-40 (Ref. 34).
4	5-30 minutes	Verify DDAF Pp is operating properly.	Y – 45 minutes	_BwCA 0.0, Loss of All AC Power, action. CN-LIS-15-40 (Ref. 34).
5	10-30 minutes	Attempt starting Emergency D/G's.	NA	_BwCA 0.0, Loss of All AC Power, action.
6	30 minutes	ELAP condition recognized and ELAP Procedures are entered.	NA	_BwCA 0.0, Loss of All AC Power, attachment B for ELAP.
7	30-90 minutes	SX Short Cycle Cooling EC is aligned to cool the B AF Pp within 2 hour after pump start.	Y - 2 hours	_BwCA 0.0, Loss of All AC Power, action. BRW-13-0031-M (Ref. 16)

Action Item	Elapsed Time	Action	Time Constraint Y/N	Remarks / Applicability
8	30 minutes to 6 hours	Connect FLEX 480V AC generators to ESF bus _32X and verify they are supplying power to Div. 2 - 125V DC battery chargers.	Y – 8 hours	BRW-14-0080-E (Ref. 8)
9	35-65 minutes	Operators dispatched to perform DC Bus Load Shed.	Y - 65 minutes	BRW-14-0080-E (Ref. 8)
10	1.5-8 hours	Start depressurization of SGs to 260 psig at ≤ 100°F/hour cooldown with SG PORV local/manual operation. SG feed is controlled with Local/Manual operation of AFW flow control valves.	Y - 8 hours	_BwCA 0.0, Loss of All AC Power, action. CN-LIS-15-39 (Ref. 35) Note 1
11	3 – 4.5 hours	Setup and establish ventilation in AEER and MCR.	4.75 hours	Directed from 0BwFSG-51 and BYR13-236/BRW-13-0218-M (Ref. 15)
12	3-10 hours	SI Accumulator borated water begins to inject into the RCS.	16 hours	CN-LIS-15-39 (Ref. 35) Note 1
13	6-10 hours	Deploy all hoses and connections in FHB for alternate SFP Fill strategy before FHB becomes uninhabitable from SFP Boiling.	Y - 10.94 hours	Directed from 0BwFSG-5 and 0FSG-11. BRW-13-0222-M (Ref. 9)
14	9-16 hours	Maintain SG pressure 260 psig and RCS temperature between 410F – 420F with SG PORV operation. Maintain SG level.	NA	CN-LIS-15-39 (Ref. 35) Note 1

Action Item	Elapsed Time	Action	Time Constraint Y/N	Remarks / Applicability
15	9-16 hours	Isolate SI Accumulators.	NA	CN-LIS-15-39 (Ref. 35) Note 1
16	11-14 hours	Stage and connect Phase 2 high pressure FLEX Pumps and ensure they are available to supply borated make-up to the RCS.	Y – 16 hours	CN-LIS-15-39 (Ref. 35)
17	16-20 hours	Connect Phase 2 med head FLEX Pumps and ensure they are available to supply make-up to the SG's.	NA	1/2BwFSG-5 action
18	24 hours	Initiate SFP Make up via 0A Refueling Water Purification Pump as required for level and temperature control.	NA	0BwFSG-11action. BRW-13-0222-M (Ref. 9)
19	24 hours	National SAFER Response Center resources begin arriving on site.	NA	National SAFER Response Center Guide
20	24-72 hours	Continue to maintain critical functions of Core Cooling (via DDAF), RCS Inventory Control (via FLEX pump injection to RCS) and SFP Cooling (via FLEX pump injection to SFP). Utilize initial National SAFER Response Center NRC equipment and resources.	NA	End of analytical simulation
Note 1 – The cooldown will be initiated as soon as time and resources permit and in all cases within 8 hours of the initiation event.				

_Figure 1: Simplified FLEX Design/Hookup

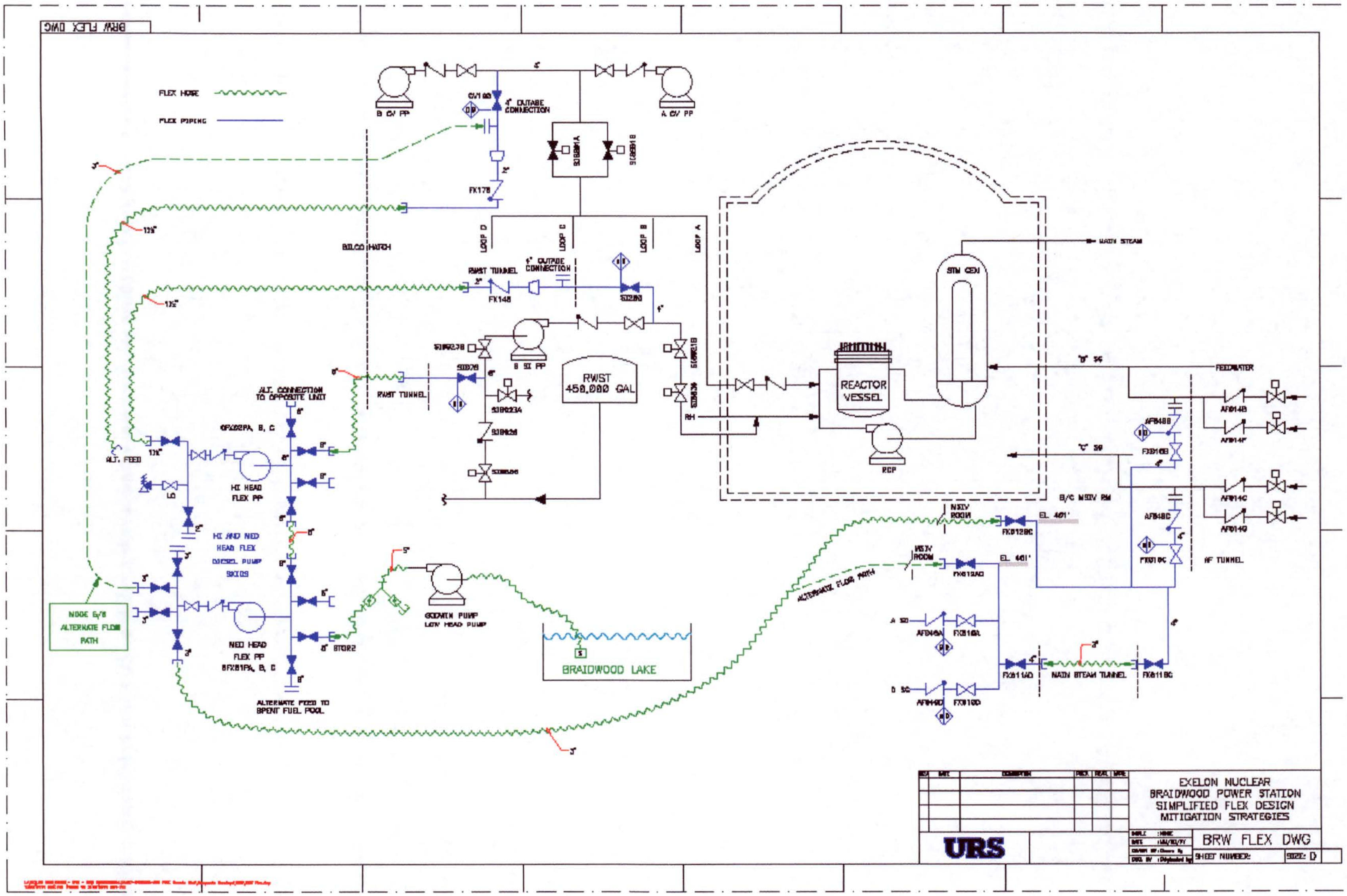

Figure 2: Braidwood Station FLEX Electrical Strategy

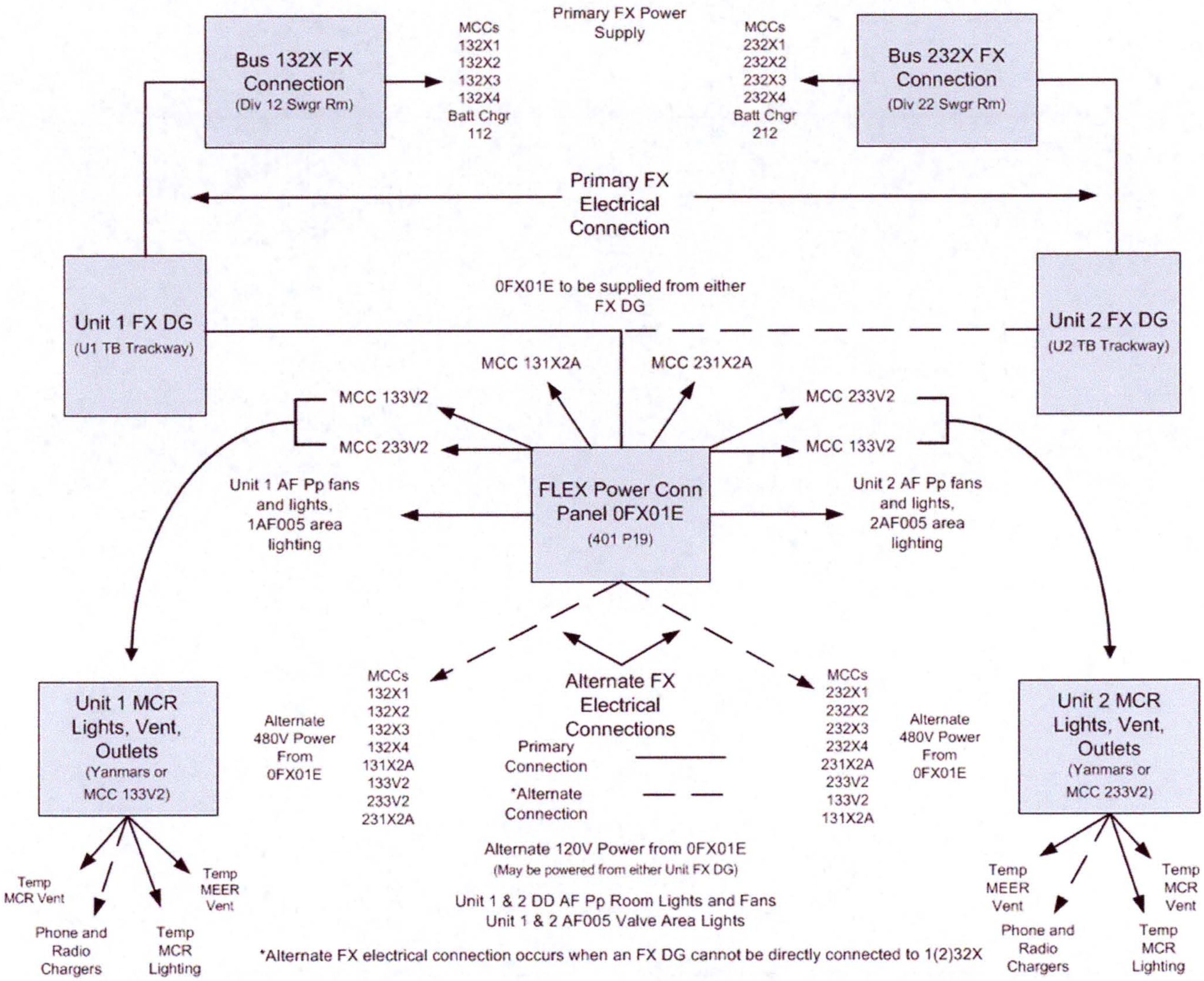

Figure 3: Unit 1 FLEX Alternate Electrical Diagram

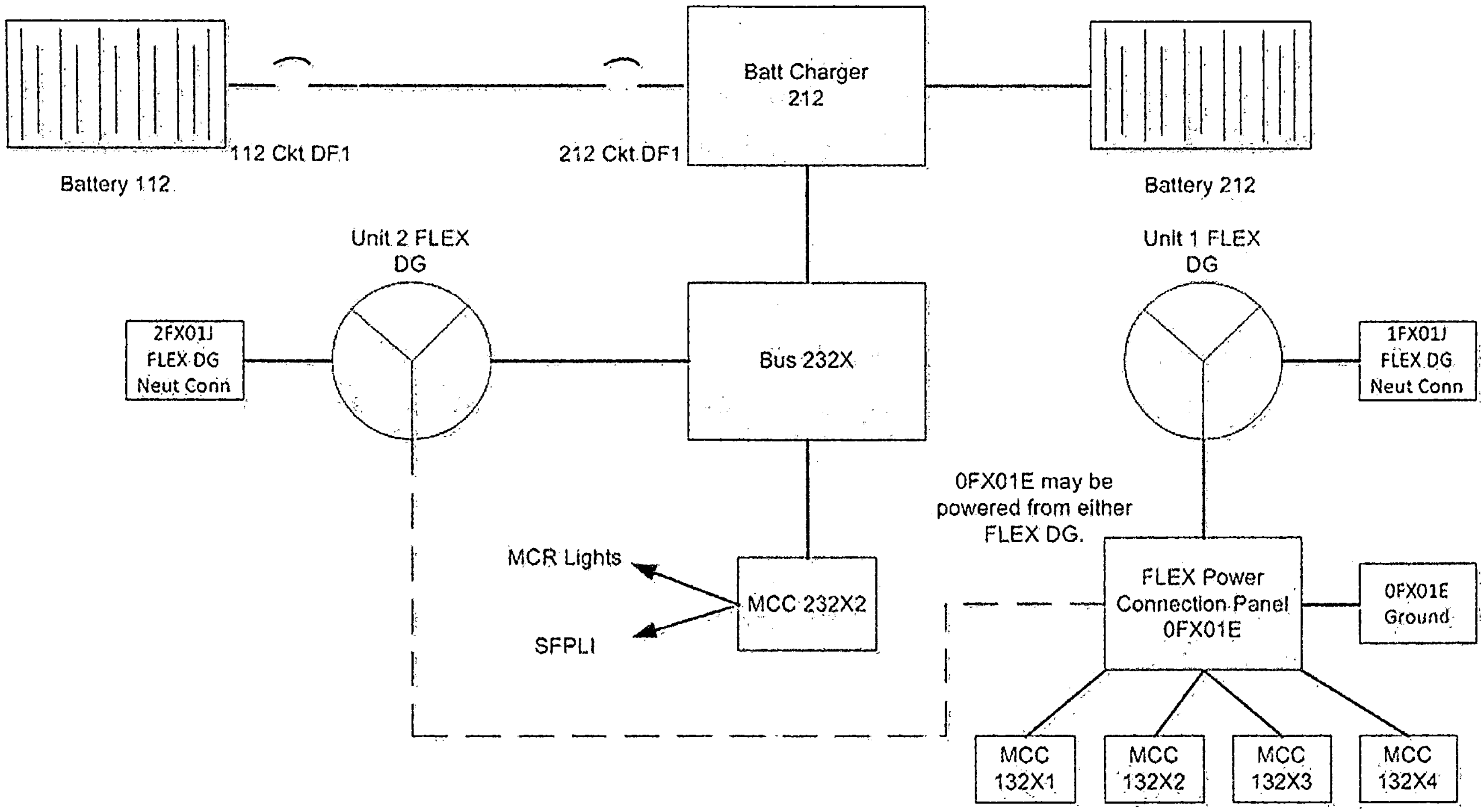

Figure 4: Unit 2 FLEX Alternate Electrical Diagram

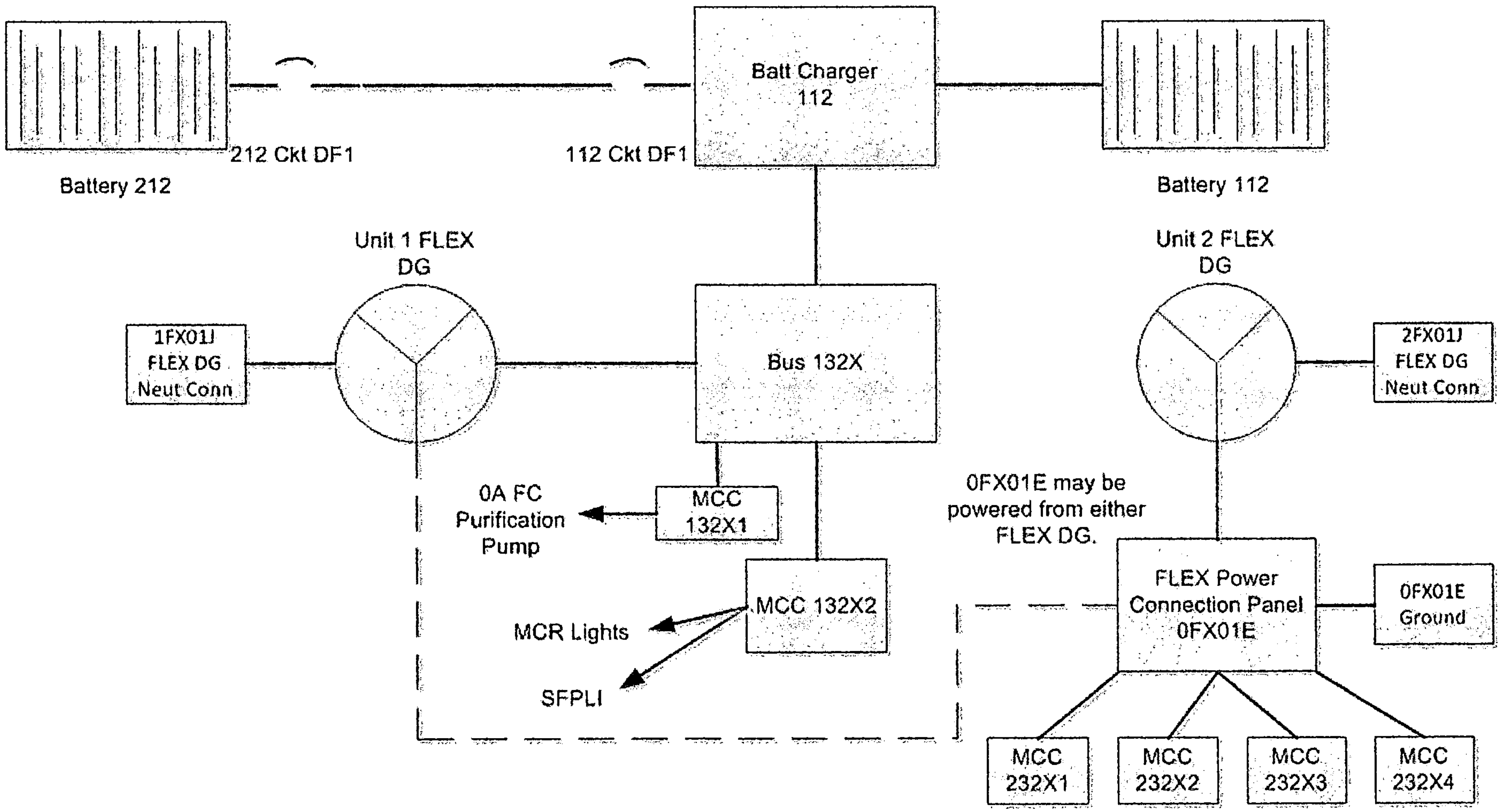

Figure 5: MCC Temp Power One Line Diagram

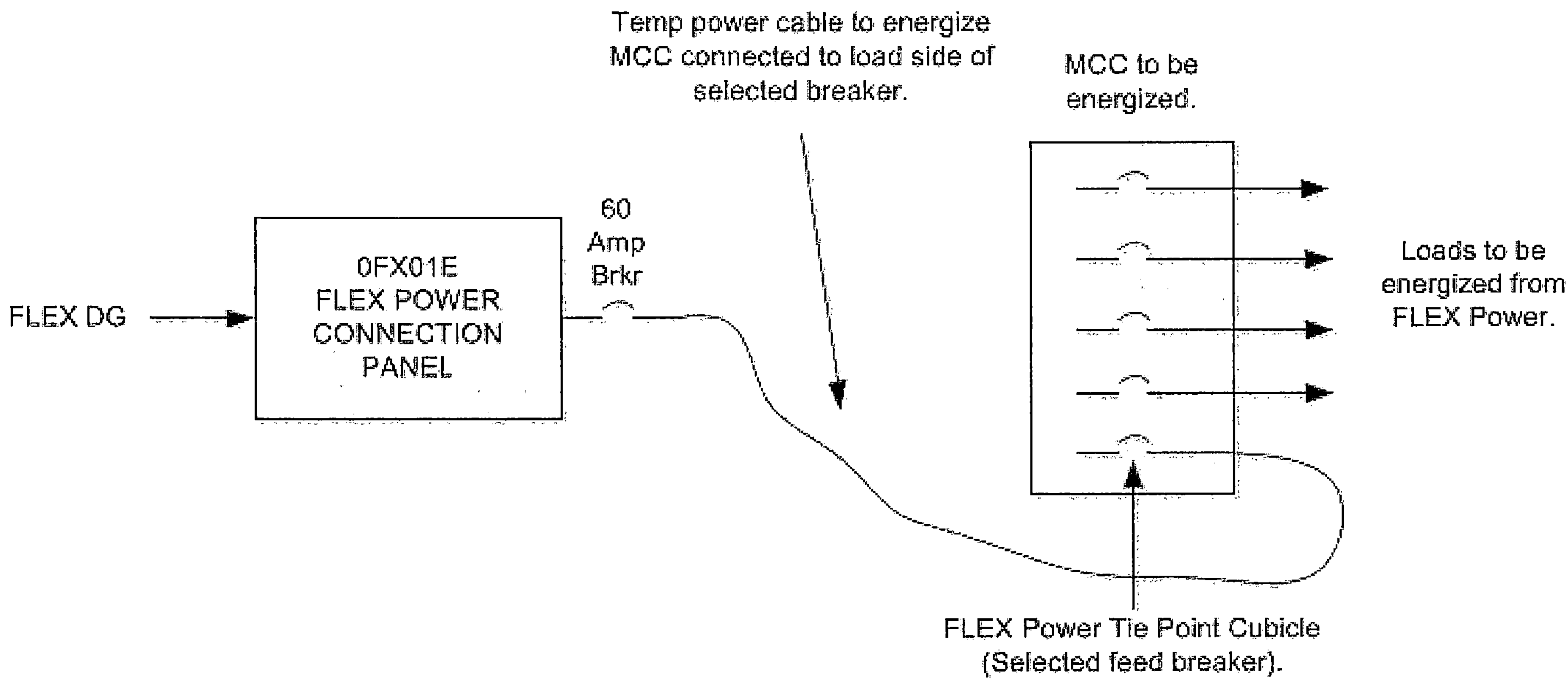

Figure 6: U-1 FX DG Cable Routing

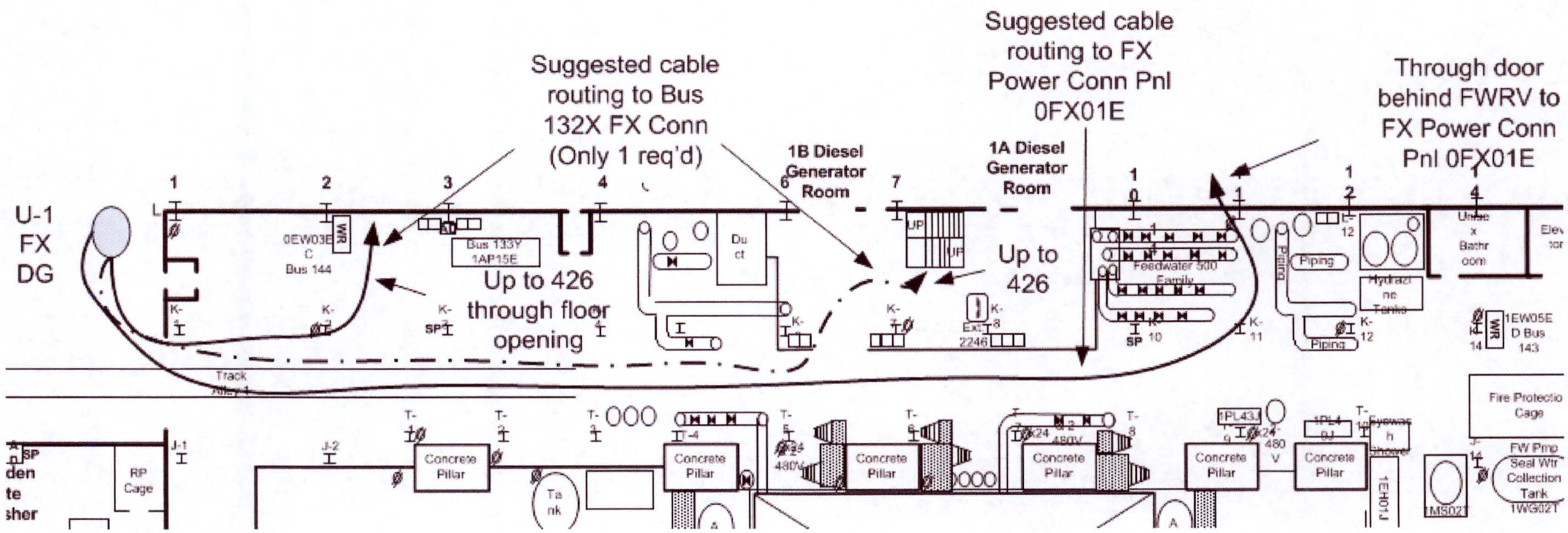

Figure 7: U-2 FX DG Cable Routing

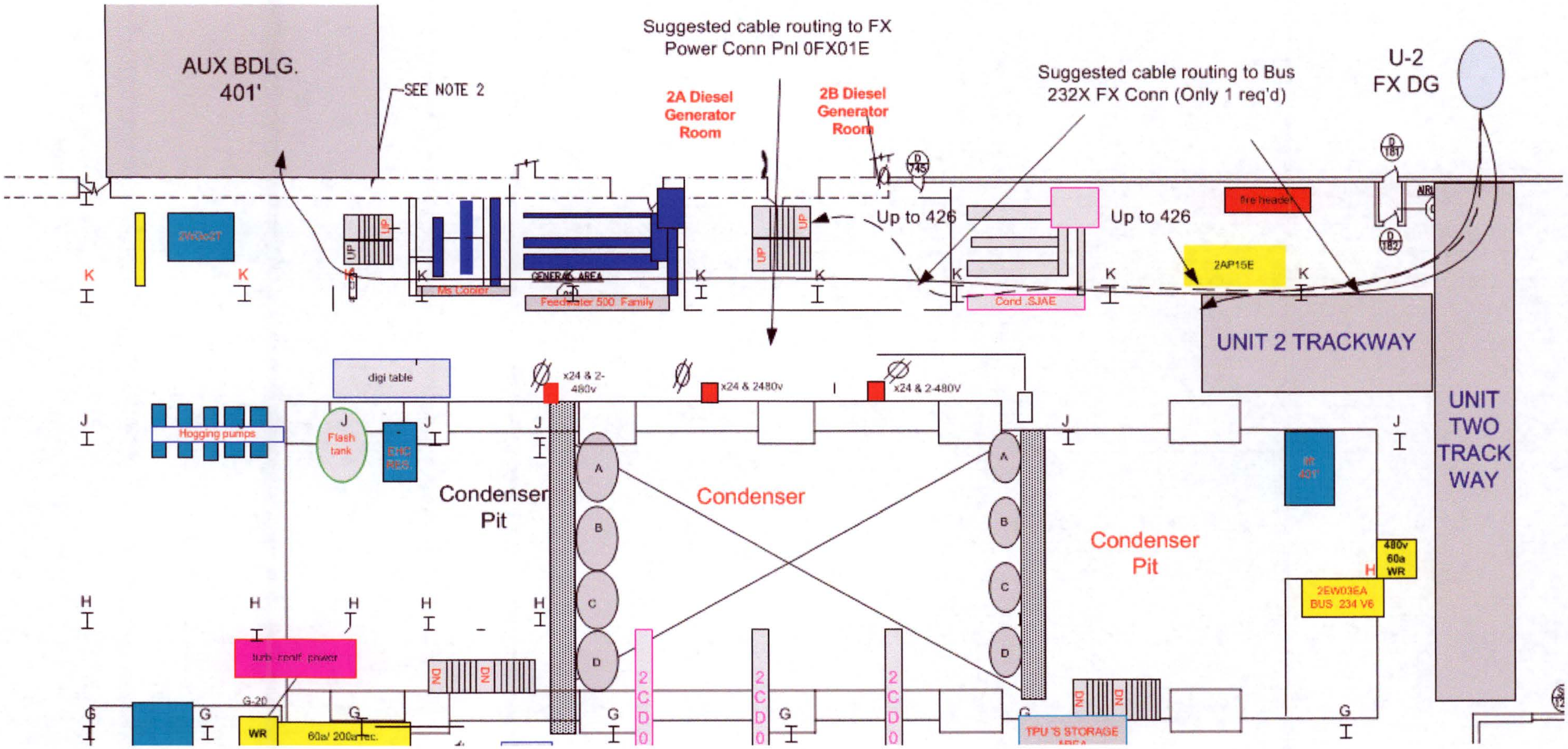

Figure 8: Aux BLDG Temporary Power Unit and Cables

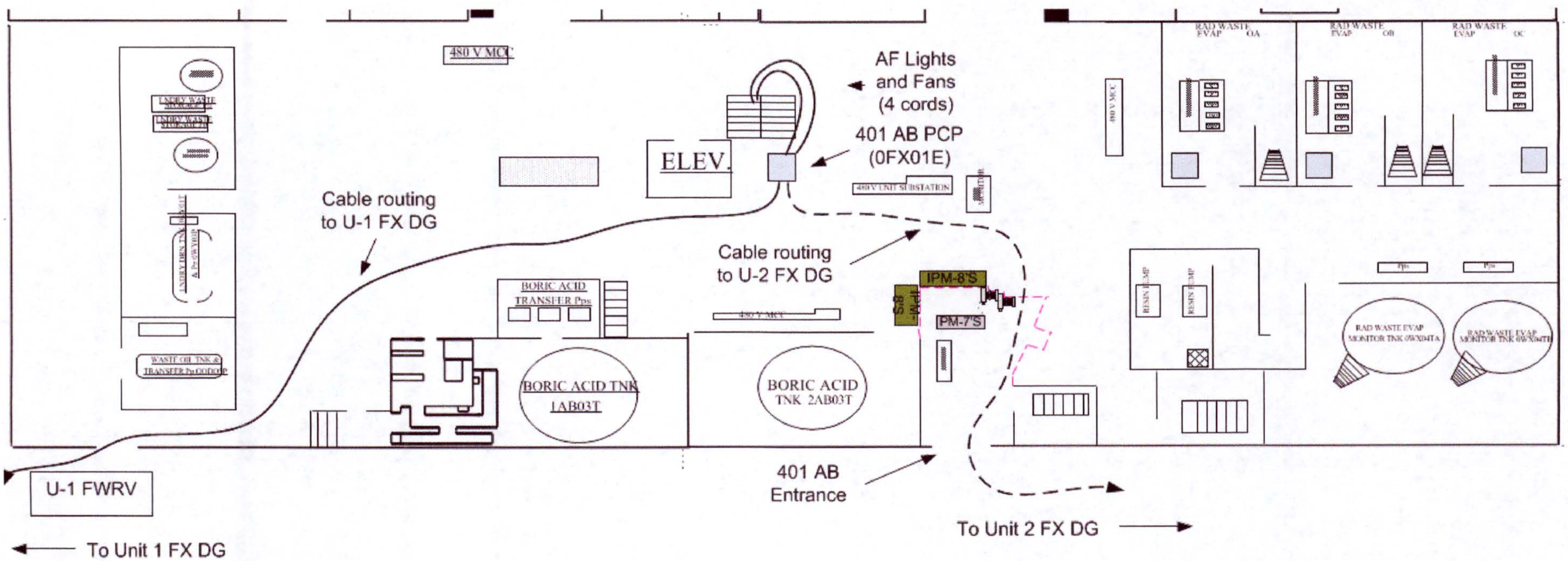

Figure 9: Normal Spent Fuel Pool Makeup

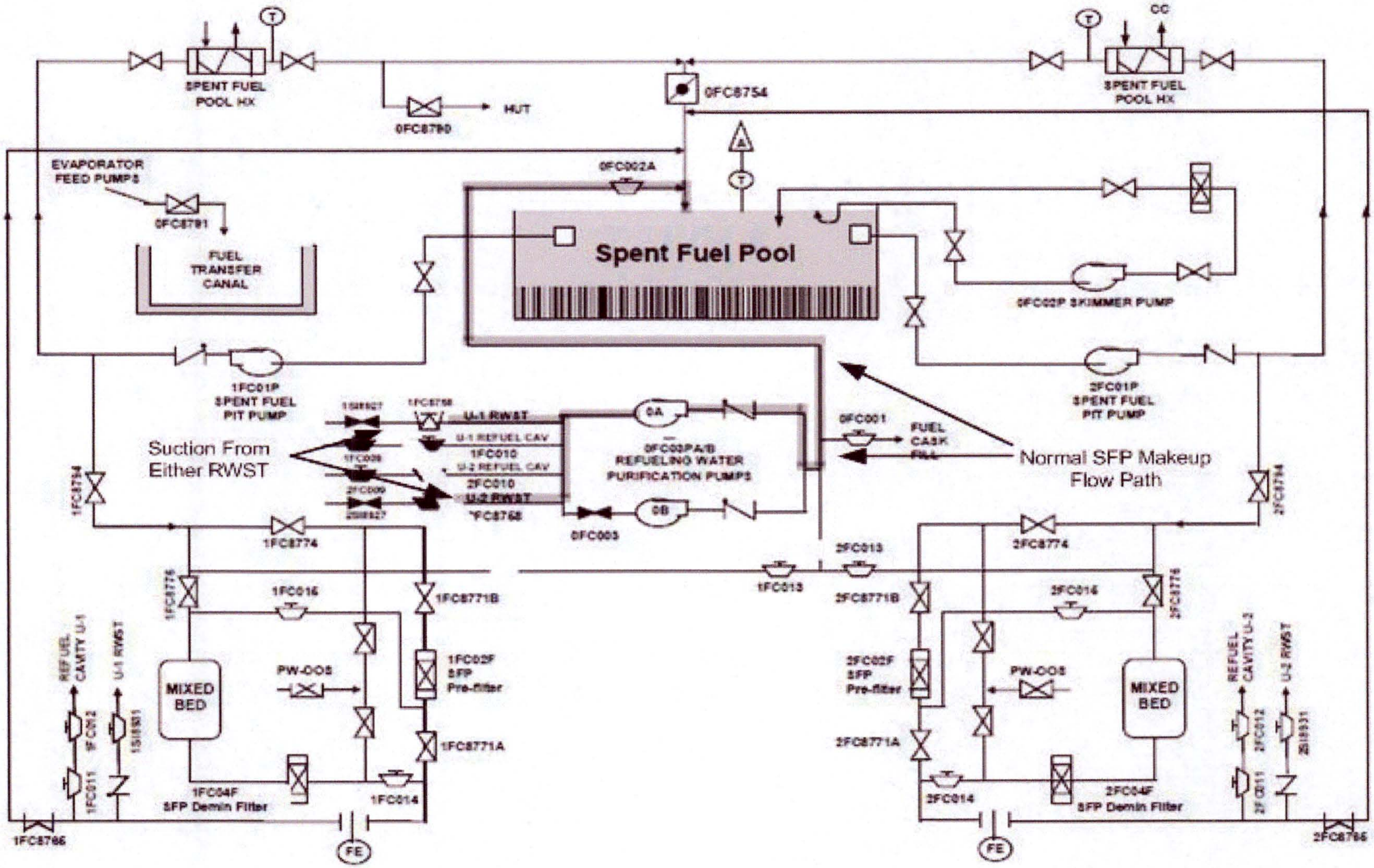

Figure 10: Alternate Spent Fuel Pool Makeup

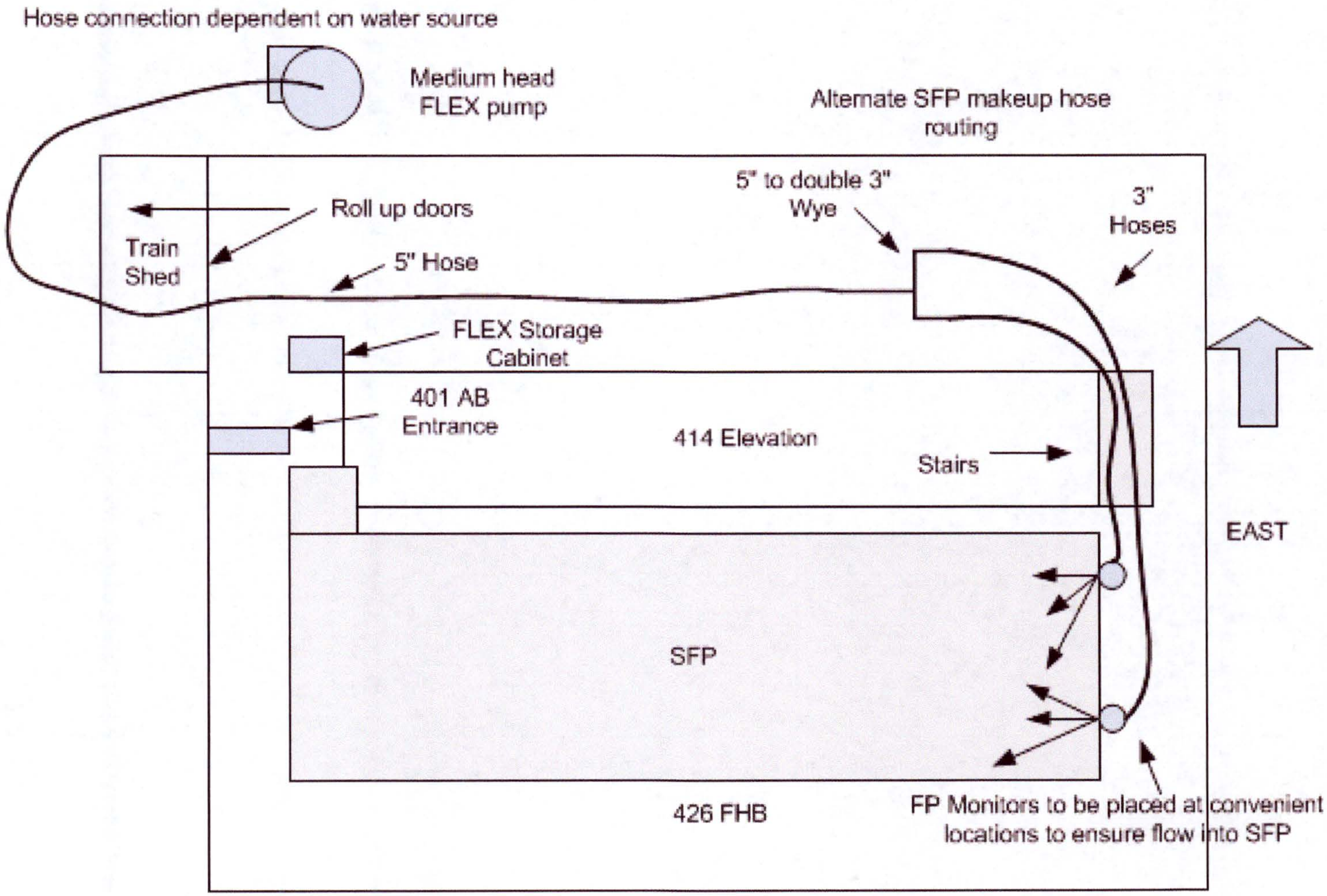

Figure 11: Low Head FLEX Pump Hose Routing

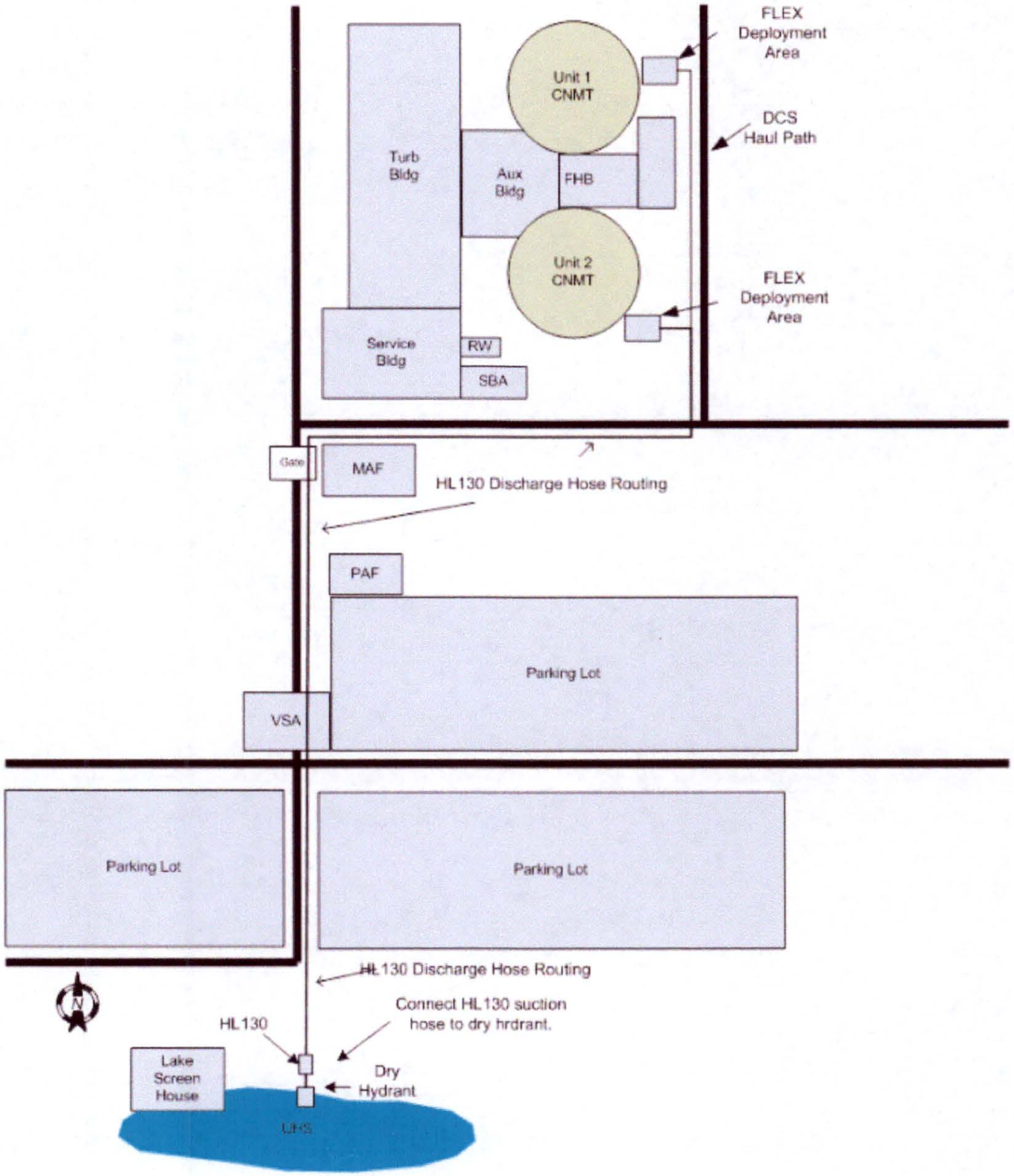

Figure 12: Medium Head FLEX Pump Layout

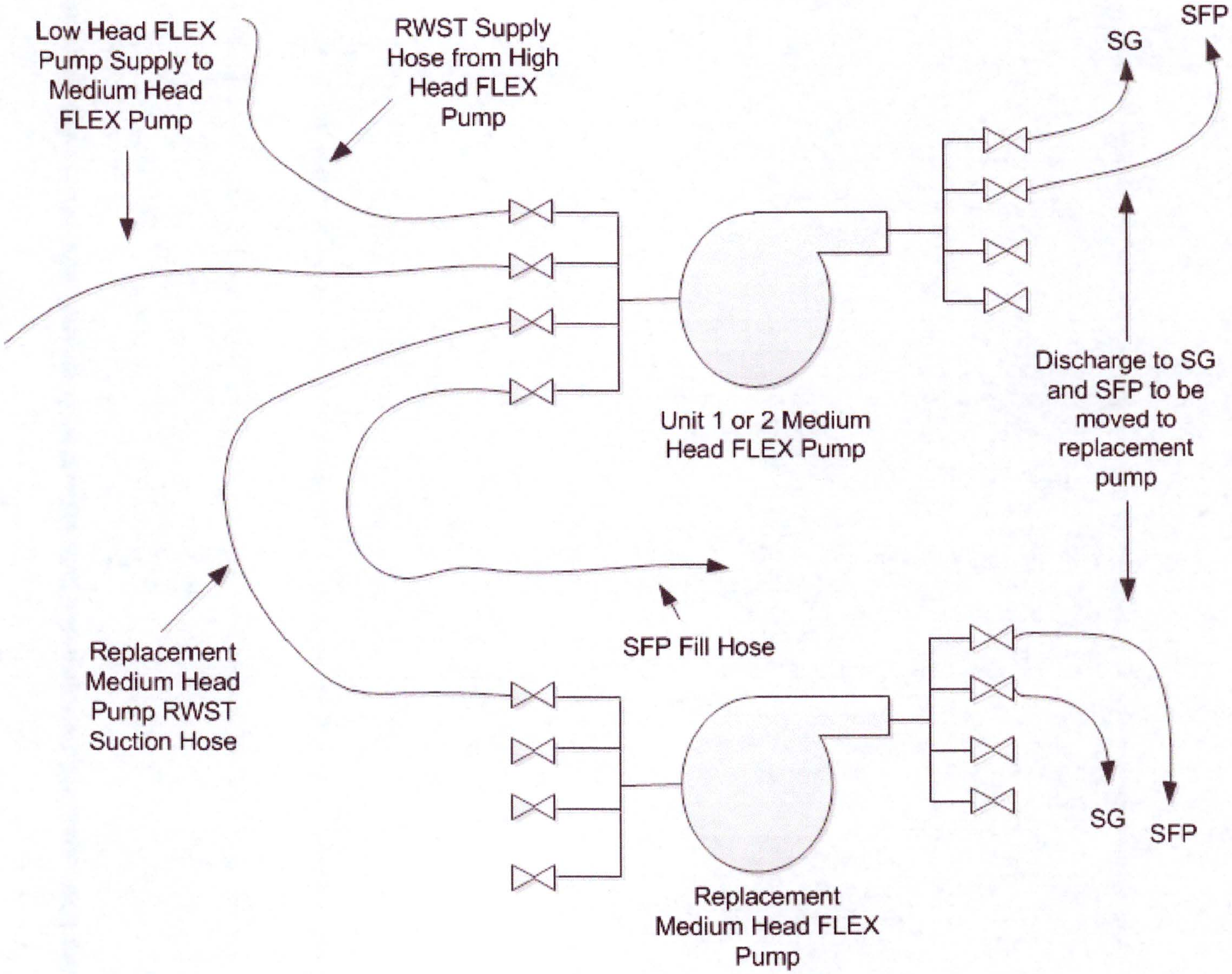

Figure 13: High Head FLEX Pump Layout

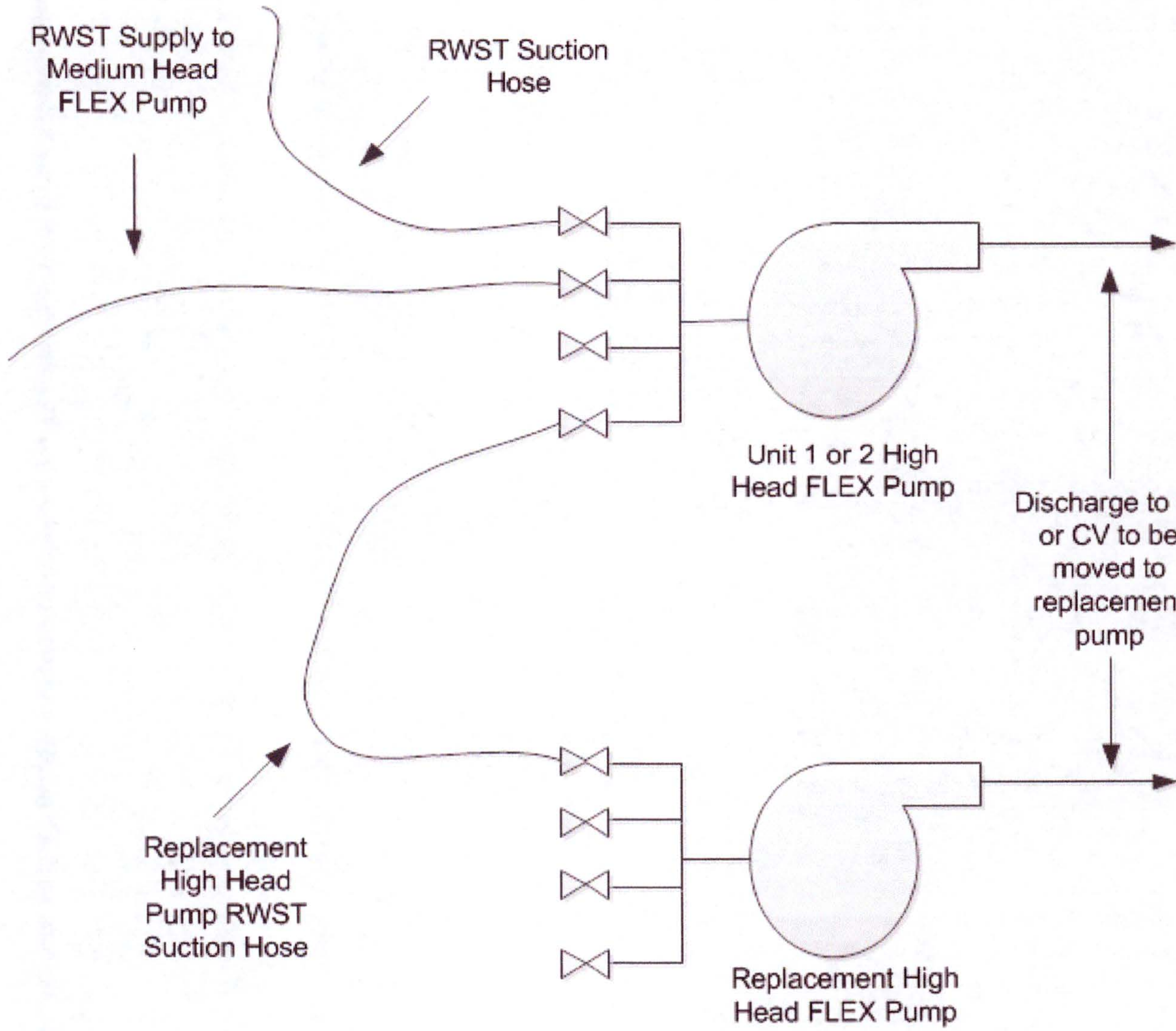

Figure 14: 364 Aux BLDG Temporary Lighting

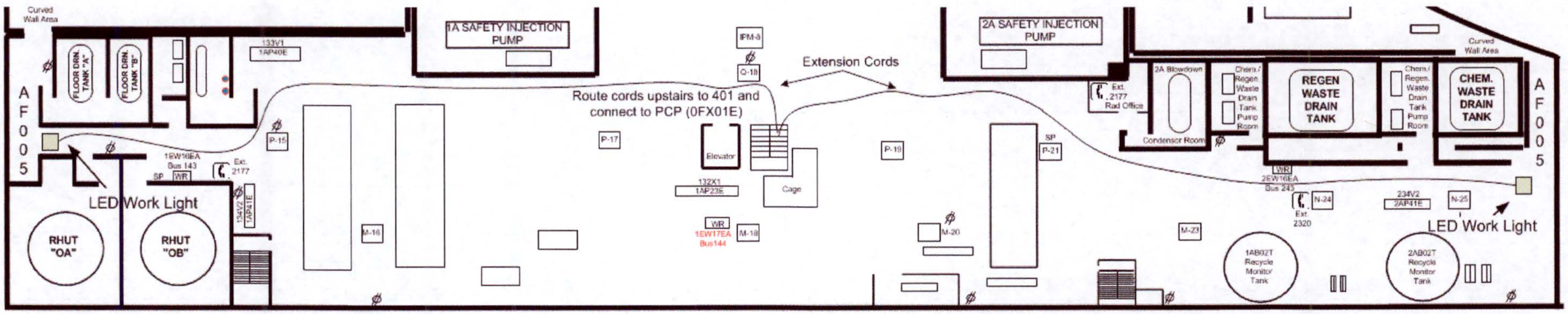

Figure 15: 383 Aux BLDG Temporary Lighting and Ventilation

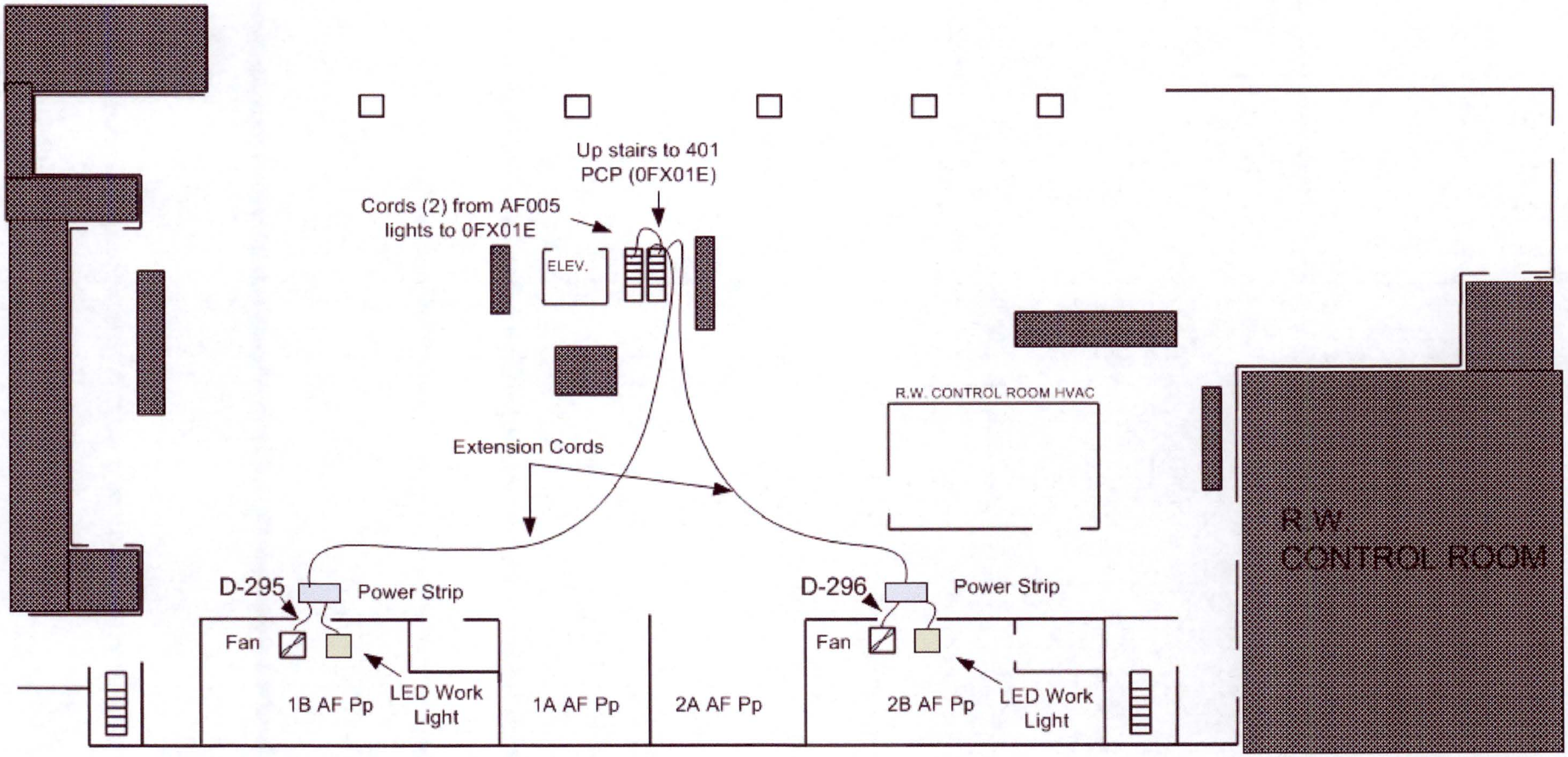

Figure 16: Main Control Room Temporary Lighting

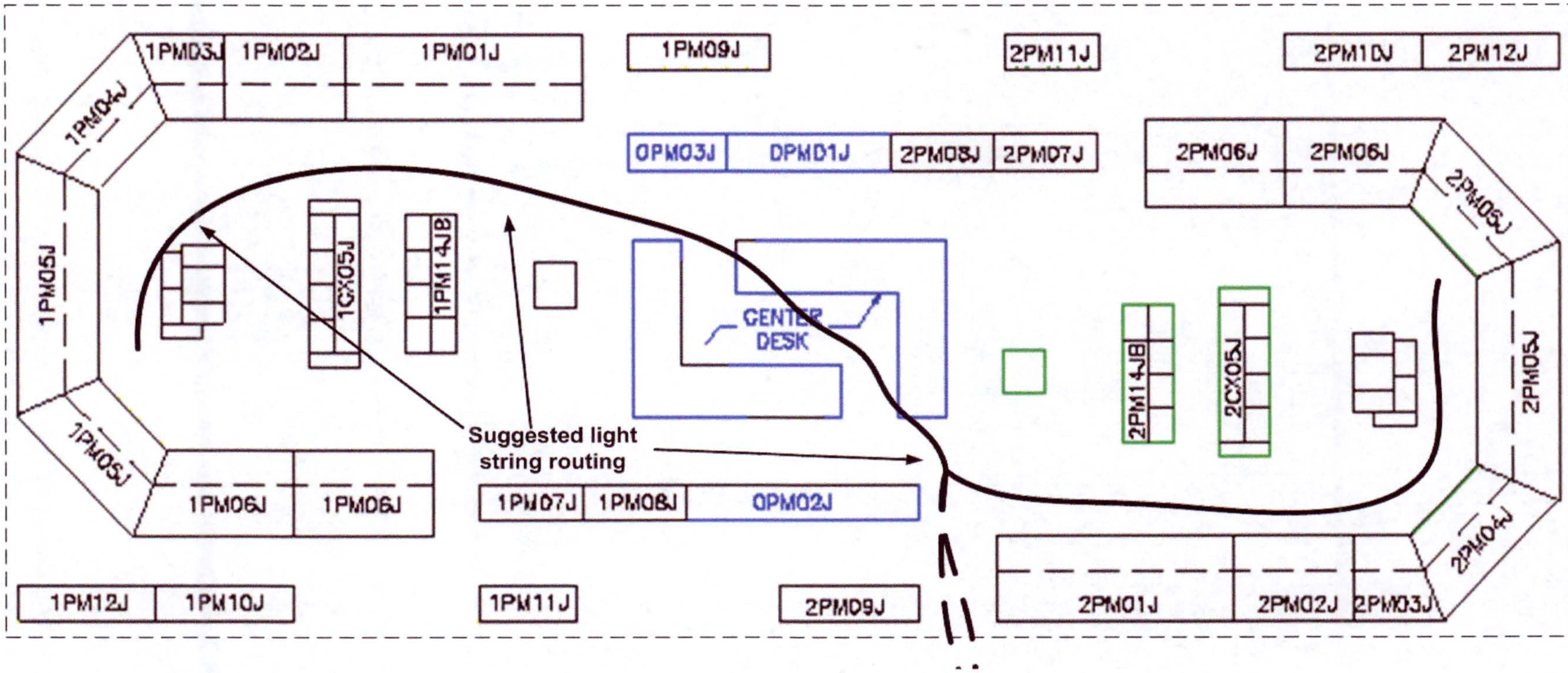

Figure 17: Main Control Room Temporary Ventilation

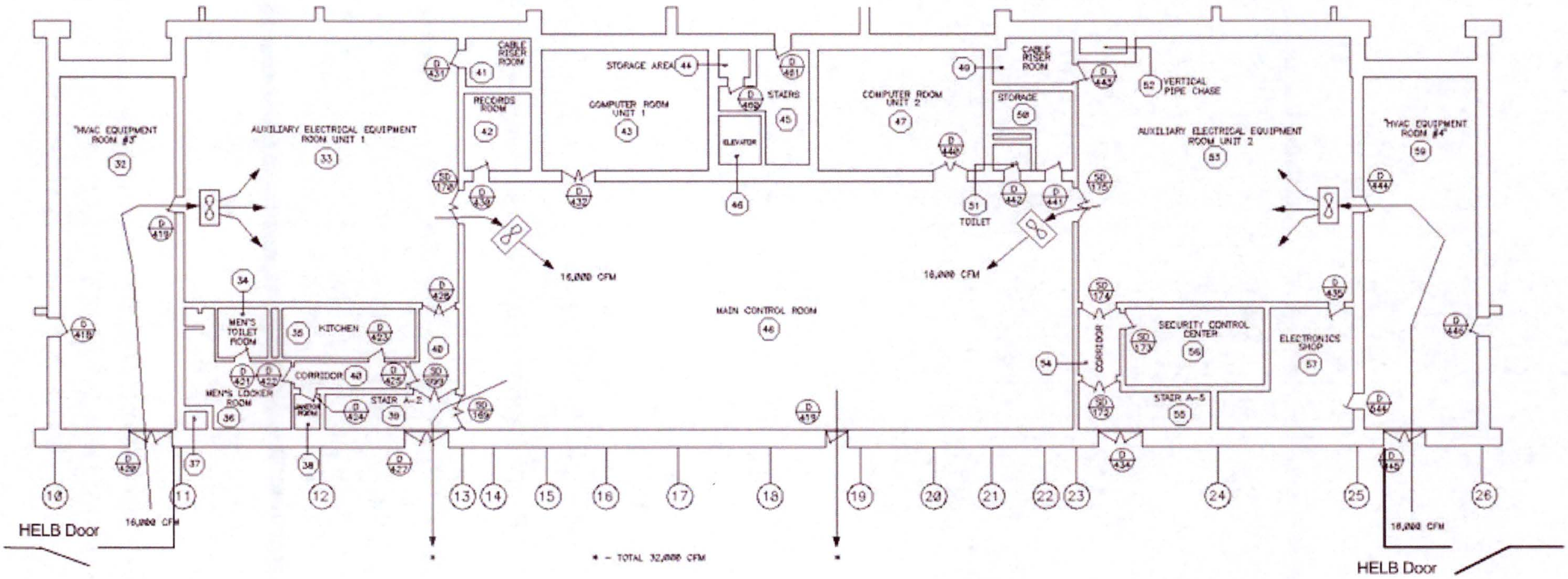

Figure 18: Unit 1 MEER Temporary Ventilation

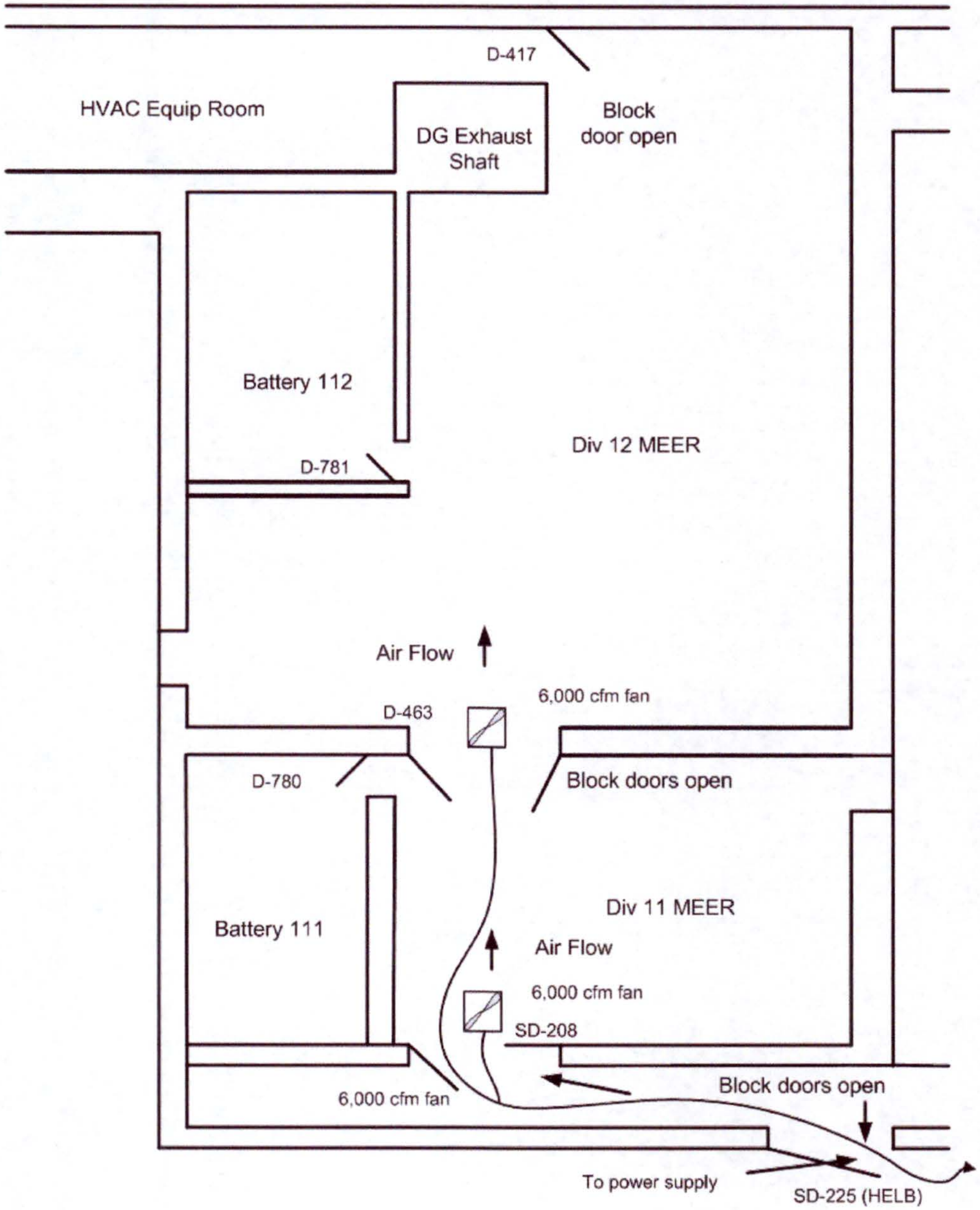

Figure 19: Unit 2 MEER Temporary Ventilation

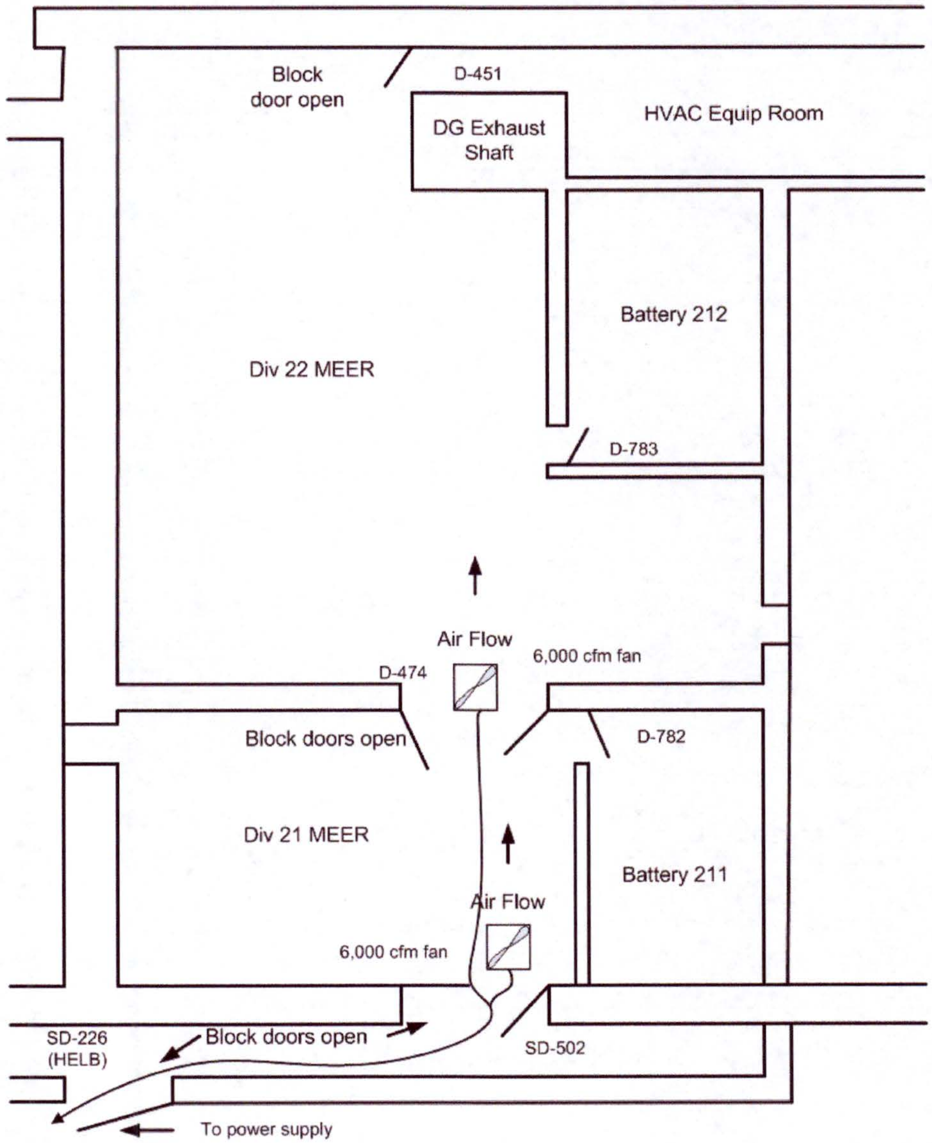

Figure 20: FLEX Equipment Staging Areas

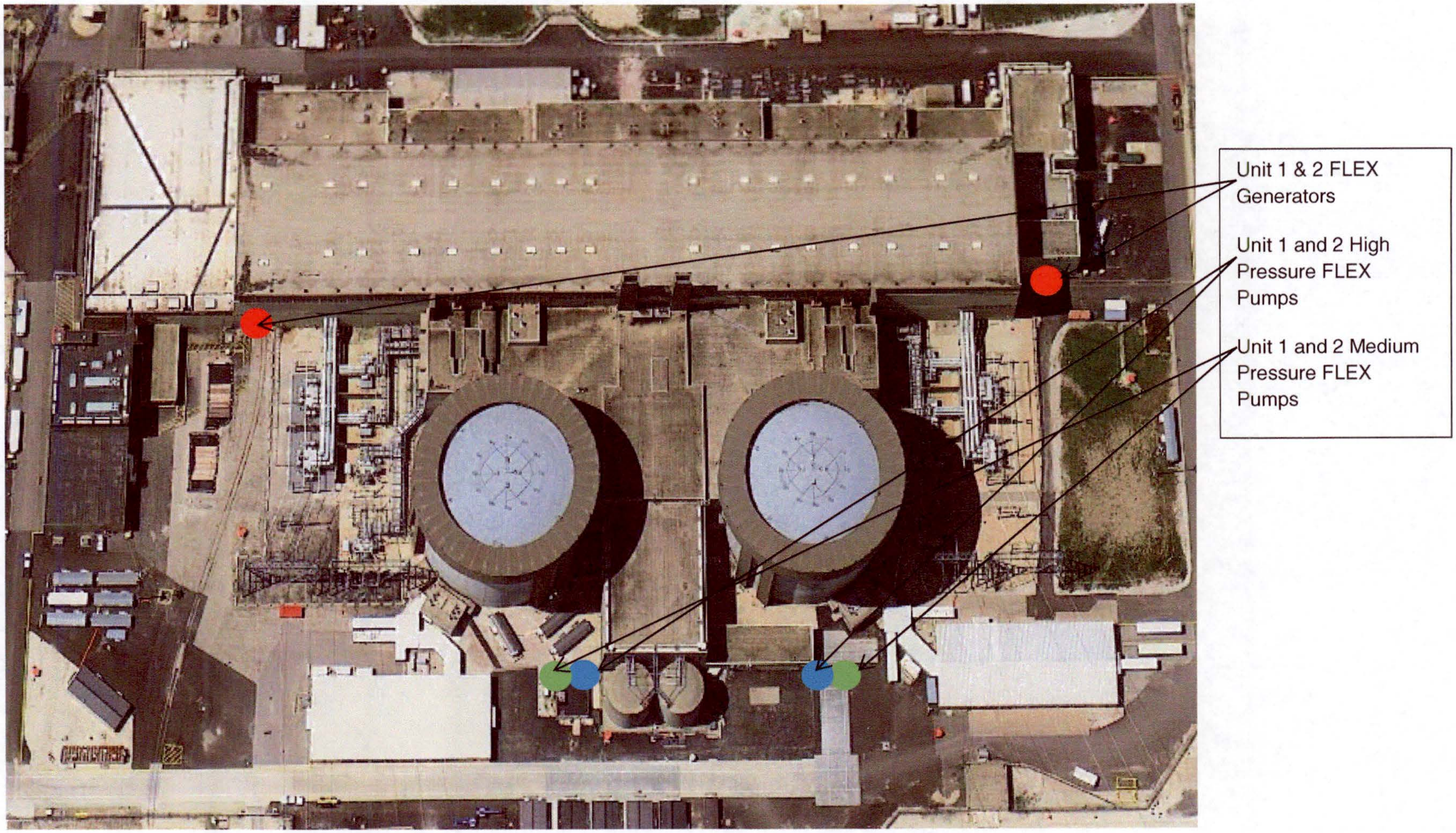

Figure 20: FLEX Equipment Staging Areas (Continue)