Exelon Generation®

Order No. EA-12-049

RS-16-090

August 16, 2016

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

Dresden Nuclear Power Station, Unit 3
Renewed Facility Operating License No. DPR-25
NRC Docket No. 50-249

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-13-020)
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-13-119)
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-14-010)

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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-14-208)
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-15-019)
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-15-210)
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-16-022)
12. NRC letter to Exelon Generation Company, LLC, Dresden Nuclear Power Station, Units 2 and 3 – Interim Staff Evaluation Relating to Overall Integrated Plan in Response to Order EA-12-049, (Mitigation Strategies) (TAC Nos. MF1046 and MF1047), dated November 22, 2013
13. NRC Letter, Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident, dated March 12, 2012
14. 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 June 30, 2015 (RS-15-154)
15. NRC letter to Exelon Generation Company, LLC, Dresden Nuclear Power Station, Units 2 and 3 – Report for the Onsite Audit Regarding Implementation of Mitigating Strategies and Reliable Spent Fuel Pool Instrumentation Related to Orders EA-12-049 and EA-12-051 (TAC Nos. MF1046, MF1047, MF1050, MF1051), dated October 9, 2015
16. Exelon Generation Company, LLC, Dresden Nuclear Power 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), dated January 12, 2016 (RS-16-005)

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 and an Overall Integrated Plan (OIP) pursuant to Section IV, Condition C. Reference 2 endorsed industry guidance document NEI 12-06, (Reference 3). Reference 4 provided the EGC initial status report regarding mitigation strategies. Reference 5 provided the Dresden Nuclear Power Station OIP.

Reference 1 required submission of a status report at six-month intervals following submittal of the OIP. References 6, 7, 8, 9, 10, and 11 provided the first, second, third, fourth, fifth, and sixth six-month status reports, respectively, pursuant to Section IV, Condition C.2, of Reference 1 for Dresden Nuclear Power Station, Unit 3.

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 Dresden Nuclear Power Station, Unit 3 as of June 17, 2016.

Dresden Nuclear Power Station, Unit 3 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 Dresden Nuclear Power Station, Unit 3 with Reference 1.

OIP open items have been addressed and closed as documented in References 6, 7, 8, 9, 10, and 11 and are considered complete pending NRC closure. EGC's response to the NRC Interim Staff Evaluation (ISE) open and confirmatory items identified in Reference 12 have been addressed and closed as documented in References 7, 8, 9, 10, and 16, 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 15 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 items.

Overall Integrated Plan Open Items

Section Reference	Overall Integrated Plan Open Item	Completion Response Reference
Sequence of Events (page 5-6)	The times to complete actions in the Events Timeline are based on operating judgment, conceptual designs, and current supporting analyses. The final timeline will be time validated once detailed designs are completed and procedures developed.	Reference 11
Sequence of Events (page 5)	Analysis of deviations between Exelon's engineering analyses and the analyses contained in BWROG Document NEDC-33771P, GEH Evaluation of FLEX Implementation Guidelines and documentation of results on Att. 1B, "NSSS Significant Reference Analysis Deviation Table." Planned to be completed and submitted with August 2013 Six Month Update.	Reference 6
Sequence of Events (page 8)	Initial evaluations 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
Deployment Strategy (pages 8-9)	Transportation routes will be developed from the equipment storage area to the FLEX staging areas. An administrative program will be developed to ensure pathways remain clear or compensatory actions will be implemented to ensure all strategies can be deployed during all modes of operation. Identification of storage areas and creation of the administrative program are open items.	Reference 11
Programmatic Controls (pages 9-10)	An administrative program for FLEX to establish responsibilities, and testing & maintenance requirements will be implemented.	Reference 10
Spent Fuel Pool Cooling Phase 2 Discussion (page 46)	Complete an evaluation of the spent fuel pool area for steam and condensation.	Reference 11
Safety Functions Support Phase 2 Discussion (page 57)	Evaluate the habitability conditions for the Main Control Room and develop a strategy to maintain habitability.	Reference 11
Safety Functions Support Phase 2 Discussion (page 57)	Evaluate the habitability conditions for the Auxiliary Electric Equipment Room (AEER) and develop a strategy to maintain habitability.	Reference 11

Interim Staff Evaluation Open Items

Open Item	Completion Response Reference
Item No. 3.1.1.1.A	Reference 7
Item No. 3.1.2.2.B	Reference 7
Item No. 3.2.4.8.A	Reference 8

Interim Staff Evaluation Confirmatory Items

Open Item	Completion Response Reference
Item No. 3.1.1.2.A	Reference 7
Item No. 3.1.1.2.B	Reference 10
Item No. 3.1.1.3.A	Reference 10
Item No. 3.1.1.3.B	Reference 7
Item No. 3.1.1.4.A	Reference 9
Item No. 3.1.2.A	Reference 10
Item No. 3.1.2.2.A	Reference 10
Item No. 3.1.2.3.A	Reference 10
Item No. 3.1.4.2.A	References 7 and 10
Item No. 3.1.5.2.A	Reference 10
Item No. 3.1.5.3.A	Reference 10
Item No. 3.2.1.1.A	Reference 8
Item No. 3.2.1.1.B	References 8 and 10
Item No. 3.2.1.1.C	Reference 8
Item No. 3.2.1.1.D	Reference 8
Item No. 3.2.1.1.E	References 8 and 10
Item No. 3.2.1.3.A	Reference 10
Item No. 3.2.1.3.B	Reference 10
Item No. 3.2.1.4.A	Reference 10
Item No. 3.2.1.4.B	Reference 10
Item No. 3.2.1.6.A	Reference 8
Item No. 3.2.2.A	Reference 10
Item No. 3.2.3.A	Reference 8
Item No. 3.2.4.2.A	Reference 16
Item No. 3.2.4.2.B	Reference 16
Item No. 3.2.4.2.C	Reference 16
Item No. 3.2.4.2.D	Reference 10
Item No. 3.2.4.4.A	Reference 10
Item No. 3.2.4.4.B	Reference 10
Item No. 3.2.4.6.A	Reference 10
Item No. 3.2.4.6.B	Reference 10
Item No. 3.2.4.6.C	Reference 10

Item No. 3.2.4.8.B	Reference 10
Item No. 3.2.4.8.C	Reference 9
Item No. 3.2.4.9.A	Reference 9
Item No. 3.2.4.9.B	References 9 and 10
Item No. 3.2.4.10.A	Reference 9
Item No. 3.4.A	Reference 10

NRC Audit Report Open Items

Audit Open Item	Completion Response Reference
ISE CI 3.2.4.2.A	Reference 16
ISE CI 3.2.4.2.B	Reference 16
ISE CI 3.2.4.2.C	Reference 16
SE 1-E	Reference 16
SE 13-E	Reference 16

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	February 14, 2013
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
Modification Development:	
Phases 1 and 2 modifications	November 13, 2015
National SAFER Response Center Operational	July 27, 2015
Procedure Development:	
Strategy procedures	November 13, 2015
Validate Procedures (NEI 12-06, Sect. 11.4.3)	October 30, 2015
Maintenance procedures	November 17, 2015
Staffing analysis	June 30, 2015
Modification Implementation	
Phases 1 and 2 modifications	December 3, 2015
Storage plan and construction	November 1, 2015
FLEX equipment acquisition	November 13 2015
Training completion	November 15, 2015
Unit 3 implementation date	June 17, 2016

ORDER EA-12-049 COMPLIANCE ELEMENTS SUMMARY

The elements identified below for Dresden Nuclear Power Station, Unit 3 as well as the site OIP response submittal (Reference 5), the 6-Month Status Reports (References 6, 7, 8, 9, 10, and 11), and any additional docketed correspondence, demonstrate compliance with Order EA-12-049.

Strategies - Complete

Dresden Nuclear Power Station, Unit 3 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 Dresden Nuclear Power Station, Units 2 and 3, 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 Dresden Nuclear Power Station, Unit 3 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 Dresden Nuclear Power Station, Unit 3 has been procured in accordance with NEI 12-06, Sections 11.1 and 11.2, received at Dresden Nuclear Power Station, Unit 3, 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 Dresden Nuclear Power Station, Unit 3 Preventative Maintenance program such that equipment reliability is achieved.

Protected Storage – Complete

The storage facilities required to implement the FLEX strategies for Dresden Nuclear Power Station, Unit 3 have been completed and provide protection from the applicable site hazards. The equipment required to implement the FLEX strategies for Dresden Nuclear Power Station, Unit 3 is stored in its protected configuration.

Procedures – Complete

FLEX Support Guidelines (FSGs) for Dresden Nuclear Power Station, Unit 3 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 Dresden Nuclear Power Station, Unit 3 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 Dresden Nuclear Power Station, Unit 3 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 13), as documented in Reference 14.

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 Dresden Nuclear Power Station, Unit 3 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 - Established

The Dresden Nuclear Power Station, Unit 3 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 16th day of August 2016.

Respectfully submitted,

Glen T. Kaegi

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

Enclosure: Dresden Nuclear Power Station, Units 2 and 3, Final Integrated Plan – Mitigating Strategies for a Beyond-Design-Basis External Event (NRC Order EA-12-049), June 2016

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

Enclosure

Dresden Nuclear Power Station, Units 2 and 3

Final Integrated Plan

Mitigating Strategies for a Beyond-Design-Basis External Event

(NRC Order EA-12-049)

June 2016

(136 Pages)

Exelon Generation.

DRESDEN
POWER STATION
UNIT 2 & UNIT 3

FINAL INTEGRATED PLAN DOCUMENT

MITIGATING STRATEGIES
NRC ORDER EA-12-049

June 2016

Dresden Power Station – Unit 2 and Unit 3

Final Integrated Plan Document – Mitigating Strategies NRC Order EA-12-049

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1. Background

In 2011, an earthquake induced tsunami caused Beyond Design Basis (BDB) flooding at the Fukushima Dai-ichi Nuclear Power Station in Japan. The flooding caused the emergency power supplies and electrical distribution systems to be inoperable, resulting in an Extended Loss of Alternating Current 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.

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

Based on NTTF Recommendation 4.2, the NRC issued Order EA-12-049 (Reference 1) on March 12, 2012 to implement mitigation strategies for BDBEEs. The Order provided the following requirements for strategies to mitigate BDBEEs:

1. Licensees shall develop, implement, and maintain guidance and strategies to maintain or restore core cooling, containment, and Spent Fuel Pool (SFP) cooling capabilities following a BDBEE.

2. 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 at all units on a site subject to the Order.

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

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

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

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

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

NRC Order EA-12-049 (Reference 1) required licensees of operating reactors to submit an overall integrated plan, including a description of how compliance with these requirements would be achieved by February 28, 2013. The Order also required licensees to complete implementation of the requirements no later than two refueling cycles after submittal of the overall integrated plan or December 31, 2016, whichever comes first.

The Nuclear Energy Institute (NEI) developed NEI 12-06 (Reference 2), which provides guidelines for nuclear stations to assess extreme external event hazards and implement the mitigation strategies specified in NRC Order EA-12-049. The NRC issued Interim Staff Guidance JLD-ISG-2012-01 (Reference 3), dated August 29, 2012, which endorsed NEI 12-06 with clarifications on determining baseline coping capability and equipment quality.

NRC Order EA-12-051 (Reference 4) required licensees to install reliable SFP instrumentation with specific design features for monitoring SFP water level.

NEI 12-02 (Reference 5) provided guidance for compliance with Order EA-12-051. The NRC determined that, with the exceptions and clarifications provided in JLD-ISG-2012-03 (Reference 6), conformance with the guidance in NEI 12-02 is an acceptable method for satisfying the requirements in Order EA-12-051.

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

2.1 General Elements - Assumptions

The assumptions used for the evaluations of a Dresden Power 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:

- The BDB external event occurs impacting both units at the site.
- Both reactors are initially operating at 100 percent rated thermal power for at least 100 days or has just been shut down from such a power history as required by plant procedures in advance of the impending event.
- Each reactor is successfully shut down when required (i.e., all control rods inserted, no ATWS). Systems designed for decay heat removal upon shutdown function normally, and reactor coolant system (RCS) overpressure protection valves respond normally, if required by plant conditions, and reseat. The emergency cooling system initiates and operates normally, providing decay heat removal, thus obviating the need for further overpressure protection valve operation.
- On-site staff is at site administrative minimum shift staffing levels.
- No independent, concurrent events, e.g., no active security threat.
- All personnel on-site 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 Dresden Power Station:

- No specific initiating event is used. The initial condition is assumed to be a loss of off-site power (LOOP) with installed sources of emergency on-site AC power and station blackout (SBO) alternate AC power sources unavailable with no prospect for recovery.
- Cooling and make-up 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 portions of the fire protection system that is robust with respect to seismic events, floods, and high winds and associated missiles are available as a water source.

- Normal access to the ultimate heat sink is lost, but the water inventory in the ultimate heat sink (UHS) remains available and robust piping connecting the UHS to plant systems remains intact. The motive force for UHS flow, i.e., pumps, is assumed to be lost with no prospect for recovery.
- 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 identified and unidentified leakage at the upper limit of Technical Specifications and reactor recirculation pump seal leak-off.
- For the spent fuel pool, the heat load is assumed to be the maximum design basis heat load. In addition, inventory loss from sloshing during a seismic event does not preclude access to the pool area.

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

- Exceptions for the site security plan or other requirements of 10CFR may be required.
- Site access is impeded for the first 6 hours, consistent with NEI 12-01 (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.
- This plan defines strategies capable of mitigating a simultaneous loss of all alternating current (AC) power and loss of normal access to the ultimate heat sink resulting from a BDB event by providing adequate capability to maintain or restore core cooling, containment, and spent fuel pool (SFP) cooling capabilities. Though specific strategies have been developed, due to the inability to anticipate all possible scenarios, the strategies are also diverse and flexible to encompass a wide range of possible conditions. These pre-planned strategies developed to protect

the public health and safety have been incorporated into the unit emergency operating procedures in accordance with established emergency operating procedure (EOP) change processes, and their impact to the design and license bases capabilities of the unit evaluated under 10 CFR 50.59.

- 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 BDB 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), dated September 12, 2006 (Reference 8).

2.2 Strategies

The objective of the FLEX Strategies is to establish an indefinite coping capability in order to 1) prevent damage to the fuel in the reactor, 2) maintain the containment function and 3) maintain cooling and prevent damage to fuel in the spent fuel pool (SFP) using installed equipment, on-site portable equipment, and pre-staged off-site resources. This indefinite coping capability will address an extended loss of all AC power (ELAP) – loss of off-site power (LOOP), emergency diesel generators (EDGs), and station blackout diesel generators (SBO DG) – with a simultaneous loss of access to the ultimate heat sink (LUHS) and loss of motive force for UHS pumps, but the water in the UHS remains available. This condition could arise following external events that are within the existing design basis with additional failures and conditions that could arise from a Beyond-Design-Basis external event.

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

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

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

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

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

The FLEX strategies are implemented by FLEX Support Guides (FSGs) in conjunction with other site emergency procedures. FSG-01 provides a Flowchart of actions to be performed under Extended Loss of AC Power/Loss of Ultimate Heat Sink conditions for all FLEX events including flooding. The entry condition for FSG-01 is “Station Blackout”. As soon as this event occurs, DGA-22, Station Blackout is entered. As directed by DGA-22, (Reference 55) the FSG-01 Flowchart actions are initiated.

The BDB flooding event requires different equipment and a different strategy than the other four BDB events. These differences are provided in the following sections and are distinctly labeled as <u>BDB Flooding Event</u>.

A conceptual diagram of the following FLEX strategies showing basic staging locations and BDB equipment and general hose and cable routing is provided in Figure 1 and Figure 2.

2.3 Reactor Core Cooling Strategy

Reactor core cooling involves the removal of decay heat using the Isolation Condenser (IC) and the High Pressure Coolant Injection (HPCI) system. An isolation condenser system provides reactor core cooling if the reactor becomes isolated from the main condenser. The isolation condenser operates by natural circulation. During operation of the isolation condenser system, steam flows from the reactor, condenses in the tubes of the isolation condenser, and flows back to the reactor by gravity. The HPCI system is provided for removal of decay heat and to provide coolant inventory control and heat dissipation from the core to the suppression chamber. HPCI is designed to pump water into the reactor vessel under those LOCA conditions which do not result in rapid depressurization of the reactor pressure vessel.

At the initiation of the event personnel will enter DGA-12 "Partial or Complete Loss of AC Power", (Reference 53) and Emergency Operating Procedures (EOPs). Reactor water level and pressure control would be accomplished using the IC and HPCI System which operate independent of all AC power. Per the UFSAR Section 5.4.6.3, (Reference 12) the Isolation Condenser will operate approximately 20 minutes without initiation of shell side make-up. In Phase 1 there are no shell side make-up sources that meet requirements for FLEX qualification.

FLEX strategies were developed in conjunction with computer simulations Modular Accident Analysis Program (MAAP) (Reference 13) to identify successful use of plant and FLEX equipment. In the initial 2.5 hours, the FLEX strategy utilizes HPCI as a Reactor Pressure Vessel (RPV) pressure control mechanism through the removal of decay heat associated with the steam being used to operate the HPCI system turbine. HPCI will be operating on minimum flow with suction established from the Suppression Pool, if the CST tanks are not available. HPCI is also used to supply high pressure RPV make-up until it is secured. Operation of the HPCI Turbine will result in a heat input to the Suppression Pool. There is no current method to remove heat from the Suppression Pool without off-site or emergency diesel generator AC power. The HPCI turbine oil cooler and gland seal condenser are cooled by water from the suppression pool. Since these components are rated at 140 °F, (Reference 12) continued operation above a suppression pool temperature of 140 °F is not desired. Associated MAAP runs and the staffing study all made the assumption HPCI would not be available after 140°F.

Once the IC shell side make-up has been established, the HPCI system can be secured. The IC removes decay heat with no loss of inventory from the reactor coolant system (although there still may be some leakage from the assumed RPV leakage into the Drywell), and with no addition of heat to the suppression pool. As long as the shell side of the IC is replenished (Phase 2) with sufficient water, the IC will remove adequate decay heat to maintain core cooling.

BDB Flooding Event

Abnormal operating procedures makes optimum use of the onsite equipment to achieve a safe shutdown of the reactor under Probable Maximum Flood (PMF) conditions. The procedures utilize several methods to discharge decay heat throughout the PMF event. During early phases when the power is available, the reactor is shutdown and cooled down per existing procedures. Once the river level reaches elevation 513 feet mean sea level (MSL), the reactor cooling is switched to the isolation condensers. Initially, multiple water sources are available for the shell side of the isolation condensers. Once the site is inundated with a flood, barge mounted flood pumps will be used to pump flood waters to remove the decay heat. One flood pump is sized to meet all make-up requirements for both units. A second flood pump on the barge serves as a back-up pump.

2.3.1 Phase 1 Strategy

Isolation Condenser (IC) and High Pressure Coolant Injection (HPCI) are utilized to remove decay heat and to control reactor pressure below ERV setpoints.

The IC will remove decay heat in the initial 20 minutes of the event until shell side inventory is reduced (Reference 12). HPCI will then be operated per FSG-02, "FLEX Strategy HPCI Operation During an ELAP Event" to control reactor pressure and provide water make-up while a source of IC shell side make-up is being established. HPCI operation is assumed for approximately 2.5 hours from event initiation at which time it is postulated Suppression Pool temperature will reach 140°F. At this point, IC shell side make-up will be established and the IC will be used to establish a Reactor cooldown and HPCI secured.

A natural ventilation path will be established through the HPCI room (FSG-31). Doors are opened in the HPCI room to minimize the potential for an area high temperature isolation of the system. In addition, per FSG-02 "Flex Strategy HPCI

Operation During An ELAP Event", HPCI room high temperature isolation is bypassed. Calculation 2013-01671 (Reference 14) indicates opening doors at 2 hours will result in acceptable room temperature values to support operation of HPCI for at least 6 hours. HPCI room temperature remains below the isolation point during this time. HPCI operation is assumed for approximately 2.5 hours in Phase 1.

To extend the 125 VDC battery and 250 VDC battery coping times, load shedding actions are taken during Phase 1 and are completed within 30 minutes. In accordance with FSG-01, "Extended Loss Of AC Power-Loss Of Ultimate Heat Sink Flowchart", battery load shedding shall be completed within 30 minutes. The 125 VDC Battery load shedding is completed using DGA-13, "Loss of 125 VDC Battery Chargers with Simultaneous Loss of Auxiliary Power" (Reference 54) and the 250 VDC Battery load shedding complete using DGA-03, "Loss of 250 VDC Battery Chargers with Simultaneous Loss of Auxiliary Power (Reference 52).

BDB Flooding Event

As directed by DGA-22, the FSG-01 Flowchart actions are initiated. For flooding conditions, three FSGs are invoked: FSG-60, "FLEX Flood Pump Deployment/Operation", FSG-61, "FLEX Fire System Isolation" and FSG-62, "FLEX Generator Deployment During a Flood". These three FSGs provide guidance in conjunction with the "Floods" procedure DOA 0010-04 (Reference 56) that provides step by step actions to be performed under flooding conditions. If a Station Blackout does not occur and a flooding event is in a forecast, DOA 0010-04 is entered based on river flood levels.

The river flooding scenario is based on rainfall forecast. A close coordination with the Dresden Lock Master of the United States Army Corp of Engineers (USACE) will be maintained when river levels are rising. Additionally, Unit 2/3 Cribhouse Intake Canal level will be measured at specified frequencies. Note that the Unit 2/3 Cribhouse is the same as the Intake Screen and Pump House (ISPH).

Based on rainfall and level predictions and measured intake canal levels, the following actions are taken per DOA 0010-04 (Reference 56).

1. If rainfall forecast exceeds two (2) inches/hour, or the river level exceeds elevation 507 ft. MSL, Attachment A of DOA 0010-04 provides guidance for

river monitoring and rainfall forecasting. Additionally, communications with the Dresden Lock Master or the US Army Corps of Engineers (USACE) are initiated and maintained to obtain information on the operability status and intentions of Dresden Lock and Dam gates. The U2/3 Crib House intake canal water level monitoring is initiated at specified frequencies.

2. If the Crib House levels are "predicted" to reach greater than elevation 507 ft. MSL, then the Duty station manager is notified to staff the Outage Control Center (OCC). Additionally the OCC is notified to initiate actions in Attachment K, FLEX Flood Preparatory Actions. Major actions include deployment of barge mounted FLEX Flood Pumps in the U3 Turbine Building Trackway and filling all the diesel fuel barrels on the barge. The U2/3 EDG Fuel Oil Tank vent line extension pipe(s) are installed. The HL130, B.5.b/Flex Pump, Dam Failure Submersible pumps/power packs, Portable Isolation Condenser Diesel Driven Make-up pump and hoses are relocated to an offsite location above elevation 529 ft. MSL so they are available during the period when flood waters recede to the plant grade level. A boat with necessary supplies and fuel is staged near the barge. Dresden has 5 boats available for use. The FLEX Diesel Generators (DG) and associated power distribution units are staged on top of the U2 reactor building interlock.

3. If the Crib House intake canal level is "predicted" to exceed EL 509 ft. anytime within the next 72 hours, then both U2 and U3 are shut down per DGP 02-01 (Reference 57). The reactor systems are cooled down as quickly as possible per Technical Specification 3.4.9 (Reference 11) to the lowest temperature possible in the time available before U2 and U3 Service Water Systems are secured at elevation 513 ft. MSL.
4. U2 and U3 reactor vessels are filled to aid in cool down if time is available before Service Water Systems are secured at elevation 513 ft. MSL.
5. OCC is notified to coordinate installation of the Isolation Condenser Make-Up Pump Building Flood Barriers or construction of a flood protection berm to protect the building to at least a level elevation 519 ft. 6 in. MSL.
6. If the Crib House level reaches elevation 508 ft. MSL, the Duty Station Manager is notified to staff the OCC and to initiate the FLEX Flood Preparatory Actions described above.
7. If the Cribhouse level reaches elevation 509 ft. MSL and is predicted to continue to rise then both units are scrammed per DGP 02-03 (Reference 43)

and the reactor systems are cooled down as quickly as possible. FSG-61, "FLEX Fire System Isolation" actions are also initiated.

8. If the Crib House level reaches elevation 513 ft. MSL, U2 and U3 Service Water Systems are secured, and DOA 1000-01 (Reference 32), Residual Heat Removal Alternatives is entered. The reactor level is restored between +55 inches and +60 inches. The reactor cooling is transferred to the Isolation Condensers (DOP 1300-03 (Reference 58)), and contingency plans are initiated to address loss of fuel pool cooling (DOA 1900-01 (Reference 59)).
9. If the Crib House level is "predicted" to exceed elevation 517 ft. MSL, then all above-ground storage tanks level will be raised to greater than or equal to 10 ft. and the below-ground water storage tanks will be filled.
10. When the Crib House level reaches elevation 517 ft. MSL, then power will be removed from transformers and MCCs on elevation 517 ft. MSL. At this point, the FLEX flooding strategy transitions to Phase 2.

2.3.2 Phase 2 Strategy

Within 2.5 hours of event initiation, the Isolation Condenser shell side make-up will be established using FLEX equipment. This is accomplished by the line-up and starting of a pre-staged 480 VAC FLEX pump powered from the FLEX diesel generator. The FLEX pumps are pre-staged and permanently mounted in the Reactor Building to minimize coping time. This is an alternate to NEI 12-06 which requires the equipment to be portable.

Temporary cables will be routed from a diesel generator through penetrations in the Reactor Building wall and then connected to the appropriate FLEX pump. After a FLEX pump is operating (time critical action, 2.5 hours) personnel will be able to route additional temporary cables from the generator to supply the safety related 480 VAC busses in the Reactor Building. The 480 VAC safety related busses will then be available to power desired loads such as Standby Liquid Control (SBLC) pumps for high pressure RPV injection and battery chargers. The pre-staged diesel generator is housed in a robust structure to provide protection for all events except flood.

The FLEX pumps utilize water from the Suppression Pool to provide the following:

- IC shell side make-up within 2.5 hrs utilizing FSG-05, "FLEX Isolation Condenser Make-up and Level Control" to cool down the RPV at approximately 15°F/hr utilizing the IC.

- Make-up to the SBLC tank for RPV make-up utilizing FSG-08, "FLEX High Pressure and Low Pressure RPV Level Control Using SBLC". Once HPCI is secured, a method of high pressure injection into the RPV is required to maintain RPV water level. The procedure also provides directions for a low pressure fill without use of the SBLC pumps once RPV pressure is reduced by the IC. SBLC pumps are powered by busses 28, 29, 38 and 39.

Actions are then taken to re-power Division 1, Division 2 Safety Related 480 VAC busses with a FLEX generator utilizing FSG-06, "FLEX Strategy For Aligning Power to U2(3) 480 Volt Safety Related Busses 28(38) and 29(39)". The following may then be performed:

- Initiate Stand By Liquid Control (SBLC) pumps for high pressure RPV make-up utilizing FSG-08, "FLEX High Pressure and Low Pressure RPV Level Control Using SBLC"
- Close Reactor Recirculation Loop isolation valves to limit inventory loss through pump seals utilizing FSG-07, "FLEX Strategy For Isolating Recirc Loops".
- Energize 125VDC and 250VDC Battery Chargers utilizing DGA-13 (Reference 52), "Loss of 125 VDC Battery Chargers with Simultaneous Loss of Auxiliary Power" and DGA-03 (Reference 54), "Loss of 250 VDC Battery Chargers with Simultaneous Loss of Auxiliary Power". The FLEX strategies ensure the Safety Related battery chargers are energized before the battery coping time is exceeded. The critical instruments fed from the battery system include reactor water level, reactor pressure, Suppression Pool level, drywell pressure, and isolation condenser level.

When the water available in both suppression pools has been exhausted, the BDBEE Shutdown Mitigation Strategy relies on transporting water from the Ultimate Heat Sink (UHS) to the plant in support of RPV core cooling, containment cooling and spent fuel pool cooling. Plant personnel will stage a hydraulic driven submersible pump into the UHS and route hoses from the UHS to the LPCI system per FSG-09, "FLEX Torus Make-up" where the supply water will be routed to one of the suppression pools through existing LPCI system piping.

BDB Flooding Event

The FLEX strategy actions described in Phase 1 continue as flood levels increase, those associated with reactor core cooling are described below:

1. When the Crib House Level reaches elevation 518 ft. MSL, the barge mounted FLEX Flood Pump is aligned and started per FSG-60. The pump takes flood water suction from the Test Boiler Pit and delivers to the fire header at elevation 538 ft. MSL. The flood pump provides make-up water to the isolation condensers, and the reactor vessel until flood waters recede and recovery and cleanup activities start. Note that the Isolation Condenser Make-up Pump Building is protected to a flood level of at least elevation 519 ft. 6 inches MSL (EC 391096 (Reference 36)). This provides sufficient time to transition from the IC Make-up pumps to the barge mounted FLEX Flood Pumps. One Flood Pump will provide make-up for the Isolation Condensers, Spent fuel Pools and Reactor Pressure Vessels for both units. The second Flood Pump on the barge provides redundancy.

2. As levels recede, off-site power sources are restored. When the Crib House level recedes to below elevation 509 ft. MSL, the Service Water System is made operational so that it may be used to control reactor temperature.

2.3.3 Phase 3 Strategy

Phase 3 will utilize Phase 2 connections and NSRC equipment as spares. Dresden relies on equipment stored off-site for Phase 3 of the FLEX mitigation strategy. Equipment may be provided from National SAFER Response Centers (NSRCs). Another nuclear plant may also provide Phase 3 equipment, if response would be faster than from the National SAFER Response Centers (NSRCs).

Temporary staging areas have been identified and details for their use in supporting Phase 3 equipment receipt, inspection and deployment to operating areas are provided in CC-DR-118-1001, SAFER Response Plan For Dresden Nuclear Power Station (Reference 40) and FSG-14, "Transition From Phase 2 to Phase 3 Equipment".

2.3.4 Structures, Systems, Components

2.3.4.1 Isolation Condenser

The performance objective of the isolation condenser is to provide reactor core cooling in the event that the reactor becomes isolated from the turbine and the main condenser by closure of the main steam isolation valves. To achieve this objective, the isolation condenser was designed for a cooling rate of 252.5 x 10^6 Btu/hr (Reference 12). The isolation condenser system is capable of operation without AC electrical power. The isolation condenser consists of two tube bundles immersed in a large water storage tank. The tubes are Type 304 stainless steel U-tubes. The shell is carbon steel. The isolation condenser system operates by natural circulation. During isolation condenser system operation, steam flows from the reactor, condenses in the tubes of the heat exchanger, and returns by gravity to the reactor via the A recirculation loop. The differential water head, created when the steam is condensed, serves as the driving force. The capacity of this system is equivalent to the decay heat rate about 530 seconds (8.83 minutes) after a scram. With no make-up water, the water level in the isolation condenser shell approaches the bottom of the tube bundles in 20 minutes. The decay heat evaluation was based on ANSI/ANS-5.1-1979 (Reference 15). In Phase 1 there are no shell side make-up sources that meet requirements for FLEX qualification. Therefore, the Isolation Condenser will lose efficiency from operation with inadequate shell-side level and will not be able to remove enough decay heat for RPV heat removal.

Once the IC has been re-initiated with shell-side make-up from FLEX equipment, the IC will remove decay heat with no loss of inventory from the reactor coolant system (although there still may be some leakage from the assumed RPV leakage into the Drywell), and with no addition of heat to the suppression pool. As long as the shell side of the IC is replenished (phase 2) with sufficient water, the IC will remove adequate decay heat to maintain core cooling.

FLEX Scenario design analysis calculation DRE14-0008 (Reference 16) credits the isolation condenser to achieve hot shutdown and assumes a reactor vessel cooldown rate of 15°F per hour. Assuming reactor vessel water temperature starts at 546°F, it would take approximately 22.3 hours to reach a hot shutdown temperature of 212°F utilizing a 15°F per hour cool down rate.

2.3.4.2 High Pressure Coolant Injection (HPCI)

The isolation condenser is backed up by the HPCI system. The HPCI subsystem is designed to pump water into the reactor vessel under those LOCA conditions which do not result in rapid depressurization of the reactor pressure vessel. The loss-of-coolant might be due to a loss of reactor feedwater which does not cause immediate depressurization of the reactor vessel. The HPCI subsystem includes a steam turbine driving a two-stage high pressure pump and a gear driven, single-stage booster pump, valves, high pressure piping, water sources, and instrumentation.

Operation of the HPCI system in the emergency mode is completely independent of AC power with the exception of the HPCI room cooler fans, and requires only DC power from the station battery to operate the controls. Calculation 2013- 01671 (Reference 14) was performed to determine the temperature of the HPCI Pump Room during an ELAP given that compensatory actions to supply cool air to the room are taken. FSG-31, Ventilation Strategies, incorporates the actions identified in Calculation 2013-01671. The calculation concluded that HPCI may be operated for up to 6 hours if actions to open doors for ventilation are completed within two hours of event initiation. HPCI room temperature remains below the isolation point during this time. Operation of the HPCI System removes heat from the RPV. This heat removal will be used to maintain RPV pressure after the Isolation Condenser becomes ineffective. Additionally, HPCI will provide make-up to the RPV to maintain water level during operation. Operation of the HPCI Turbine will result in a heat input to the Suppression Pool. There is no current method to remove heat from the Suppression Pool without AC power. Once the IC shell side make-up has been initiated from FLEX equipment, the HPCI system can be secured.

2.3.4.3 Standby Liquid Control (SBLC)

There will be no high pressure make-up available to the RPV until Safety Related 480 VAC busses (28, 29, 38 and 39) are energized by a FLEX Generator at approximately the 6 hour time frame. Once the 480 VAC Busses are energized per FSG-6, “FLEX Strategy For Aligning Power To U2(3) 480 Volt Safety Related Busses 28(38) And 29(39)” SBLC can be put into operation.

SBLC is designed to pump sodium pentaborate solution into the RPV to bring the reactor to a shutdown condition at any time during core life independent of control rod system capabilities. The purpose of SBLC in a FLEX event is to utilize the components and inventory for vessel make-up. The equipment for the SBLC system is located in the reactor building and consists of an unpressurized tank for low-temperature sodium pentaborate solution storage; two positive displacement pumps; and the necessary piping. The sodium pentaborate solution is delivered to the reactor by either one or both of two 40-50 gal/min, stainless steel pumps that draw from a tank which has a capacity of 5250 gallons available for use until make-up to the tank can be established with a FLEX pump and hoses. FSG-08, "FLEX High Pressure and Low Pressure RPV Level Control Using SBLC" provides the necessary guidance.

Based on MAAP runs (Reference 13) if it is assumed no RPV make-up is available after HPCI fails, RPV water level drops slowly reaching Top of Active Fuel (TAF) at 16.8 hours. Therefore adequate inventory above TAF is available in the RPV to support restoration of high pressure make-up at approximately the 6 hour time frame.

2.3.4.4 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 shedding of non-essential equipment has been conservatively calculated to provide a coping time of 6 hours of operations.

2.3.4.5 Suppression Pool

The transition phase of the Shutdown Mitigation Strategy requires the availability of water from the suppression pool to be utilized as the suction for FLEX make-up pumps supplying make-up water to the isolation condenser shells, RPV vessel make-up, SFP make-up and containment cooling.

An evaluation (Reference 16) was performed to determine the amount of water available for use in each suppression pool. This data then was used to determine the amount of time plant personnel have available to stage portable pumps and hoses near the UHS to transport additional make-up water to the plant. This determination also attempts to quantify the amount of water available in the UHS to determine the length of time that this water supply would be available for long term cooling during the final phase of the Shutdown Mitigation Strategy. Results were used to determine whether additional sources of water will be required utilizing off-site plant resources. In some cases this report uses approximate values for ease of discussion. DRE14-0008 (Reference 16) provides details regarding specific make-up values. See Section 2.15 for further discussion pertaining to this topic.

2.3.4.6 Ultimate Heat Sink

As water from both suppression pools has been expended, operations personnel will transport water from the site ultimate heat sink (UHS) to either Unit's suppression pool using portable pumps and hoses to provide additional make-up water to the isolation condenser shells, RPV vessel make-up, SFP make-up and containment cooling. The guidance to accomplish FLEX Suppression Pool make-up is contained in FSG-09.

The FLEX hydraulic submersible pumps will be lowered into the intake bay (UHS) per FSG-9, FLEX Torus Make-up" using a mobile crane per FSG-35, "Carrydeck Crane Operation". The elevation can be adjusted using the crane so that effectively all the UHS volume will be available. The submersible pump is fitted with a suction strainer to prevent large debris from entering the pump.

2.3.5 FLEX Strategy Connections

The flow path for Reactor Core Cooling involves taking suction from the suppression pool via temporary hoses, through the FLEX pump discharge, to a LPCI system riser via temporary hose. The flow path then exits LPCI and ties into the Isolation Condenser clean demineralizer make-up header which contains the FLEX valve manifold. IC shell side make-up can be fed directly from the clean demineralizer make-up header. The manifold supplies make-up to the Standby Liquid Control (SBLC) system. The SBLC pumps are used to inject water into the RPV.

BDB Flooding Event

For the flooding strategy, the flow path for Reactor Core Cooling involves taking suction from flood waters in the Test Boiler Pit and delivering it to the fire header at elevation 538 ft. MSL. During flood preparations, the fire protection flow path has been isolated per FSG-61, "FLEX Fire System Operation" to prevent flow to areas not desired leaving the reactor building supply path open. The reactor building supply is used to provide make-up to the SBLC system and the IC shell side make-up.

The below connection descriptions provide more detail on these flow paths. Connections associated with electrical supply to FLEX plant components are described in Section 2.9.

2.3.5.1 LPCI Piping Connections in Corner Rooms

The FLEX pump suction and discharge ports are not permanently connected to existing piping. During normal plant operation, the FLEX pumps are pre-staged and in a ready state with a 6 in. Storz fitting installed on the suction and 5 in. Storz fitting installed on the discharge. When the BDBEE occurs, a FLEX pump will be connected to the LPCI system per FSG-04 which draws suction from the suppression pool via flexible hoses. Pipe taps and Storz fittings installed on the LPCI system will provide the tie-in points for the pump. Figure 3 provides a typical illustration for this connection.

2.3.5.2 LPCI Riser Connections on 517 ft.

A Storz fitting connection is installed on each of the two LPCI divisions per unit, for a total of four. One riser connection will be utilized per FSG-04 to connect to the Isolation Condenser clean demineralizer make-up header. This connection will be determined by the FLEX pump that is placed in service. Figure 4 provides a typical illustration for the Isolation Condenser clean demineralizer make-up header connection. The opposite division riser on the same unit will be the connection used for suppression pool make-up from the UHS per FSG-09. Figure 14 provides a typical illustration for the suppression pool make-up connection. The Storz fitting connections installed are a 4 in. fitting, hose connection, and isolation valve on LPCI lines 2-1509-16-DX and 2-1504-16-DX on Elevation 517 ft., and a 4 in. fitting, hose connection, and isolation valve on LPCI lines 3-1509-16-DX and 3-1504-16-DX on Elevation 517 ft.

Once the suppression pool volume is reduced to 11 ft., the FLEX strategy will take water from the UHS via diesel driven hydraulic submersible pumps (Godwin Heidra 200 series) per FGS-09. The submersible pump will be utilized at the required time after a postulated

BDBEE and hoses will be connected to restore water to a suppression pool. Figure 10, Figure 12, Figure 13, and Figure 14 provide the hose deployment routes from the UHS to reactor building Elevation 517 ft. where it connects to the designated LPCI riser.

2.3.5.3 IC Make-up header connection 517 ft.

As noted in 2.3.5.2, one riser connection will be utilized to connect to the Isolation Condenser clean demineralizer make-up header per FSG-04. One 6 in. branch line off of the existing isolation condenser make-up line 2/3-43221-8 in.-L was installed near the south wall of the Unit 2 Reactor Building on Elevation 517 ft. Two 6 in. Storz fitting connections and isolation valves have been installed off of this branch connection. This connection provides the primary supply to the Isolation Condenser shell side. It requires no additional hoses to be run. This header includes a FLEX valve manifold discussed in Section 2.3.5.4. Figure 4 provides a typical illustration for the Isolation Condenser clean demineralizer make-up header connection.

2.3.5.4 IC Make-up Header 545 ft. FLEX Valve Manifold

An 8 in. branch line has been installed off of existing make-up demineralizer line 2/3-43221-8 in.-L near the South wall of the Unit 2 Reactor Building on Elevation 545 ft. Eight Storz fitting connections and isolation valves, varying in size from 2 in. to 6 in. are installed off of the branch line. This assembly serves as a valve manifold to which temporary flexible hoses can be connected to distribute cooling water to other tap connections in various plant locations as required for the FLEX mitigation strategies. For Reactor Core Cooling, hoses are routed to the SBLC system tank per FSG-08. Figure 5 through Figure 9 provide a typical illustration for these connections.

2.3.5.5 SBLC Tank 589 ft. (High Pressure)

Per FSG-08, "FLEX High Pressure And Low Pressure Level Control Using SBLC" 2 in. hoses are routed from the FLEX valve manifold on Elevation 545 ft. through a stairwell up to Elevation 589 ft. on both units. This hose provides make-up to the SBLC tank. The SBLC pumps take suction from this tank and inject into the RPV once they have been powered by the FLEX generator by energizing Bus 28/29 and 38/39 per FSG-06.

2.3.5.6 SBLC Test Connection 589 ft. (Low Pressure)

As noted in Section 2.3.5.5, FSG-08, "FLEX High Pressure And Low Pressure Level Control Using SBLC" also provides for the same hose routed from the FLEX valve manifold on Elevation 545 ft. to 589 ft. to be connected to a SBLC Test Connection and provide a direct feed to the RPV in low pressure conditions without use of the pumps.

2.3.5.7 RPV Injection Using LPCI Piping (Low Pressure)

FSG-11 "FLEX Injection Through LPCI" is also provided as a flow path for RPV injection at low pressure. The procedure provides guidance to establish a flow path from the FLEX pump discharge connection on the LPCI system piping to directly inject water to the RPV.

BDB Flooding Event

2.3.5.8 Fire Header Connection 538 ft.

Per FSG-60, "FLEX Flood Pump Deployment/Operation" a diesel pump set on a floating barge takes suction from flood waters in the Test Boiler Pit and connects to the fire header at elevation 538 ft. This connection consists of a 6 in. Storz fitting on a fire protection header that runs to the reactor building. During flood preparations, the fire protection flow path has been isolated per FSG-61 to prevent flow to areas not desired leaving the reactor building supply path open.

One 6" tee connection including isolation valve was installed on Unit 3. This connection also provided for hose connections and pipe supports. It is connected to the existing Fire Protection Header Line 3-4110B-6-O at Elevation 538 ft. – 0 in above the Unit 3 Turbine Building Trackway. The FLEX barge mounted flood pump provides flow to the Fire Header through this connection which feeds the fire header and provides the water source needed for Fuel Pool make-up, SBLC tank make-up, and IC shell side make-up.

2.3.5.9 Reactor Building Fire Protection Header feed to SBLC

A local hose reel off the reactor building fire protection header is used to provide both high pressure and low pressure make-up to the RPV using the SBLC tank and test connection as described in Sections 2.3.5.5 and

2.3.5.6. DOA 0010-04, "Floods" (Reference 56) provides the necessary guidance.

2.3.6 Key Parameters

FSG-30, "FLEX Strategy For Obtaining Alternate Readings" provides details on obtaining Suppression Pool temperature in a FLEX event. Instrumentation providing the following key parameters is credited for all phases of the reactor core cooling and decay heat removal strategy:

- Suppression Pool Temperature – Upon a FLEX event, Suppression Pool temperature monitoring in the control room is lost. FSG-30 provides guidance to obtain Suppression Pool temperature using a Fluke meter from the control room or from the plant.

- IC Shell Side Level - The isolation condenser requires a minimum level of water to meet its design basis heat load prior to make-up. Level indication and level alarms are provided in the main control room. The level indication transmitter, which is located in the vicinity of the isolation condenser level sight glass, is qualified for the expected station blackout temperature profile. The power supply for the level transmitter is supplied from the essential service system uninterruptible power supply (ESS UPS). These power supplies remain available due to the FLEX load shedding procedural guidance and restoration of battery chargers.

- RPV Pressure – Control room indication for RPV Wide Range (WR) pressure requires 125 VDC from the Class 1E batteries on each unit. U2 DIV 1 2A-1 Bkr 27 and U3 DIV 1 3A-1 Bkr 15. These power supplies remain available due to the FLEX load shedding procedural guidance and restoration of battery chargers. In the event these are lost, pressure can be monitored locally from racks 2202(3)-5/6 and 2202(3)-7/8. There is no power required for these instruments.

- RPV Level – Control Room indication for RPV level monitoring uses narrow range and medium range instruments powered from ESS UPS. These power supplies remain available due to the FLEX load shedding procedural guidance and restoration of battery chargers. As stated above for RPV pressure, RPV level can also be monitored locally from racks 2202(3)-5/6 and 2202(3)-7/8. There is no power required for these instruments.

- Suppression Pool Level – Control Room indication of narrow range Suppression Pool level (-20" to +20") remains available due to the FLEX load shedding procedural guidance and restoration of battery chargers. When Suppression Pool level is outside this band, FSG-60 provides guidance on obtaining a reading from the wide range level indication (0 feet to 30 feet).

Portable BDB FLEX equipment is supplied with the local instrumentation needed to operate the equipment. The use of these instruments is detailed in the associated FSGs for use of the equipment. These procedures are based on inputs from the equipment suppliers, operating experience, and expected equipment function in an ELAP.

In the unlikely event that 125 VDC and/or ESS Bus infrastructure is damaged, FLEX strategy guidelines for alternately obtaining the critical parameters is provided in FSG-30, "FLEX Strategy For Obtaining Alternate Readings"

2.3.7 Thermal Hydraulic Analyses

The IC and HPCI are operated to control reactor pressure below ERV setpoints (Reference 13).

Per MAAP analysis (Reference 13) after Recirculation Loops are isolated and the Isolation Condenser is controlling reactor pressure, RPV leakage will be reduced to approximately 15 gpm at time T = 6.0 hours. Make-up from SBLC can be utilized to maintain RPV level above Top of Active Fuel (TAF).

Analysis No. DRE14-0006 (Reference 17) was completed to determine the pump performance requirements of the FLEX Pumps to provide required make-up water from the supply source to the Unit 2 and 3 Isolation Condensers (ISCO), Spent Fuel Pools (SFP), and Reactor Pressure Vessels (RPV) during the Beyond-Design-Basis External Events. There are 3 locations where different pumps are stationed to support FLEX mitigation strategies:

1) In the Reactor Building Basement in parallel with the LPCI pumps (designated FLEX Pumps)

2) At the Intake Canal to provide Suppression Pool Make-up from the UHS (designated Diesel Driven Submersible UHS Pumps)

3) Two flood pumps located on a floating barge at elevation 517 ft. of the Turbine Building (designated Barge Mounted Diesel Pumps).

The FLEX Pumps must be capable of supplying the required flow rates from the Suppression Pool to the processes for all cases except the Maximum Probable Flood Scenario. The Diesel Driven Submersible UHS Pumps must be capable of supplying the required flow rates from the Intake Canal to the suppression pool in order for the FLEX pumps to continue supplying the required processes at longer times into the event. For the Maximum Probable Flood case, the barge mounted diesel pump located in the Turbine Building at elevation 517 ft. was analyzed.

The ability of these pumps was evaluated to determine if the pumps can provide the required pump total developed head (TDH) to supply the required make-up locations during each analyzed alignment. The most conservative flow path to each make-up location was analyzed to ensure all possible flow paths were conservatively analyzed.

The required NPSH for each pump is compared to the available NPSH to ensure proper pump operation. Low available NPSH can cause cavitation, excessive vibration, and/or damage to the pump internals. Additionally, cavitation can potentially degrade flow through the pump and thus degrade flow to the required processes. Margin is applied to the required NPSH to ensure adequate NPSH available is supplied to the pump and no flow degradation or pump damage will occur.

The calculation (Reference 17) determined the maximum flow for the FLEX pumps based on maintaining available NPSH marginally above the required NPSH. This gives an upper flow bound for FLEX pump operation.

The minimum head requirement for the FLEX pump is a TDH of 303 ft. at 1,000 gpm. This pump is supplied with an available NPSH of 20.5 feet at 1,000 gpm. Goulds Model ICI Size 125-100-250 operating at 3550 rpm is evaluated against the system requirements and is found to meet the flow (1,000 gpm), TDH (304 ft. at 1,000 gpm), and NPSH requirements (NPSHr = 8.9 at 1,000 gpm).

The Diesel Driven Submersible UHS Pump has an operating flow rate of 805 gpm. The minimum available NPSH is 25 feet at 805 gpm with the Heidra 200 Submersible Pump operating at 2,200 rpm.

A limiting flow configuration was used for sizing the Barge Mounted Diesel Pump. The minimum head requirement for the Barge Mounted Diesel Pump is a TDH of 176 feet at 850 gpm. The minimum available NPSH is 10 feet. The maximum system pressure at Barge Mounted Diesel Pump shutoff conditions is 152 psig.

The pumps were sized to meet the requirements as determined by the analysis. The FLEX pumps provide the flow in a non-flood scenario and the Barge Mounted Diesel pump provides the flow in a flooding event. In summary, the analysis determined the following flow requirements and associated time line: (Reference 25)

- Isolation Condenser make-up flow of 475 gpm with 17.9 psia per unit 2.5 to 10 hours after the ELAP event. (FLEX Pump)
- Standby Liquid Control (SBLC) make-up flow of 25 gpm with 14.7 psia per unit 2.5 to 10 hours after the ELAP event. Note the SBLC path will be used to provide make-up to the Reactor Pressure Vessel (RPV). (FLEX Pump)
- Isolation Condenser make-up flow of 300 gpm with 17.9 psia per unit 10 to 15 hours after the ELAP event. (FLEX Pump)
- SBLC make-up flow of 25 gpm with 14.7 psia per unit 10 to 15 hours after the ELAP event. (FLEX Pump)
- SFP make-up flow of 32 gpm (Reference 17) with 14.7 psia per unit 10 to 15 hours after the ELAP event. (FLEX Pump)
- Suppression Pool make-up flow of 402.5 gpm with 14.7 psia per unit 15 hours after the ELAP event. (Diesel Driven Submersible UHS Pump)
- For the flooding scenario, Isolation Condenser make-up flow of 396 gpm (354 gpm long term) with 17.9 psia per unit 10 to 15 hours after the ELAP event. (Barge Mounted Diesel Pump)
- For the flooding scenario, SBLC make-up flow of 29 gpm (28 gpm long term) with 14.7 psia per unit 10 to 15 hours after the ELAP event. (Barge Mounted Diesel Pump)
- For the flooding scenario, SFP make-up flow of 32 gpm with 14.7 psia per unit 10 to 15 hours after the ELAP event. (Barge Mounted Diesel Pump)

Dresden conducted a complete hydraulic analysis of the primary make-up strategies for the above water locations needed for FLEX.

2.3.7.1 Make-up Water Requirements

Calculations were performed to determine the inventory required for core decay heat removal, and RCS cooldown associated with the volumes of various onsite water sources (See section 2.15).

The submersible pumps will be utilized at the required time after a postulated BDBEE; the basis for these pumps to provide adequate flow to meet the cooling needs of the RPV, Containment, and SFP per Hydraulic Analysis DRE-14-0006 (Reference 17).

2.3.8 Reactor Recirc Pump Seals

The RPV will lose mass and energy to the Containment atmosphere through the Recirculation Pump seals. The rate and magnitude of the mass and energy loss is dependent on reactor pressure. Reactor recirculation pump seal leakage of 36 gpm is postulated per Dresden Licensing Basis for Station Blackout (SBO) (Reference 21). It is assumed the 18 gpm leakage from each Reactor Recirculation Pump Seals will continue until reactor recirculation pumps are isolated per FSG-07.

2.3.9 FLEX Equipment and Water Supply

2.3.9.1 Flex Pumps

Each Unit has two (2) motor-driven FLEX pumps (one primary, one alternate to meet NEI 12-06 N+1 requirement) on Elevation 476 ft. in the Reactor Building to support all BDBEE specified per NEI 12-06 except for flooding. Each of the four FLEX pumps is individually capable of supplying the required flow to serve all require plant cooling loads during the Transition Phase of the FLEX Shutdown Strategy (Reference 17). All FLEX pumps installed in the Reactor Building basement are Goulds Model ICI, Frame 42, Size 125-100-250 electric motor driven (150hp @ 460V) and pump approximately 1,000 gpm flow.

FSG-03, "FLEX Strategy For Supplying Power To FLEX Pumps" contains supplemental guidance for aligning Unit 2(3)A and 2(3)B FLEX pumps prior to operation. As cable is laid outside from the FLEX DG and connected to a Reactor Building penetration, other cables will also be connected and run from that penetration to the desired FLEX Pump electrical box connection, in the Corner Room or Suppression Pool basement as applicable. Reactor Building power cables are also pre-staged and kept inside the cable reel enclosures. If the "B" FLEX Pumps (N + 1), located in the Suppression Pool Basement are utilized during a FLEX event, the submarine door will be blocked open and cables will be run through the door to connect to the FLEX Pump electrical box connection located near the pump. The FLEX pumps utilize water from the Suppression Pool to provide IC shell side make-up per FSG-05 "FLEX Isolation Condenser Make-up and Level Control", and SBLC tank make-up utilizing FSG-08, "FLEX High Pressure and Low Pressure RPV Level Control Using SBLC".

Both FSG-05 "FLEX Isolation Condenser Make-up and Level Control", and FSG-08, "FLEX High Pressure and Low Pressure RPV Level Control Using SBLC" (See Section 2.3.5.6) provide for alternate methods to perform the desired function in the event the primary method fails. For the Isolation Condenser, this will require the stringing of hoses to the Isolation Condenser floor and connecting to an installed FLEX connection (See Figures 18, 19, and 20).

2.3.9.2. Diesel Driven Hydraulic Pump (UHS)

The Godwin Heidra 200 Hydraulic Powerpack and Submersible Pump is a diesel driven submersible pump positioned in the Ultimate Heat Sink to provide make-up water to the suppression pool. The deployment method per FSG-09, "FLEX Torus Make-up" lowers the pump directly into the intake canal of the 2/3 Cribhouse. See Figure 10, Figure 12, Figure 13, and Figure 14 for more information on pump placement, connections, and deployment paths.

2.3.9.3 FLEX diesel driven pump(s) on floating barge

During a postulated Flooding FLEX BDBE Event, two diesel-driven pumps (HL150M series) pre-staged on top of a floating platform will be placed in the Unit 3 Turbine Building Trackway per DOA 0010-04, "Floods" (Reference 56) as flood waters rise. One pump is sized to provide adequate flow to meet the cooling needs of the RPV, Containment, and SFP during a flooding event and is bound by Hydraulic Analysis DRE-14-0006 (Reference 17) (See Figure 21 and Figure 22).

2.3.9.4 FLEX Diesel Generator

One 800 KW FLEX generator is located within a robust structure with respect to seismic events, high winds and associated missiles near the Unit 3 Reactor Building. The N+1 trailer mounted DG is located in FLEX Building C outside the Protected Area at the south end of the contractor parking lot (See Figure 26 and Section 2.7). The generator supplies power to the pre-staged FLEX pumps and safety related 480 VAC Busses. These diesel generators are trailer mounted units each capable of supplying power to all anticipated loads for both Units at Dresden after the event. The primary and N+1 diesel generators are both rated at 800 kW/1000 kVA, 480 VAC, 3 phase, 60Hz, with an integral 400 gallon fuel tank capable of supporting 7 hours of operation at full load. Per the FLEX diesel generator sizing calculation DRE14-0037 (Reference 18), the FLEX generator is capable of supplying one FLEX pump and Busses 28, 29, 38, and 39 and associated MCCs.

2.3.9.5 Water Supplies

Suppression Pool

The suppression pool offers a relatively clean source of make-up water to the RPV; first from HPCI and later from the operating FLEX pump. At the beginning of the event, the suppression pool is near reactor quality water. Reactor coolant leakage into the drywell and Phase 1 usage of suppression pool inventory require water addition from the UHS to maintain suppression pool level. This will degrade suppression pool water quality, but it will remain a favorable water source (See section 2.15).

Ultimate Heat Sink

The UHS consists of water sources for the cooling water systems, necessary retaining structures, and the canals connecting the water sources with the intake structures. These water sources include the man made cooling lake and/or the Des Plaines and Kankakee rivers. These cooling water sources provide the normal heat sink for the disposal of unusable energy inherent in the thermodynamic cycle of the two operating Dresden reactor and turbine-generator plants. The cooling water also provides the principal means for removal of fission product decay heat following a unit shutdown. The Kankakee River is the normal source of emergency cooling water for Dresden Station. In the event of a loss of this water source, there is a limited supply of water trapped, by design, in the intake and discharge canals. Per Dresden UFSAR, (Reference 12) Section 9.2.5.2, due to the topography of the circulating water canals and piping, approximately 9 million gallons of river water are trapped within the canals, not including water in the cooling lake. This is due to the topographical high points in both the intake and discharge flumes (See Figure 11).

Dresden Cooling Lake

A cooling lake was formed by constructing an impervious earth-fill dike. The purpose of the cooling lake is to provide adequate cooling of the circulating and service water before discharge to the Illinois River. The lake is connected to the intake and discharge flumes of Units 2 and 3 by two canals (one intake and one discharge); each canal is about 11,000 feet long. As stated above, due to the topography of the circulating water canals and piping, approximately 9 million gallons of river water are trapped within the canals, not including water in the cooling lake. The UFSAR (Reference 12) Section 2.4.8.2 states the cooling lake encompasses a storage area of 1284 acres with an average depth of 8 feet; thus, the lake contains a maximum volume of 14,590 acre-feet. At 325,853 gallons per acre-foot, this equates to 4.75E+9 gallons. Lake water and/or this impounded river water would be used as a heat sink for the long-term removal of decay heat from the reactors. The flow control station and cooling lake spillway gates, etc. would be adjusted to prevent loss of lake water to the river.

2.3.10 Electrical Analysis

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. The Safety Related DC system at Dresden Station consists of one Safety Related 125V Main Station Battery and one Safety Related 250V Station Battery for each unit. The Safety Related 125V Main Station Battery supplies the unit's Division I loads and the opposite unit's Division

II loads. The Safety Related 250V Station Batteries supply the unit's Turbine Building MCC and the opposite unit's Reactor Building MCC. Non-Safety Related 250V batteries installed on each unit power only the main turbine emergency bearing oil pump.

The FLEX strategies ensure the Safety Related battery chargers are energized before the battery coping time is exceeded. The critical instruments fed from the battery system include reactor water level, reactor pressure, Suppression Pool level, drywell pressure, and isolation condenser level.

EC 391973 (Reference 37) was developed to evaluate battery load shedding to support FLEX events. The evaluation addressed both 125V and 250V battery systems. The evaluation identified that with the load shed the 125V and 250V batteries will maintain acceptable capacity for a minimum of 6 hours. This time supports the FLEX Strategy time line actions.

The case of extreme low temperatures was examined to determine the effect this may have on each battery's capability to perform its function. Given that the battery rooms are all interior rooms and constructed of concrete or concrete blocks, a heat loss estimate was calculated for the rooms and batteries themselves. The battery cell initial temperature was assumed to start at 65°F since this aligns with Dresden Technical Specifications Surveillance Requirements (Reference 11) which requires battery temps to be greater than or equal to the minimum established design limit of 65°F. It is a conservatively low value given historical data that shows the average battery temperature is approximately 77°F. It was determined that it is reasonable to conclude the battery capabilities are adequate to support FLEX actions until battery chargers are restored. The Dresden FLEX Sequence of Events timeline re-energizes battery chargers within six hours of event initiation.

The 480 VAC power distribution system provides power to the Essential Safety Systems (ESS) busses at Dresden. The ESS busses provide power to critical loads for achieving and maintaining safe shutdown, such as instrument panels.

Transmittal of Design Information (TODI) 14-001 (Reference 67) was generated to identify the minimum loads required during a FLEX event. Dresden Calculation DRE14-0037 (Reference 18) was performed to confirm the loading was within the limitations of the FLEX Diesel Generator. The calculation (Section 11.1) identified a steady state loading of 668 kW. The FLEX Diesel Generator is rated at 800 kW. Therefore, the loading is within the capability of the FLEX Diesel Generator.

2.4 Spent Fuel Pool Cooling/Inventory

Dresden spent fuel pools (SFP) are designed to withstand the anticipated earthquake loadings as a Class I structure (Reference 12). Each unit has its own spent fuel pool measuring 33 ft. x 41 ft. Each pool is a reinforced concrete structure, completely lined with seam-welded stainless steel plates welded to reinforcing members (channels, I beams, etc.) embedded in concrete. The normal depth of water in the spent fuel pool is 37 feet, 9 inches. The water in the spent fuel pool is continuously filtered and cooled by the spent fuel pool cooling system. The basic FLEX strategy for maintaining SFP safe level is to monitor SFP level and provide sufficient make-up to the SFPs to maintain a safe level.

BDB Flooding Event

The FLEX flooding strategy discussed in section 2.3 also supports Spent Fuel Pool cooling as described in the below sections.

2.4.1 Phase 1 Strategy

The loss of all AC Power Sources causes a loss of forced circulation and heat removal. At initial conditions, the spent fuel pool is assumed to be at 19 feet above the top of active fuel which is the minimum level per Technical Specifications (Reference 11). EC 371913 (Reference 38) was completed and incorporated a review of Spent Fuel Pool response to an ELAP.

Under non-outage conditions, the maximum SFP heat load is 14.912 MBtu/hr (Reference 17). Loss of SFP cooling with this heat load and an initial SFP temperature of 150°F results in a time to boil of 9.54 hours, and 110.07 hours to the top of active fuel. Therefore, completing the equipment line-up for initiating SFP make-up at approximately 12 hours into the event ensures adequate cooling of the spent fuel is maintained by keeping the fuel covered.

The worst case SFP heat load during an outage is 39.688 MBtu/hr. Loss of SFP cooling with this heat load and an initial SFP temperature of 150°F results in a time to boil of 3.58 hours, and 41.36 hours to the top of active fuel. With the entire core being located in the SFP, manpower resources normally allocated to core cooling along with the Operations outage shift manpower can be allocated to aligning SFP make-up which ensures the system alignment can be established prior to the point at which SFP conditions become challenged. Therefore completing the equipment line-up for initiating SFP make-up at 8 hours into the event ensures adequate spent fuel level is maintained by keeping the fuel covered (Reference 38).

BDB Flooding Event

The series of FLEX flooding actions described in Section 2.3.1 also support Spent Fuel Pool cooling with no additional actions involved.

2.4.2 Phase 2 Strategy

The Phase 2 strategy provides make-up to the spent fuel pool utilizing hoses connected to the FLEX valve manifold on Unit 2 545 ft. elevation which is supplied by the pre-staged FLEX pump.

The Primary method connects hoses from the manifold to connections on the installed Shut Down Cooling (SDC) system (same elevation) which feeds directly to the FPC piping. FSG-10 "FLEX Spent Fuel Pool Make-Up" gives the guidance necessary to accomplish this line up.

The Alternative method is also provided by FSG-10 "FLEX Spent Fuel Pool Make-Up". The Alternate method routes hoses from the manifold to alternative connections in the installed Fuel Pool piping. The alternative routing involves longer hose runs to higher elevations.

Additionally, FSG-12 "Flex Spent Fuel Pool Spray Strategy", sets up equipment in advance of high dose rates or temperatures on the refuel floor precluding access to the refuel floor. Spray cooling of the spent fuel pool (if required) utilizes hoses connected to the FLEX valve manifold on Unit 2 545 ft. elevation which is supplied by the pre-staged FLEX pump. Monitor nozzles and hoses are staged on the refuel floor early in the event to make it available for use in the case of failure of the primary and alternate methods. Spray monitors and sufficient hose length required for the SFP spray option are located in storage lockers in the Reactor Building.

BDB Flooding Event

The series of FLEX flooding actions described in Section 2.3.2 also support Spent Fuel Pool cooling. When the Crib House Level reaches elevation 518 ft., the barge mounted FLEX Flood Pump is aligned and started. The pump takes flood water suction from the Test Boiler Pit and delivers to the fire header at elevation 538 ft. The flood pump provides make-up water to the spent fuel pool until flood waters recede and recovery and cleanup activities start.

2.4.3 Phase 3 Strategy

Phase 3 will utilize Phase 2 connections and National SAFER Response Centers (NSRCs) equipment as spares. Dresden relies on equipment stored off-site for Phase 3 of the FLEX mitigation strategy. Equipment may be provided from NSRCs. Another nuclear plant may also provide Phase 3 equipment, if response would be faster than from the NSRCs.

Temporary staging areas have been identified and details for their use in supporting Phase 3 equipment receipt, inspection and deployment to operating areas are provided in CC-DR-118-1001, SAFER Response Plan For Dresden Nuclear Power Station (Reference 40) and FSG-14, "Transition From Phase 2 to Phase 3 Equipment".

2.4.4 Structures, Systems, and Components

2.4.4.1 SDC and FPC Piping and Supports

SDC and FPC piping and supports are installed equipment used to provide a flow path to the spent fuel pool. The piping and supports are contained within the Reactor Building and are seismically qualified.

2.4.4.2 Primary Connection

The Primary method connects hoses from the FLEX Valve manifold on Unit 2 545 foot elevation to connections on the installed Shut Down Cooling (SDC) system (same elevation) which feeds directly to the FPC piping. Two Primary connections were installed (one for Unit 2 and one for Unit 3). SFP make-up water from the FLEX pumps will be connected from the LPCI System to the FLEX Valve Manifold and then to the Fuel Pool Cooling System via a two inch flexible hose.

2.4.4.3 Alternate Connection

The Alternate connections utilize the same valving at the FLEX valve manifold and water sources as does the Primary. The hoses are run to alternate connections to installed fuel pool piping hydrolazing taps with isolation valves. The alternate connections are less desirable due to the additional hose runs that are required. For Unit 2 the hoses are run from the 545 ft. elevation to the 589 ft. elevation. For Unit 3 the hoses are run from the 545 ft. elevation to the 570 ft. elevation. In addition, the hydrolazing taps are fitted with pipe caps that need to be removed and STORZ fittings installed. (See Figures 35, 36, 37, 38)

2.4.4.4 Spray Option Connection

An additional alternate strategy utilizes a spray option to achieve SFP make-up. The spray strategy as required by NEI 12-06 Table C-3 (Reference 2) is to provide flow through portable spray monitors set up on the refuel floor next to the SFP (See Figure 34).

Fuel Pool Spray is a strategy set up as a contingency action for fuel pool make-up in the case where all other strategies have failed. It is imperative to place the required equipment on the refuel floor prior to the environmental degradation to the point of limiting access due to safety concerns. It is not expected to have to utilize this strategy, but early completion of the refuel floor portions is intrinsic to success.

For each unit, a six inch hose will be run from the FLEX valve manifold on 545 ft. elevation to the Unit 2 equipment hatch. A pair of three inch hoses will then be lowered from the refuel floor and attached to the six inch hose with a gated wye. The three inch hoses are connected to two spray monitors (one oscillating and one fixed directional) and pre-staged prior to the refuel floor environment reaching dangerous levels from temperature or dose. Once the spray system is set up, flow can be controlled via the gated wyes on the 545 ft. elevation. The oscillating spray monitors will be set up at opposite ends of the refuel floor to spray its respective SFP. The fixed directional monitors are set up at opposing ends of each SFP and spray towards its respective SFP. These spray monitors will spray water into the SFP to maintain water level.

2.4.5 FLEX Strategy Connections

The flow path for Spent Fuel Pool Cooling/Inventory uses the same flow path described in Section 2.3.5 up to the FLEX valve manifold. From the manifold, a hose is run on the same elevation to a branch line on the Shut Down Cooling (SDC) system. An alternate path runs from the FLEX valve manifold to a Fuel Pool Header hydrolazing tap on the 589 ft. elevation on Unit 2 and 570 ft. elevation on Unit 3. From these connections, there is a direct path to the fuel pool. Fuel pool level is monitored from the level instrumentation installed per NRC Order EA 12-051 (Reference 4).

BDB Flooding Event

For the flooding strategy, the flow path for Spent Fuel Pool Cooling/Inventory is the same flow path described in Section 2.3.5 for the flooding event. A local fire hose reel is used to provide water directly to the fuel pool.

The below connection descriptions provide more detail on the Spent Fuel Pool Cooling unique flow paths. Connections associated with electrical supply to FLEX plant components are described in Section 2.9.

2.4.5.1 Shut Down Cooling (SDC) Connections 545 ft.

From the FLEX valve manifold, a 2 in. hose is run on the same elevation to a branch line with Storz fitting on the Shutdown Cooling (SDC) system per FSG-10. For Unit 2, one 2 inch line, hose connection with isolation valve utilizing an existing flange on Fuel Pool Cooling (FPC) line 2-1012-6-K on Elevation 545 ft. was installed. The valve is a two inch stainless steel valve with valve number 2-1099-26. For Unit 3, a similar valve was installed, one 2 inch line, hose connection with isolation valve utilizing an existing flange on the 2 inch cleaning tap (for Hydrolazing) line that is connected to Fuel Pool Cooling (FPC) line 3-1012-6-K on Elevation 545 ft. The valve is a two inch stainless steel valve with valve number 3-1099-26.

From this connection, there is a direct path to the fuel pool through the Shutdown Cooling line. Figure 15, Figure 16 and Figure 17 provide a typical illustration for these connections.

2.4.5.2 Unit 2 Fuel Pool Header Hydrolazing Tap Connection 589 ft. (alternate)

From the FLEX valve manifold, a 2 in. hose is run through a stairwell up to 589 ft. elevation and connected to the Fuel Pool Header hydrolazing tap near SBLC per FSG-10. From this connection, there is a direct path to the fuel pool.

2.4.5.3 Unit 3 Fuel Pool Header Hydrolazing Tap Connection 570 ft. (alternate)

From the FLEX valve manifold, a 2 in. hose is run through a stairwell up to 570 ft. elevation and connected to the Fuel Pool Header hydrolazing tap near sample panel 2253-30 per FSG-10. From this connection, there is a direct path to the fuel pool.

BDB Flooding Event

A connection to the existing Fire Protection Header Line 3-4110B-6"-O at Elevation 538 ft. – 0 in. above the Unit 3 Turbine Building Trackway feeds the fire header and provides the water source needed for Fuel Pool make-up, SBLC tank make-up, and IC shell side make-up.

2.4.5.4 Refuel Floor Fire Hose Reel 613 ft.

A local hose reel off the reactor building fire protection header is used to run a hose to the fuel pool. Guidance is provided for Fuel Pool make-up per DOA 0010-04, "Floods" (Reference 56).

2.4.6 Key Parameters

Spent Fuel Pool Level Instrumentation (SFPLI) was installed per NEI 12-02 (Reference 5). Each spent fuel pool has two level transmitters. Each transmitter has a display in the Turbine Building.

The primary and backup SFPLI instrument channels will be normally powered from 120 VAC. Upon loss of normal AC power, individual batteries installed in each channel's electronics/UPS enclosure will automatically maintain continuous channel operation for at least (3) days (Reference 68). The power cables are routed so that spatial and physical separation is maintained between the primary and backup channels. Additionally, a receptacle and a selector switch are installed in each channel electronics/UPS enclosure to directly connect emergency power to the SFPLI. The 120 VAC power for the primary and backup level indicating displays will be provided from Unit 2 Essential Service Bus (Unit 2 primary and Unit 3 primary) and Unit 3 Essential Service Bus (Unit 2 backup and Unit 3 backup). The ESS busses are initially powered from the safety related 250VDC batteries during an ELAP. Procedure FSG-6, "FLEX Strategy For Aligning Power To U2(3) 480 Volt Safety Related Busses 28(38) And 29(39)" restores power to the 480V busses 28/29/38/39 with the use of the FLEX Diesel Generator and procedure DGA-03 (Reference 52)restores power to the battery system prior to the depletion of the batteries. Therefore, the SFPLI systems will not lose power during an ELAP.

2.4.7 Thermal-Hydraulic Analysis

The loss of all AC Power Sources causes a loss of forced circulation and heat removal. At initial conditions, the spent fuel pool is assumed to be at 19 feet above the top of active fuel which is the minimum level per Technical Specifications (Reference 11). EC 371913 (Reference 38) was completed and incorporated a review of Spent Fuel Pool response to an ELAP.

Under non-outage conditions, the maximum SFP heat load is 14.912 MBtu/hr. Loss of SFP cooling with this heat load and an initial SFP temperature of 150°F results in a time to boil of 9.54 hours, and 110.07 hours to the top of active fuel.

The worst case SFP heat load during an outage is 39.688 MBtu/hr. Loss of SFP cooling with this heat load and an initial SFP temperature of 150°F results in a time to boil of 3.58 hours, and 41.36 hours to the top of active fuel. With the entire core being located in the SFP, manpower resources normally allocated to core cooling along with the Operations outage shift manpower can be allocated to aligning SFP make-up which ensures the system alignment can be established prior to the point at which SFP conditions become challenged. Therefore completing the equipment line-up for initiating SFP make-up at 8 hours into the event ensures adequate spent fuel level is maintained by keeping the fuel covered.

In accordance with NEI 12-06 Section 3.2.1, (Reference 2) the baseline assumption is all boundaries of the SFP are intact as is the cooling system and attached piping. In accordance with FLEX Hydraulic Analysis DRE14-0006, (Reference 17) Dresden has the capability to provide the required flow for spent fuel pool sprays of 250 gpm per unit. Due to the timeline required to establish fuel pool sprays and the reduction of loads needed prior to that, the total flow required for the coping strategies is at all times within the capacity of the FLEX pumps.

2.4.8 FLEX Equipment and Water Supplies

FLEX pumps, suppression pool, ultimate heat sink, and Dresden cooling lake are utilized in a similar manner as in the reactor core cooling strategy (See Section 2.3.9 for information).

2.4.9 Electrical Analysis

The SFP will be monitored by instrumentation installed in response to Order EA-12-051 (Reference 4). The power for this equipment has backup battery capacity for 72 hours (Reference 68). 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.

Further electrical analysis for Spent Fuel Pool Cooling/Inventory is covered in Section 2.3.11 for Core Cooling. This same methodology and strategy applies to Spent Fuel Pool Cooling/Inventory.

2.5 Containment Integrity

At the initiation of the event personnel will enter DGA-12, "Partial or Complete Loss of AC Power", and Emergency Operating Procedures (EOPs). Reactor water level and pressure control would be accomplished using the HPCI System which is independent of all AC power. Operation of the HPCI Turbine will result in a heat input to the Suppression Pool. There is no current method to remove heat from the Suppression Pool without off site or Emergency Diesel Generator AC power.

Once the IC shell side make-up has been initiated, the HPCI system can be secured. The IC removes decay heat with no loss of inventory from the reactor coolant system (although there still may be some leakage from the assumed RPV leakage into the Drywell), and with no addition of heat to the suppression pool. As long as the shell side of the IC is replenished (Phase 2) with sufficient water, the IC will remove adequate decay heat to maintain core cooling. MAAP analysis Cases 12 and 13 (Reference 13) identified drywell pressure would be approximately 20 psig at 2.5 hours from the start of the event, at which time, actions to supply the IC shell side make-up will be complete and HPCI secured. Additionally, the RPV will lose mass and energy to the Containment atmosphere through the Recirculation Pump seals. The rate and magnitude of the mass and energy loss is dependent on reactor pressure. There will also be heat loss to the Containment atmosphere from the RPV while it remains at elevated temperature (greater than cold shutdown conditions). The rate and magnitude of Containment pressure and temperature increase is dependent on the mass and energy loss, the RCS heat loss, and the free volume of the Containment structure.

Removal of decay heat from the RPV utilizing the Isolation Condenser as well as isolating the Recirculation Loops when AC power is available will limit the heatup of the Primary Containment. MAAP runs performed (DR-MISC-043, Cases 12 and 13) (Reference 13) identify that Primary Containment pressure and temperature will remain below design limits if these actions are taken.

BWROG document NEDC-33771P, "GEH Evaluation of FLEX Implementation Guidelines" (Reference 27) has been compared to the Dresden proposed strategies and Modular Accident Analysis Program (MAAP) results. The results of the BWROG document and Dresden response are consistent. In each case at the end of 24 hours the peak containment values are below their respective design limits with significant margins to the limits.

BDB Flooding Event

The flooding strategy discussed in section 2.3 also applies to Containment Integrity and any notable differences will be addressed in the following sections.

2.5.1 Phase 1

RPV pressure control is initially controlled with the IC for the first 20 minutes. Pressure control is then supplemented using the HPCI System which is independent of all AC power. Once shell side make-up for the IC is established, the operation of the IC results in reactor decay heat being removed with minimal heat input into the Primary Containment. As a result containment parameters are not challenged and venting is not anticipated.

BDB Flooding Event

The series of FLEX flooding actions described in Section 2.3.1 also support Containment Integrity with no additional actions involved.

2.5.2 Phase 2

Suppression Pool volume contains an adequate supply to provide the water needed for all FLEX strategies for the first 14.5 hours while maintaining the downcomers submerged. FSG-9, FLEX Suppression Pool Make-up" directs personnel to use a submersible pump positioned in the Ultimate Heat Sink to provide make-up water to the suppression pool. This line-up is accomplished at 14 hours. Margin is built into the strategy in that Suppression Pool Inventory may be reduced below the downcomers to one foot above the ECCS strainers providing an additional 6 hours of inventory. Section 2.15 provides details.

BDB Flooding Event

The series of FLEX flooding actions described in Section 2.3.2 also support Containment Integrity. When the Crib House Level reaches elevation 518 ft., the barge mounted FLEX Flood Pump is aligned and started. The pump takes flood water suction from the Test Boiler Pit and delivers to the fire header at elevation

538 ft. The flood pump provides make-up water to the IC until flood waters recede and recovery and cleanup activities start.

2.5.3 Phase 3

Phase 3 will utilize Phase 2 connections and NSRC equipment as spares. Dresden relies on equipment stored off-site for Phase 3 of the FLEX mitigation strategy. Equipment may be provided from (NSRCs). Another nuclear plant may also provide Phase 3 equipment, if response would be faster than from the NSRCs.

Temporary staging areas have been identified and details for their use in supporting Phase 3 equipment receipt, inspection and deployment to operating areas are provided in CC-DR-118-1001, SAFER Response Plan For Dresden Nuclear Power Station (Reference 40) and FSG-14, "Transition From Phase 2 to Phase 3 Equipment".

2.5.4 Structures, Systems, Components

The structures, systems and components for Containment Integrity are covered in Section 2.3.4 for Reactor Core Cooling. The same methodology and strategy applies to Containment Integrity.

2.5.5 FLEX Strategy Connections

The flow path for Containment Integrity uses the same flow path described in Section 2.3.5 up to the IC Make-up header connection. Once that connection is made, there is a direct path to each units IC shell side.

BDB Flooding Event

For the flooding strategy, the flow path for Containment Integrity is the same flow path described in Section 2.3.5 for the flooding event. The reactor building fire protection header provides a direct path to each units IC shell side.

The below connection descriptions provide more detail on the Containment Integrity unique flow paths. Connections associated with electrical supply to FLEX plant components are described in Section 2.9.

2.5.5.1 IC Shell Side Make-up Connection at Fire Protection branch line (alternate)

A connection to the existing Fire Protection Header Line 3-4110B-6"-O at Elevation 538 ft. – 0 in. above the Unit 3 Turbine Building Trackway feeds the fire header and provides the water source needed for Fuel Pool make-up, SBLC tank make-up, and IC shell side make-up.

BDB Flooding Event

One 6" tee connection including isolation valve was installed on Unit 3. This connection also provided for hose connections and pipe supports. It is connected to the existing Fire Protection Header Line 3-4110B-6"-O at Elevation 538 ft. – 0 in. above the Unit 3 Turbine Building Trackway. The floating barge and pump provides flow to the Fire Header through this connection which feeds the fire header and provides the water source needed for Fuel Pool make-up, SBLC tank make-up, and IC shell side make-up.

2.5.5.2 IC Shell Side Make-up- Reactor Building Fire Protection Header

When the reactor building fire protection header is placed in operation per FSG-60 and FSG-61, a direct path to the IC shell side fill line is provided. DOA 0010-04, "Floods" provides direction to align valves to support this flow path.

2.5.6 Key Parameters

FSG-30, "FLEX Strategy For Obtaining Alternate Readings" provides details on obtaining Suppression Pool temperature in a FLEX event. Instrumentation providing the following key parameters is credited for all phases of containment integrity.

- Drywell Pressure – FSG-30 FLEX "Strategy For Obtaining Alternate Readings" provides guidance to obtain Drywell pressure using a Fluke meter from the control room or from the plant.

- Suppression Pool Temperature - Upon a FLEX event, Suppression Pool temperature monitoring in the control room is lost. FSG-30 provides guidance to obtain Suppression Pool temperature using a Fluke meter from the control room or from the plant.

2.5.7 Thermal-Hydraulic Analyses

Modular Accident Analysis Program (MAAP) computer code was used to simulate the Extended Loss of AC Power (ELAP) event for Dresden and is an acceptable method for establishing a timeline which meets the intent of NRC Order EA-12-049. Several Dresden MAAP cases were run to analyze methods to maintain containment integrity, with the goal to be avoidance of lifting an Electromatic Relief Valve (ERV) or Safety Valve and maintaining Primary Containment pressure below its design limit of 62 psig (UFSAR Design Basis Section 6.2.1.1 (Reference 12)).

The MAAP cases (Reference 13) indicate HPCI availability of approximately 2.5 hours to suppression pool temperature of 140°F. At this time the IC shell side make-up is established and HPCI secured, stopping the heat input to the suppression pool. With IC shell side make-up established, a controlled cool down of the RPV is commenced. These actions provide margin to the primary containment design pressure limit.

Suppression Pool initial temperature was designated at 95°F, the Technical Specification limit for maximum suppression pool temperature.

2.5.8 FLEX Equipment and Water Supplies

The FLEX equipment and water supplies for Containment Integrity uses the same flow path described in Section 2.3.5 up to the IC Make-up header connection. Once that connection is made, there is a direct path to each units IC shell side.

2.5.9 Electrical Analysis

The electrical analysis for Containment Integrity is covered in Section 2.3.10 for Reactor Core Cooling. The same methodology and strategy applies to Containment Integrity.

2.6 Characterization of External Hazards

In an effort to standardize the approach taken to implement FLEX mitigation strategies within the Exelon Nuclear Fleet, the Exelon Severe Accident Mitigation Group created a position paper documenting ELAP Design Basis (Reference 28). The purpose of this paper is to clarify the Severe Accident Management Group position for documenting the design bases, as defined in 10CFR50.2, for systems, structures, and components (SSC) used to mitigate the consequences of an Extended Loss of AC Power (ELAP) condition. This position paper states:

- "A reasonably conservative outside ambient temperature should be used for the supply air temperature (Tin). It need not be the worst case temperature recorded for the site. An outside temperature that is not exceeded more than 1% of the time is considered reasonably conservative for a BDBEE."

- Section 2.3.2 of the Dresden UFSAR, (Reference 12) Local Meteorology defines the current design basis meteorological conditions for the Dresden Nuclear Power Station. The extreme maximum and minimum temperatures appropriate at the Dresden site for general plant design (i.e., HVAC systems) are 94°F equaled or exceeded 1% of the time, and -5°F (equaled or exceeded 99% of the time). The design of most HVAC systems as described in UFSAR Section 9.4 is based on outside air temperatures varying between -6°F and +93°F. For this reason, an outside ambient air temperature of 94°F is considered to be the current design basis extreme high temperature considered for an event involving an extended period of extreme heat.

- Meteorological records of Dresden site specific data has been maintained since June 1971. The meteorological measurements program at the Dresden site consists of monitoring wind direction, wind speed, temperature, and precipitation. A meteorological tower is located on the Dresden site that is equipped with instrumentation that conforms with the system accuracy recommendations of Regulatory Guide 1.23 (Reference 10) and ANSI/ANS 2.5 (1984) (Reference 19). The equipment is placed on booms oriented into the generally prevailing wind at the site. Ambient air temperatures are measured at the 35 foot elevation of the meteorological tower and are recorded on an hourly basis. Operation and maintenance of the meteorological tower is maintained by Murray & Trettel. A search of the site meteorological records validated that the temperature range of -6°F and +93°F is consistent with the outside ambient temperature extremes actually experienced at the site a high percentage of the time.

- A historical meteorological data search was performed for an expanded area surrounding the Dresden site. Dresden station is located in Grundy County in the State of Illinois. Using the historical meteorological data base maintained by the National Climatic Data Center (www7.ncdc.noaa.gov), the temperature range of -6°F and +93°F was validated to be consistent with the outside ambient temperature extremes actually experienced at the site a high percentage of the time.

2.6.1 Seismic

A seismic BDBEE for Dresden is an event that occurs with little or no warning time and results in loss of off-site power, loss of intake/UHS and damage to non-robust equipment and buildings. The FLEX Strategy provides guidance to use installed and portable equipment to maintain or restore core cooling, containment, and spent fuel pool (SFP) cooling capabilities. The credited FLEX equipment has been assessed based on the current Dresden seismic licensing basis to ensure that at minimum, N sets of credited BDB equipment remains accessible and functional after a Beyond Design Basis external event. The Dresden seismic hazard is considered to be the earthquake magnitude associated with the design-basis seismic event. Per Sections 2.5.1.2 and 3.7.1 of the Dresden UFSAR (Reference 12), the design basis earthquake is 0.2 g for horizontal ground motion and 0.133 g for vertical ground motion.

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. DRESDEN 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 Safe Shutdown Earthquake (SSE) does not envelop the new GMRS over the entire frequency range. This reevaluated seismic hazard has been addressed in the industry initiative referred to as the Augmented Approach (Reference 63). The Augmented Approach requires plants to address the GMRS by performing the Expedited Seismic Evaluation Process (ESEP) as an interim measure while completing the long-term seismic risk evaluation. The Augmented Approach evaluated the seismic capability of a subset of FLEX-credited installed plant equipment to provide confidence that the equipment would retain function during and after a beyond design basis seismic event using seismic margins assessment to a Review Level Ground Motion (RLGM) capped at 2 x SSE from 1 to 10 Hz. NRC endorsement of use of the EPRI Augmented Approach was provided in Reference 64. The subset of FLEX-credited installed plant equipment required, listed as the Expedited Seismic Equipment List (ESEL), had been evaluated and concluded to be seismically adequate for the BDB seismic event in Reference 65. The Dresden ESEP Report (Reference 65) was reviewed and accepted by the NRC in Reference 66.

For FLEX strategies, the earthquake is assumed to occur without warning and result in damage to non-seismically designed structures and equipment. Non-seismic structures and equipment may fail in a manner that would prevent accomplishment of FLEX-related activities (normal access to plant equipment, functionality of non-seismic plant equipment, deployment of Beyond-Design-Basis (BDB) equipment, restoration of normal plant services, etc.). The diverse nature of the FLEX strategies has been discussed. The ability to clear haul routes from seismic debris to facilitate the deployment of the BDB Phase 2 equipment is addressed in Section 2.8.

2.6.2 External Flooding

The Dresden site is located at the confluence of the Des Plaines and Kankakee Rivers that forms the Illinois River. The site is also located just upstream of the Dresden Island Lock and Dam, which is owned and operated by the USACE. The nominal ground elevation of the Dresden site is about elevation 516 feet MSL at the location of the principal structures of Units 2 and 3, and the design plant grade is elevation 517 feet MSL. The finished floor elevation of the plant structure is 517.5 feet MSL.

Dresden station has two flood scenarios that must be considered for the FLEX Strategies: River flooding and Local Intense Precipitation (LIP).

River flooding is the worst case BDBEE flooding event for Dresden and is the result of precipitation occurring over an extended period of time which eventually causes a loss of off-site power (Reference 30). This requires a very large storm which can be forecasted. Therefore, the FLEX flooding strategy involves pre-staging equipment above maximum flood levels. The maximum credible flood level with wave run-up for Dresden is approximately 12 ft. above grade level (Elevation 529 ft.) (Reference 30). The FLEX Flood response involves a reactor shutdown and cool down prior to flood levels reaches specified elevations. This is accomplished using installed plant systems prior to the loss of all electrical power on-site (ELAP).

The Local Intense Precipitation event for Dresden is characterized by 1-hour, 1 square mile probable maximum precipitation (PMP) event distribution using Hydrometerological Reports (HMRs) 51 and 52 (National Oceanic and Atmospheric Administration (NOAA), 1978 and 1982) (Reference 29). Using this, Dresden computed a cumulative depth of the 1-hour, 1-square mile PMP of 17.97 inches. Based on this rainfall model, flooding depths were computed for several openings around the reactor and turbine building by a FLO-2D model. The maximum flood elevation of 518.1 feet MSL occurs at several Category 1 structures. The flooding depths range between 0.1 foot (Reactor Building, U3) to

1.7 feet (Turbine Building U2). The CDB LIP flood has a maximum flood elevation of 517.45 feet MSL; whereas, the plant floor level is elevation 517.5 feet MSL so the LIP water does not enter any structures at the CDB 517.5 ft. MSL elevation. The maximum reevaluated LIP flood elevation is 518.1 feet MSL (Reference 30). The maximum flood inundation time above elevation 517.5 feet MSL is 1.75 hours. The largest leak path for water ingress to the reactor building is due to U2 Trackway interlock where the maximum flood height is 0.54 feet for 1.35 hour (Reference 66).

Dresden Station submittal to the NRC for Mitigating Strategies Assessments for Flooding (Reference 30) concluded that the current FLEX strategies can be successfully implemented for both flooding scenarios applicable to Dresden:
a) River flood (River PMF plus upstream dam failure and
b) LIP event.
The reevaluated flood hazard parameters (i.e. MSFHI) for the river flood were used to develop FLEX implementation strategies. During a PMF event, all the required flood mitigation equipment is either deployed or staged at higher elevations due to sufficient advance warning time. For the LIP event, no warning time is assumed and the evaluation concluded that this event has no adverse impact on FLEX equipment or its deployment. An evaluation (Reference 30) quantified the water ingress and its impact on FLEX strategy during a LIP event. It was determined that no safety related equipment or FLEX equipment was adversely impacted by the water ingress.

2.6.3 Severe Storms with High Wind

A tornado or high winds BDBEE for Dresden is an event that occurs with little or no warning time and results in loss of off-site power, loss of intake/UHS and damage to non-robust equipment and buildings. The FLEX Strategy provides guidance to use installed and portable equipment to maintain or restore core cooling, containment, and spent fuel pool (SFP) cooling capabilities.

As a minimum, all Dresden structures are designed to withstand a 110-mph wind load, which is in excess of the Uniform Building Code requirements (UFSAR Section 3.3.1.1 (Reference 12). Annual wind frequencies show a rather uniform distribution of wind direction which is typical of mid-continent locations. The most frequent wind directions are from the west and south sectors. The highest velocity of wind officially reported at various locations around the site area is 87 mph at Chicago and 75 mph at Peoria. Higher gusts are reported unofficially, up to 109 mph during heavy thunderstorms and scattered tornadic activity. Thus, the design criterion that structures be capable of withstanding wind loadings of 110 mph is considered appropriate for withstanding the anticipated sustained winds (UFSAR Section 2.3.2 (Reference 12)).

For tornadoes, the Dresden UFSAR indicates that there were 233 tornadoes reported within an approximate 60-mile radius from the Dresden site, excluding the water area over Lake Michigan, during 1950 - 1977. On the average, eight tornadoes are expected to occur in the vicinity of the Dresden site every year. Based on the path length and width data from tornadoes occurring in the site region, the recurrence interval for a tornado at the site is calculated to be approximately 870 years. Two tornadoes have been reported near the Dresden site since 1965. On November 12, 1965, a tornado moving east-northeast at approximately 70 mph passed 4 miles west of the site. The second tornado, on May 24, 1966, passed near the site, resulting in the loss of one transmission line. (UFSAR Section 2.3.1.1 (Reference 12)).

The tornado parameters used in the design of structures at Dresden Station are a maximum tangential velocity of 300 mph and a pressure drop of 6.3 psi (UFSAR Section 3.3.2.1 (Reference 12)).

Two types of tornado missiles are considered in the design of structures at Dresden Station. They are a 1 inch diameter by 3 feet long steel rod weighing 8 lbs. with a horizontal velocity equal to 317 ft/s and a 13.5 inch diameter by 35 feet long utility pole weighing 1490 lbs. with horizontal velocity equal to 211 ft/s. These missiles were considered to be capable of striking in all directions with vertical speeds equal to 80% of the horizontal speeds (UFSAR Section 3.5.4 (Reference 12)).

2.6.4 Ice, Snow and Extreme Cold

An extreme cold BDBE Event is an event where a regional weather pattern characterized by low external temperatures occurs over a prolonged period of time. This cold weather pattern includes accumulation of snow and ice. The combination of extreme cold temperatures including snow and ice accumulation challenges off-site power and on-site power capabilities by stressing the grid and making cooling systems, such as the UHS, less effective due to low water temperatures (e.g. loss of some water sources to the ultimate heat sink and frazil ice formation in the intake structure that challenges adequate DG cooling).

At the time of original plant licensing, the normal annual precipitation in the area was 33.18 inches. A 24-hour maximum rainfall of 6.24 inches had been recorded. The average annual snowfall since 1929 was 37.1 inches. The maximum snowfall from 1929 through mid-1967 was 66.4 inches, recorded in the winter of 1951-1952 (Reference 12).

On the average, hail storms occur about 2 days per year, and freezing rain occurs approximately 12 days per year. The maximum radial thickness of ice expected in the site region is about 1 inch (UFSAR 2.3.2) (Reference 12). In SEP Topic II-2.A, (Reference 69) the NRC concluded that the extreme maximum and minimum temperatures appropriate at the Dresden site for general plant design (i.e., HVAC systems) are 94°F (equaled or exceeded 1% of the time), and -5°F (equaled or exceeded 99% of the time). As described in UFSAR Section 9.4, the design of most HVAC systems is based on outside air temperatures varying between -6°F and +93°F.

Using the information above, an Extreme Cold BDBEE for Dresden Station is defined as an event where a regional weather pattern characterized by low external temperatures reaching a peak of -6 °F daily over a prolonged period of time or heavy snowfall/ice challenges off-site power and on-site power capabilities by stressing the grid resulting in an extended loss of AC Power (ELAP).

2.6.5 High Temperatures

An extreme heat BDBEE is an event where a regional weather pattern characterized by high external temperatures occurs over a prolonged period of time challenging off-site power and on-site power capabilities by stressing the grid and making cooling systems, such as the UHS, less effective due to high water temperatures (e.g. inadequate DG cooling).

In SEP Topic II-2.A (Reference 69), the NRC concluded that the extreme maximum and minimum temperatures appropriate at the Dresden site for general plant design (i.e., HVAC systems) are 94°F (equaled or exceeded 1% of the time), and -5°F (equaled or exceeded 99% of the time). As described in UFSAR Section 9.4 (Reference 12), the design of most HVAC systems is based on outside air temperatures varying between -6°F and +93°F.

Using the information above, an Extreme Heat BDBEE for Dresden Station is defined as an event where a regional weather pattern characterized by high external temperatures reaching a peak of +94 °F daily over a prolonged period of time challenges off-site power and on-site power capabilities by stressing the grid resulting in an extended loss of AC power (ELAP).

2.7 Protection of FLEX Equipment

The storage strategy satisfies the guidelines listed in NEI 12-06 (Reference 2).

- The onsite FLEX storage areas consist of two (2) BDB event protected buildings, one (1) commercial building and various smaller storage areas throughout protected areas in the existing plant structure (Reactor Building, Main Control Room, etc. (Reference 41)). Figure 23 provides an overhead view indicating the location of storage buildings.

- FLEX Building A is a 31 ft. X 40 ft. protected structure located inside the Protected Area at the south west corner of the Reactor Building and west of U3 HRSS Building (See Figure 24). The building is constructed of reinforced concrete with tornado missile barrier in front of the overhead door. This building houses the 800 kW FLEX Diesel Generator. Equipment to support or connect the generator to support FLEX needs will also be stored in this building. These include Temporary Power Distribution Unit (TPDU), submersible fuel oil pumps and temporary electrical cables. FLEX Building A is not flooded by LIP event since its floor level is at elevation 518.5 feet MSL. Access to the building does not require AC power. All doors are manually operated. The building is heated. The diesel generator enclosure is also heated. In addition, the diesel generator is maintained warm in winter months by maintaining a keep warm system in operation. Operator rounds verify the keep warm system is functional.

- FLEX Building B is a 50 ft. X 75 ft. protected structure located inside the Protected Area east of the Chemical Cleaning Building (See Figure 25). The building is constructed of reinforced concrete with tornado missile barriers in front of the overhead doors. This building houses FLEX equipment such as at least one of the CCSW Emergency Pumps (FLEX submersible pumps), F750 Truck, Carry Deck Crane, Hose Trailer(s), and miscellaneous smaller FLEX equipment. The FLEX Building B has a finished floor level at elevation 517.5 feet MSL. All equipment in this building is either trailer mounted or elevated so that it is not impacted by LIP flood at elevation 518.8 feet. Access to the building does not require AC power. All doors are manually operated. The building is heated. The large diesel driven equipment is maintained warm in winter months by maintaining a keep warm system in operation. Operator rounds verify the keep warm systems are functional.

- Equipment stored in the FLEX Building A and FLEX Building B:

  Equipment spacing is credited during a seismic event to preclude seismic interaction that could cause damage to the equipment. Where a specific piece of equipment could not be credited based on spacing, tie-downs are used. Tie-downs are used on all applicable equipment in the building as an additional barrier to seismic interaction. Miscellaneous items are stored on shelves attached to the FLEX building walls. Equipment is located a sufficient distance away from shelves to ensure items stored on shelves will not contact equipment if they fall from the shelves during a seismic event.

- FLEX Building C is a 50 ft. X 125 ft. commercial building located outside the Protected Area at the south end of the contractor parking lot (See Figure 26). The building houses the "N+1" 800 kW FLEX Diesel Generator, "N+1" TPDU, FLEX Flood Pumps, FLEX Flood Barge, hoses to support the FLEX Flood Pumps, Boats and various smaller pieces of equipment. The FLEX Building C has a floor level at elevation 517.83 feet MSL. This building is outside the protected area in a parking lot southeast of the reactor building. None of the equipment is needed during a LIP flooding event. The building is heated. The diesel generator enclosure is also heated. In addition, the diesel generator is maintained warm in winter months by maintaining a keep warm system in operation. Operator rounds verify the keep warm system is functional.

- The River flooding storage strategy employs NEI 12-06 Section 6.2.3.1.1.c. The maximum credible flood level with wave run-up for Dresden is approximately 12 ft. above grade level. None of the structures on site are protected from external flooding. Applicable FLEX equipment will be moved from storage to locations that are above the flood levels. As an example, the FLEX Diesel Driven Flood Pumps will be on a barge. The barge will be moved into a location that allows connection to plant piping. The barge will float keeping the pumps above the flood waters. As stated in Section 2.6.2, the LIP flooding event has no adverse impact on FLEX equipment or its deployment.

- The large diesel-driven equipment that can be susceptible to extreme cold weather is outfitted with battery chargers/tenders and onboard heating equipment, as necessary, to ensure their starting capability even if the building heating system is inoperable for some period of time. Otherwise, the installed building heating systems are capable of maintaining acceptable temperature conditions in the winter and the ventilation system will maintain acceptable temperature conditions in the summer.

2.8 Planned Deployment of FLEX Equipment

2.8.1 Haul Paths

Primary and alternate deployment routes for Phase 2 portable FLEX equipment are identified in FSG-40, "FLEX Deployment Path And Debris Removal". If a path is found blocked, the Shift Manager is notified to evaluate the obstruction and establish alternate pathways as needed.

These deployment routes have been reviewed for potential soil liquefaction and have been determined to be stable following a seismic event. Additionally, the primary haul paths minimize travel through areas with power lines, narrow passages, etc. to the extent practical. However, high winds can cause debris from distant sources to interfere with planned haul paths. Debris removal equipment is stored inside the FLEX Building B and is protected from the severe storm and high wind hazards such that the equipment remains functional and deployable to clear obstructions from the pathway between the storage building and its deployment locations.

The FLEX deployment area, near the 2/3 cribhouse, provides two access routes and pump staging areas. Either of the travel paths could require some minor debris removal to allow a FLEX pump to be placed in close proximity to the Ultimate Heat Sink. FLEX strategies include reasonable time to remove enough debris to clear a usable travel path using the Ford F750 with the snow plow and additional debris removal equipment stored in FLEX Building B.

Per CC-DR-118 (Reference 41), when only one deployment path is available, temporarily blocking this path to support plant operations is acceptable. Compensatory actions should be considered depending upon the duration of the blockage.

Deployment paths and staging areas are contained in the snow removal plan. These areas are maintained as a priority after site safety concerns are addressed.

2.8.2 Accessibility

Deployment paths shall be reviewed on a monthly bases to ensure they are maintained available, are in a condition to allow transport of FLEX equipment, and are not blocked per DOS 0010-47, "Operations Monthly FLEX Inspections" (Reference 70).

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.

Equipment deployment from the FLEX Building A or B (inside the PA) may require minimal debris removal, at the buildings. The FLEX equipment storage building incorporates multiple access doors for equipment deployment.

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 BDB external event and subsequent ELAP event, FLEX coping strategies require the routing of hoses and cables through various barriers in order to connect portable BDB 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.

The ability to open doors for ingress and egress, ventilation, or temporary cables/hoses routing is necessary to implement the FLEX coping strategies. Security doors and gates that rely on electric power to operate opening and/or locking mechanisms are barriers of concern. With the declaration of an ELAP, or entry into 50.54(x) for a FLEX event, the Shift Manager would suspend Safe-Guards and notify Security to open 2/3 Cribhouse Security gates and the 2/3 EDG Interlock personnel access door. The Shift Manager also authorizes security keys to be dispensed from the Safe-Guards safe to Operations personnel as they are dispatched to facilitate opening and chocking open security doors.

Equipment has been pre-staged to allow for quicker availability of FLEX pumps to meet the 2.5 hour time critical action. Flexible cables are stored on cable reel enclosures in FLEX building A as well as inside the Reactor Building. These will be deployed from there, through penetrations into the U3 Reactor Building. Since debris may block access from FLEX Building A penetrations to the preferred Reactor Building access penetration, multiple penetrations have been provided.

2.9 Deployment of Strategies

The mechanical deployment strategies for Reactor Core Cooling, Spent Fuel Pool Cooling, and Containment Integrity are described in Sections 2.3.5, 2.4.5, and 2.5.5. The electrical deployment strategies are provided below.

Deployment may require deviation from normal work practices to support timely implementation of strategies. EP-AA-112-100 (Reference 42) Section 4.5, Deviations from Normal Work Practices and Safety Standards during a Beyond Design Basis External Event (BDBEE) provides the following guidance:

> Deviations from normal station processes may be authorized by the Shift Manager, or designee, in order to take action to maintain or restore core cooling, mitigate an off-site release in progress, or if fuel damage is imminent without action.

FSG-38, "FLEX Auxiliary Equipment Deployment" discusses deployment of auxiliary equipment to be used in support of various strategies. It also includes a list of light stringers to be utilized as needed for supplemental lighting, including the portable 120/240 VAC diesel generators to power them. The procedure includes the delivery of prestaged palletized support equipment form FLEX Building B to specific locations as needed for FLEX strategies.

2.9.1 FLEX Pump Electrical Deployment Flood

After a BDB event, FSG-36, "FLEX Damage Assessment" is used to compile data from reports from the field. A walk down of the Reactor Building penetrations may be performed to determine penetrations that are available for use to connect power cables from FLEX Building A to the Flex Pumps. Certain penetrations may be obstructed outside the Reactor Building by debris caused by the destructive event. The preferred penetration is on the Unit 3 Reactor Building 517 ft. west wall at column M-50. The alternate penetration is located on the South wall of the Unit 3 Reactor Building at column N-49 (See Figure 27). These penetrations are equipped with cable connection junction boxes. Additional FLEX penetrations without cable connection junction boxes are located on Unit 3

Reactor Building 517 ft. West and South walls. These can be used if the preferred and alternate penetrations are not accessible.

FLEX Pump power cables are routed per FSG-03, "FLEX Strategy For Supplying Power To FLEX Pumps". The preferred FLEX pump to start first is the "3A" due to its proximity to the penetration and therefore requiring less cable pulling (See Figure 28). However, prioritization is given to the Flex Pump powered up first based on conditions. When setting cables from either Unit 2 or Unit 3 pumps, they will be routed in a manner that uses the same Reactor Building penetration since the Temporary Power Distribution Unit (TPDU) connection in FLEX Building A is the same for all the FLEX pumps (See Figures 28 – 31).

Penetrations in FLEX Building A include one on the north side and three on the east side (See Figure 27). Cables from the building are routed through these penetrations as needed. The north penetration is the shortest route for cables to the U3 Reactor Building west wall penetration/connection. Any of the east wall penetrations is preferred to route cables to the U3 Reactor Building south wall penetration/connection. However, any penetration is available as needed. Using 2(3)A Flex Pump is preferred over using the 2(3)B Flex Pump for ease of set up. The electrical cables for the FLEX Pump connections are color coded brown, yellow, orange and green (ground). Actions inside and outside the Reactor Building are performed concurrently to ensure the FLEX actions are completed within the expected time frames.

2.9.2 Busses 28(38) and 29(39) Electrical Deployment

Per FSG-6, "FLEX Strategy For Aligning Power To U2(3) 480 Volt Safety Related Busses 28(38) And 29(39)", the 480V Buses 28(38) and 29(39) are powered from a pre-staged 480V standby diesel generator under an extended loss of alternating current power (ELAP) condition. Multiple operators are required to complete this, with actions being performed inside the Reactor Building and outside. Actions include running cables from the 480 VAC safety related busses on the Reactor Building third floor to the Reactor Building first floor elevation and to the outside through penetrations in the Reactor Building wall. The actions will power the busses from the FLEX diesel generator through a Temporary Power Distribution Unit (TPDU) (See Figure 32 and Figure 33).

After a BDB event, a walk down of the Reactor Building penetrations is performed as soon as possible, to determine the penetrations that are available for use. Certain penetrations may be obstructed by debris caused by the destructive event. The preferred penetrations are those on the Unit 3 Reactor Building 517 ft. West wall.

Available penetrations include the following: (See Figure 32).

- Preferred - One eight inch penetration between Columns L-50 and M-50 behind MCC 39-1.
- Alternate - Two four inch openings approximately 6 feet from ground level. Inside the building these openings are above the stairwell to the U3 West Corner Room.

Other alternate penetrations are located on the South side of the Unit 3 Reactor Building, just east of the RPR Interlock. There are multiple openings in this area. The five openings farthest to the West are used to avoid abrading the cables on the corner of the outside structures. Three of these five openings are approximately six feet from the ground and two of them are approximately two feet from the ground.

Penetrations in FLEX Building A include one on the North and three on the East. Cables in the building are routed through these penetrations as needed.

Bus Connection Devices (BCDs) are stored near Reactor Building Bus 28/29 and Bus 38/39. Each BCD has six leads. The leads are color coded to match the cables that will be connected to them. The BCDs are to be placed into an available Bus load cubicle to restore power via connection to the FLEX DG with cables routed through the Reactor Building. A spare cubicle or cubicle at a workable height for BCD installation is preferred. Although this cubicle may be selected for convenience, the only prioritization regarding cubicle use is avoidance of using an MCC Feed. Otherwise, utilizing a cubicle available to expeditiously restore power to the 480 Volt Busses is acceptable. If necessary, a load breaker (except an MCC Feed) can be removed from the Bus and the BCD placed in to the vacated cubicle.

In addition to the power cables, a neutral connection is required. The neutral connects Bus 28/29 (as a unit) and Bus 38/39 (as a unit) to the FLEX DG through the TPDU. White cable is strung from the TPDU to a Neutral Connection panel on the third floor of the Reactor Building. Either unit can be connected first and then Bus 28/29 and Bus 38/39 is cross connected via the same Neutral Connection Panels with white neutral cables strung between the units. Once the neutral connection is made and the FLEX DG is in operation, the neutral disconnect should be turned on first, before energizing the busses.

When the neutral connection is completed for the switchgear, the 480 VAC neutral disconnect switch (mounted on the TPDU) is closed to safely make the connection to the live DG neutral. The circuit breaker at the TPDU that feeds the switchgear can then be closed.

2.9.3 Electrical Strategy

Electric power will supplied from a pre-staged 800 kW Diesel Generator to a Temporary Power Distribution Unit (TDPU). Temporary cables will be routed from the TDPU to the desired FLEX Pump and also to safety related 480 VAC electrical busses in the Reactor Building. Utilizing installed cross-tie circuitry both 480 VAC busses on each Unit will then be powered. Desired loads such as battery chargers, Standby Liquid Control (SBLC) Pumps and various AC powered motor operated valves will be energized as needed.

BDB Flooding Event

The existing procedure DOA 0010-04 “Floods” (Reference 56) makes optimum use of the onsite equipment to achieve a safe shutdown of the reactor under PMF conditions. Because the flood event is precipitation based there is time to prepare. Per FSG-62, “FLEX Generator Deployment During A Flood”, both FLEX portable DG’s will be placed at a location above the highest flood level, during site flooding preparation actions. (One DG from FLEX Building A and the other DG will be brought inside the Protected Area from FLEX Building C). Currently, diesel driven FLEX FLOOD Pumps will be used to supply Dresden’s water supply needs, so no cables will need to be run to the FLEX Pumps in the corner rooms. Flexible cabling will be routed from the FLEX Diesels to the safety related 480 VAC busses in the Reactor Building (Busses 28/29 and 38/39) using modified breakers (BCD’s) that can be racked into empty cubicles on the Busses. The 480 VAC safety related busses will then be available to power desired loads.

2.9.4 Refueling of Equipment

A submersible pump capable of being lowered directly into a main fuel oil storage tank was identified. FSG-32, Fueling Flex Portable Equipment has been developed to provide direction for use of the pump and methods to refuel FLEX equipment. Use of the submersible pump allows greater flexibility in that fuel oil can be obtained from any Emergency Diesel Generator main fuel oil storage tank.

Off-site testing of the submersible pump confirms a minimum pumping capacity of 1.3 gpm (78 gph) for each submersible pump (Reference 20). At the present time the largest fueling need is the FLEX Diesel Generator which has a fuel burn rate of approximately 57 gph at full load. One submersible pump will meet this requirement with margin.

The fuel oil use evaluation (Reference 25) for equipment requiring refueling in the current strategy identifies fuel usage of approximately 68 gph (56.7 gph – FLEX generator, 7.6 gph – pump in Ultimate Heat Sink, 4.5 gph – all 6 small portable generators operating). During a maximum probable flooding event, the fueling requirement of the pump in the UHS is eliminated and is replaced with the diesel driven barge mounted pump. The barge mounted pump maximum fuel oil consumption at full load is 12.2 gph per FSG-32, “Fueling FLEX Portable Equipment”, for a total fuel usage of approximately 73 gph. These calculated fueling requirements are within the capacity of 1 submersible fuel oil pump with margin.

Multiple pumps have been obtained for use. More than one pump can be in operation at a time which further increases available refueling rates for FLEX equipment.

There are three Emergency Diesel Generator main fuel oil storage tanks. Each has a Technical Specification minimum volume of 10,000 gallons (Reference 11). With an overall fuel consumption rate of 69 gph each storage tank would provide a minimum of six days fuel requirements. Within this time off-site support would be available to obtain additional fuel.

The same basic strategy is employed during flood events with some differences. The Dresden flood event is precipitation based and therefore, time is available to prepare for the flood. During those preparations station personnel will install a standpipe on the 2/3 EDG Main Fuel Oil Tank vent line. The standpipe is designed such that additional sections can be added/removed as the flood waters rise and recede. The submersible pump described above will be lowered into the standpipe. A floating platform will provide a working location for personnel and equipment to support pumping fuel oil out of the 2/3 EDG fuel oil tank.

2.10 Offsite Resources

2.10.1 National SAFER Response Center

To meet the requirements of Phase 3, the Strategic Alliance for FLEX Emergency Response (SAFER) team, an alliance between AREVA and Pooled Equipment Inventory Corporation (PEICo), was established. The SAFER team is contracted by the nuclear industry through PEICo to establish National SAFER Response Centers (NSRC) operated by Pooled Inventory Management (PIM) and in collaboration with AREVA to purchase, store, and deliver emergency response equipment in the case of a major nuclear accident or BDBEE in the U.S. The equipment will mitigate events that cause an extended loss of electrical power or motive force, and a loss of access to a site's ultimate heat sink.

The industry has established two (2) National SAFER Response Centers (NSRCs) to support utilities during BDB events. Onsite BDB equipment hose and cable end fittings are standardized with the equipment supplied from the NSRC.

In the event of a BDB external event and subsequent ELAP/LUHS condition, equipment will be moved from an NSRC to a local assembly area established by the Strategic Alliance for FLEX Emergency Response (SAFER) team. For Dresden, the local assembly area is the Pontiac Municipal Airport. From there, equipment can be taken to LaSalle County Generating Station Staging Area D or the Dresden site and staged at the SAFER onsite Staging Area "B" near the FLEX Building C Storage Building. Communications will be established between the Dresden plant site and the SAFER team via satellite phones and required equipment moved to the site as needed. First arriving equipment will be delivered to the site within 24 hours from the initial request.

Primary and alternate deployment routes for Phase 3 portable FLEX equipment are described in CC-DR-118-1001, SAFER Response Plan For Dresden Nuclear Power Station (Reference 40).

See Figure 43 for SAFER and Site Responsibilities and Figure 44 for a generic Phase 3 timeline.

2.10.2 Equipment List

FSG-14, "Transition From Phase 2 to Phase 3 Equipment" contains supplemental guidance for deployment and operation of SAFER equipment. Dresden can cope indefinitely with the BDBEE/ELAP/LUHS event with the Phase 2 equipment already onsite, however, some of the NSRC equipment is used as spares or backups to this equipment.

Table 1 – Generic NSRC Equipment

Equipment	Performance Characteristics	
Medium Voltage Generator	4160 VAC	1 MW
Low Voltage Generator	480 VAC	1000 KW
Cable / Electrical	Various	
High Pressure Injection Pump	2000 PSI	60 GPM
SG/RPV Make-up Pump	500 PSI	500 GPM
Low Pressure / Medium Flow Pump	300 PSI	2500 GPM
Low Pressure / High Flow Pump	150 PSI	5000 GPM
Hose / Mechanical Connections	Various	
Lighting Towers	40,000 lumens	(minimum)
Diesel Fuel Transfer	500 gallon air-lift container	
Diesel Fuel Transfer Tank	264 gallon tank, with mounted AC/DC pumps	
Portable Fuel Transfer Pump	60 GPM after filtration	
Electrical Distribution System	4160 V, 250 MVA, 1200 A	

Table 2 – Site Specific NSRC Equipment

Equipment	Performance Characteristics

Suction Booster Lift Pump	5000 GPM

Table 3 – Additional NSRC Equipment

Standard Hose and Mechanical Connection Deployment Module:

Quantity	Description	Pressure Rating	Diameter	Length
4	HP Hose, 2500 psi, 1 ½ inch	2500 psi	1 ½ inch	50 feet
4	HP Hose, 2500 psi, 1 ½ inch	2500 psi	1 ½ inch	100 feet
9	SG/RPV Hose	500 psi	2 ½ inch	100 feet
48	Low Pressure/Medium Flow and Low Pressure/High Flow Discharge Hose	300 psi	5 inch	50 feet
2	HP Suction Hose	150 psi	2 ½ inch	100 feet
4	SG/RPV Suction Hose	150 psi	6 inch	10 feet
8	Low Pressure/Medium Flow Suction Hose	150 psi	6 inch	10 feet
12	Low Pressure/High Flow Suction Hose	150 psi	6 inch	10 feet
8	Female NPT SS hydraulic couplings	2500 psi	1 ½ inch	NA
3	6 inch to 5 inch Storz Adapters	NA	NA	NA
2	5 inch Storz to 2 ½ inch NH Swivel Rocker Lug Female Thread	NA	NA	NA
1	5 inch Storz x 5 inch Storz Outlets x 5 inch Storz Inlet Large 2-way Ballo Valves	NA	NA	NA
1	Set of 4 Storz x Spanner Wrench with holder	NA	NA	NA

1	Set-Triple Holder, (1) Style K05 Hydrant Wrench & (2) K01 Spanner Wrenches	NA	NA	NA
12	6 inch Big Water Self Leveling Floating Strainer	NA	NA	NA

Table 4 – Mechanical Connection Types, Sizes, and Color Coding

Pump	Description	Hose Connector Color Code	No. Header Connections	Number of Connections Full Flow
Discharge Hoses				
High Pressure	Hose, 2500 psi, 1-1/2" NPT	Red	1	1
SG/RPV	Hose, 500 psi, 2-1/2", NH	Yellow	3	2
Low Pressure Medium Flow	Hose, 300 psi, 5", Storz	Blue	4	3
Low Pressure High Flow	Hose, 300 psi, 5", Storz	Blue	6	5
Suction Hoses				
High Pressure	Hose, 150 psi, 2-1/2" NPT	Black with red stripe	1	1
SG/RPV)	Hose, 150 psi, 6" NH	Black	2	1
Low Pressure Med Flow	Hose, 150 psi, 6" NH	Black	4	3
Low Pressure High Flow	Hose, 150 psi, 6" NH	Black	6	5

Table 5 – Generator Output Color Code

Output	Color	Quantity per Set/Module 480 VAC	Quantity per Set/Module 4160 VAC
Line Phase L1	Brown	6	2
Line Phase L2	Orange	6	2
Line Phase L3	Yellow	6	2
Neutral	White	2	1

2.11 Equipment Operating Conditions

2.11.1 Ventilation

FSG-31, FLEX Ventilation Strategies, provides operators guidance on strategies to minimize temperature increase and alleviate the impact on equipment from the loss of ventilation systems following an ELAP.

Initially ventilation efforts will involve opening doors at key locations to provide natural circulation through areas. As power becomes available mechanical means such as installed ventilation systems and/or portable fans will be used to augment cooling in desired areas.

2.11.1.1 HPCI Room

Calculation 2013-01671 (Reference 14) was performed to determine the temperature of the HPCI Pump Room during an ELAP given that compensatory actions to supply cool air to the room are taken. FSG-31, Ventilation Strategies, incorporates the actions identified in Calculation 2013-01671 (Reference 14).

Analysis (Reference 14) indicates opening doors at 2 hours will result in acceptable room temperature values to support operation of HPCI for at least 6 hours. HPCI room temperature remains below the isolation point during this time. In addition, per FSG-02, "Flex Strategy HPCI Operation During An ELAP Event", HPCI room high temperature isolation is bypassed. HPCI operation is assumed for approximately 2.5 hours in Phase 1.

2.11.1.2 Auxilliary Electrical Equipment Room (AEER)

Temporary ventilation involving opening doors and use of portable fans will be utilized if required per direction contained in FSG-31, "FLEX Ventilation Strategies" and DOA 5750-01, "Ventilation System Failure (Reference 62) (See Figure 40).

The vendor manual was reviewed (Reference 31). The document identifies the ESS UPS Unit may be operated at reduced loads at temperatures of 50°C (122°F). SBO Calculation 3C2/3-0389-001 (Reference 22) identified requirements for AEER and main control room temperatures. The AEER heat load of 47 KW (160,378 Btu/hr) will cause room temperature to rise if no ventilation is required. The steady state temperature of the room is estimated by an energy balance. For a fan with 13,000 cfm capacity, air density of 0.07 lbm/cu ft., and specific heat of 0.24 Btu/lbm-F, the temperature rise between the incoming air and the exhausting air will be 12.24°F. Thus, if the outside air is 95°F, long term steady state temperature of the room will be 107.24°F (Reference 24). The actions of DOA 5750-01, "Ventilation System Failure" (Reference 62) and similar actions in FSG-31, FLEX Ventilation Strategies" were developed to keep AEER temperature below 120°F. These include opening doors and when possible utilizing portable fans. FLEX related revisions to DGA-03, "Loss of 250 VDC Battery Chargers with Simultaneous Loss of Auxiliary Electrical Power" provide direction to open selected breakers on the ESS Bus to reduce loading (Reference 52).

2.11.1.3 Main Control Room (MCR)

Actions for Loss of Main Control Room Ventilation are taken as required by temperatures. SBO Calculation 3C2/3-0389-001 (Reference 22) identified requirements for AEER and main control room temperatures. Performance of DOA 5750-01, "Ventilation System Failure" actions, (Reference 62) direct control room doors to be blocked open to establish natural air flow. Further actions are taken to provide forced circulation using portable fans to force air flow. These fans can be powered from a FLEX DG or smaller portable diesel generator. Actions may not be required based on temperatures in the MCR. Operators will utilize FSG-31, "FLEX Ventilation Strategies" (See Figure 39).

For heat stress concerns, bottled water is stored on site and cooling garments are stored in freezers which are also capable of being powered by a FLEX DG or smaller portable diesel generator. The effect of putting these measures into action provides sufficient assurance that the Main Control Room environmental conditions will not be so adverse as to preclude execution of FLEX strategies.

2.11.1.4 Refuel Floor

The Spent Fuel Pool area is ventilated by opening doors to allow air to flow into the Reactor Building and out through the Refuel Floor doorway to the Turbine Building Roof utilizing natural circulation.

2.11.1.5 Battery Rooms

Battery Room ventilation is established by opening doors to reduce hydrogen buildup once battery chargers are energized (See Figures 41 and 42). Portable explosion proof fans with temporary flexible ducting will be utilized as necessary to increase air flow in the area when electrical power is available. The batteries will not begin generating significant amounts of hydrogen until the chargers are re-energized and the batteries begin to charge. The Dresden FLEX Sequence of Events timeline energizes the battery chargers six hours into the event. The amount of hydrogen calculated to reach 1% concentration in the battery room air volume is reached at approximately eight hours after event initiation (Reference 23). Opening the doors early and subsequent placement of fans in the battery rooms prevents the hydrogen build-up reaching explosive concentrations. Battery Room heat load is negligible and temperature rise in the battery rooms is less than or equal to 10°F (Reference 24).

2.12 Habitability

While it is anticipated that certain areas of the plant critical for the success of the FLEX Shutdown Mitigation Strategy will exceed 120 °F, operating personnel working in these areas will be protected through the application of heat stress control measures such as the use of cooling garments and personnel rotation. Exelon procedure SA-AA-111, "Heat Stress Control", (Reference 46) defines a Very High Temperature area as one in which the dry bulb temperature is between 145°F and 160°F (section 2.25). Section 4.7 of the procedure provides direction for the use of cooling garments to extend stay times in areas with elevated temperatures. Sections 4,7.5.1.B.1 and 4,7.5.2.B.3 allow for personnel working in cooling garments to work for 60 minutes in areas with elevated temperatures. The FLEX Shutdown Mitigation Strategy will employ use of cooling garments. Freezers capable of being supplied by sources powered from the pre-staged 800 kW diesel generator or a smaller portable generator will be used to maintain a sufficient supply of these cooling garments throughout the shutdown time line. Based on the use of cooling garments and other heat stress controls such as working in pairs and rotating personnel it is reasonable to assume the Operator actions required to implement the FLEX strategies can be accomplished.

2.13 Lighting

Battery powered emergency lighting is available at critical plant locations to support in-field activities. Operators are provided with helmet mounted LED lights and/or flashlights that provide illumination for task completion. Portable light stands have been purchased to support lighting in deployment locations as desired when power is available. Additionally, small diesel generators have been purchased and are used to power electrical devices including lighting in remote locations. FSG-38, "FLEX Auxiliary Equipment Deployment" discusses deployment of light stands and light stringers.

2.14 Communication

FSG-39, FLEX Communciations Options, discusses the available Onsite communications. Communications may be performed using the installed sound powered headset system within the power block and 800 Mhz radios in the talkaround mode. Public Address announcements are made by using hand-held bullhorns.

Offsite communications will utilize hand-held satellite phones staged in the Control Room and Technical Support Center.

Battery chargers for portable communications equipment are stored in the Main Control Room. Upon initiation of the ELAP, the FLEX Diesel Generator can power the battery chargers.

2.15 Water Sources

Dresden uses the suppression pool as the primary water source and the UHS as its make-up for RPV level, containment cooling and SFP make-up throughout the ELAP/LUHS non-flood event.

2.15.1 Suppression Pool

The suppression pool offers a relatively clean source of make-up water to the RPV; first from HPCI and later from the operating FLEX pump. At the beginning of the event, the suppression pool is near reactor quality water. Reactor coolant leakage into the drywell and Phase 1 usage of suppression pool inventory require water addition from the UHS to maintain suppression pool level. This will degrade suppression pool water quality, but it will remain a favorable water source.

Using information from the Calculation DRE14-0008 (Reference 16) Table 1, Volume of Suppression Pool Water as a Function of Water Height, for 14.7 feet, (the center of the Technical Specification allowed suppression pool water level band), the total volume of water contained is 882,181 gallons.

Keeping the downcomers covered maintains the critical functions of the ECCS suction strainers and the ERV T-Quenchers. Uncovering the Drywell to Suppression Pool downcomers will impact scrubbing effects through Suppression Pool water of any activity in the Drywell if Containment Venting is required. However, if the Isolation Condensers are operating as expected Containment Venting is not expected based on MAAP runs (Reference 13) performed to support FLEX response. Therefore, it is reasonable to assume Suppression Pool water level could be reduced below the Drywell to Suppression Pool downcomers.

DRE14-0008 Table 1, (Reference 16) Volume of Suppression Pool Water as a Function of Water Height, provides the Suppression Pool Water volume in cubic feet (1 cubic foot = 7.48052 gallons) as a function of liquid height (ft.) in the Suppression Pool. The adjustment factor columns take into account the space occupied by the internals.

Table 6 – Suppression Pool Levels

Suppression Pool Level in Feet	Volume in gallons	
14.7	882,181	Normal level
11.0	280,621	Downcomers submerged
9.4	397,029	ECCS Suction

		strainer submergence
6.0	624,410	ERV T-Quencher submerged

Assuming the event occurs with the units on-line, FLEX make-up needs will vary for approximately the initial 24 hours. After that the Units are anticipated to be in a stable condition in which make-up needs will be relatively consistent.

Table 7 –_Reactor On-Line

T = Time Hours	IC Make-up gpm	RPV Make-up gpm	Fuel Pool Make-up gpm	Total Make-up gpm
T = 0 thru 2.5	0	0	0	0
T = 2.5 thru 6.0	890	0	0	890
T = 6 thru 10	720	50	0	770
T = 10 thru 25	642	50	58	750
T = 25+	0	50	58	108

If the units are shutdown prior to the event, initial make-up needs will be less due to not having to supply the IC shell side, but Fuel Pool make-up will increase due to assumed full core off-load.

Table 8 –_Reactor Shut Down

T = Time Hours	RPV Make-up	Fuel Pool Make-up	Total Make-up gpm
T = 0 thru 25+	50	156	206

The highest FLEX Make-up requirement identified in the discussion above is the T = 2.5 hour on-line requirement of 890 gpm. The highest FLEX Make-up long term requirement is the shutdown condition of 206 gpm.

Dresden Calculation DRE14-0008 (Reference 16) utilized the above information to provided integrated use of Suppression Pool water. The two Suppression Pools contain 794,058 gallons of water above the ECCS Suction Strainers. The integration portion of the calculation identifies the first Suppression Pool will provide approximately 8.5 hours of FLEX Make-up needs. The second Suppression Pool inventory will supply FLEX Make-up needs for an additional 9.5 hours. The total time of Suppression Pool inventory without make-up is approximately 18 hours.

Assuming that water would be drawn from the initial suppression pool starting 2.5 hours into the event, plant personnel would have to stage the hydraulic driven submersible pump at the UHS and hoses routed into the plant by 20.5 hours (2.5 + 18) from the initiation of the BDBEE.

2.15.2 Lake, Intake and Discharge Head Works

2.15.2.1 Ultimate Heat Sink (UHS)

Once a FLEX pump is available at T + 2.5 hours, raw water from the UHS is used to make-up to the suppression pool to compensate for RCS leakage into the drywell. The FLEX pump takes suction from the suppression pool through the common ECCS suction strainer. The strainers are stainless steel perforated plates with 1/8 inch diameter openings. The ECCS suction strainer will prevent solids greater than1/8 inch from entering the system and being injected into the RPV.

The volume of water available for cooling during a Fukushima or FLEX event is the volume of water contained in the Intake Canal between elevation 494.2 feet and 487.67 feet. This volume of water is estimated to be approximately 2.144 million gallons (Reference 44). Assuming that 900 gpm of cooling water is required during the initial phase of a Fukushima event, the 2.144 million gallons of water available in the Intake Canal would be exhausted in 40 hours. This also assumes that the FLEX pumps would continue to run at full capacity until the water level in the Intake Canal reaches the suction piping at the 487.67 ft. elevation.

FLEX Scenario design analysis calculation DRE14-0008 credits the isolation condenser to achieve hot shutdown and assumes a reactor vessel cooldown rate of 15°F per hour. Assuming reactor vessel water temperature starts at 546°F, it would take approximately 22.3 hours to reach a hot shutdown temperature of 212°F utilizing a 15°F per hour cool down rate. As such, there would be sufficient water in the Intake Canal to achieve hot shutdown of both units.

2.15.2.2 Intake and Discharge Canals

The Kankakee River is the normal source of emergency cooling water for Dresden Station. In the event of a loss of this water source (Dresden Lock and Dam Failure), there is a limited supply of water trapped, by design, in the intake and discharge canals. Due to the topography of the circulating water canals and piping, approximately 9 million gallons of river water are trapped within the canals, not including water in the cooling lake (Reference 12). This is due to the topographical high points in both the intake and discharge flumes. During such an event, two sources of water are created. One source of water is contained in the Discharge Canal which contains 28,984 cubic feet or 216,800 gallons of water at the maximum water level of 495 feet (Reference 26) At 494 ft. elevation, the corresponding volume is 21,809 cubic feet or 163,142 gallons. However, under the dam failure scenario, the water in the discharge canal will equalize in level with the intake canal at an elevation of 494.2 ft. This will occur from any of the following reasons:

1) leakage through the flow diverter gates in the discharge canal
2) backflow through the circulating water system piping
3) opening of the deicing line (Reference 12)

By interpolation, the discharge canal volume at 494.2 ft. is determined to be 23,244 cubic feet or 173,877 gallons.

The second source of water is contained in the Intake Canal which contains 332,488 cubic feet or 2,487,183 gallons of water at the maximum water level of 494.2 feet (Reference 26).

The volume and surface area of the water in the intake and discharge canals that are credited in the above discussion are shown in the following tables as identified in calculation DRE03-0026 (Reference 26).

Table 9 – Intake Canal Geometry

Elevation (feet)	Volume (cubic feet)	Surface Area (square feet)
494.2	332,488	156,816
493	202,084	72,371
489.9	85,731	26,610
486.5	24,603	11,594

483.5	1,450	2,685
482.5	0	0

Table 10 – Discharge Canal Geometry

Elevation (feet)	Volume (cubic feet)	Surface Area (square feet)
498	305,840	138,777
497	169,305	134,295
496	37,251	8,813
495	28,984	7,721
494	21,809	6,629
493	15,727	5,536
492	10,736	4,444
491	6,838	3,352
490	4,032	2,260
489	2,318	773
488	1,545	773
487	773	773
486	0	0

Per DOA 0010-01, "Dresden Lock and Dam Failure" (Reference 74) the river water will be pumped into the intake canal within 24 hours using two portable pumps. The level in the intake canal will be maintained as high as possible without causing water to overflow back to the river past the high point invert in the intake canal at 492.2 ft. elevation.

2.15.2.3 Cooling Lake

As discussed in Section 2.3.9.5, the cooling lake encompasses a storage area of 1284 acres with an average depth of 8 feet; thus, the lake contains a maximum volume of 14,590 acre-feet. At 325,853 gallons per acre-foot, this equates to 4.75E+9 gallons. Lake water and/or this impounded river water would be used as a heat sink for the long-term removal of decay heat from the reactors. The flow control station and cooling lake spillway gates, etc. would be adjusted to prevent loss of lake water to the river. These sources of water provide an almost inexhaustible supply of make-up water in support of the FLEX Shutdown Mitigation Strategy.

2.15.3 Spent Fuel Pool (SFP)

At Dresden, any water source available is acceptable for use as make-up to the SFP, however, the primary source would be from the UHS via the FLEX pump. Water quality is not a significant concern for make-up to the SFP. Likewise, boration is not a concern since boron is not being removed from the SFP when boiling.

2.16 Shutdown and Refueling Modes Analysis

Dresden Power Station will abide by the Nuclear Energy Institute position paper entitled "Shutdown/Refueling Modes" (Reference 60) addressing mitigating strategies in shutdown and refueling modes. This position paper is dated September 18, 2013, and has been endorsed by the NRC staff (Reference 61). These mitigating strategies are defined below.

Using the NEI position paper to further develop and clarify the guidance provided in NEI 12-06 (Reference 2) related to industry's ability to meet the intent of Order EA-12-049, (Reference 1) Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond Design Basis External Events, during shutdown and refueling modes of operation, the following Exelon fleet strategy objectives are established:

1. A defense in depth approach will be used to support FLEX strategies during shutdown/refueling modes. The defense in depth approach is selected over development of mode specific FLEX Support Guidelines (FSGs) and supporting analysis for the following reasons:

- Outage conditions are highly diverse and will be a significant challenge to developing modifications, procedures and supporting analysis that will be valid under all shutdown/refueling conditions.
- The time duration of shutdown/refueling conditions is small compared to the time at operating conditions such that the risk of external initiating events concurrent with shutdown/refueling conditions is very small. Additionally, due to the large and diverse scope of activities and configurations for any given nuclear plant outage (planned or forced), a systematic approach to shutdown safety risk identification and planning, such as that currently required to meet §50.65(a)(4) along with the availability of the FLEX equipment, is the most effective way of enhancing safety during shutdown.

- Resource availability is much greater and more diverse during outages, particularly during high risk evolutions such as shutdown and refueling mode operations and reduced inventory conditions (e.g., RPV water level below the vessel flange with irradiated fuel seated in the reactor vessel (BWR), mid-loop operation with fuel seated in the reactor vessel or reactor vessel head installed with Reactor Coolant System loops isolated (PWR)). This includes command and control structures to support event mitigation and recovery.
- Shutdown Safety Management Program procedures require availability of a greater number of systems than required by plant Technical Specifications to ensure capability of key safety functions. Contingency plans are developed as required when the defense in depth is reduced below a specified minimum value. A defense in depth strategy is recognized by previous NRC and industry initiatives to improve shutdown safety.

2. No modifications, analyses, or engineering evaluations need to be performed to support shutdown/refueling FLEX strategy implementation. This approach is fully consistent with the NEI position paper on shutdown/refueling modes and the NRC endorsement letter of the NEI position paper.

2.17 Sequence of Events

The following is the shutdown mitigation strategy timeline for all BDBEEs with the exception of a Flooding Event (Reference 41).

Action item	Elapsed Time	Action	Time Constraint Y/N	Remarks / Applicability
	0	**Event Starts**	NA	Plant @100% power
	0	Reactor scram	NA	Loss of power to Reactor Protection System results in a reactor scram.
1.	1 min	Personnel enter DGP 02-03 and DGA 12	N	These actions will provide direction for reactor control and options for loss of AC power.
2.	1 min	Isolation Condenser initiated for pressure control (or verified operating if auto initiation occurs)	N	DEOP 100 will direct action based on reactor pressure.
3.	2 mins	Attempt to start EDGs upon identification of failure to auto start.	N	Per FLEX event initial conditions the EDGs are not available.
4.	3 mins	Attempt to Start IC Make-up Pump for IC Shell side make-up	N	There are no fully qualified make-up sources for shell side make-up.
5.	5 mins	Personnel dispatched to investigate EDG failure to start.	N	Per FLEX event initial conditions the EDGs are not available.
6.	5 mins	HPCI initiated for inventory control and reactor pressure control (or verified operating if auto initiation occurs).	N	HPCI suction will auto swap to the Suppression Pool due to CSTs being assumed lost with the FLEX event (not missile protected).
7.	10 mins	Attempt to start SBO DG for either Unit	N	Per FLEX event initial conditions the SBO DGs are not available.
8.	15 mins	Personnel dispatched to investigate SBO DG failure to start.	N	Per FLEX event initial conditions the SBO DGs are not available.

Action item	Elapsed Time	Action	Time Constraint Y/N	Remarks / Applicability
9.	15 mins	Perform 125 VDC load shedding per DGA 13	N	This is an immediate action of DGA 13 to prolong battery availability. Must be completed by 30 minutes after event initiation.
10.	20 mins	Isolation Condenser heat removal rate begins to drop as shell side level is lost due to lack of shell side make-up.	N	Per UFSAR, the IC will operate for approximately 20 minutes without shell side make-up. Depending on existing plant conditions the IC could operate longer than 20 minutes. Longer operation improves FLEX margin.
11.	20 mins	Operate HPCI to control reactor pressure as the Isolation Condenser becomes less effective due to low shell side water level.	N	Per UFSAR, the IC will remove the decay heat produced after 530 seconds from the SCRAM for 20 minutes without shell side make-up. HPCI operation will aid in reactor pressure control until an IC shell side make-up source can be established.
12.	30 mins	125 and 250 VDC Load Shed Completed (actions identified in DGA 03, DGA 12 and DGA 13)	Y	DGA 12 Step D.13 identifies that load shedding to maintain battery availability must be completed if DC chargers are unavailable.

Action item	Elapsed Time	Action	Time Constraint Y/N	Remarks / Applicability
13.	30 mins	Initiate actions for Loss of AEER Ventilation and Main Control Room Ventilation as required by temperatures.	N	Perform DOA 5750-1 actions, MCR - Attachment A Step 1.e. AEER - Attachment C Step 6. Actions may not be required based on temperatures in the MCR and/or AEER.
14.	1 hour	Control Room crew has assessed SBO and plant conditions and declares an Extended Loss of AC Power (ELAP) event. • Personnel dispatched to implement the FLEX strategy for supplying make-up water to the Isolation Condenser shell side. • Personnel dispatched to implement the FLEX strategy for supplying power to the FLEX Make-up Pump and station battery chargers	N	Time is a reasonable approximation based on operating crew assessment of plant conditions
15.	2 hours	Establish natural circulation air flow to HPCI room by opening doors. (FSG-31)	Y	Analysis (Calculation 2013-01671) indicates opening doors at 2 hours will result in acceptable room temperature values to support operation of HPCI for at least 6 hours. HPCI room temperature remains below the isolation point during this time. HPCI operation is assumed for approximately 2.5 hours in Phase 1.

Action item	Elapsed Time	Action	Time Constraint Y/N	Remarks / Applicability
16.	2 hours	Defeat HPCI high temperature and flow isolations (FSG-02)	N	Ensure HPCI remains available during the event.
17.	2.5 hours	FLEX strategy for supplying power to a FLEX Make-up Pump completed. (FSG-03)	Y	Involves running temporary cables and connecting to the selected FLEX Make-up pump.
18.	2.5 hours	FLEX pump connected and supplying Isolation Condenser shell side make-up. (FSG-04)	Y	Due to pre-staging of major components, it is reasonable to expect the FLEX pump can be available within this time period.
19.	2.5 hours	Isolation Condenser initiated for RPV pressure control. (FSG-05)	Y	Complete prior to loss of HPCI to ensure RPV heat removal mechanism operating prior to MAAP analysis assumed HPCI loss.
20.	2.5 hours	HPCI assumed to fail due to suppression pool temperature of ≥140°F	N	HPCI may continue to operate above 140°F but it is not relied upon past this point. Restoration of the Isolation Condenser will replace the need for HPCI in terms of RPV pressure control. Additionally continued operation of HPCI will add additional heat to the containment.

Action item	Elapsed Time	Action	Time Constraint Y/N	Remarks / Applicability
21.	2.5 hours	Personnel dispatched to either: Cross connect the suppression pools between the two Units (FSG-04, Attachment E) OR Connect, align and start a FLEX pump from the opposite Unit Suppression Pool. (FSG-04)	N	The water in the initial Suppression Pool will be sufficient for approximately 5.5 hours.
22.	6 hours	FLEX strategy for supplying power to 480 VAC busses and associated Motor Control Centers (MCCs) completed. (FSG-06)	Y	When the busses are energized, power will be available to supply power to battery chargers and other desired loads such as SBLC and SBGT. EC 391973 identifies the batteries will remain available for at least 6 hours without chargers.
23.	6 hours	Personnel dispatched to deploy pump and line-up water supply from the Ultimate Heat Sink (UHS). (FSG-09)	N	Additional site resources will be available 6 hours after event initiation to aid in this effort. The resources include personnel of operate equipment such as mobile lifting device to deploy submersible pump in the UHS.
24.	6 hours	Dispatch personnel to Stage equipment for Fuel Pool Spray prior to the Spent Fuel Pool reaching the boiling point. (FSG-12)	N	This will minimize personnel having to enter a hazardous area later in the event
25.	7 hours	Isolate both Reactor Recirculation Loops by closing suction and discharge valves. (FSG-07)	N	Recirculation loops are isolated to reduce RPV leakage. The sooner this is accomplished the more reactor inventory is conserved.

Action item	Elapsed Time	Action	Time Constraint Y/N	Remarks / Applicability
26.	7 hours	Initiate SBLC as necessary for RPV level control. (FSG-08)	N	Per MAAP analysis after Recirculation Loops are isolated and the Isolation Condenser is controlling reactor pressure, RPV leakage will be reduced to approximately 15 gpm at T = 6.0 hours. Make-up from SBLC can be utilized to maintain RPV level above Top of Active Fuel (TAF).
27.	8 hours	Personnel dispatched to establish additional temporary ventilation to the MCR and AEER (portable fans and associated generators).	N	FSG-31provides direction. This is a continued effort to support Main Control Room personnel.
28.	12 hours	Make-up to the Spent Fuel Pools using FLEX pump strategy is available. (FSG-10)	Y	EC 371913, Revision 2, Time-to-Boil Curves., identifies a time to boil of 9.54 hours, and 110.07 hours to the top of active fuel. Therefore completing the equipment line-up for initiating SFP make-up at 12 hours into the event ensures adequate cooling of the spent fuel is maintained.
29.	14 hours	Make-up available from UHS using portable equipment. (FSG-09)	Y	Long term make-up water source will be available before the water contained in the Suppression Pools for both Units is exhausted. Make-up from the UHS will be required at approximately this time based on review of make-up water use.

Action item	**Elapsed Time**	**Action**	**Time Constraint Y/N**	**Remarks / Applicability**
30.	24 hours	Initial equipment from Regional Response Center becomes available.	N	NEI 12-06 assumption.
31.	24-72 hours	Continue to maintain critical functions of core cooling (via IC and make-up water injection), containment (via hardened vent opening) and SFP cooling (FLEX pump injection to SFP). Utilize initial NSRC equipment in spare capacity. (FSG-14)	N	None

2.18 Programmatic Elements

2.18.1 Overall Program Document

Dresden procedure CC-DR-118 (Reference 41) provides a description of the Diverse and Flexible Coping Strategies (FLEX) Program for Dresden. This procedure implements Exelon fleet program document CC-AA-118 (Reference 45) which contains governing criteria and detailed requirements. The key elements of the program include:

- Summary of the Dresden FLEX strategies
- Maintenance of the FSGs including any impacts on the interfacing procedures (DEOPs, DOPs, DOSs, etc.)
- Maintenance and testing of FLEX equipment (i.e., SFP level instrumentation, emergency communications equipment, portable FLEX equipment, FLEX support equipment, and FLEX support vehicles)
- Portable equipment deployment routes, staging areas, and connections to existing mechanical and electrical systems
- Validation of time critical operator actions
- The FLEX Storage Buildings and the Regional Response Center
- Supporting evaluations, calculations, and FLEX drawings

- Tracking of commitments and FLEX equipment unavailability
- Staffing and Training
- Configuration Management
- Program Maintenance

The instructions required to implement the various elements of the FLEX Program at Dresden and ensure readiness in the event of a BDBEE are contained in Exelon fleet program document CC-AA-118, "Diverse and Flexible Coping Strategies" (FLEX) and Spent Fuel Pool Instrumentation Program Document (Reference 45).

Design control procedure CC-AA-102, "Design Input and Configuration Impact Screening" (Reference 47) 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.

Design control procedure CC-AA-309-101, "Engineering Technical Evaluations" (Reference 48) has been revised to ensure technical evaluations are performed when new information is received that potenetially challenges the conservatism of current external event design assumptions.

Future changes to the FLEX strategies may be made without prior NRC approval provided:

1) Revised FLEX strategies meet the requirements of NEI 12-06 (Reference 2) or a previously approved alternate approach,

And

2) An engineering basis is documented that ensures that the change in FLEX strategies continues to ensure the key safety functions (core and SFP cooling, containment integrity) are met.

2.18.2 Procedural Guidance

The inability to predict actual plant conditions that require the use of BDB equipment makes it impossible to provide specific procedural guidance. As such, the FSGs will 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 BDB external event conditions, and are not used inappropriately in lieu of existing procedures. When FLEX equipment is needed to accomplish FLEX strategies or supplement EOPs, the ELAP flowchart, EOP, Severe Accident Mitigation Guidelines (SAMGs), or Extreme Damage Mitigation Guidelines (EDMGs) will direct the entry into and exit from the appropriate FSG procedure.

FLEX strategy support guidelines have been developed in accordance with BWROG guidelines. FLEX Support Guidelines will provide available, pre-planned FLEX strategies for accomplishing specific tasks. FSGs will be used to supplement (not replace) the existing procedure structure that establishes command and control for the event. See Figure 45 for a listing of Dresden FSGs.

Procedural interfaces have been incorporated into FSG-01, "Extended Loss of AC Power/Loss of Ultimate Heat Sink Flowchart" to the extent necessary to include appropriate reference to FSGs and provide command and control for the ELAP.

Changes to FSGs are controlled by Exelon fleet procedure AD-AA-101, Processing of Procedures and T&RMs (Reference 49). 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 has been accomplished in accordance with the guidelines provided in NEI APC 14-17, FLEX Validation Process, issued July 18, 2014.

2.18.3 Staffing

Using the methodology of NEI 12-01, Guideline for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities (Reference 7), an assessment of the capability of Dresden on-shift staff and augmented Emergency Response Organization (ERO) to respond to a BDBEE was performed (Reference 71).

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

1) an extended loss of AC power (ELAP)
2) an extended loss of access to ultimate heat sink (UHS)
3) impact on units (the unit is in operation at the time of the event)
4) impeded access to the unit by off-site 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.

Dresden Operations 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) and FSG-01, "Extended Loss of AC Power/Loss of Ultimate Heat Sink Flowchart". Particular attention was given to the sequence and timing of each procedural step, its duration, and the on-shift individual performing the step to account for both the task and time motion analyses of NEI 10-05, Assessment of On-Shift Emergency Response Organization Staffing and Capabilities (Reference 9).

This Phase 2 Staffing Assessment (Reference 71) concluded that the current minimum on-shift staffing as defined in the Emergency Response Plan for Dresden, as augmented by site auxiliary personnel, is sufficient to support the implementation of the FLEX strategies, as well as the required Emergency Plan actions, with no unacceptable collateral duties.

The Phase 2 Staffing Assessment (Reference 71) 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 Dresden site resources, supplemented by Exelon fleet resources, as necessary.

2.18.4 Training

Dresden's Nuclear Training Program has been revised to assure personnel proficiency in the mitigation of BDB external events is adequate and maintained. These programs and controls were developed and have been implemented in accordance with the Systematic Approach to Training (SAT) Process.

Using the SAT process, Job and Task analyses were completed for the new tasks identified applicable to the FLEX Mitigation Strategies. Based on the analysis, training for Operations was designed, developed and implemented for Operations continuing training. "ANSI/ANS 3.5, Nuclear Power Plant Simulators for use in Operator Training" (Reference 72) certification of simulator fidelity is considered to be sufficient for the initial stages of the BDB external event scenario training. Full scope simulator models have not been explicitly upgraded to accommodate FLEX training or drills. Overview training on FLEX Phase 3 and associated equipment from the SAFER NSRCs was also provided to Dresden operators. 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.

Initial training has been provided and periodic training will be provided to site emergency response leaders on BDB emergency response strategies and implementing guidelines. Continuing training including FLEX drills has been incorporated into EP-AA-122, Drills and Exercise Program (Reference 50). Personnel assigned to direct the execution of mitigation strategies for BDB external events have received the necessary training to ensure familiarity with the associated tasks, considering available job aids, instructions, and mitigating strategy time constraints.

Where appropriate, integrated FLEX drills will be conducted periodically; with all time-sensitive actions evaluated over a period of not more than eight years. It is not required to connect/operate temporary/permanently installed equipment during these drills. Dresden has incorporated FLEX drills into the Drill and Exercise program per EP-AA-122 (Reference 50).

2.18.5 Equipment List

The equipment stored and maintained in the FLEX Storage Buildings and various pre-staged locations at Dresden necessary for the implementation of the FLEX strategies in response to a BDB external event are listed in Table 11 (Reference 41). Table 11 identifies the quantity, applicable strategy, and capacity/rating for the major BDB/FLEX equipment components only. Details regarding fittings, tools, hose lengths, consumable supplies, etc., are not in Table 11 but are detailed in DOS 0010-43 Operations FLEX Equipment Inventory (Reference 73).

Table 11 – Major BDB/FLEX equipment

Phase	Description of Equipment	Strategy

Phase	Description of Equipment	Strategy
2	Four (4) Hydro-Aire FLEX Pumps (pre-staged motor driven approx. 1000 gpm)	Core, SFP
2	Two (2) 800 KW 480V AC diesel generators	Core, SFP, Instrumentation, Accessibility
2	Two (2) Submersible Pumps (pump water from Ultimate Heat Sink) – also referred to as the CCSW Emergency Pumps	Core, SFP, Containment
2	Two (2) Temporary Power Distribution Units (TPDU)	Core, SFP, Instrumentation, Accessibility
2	Three (3) Bus Connection Devices (BCD)	Core, SFP, Instrumentation, Accessibility
2	Portable instrumentation power supply (Fluke 707 or equivalent)	Core, Instrumentation, Containment
2	Two (2) Godwin/Xylem HL-150M Diesel Driven skid mounted pumps (support the flood strategy)	Core, SFP, Containment
2	Barge (floating work platform for Flood Pumps – HL150M)	Core, SFP, Containment
2	F-750 Stake Bed Truck with plow	Accessibility
2	Mobile Crane (supports deployment of Submersible pumps)	Core, SFP, Containment
2	Six (6) Yanmar YDG5500EV Portable Generators	Accessibility
2	Six (6) 42" Fans (CFM is 13,300 on high and 9,500 on low speed)	Accessibility
2	Ten (10) 1HP motor smoke removal type fans - includes 20' of lightweight flexible tubing	Accessibility
2	Three (3) explosion proof smoke removal type fans – includes lightweight flexible tubing	Accessibility
2	Two (2) Park-it Dollies	Accessibility
3	Equipment available from the SAFER Response Centers is listed in CC-DR-118-1001	Core, SFP, Containment, Accessibility

2.18.6 N + 1 Equipment Requirement

NEI 12-06 (Reference 2) invokes an N+1 requirement for the major BDB FLEX equipment that directly performs a FLEX mitigation strategy for core cooling, containment, or SFP cooling in order to assure reliability and availability of the

FLEX equipment required to meet the FLEX strategies. Sufficient equipment has been purchased 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 equipment required by FLEX strategies for all units on-site. Therefore, where a single resource is sized to support the required function of both units a second resource has been purchased to meet the +1 capability. In addition, where multiple strategies to accomplish a function have been developed, (e.g., two separate means to repower instrumentation) the equipment associated with each strategy does not require N+1 capability.

The N+1 capability applies to the portable FLEX equipment that directly supports maintenance of the key safety functions identified in Table 3-2 of NEI 12-06 (Reference 2). Other FLEX support equipment provided for mitigation of BDB external events, but not directly supporting a credited FLEX strategy, is not required to have N+1 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 has been selected. These hoses and cables are passive components being stored in a protected facility. It is postulated the most probable cause for degradation/damage of these components would occur during deployment of the equipment. Therefore the +1 capability is accomplished by having sufficient hoses and cables to satisfy the N capability + 10% spares or at least 1 length of hose and cable. This 10% margin capability ensures that failure of any one of these passive components would not prevent the successful deployment of a FLEX strategy.

The N+1 requirement does not apply to the BDB FLEX support equipment, vehicles, and tools. However, these items are covered by an 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

Periodic testing and preventative maintenance of the BDB/FLEX equipment conforms to the guidance provided in INPO AP-913 (Reference 33). A fleet procedure has been developed to address Preventative Maintenance (PM) using EPRI templates or manufacturer provided information/recommendations, equipment testing, and the unavailability of equipment.

EPRI has completed and has issued “Preventive Maintenance Basis for FLEX Equipment – Project Overview Report” (Reference 34). Preventative Maintenance Templates for the major FLEX equipment including the portable diesel pumps and generators have also been issued.

The PM Templates include activities such as:

- Periodic Static Inspections
- Fluid analysis
- Periodic operational verifications
- Periodic functional verifications with performance tests

The EPRI PM Templates for FLEX equipment conform to the guidance of NEI 12-06 (Reference 2) providing assurance that stored or pre-staged FLEX equipment are being properly maintained and tested. EPRI Templates are used for equipment where applicable. However, in those cases where EPRI templates were not available, Preventative Maintenance (PM) actions were developed based on manufacturer provided information/recommendations and Exelon fleet procedure ER-AA-200, Preventive Maintenance Program (Reference 51). Refer to Table 12 for an overview. Detailed information on FLEX and FLEX support equipment PM's is contained in FLEX program document CC-DR-118 (Reference 41).

Table 12 – Maintenance Procedures for Flex Equipment

Document No.	Title
SR# 90377	FLEX FLOOD PUMP PM's
SR# 90377	FLEX PUMP PM's
SR# 90377	FLEX DG PM's
SR# 90377	FLEX CARRY DECK CRANE PM'S
SR# 90377	FLEX PORTABLE DIESEL GENERATORS
DOS 1500-19	OPERATION OF THE DRESDEN LOCK AND DAM FAILURE CCSW EMERGENCY PUMP
OPERATOR ROUNDS PROGRAM	WEEKLY FLEX EQUIPMENT INSPECTION
DOS 0010-47	MONTHLY FLEX INSPECTION (SR# 90355)
DOS 0010-36	OPERATIONS SUPPORT EQUIPMENT INSPECTION
DOS 0010-43	OPERATIONS FLEX EQUIPMENT INSPECTION (SR# 90354)
WO 1871544	4 YEAR SNOW REMOVAL PLAN VERIFICATION (SR# 90352)
WO 1871545	7 YEAR FLEX PROCEDURE WALKDOWNS (SR# 90353)
SR# 90370	ANNUAL SFPLI INSPECTION AND CALIBRATION
SR# 90372	2Y REPLACE SFPLI BATTERIES
SR# 90373	7Y REPLACE SFPLI TRANSMITTERS
OPERATOR ROUNDS PROGRAM	SFPLI CHANNEL CHECKS

3. References

1 NRC Order EA-12-049, Issuance of Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events, March 12, 2012

2 NEI 12-06, Diverse and Flexible Coping Strategies (FLEX) Implementation Guide, Revision 0, August 2012.

3 NRC 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

4 NRC Order EA-12-051, Issuance of Order to Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation, March 12, 2012

5 NEI 12-02, Industry Guidance for Compliance with NRC Order EA-12-051, "To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation", Revision 1, August 2012

6 NRC JLD-ISG-2012-03, Compliance with Order EA-12-051, Reliable Spent Fuel Pool Instrumentation, Revision 0, August 29, 2012

7 NEI 12-01, Guideline for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities, Revision 0, April 2012

8 Task Interface Agreement (TIA) 2004-04, "Acceptability of Proceduralized Departures from Technical Specification (TSs) Requirements at the Surry Power Station"

9 NEI 10-05, Assessment of On-Shift Emergency Response Organization Staffing and Capabilities

10 Regulatory Guide 1.23, Meteorological Monitoring Programs for Nuclear Power Plants

11 Dresden Units 2 and 3 Technical Specifications

12 Dresden Nuclear Power Station Updated Final Safety Analysis Report (UFSAR), Revision 11.

13 DR-MISC-043 Rev 2, MAAP Analysis to Support FLEX Initial Strategy

14 Calculation 2013-01671, Transient Analysis of HPCI Pump Room for Extended Loss of AC Power

15 ANSI/ANS-5.1-1979, Decay Heat Power in Light Water Reactors

16 DRE14-0008, IC Shell, Spent Fuel Pool and RPV Make-up Requirements under FLEX Scenarios

17 DRE14-0006, FLEX Hydraulic Analysis

18 DRE14-0037, FLEX Diesel Generator Sizing Calculation

19 ANSI/ANS 2.5 (1984) Standard for Determining Meteorological Information at Nuclear Power Sites

20 EC 394206 Revision 3 FUKUSHIMA NRC ORDER EA-12-049: U3 MECHANICAL FLEX MODIFICATIONS

21 Dresden and Quad Cities Licensing bases for SBO, dated May 18, 1990 and Dresden and Quad Cities SER NDIT (DG00-000571)

22 Calculation 3C2/3-0389-001, Loss of Ventilation During a Station Blackout (SBO)

23 Dresden ISE Open Item (ML13220A238) 9/17/15. Audit Item CI 3.2.4.2.B

24 Dresden ISE Open Item (ML13220A238) 9/17/15. Audit Item CI 3.2.4.2.C

25 Dresden ISE Confirmatory Items (ML13220A238) 9/17/15.

26 DRE 03-0026, Intake/Discharge Canal Water Volume

27 BWROG document NEDC-33771P, "GEH Evaluation of FLEX Implementation Guidelines"

28 EXC-WP-06, Exelon Position Paper—ELAP Design Basis

29 Hydrometerological Report 51 and 52, National Oceanic and Atmospheric Administration (NOAA), 1978 and 1982

30 Dresden MSA For Flooding, 6/30/16

31 Vendor Manual, Instruction 01268, Installation—Operating—Servicing for Static Line Voltage Regulators Single and Three Phase

32 DOA 1000-01 Residual Heat Removal Alternatives, Rev 36

33 INPO AP-913, Periodic Testing and Preventative Maintenance of the BDB/FLEX equipment

34 Preventive Maintenance Basis for FLEX Equipment – Project Overview Report (EPRI Report TR-3002000623), September 2013.

35 Not Used

36 EC 391096, Isolation Condenser Pump House Flood Protection

37 EC 391973, Extend 125VDC and 250VDC Battery Coping Time with Load Shedding

38 EC 371913, Revision 2, Time To Boil Curves - OP-DR-104-1001

39 Not Used

40 CC-DR-118-1001, SAFER Response Plan for Dresden Nuclear Power Station, Rev 0

41 CC-DR-118, Site Implementation of Diverse and Flexible Coping Strategies (FLEX) and Spent Fuel Pool Instrumentation Program, Rev 0

42 EP-AA-112-100, Control Room Operations, Rev 14

43 DGP 02-03, Reactor SCRAM, Rev 105

44 DRE16-0011 Rev. 0 Required Ultimate Heat Sink Capacity

45 CC-AA-118, Diverse and Flexible Coping Strategies (FLEX) and Spent Fuel Pool Instrumentation Program Document, Rev 01

46 SA-AA-111—Heat Stress Control, Rev 16

47 CC-AA-102, Design Input and Configuration Change Impact Screening, Rev 29

48 CC-AA-309-101, Engineering Technical Evaluations, Rev 15

49 AD-AA-101, Processing of Procedures and T&RMs, Rev 28
50 EP-AA-122, Drills and Exercise Program, Rev 18
51 ER-AA-200, Preventative Maintenance Program, Rev 2
52 DGA-03, Loss of 250 VDC Battery Chargers with Simultaneous Loss of Auxiliary Electrical Power, Rev 14
53 DGA-12, Loss of Offsite Power, Rev 74
54 DGA-13, Loss of 125 VDC Battery Chargers with Simultaneous Loss of Auxiliary Electrical Power, Rev 20
55 DGA-22, Station Blackout, Rev 1
56 DOA 0010-04, Floods, Rev 45
57 DGP 02-01, Unit Shutdown, Rev 161
58 DOP 1300-03, Manual Operation of the Isolation Condenser, Rev 37
59 DOA 1900-01, Loss of Fuel Pool Cooling, Rev 27
60 NEI Position Paper: "Shutdown/ Refueling Modes," dated September 18, 2013 (ML13273A514).
61 Letter to Mr. J.E. Pollock (NEI) from Mr. J. R. Davis (NRC) dated September 30, 2013 endorsing NEI Shutdown/Refueling Modes Position Paper, (ML13267A382)
62 DOA 5750-01, Ventilation System Failure, Rev 67
63 Electric Power Research Institute (EPRI) Report 30020000704 (Dated May 2013), Seismic Evaluation Guidance: Augmented Approach for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic.
64 NRC Letter to Mr. J. E. Pollock (NEI), Electric Power Research Institute Final Draft Report XXXXXX, "Seismic Evaluation Guidance: Augmented Approach for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic," As An Acceptable Alternative to the March 12, 2012, Information Request for Seismic Reevaluations, May 7, 2013, U.S. Nuclear Regulatory Commission (ML13106A331).
65 Exelon Generation Company, LLC Expedited Seismic Evaluation Process Report (CEUS Sites), Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-Ichi Accident (Exelon Regulatory Correspondence No. RS-14-297, December 26, 2014)
66 NRC Letter to Mr. B. C. Hanson (Exelon Generation Company, LLC), Dresden Nuclear Power Station, Units 2 and 3 – Staff Review of Interim Evaluation Associated with Reevaluated Seismic Hazard Implementation Near-Term Task Force Recommendation 2.1 (TAC Nos. MF5239 and MF5240), June 30, 2015, U.S. Nuclear Regulatory Commission (ML 15173A244)Exelon Generation Company, LLC Letter to USNRC, Response to March 12, 2012 Request for Information Enclosure 2, Recommendation 2.1, Flooding, Required Response 2, Flooding Hazard Reevaluation Report, dated May 10, 2013 (RS-13-110)

67 TODI 14-001 Design and Engineering of FLEX Electrical Modification: Electrical Loads Rev 0. January 9, 2014.

68 EC 398999, Spent Fuel Pool Instrumentation - Fukushima

69 SEP Topic II-2.A Severe Weather Phenomena, December 24, 1980

70 DOS 0010-47, Rev 001, Operations Monthly FLEX Inspections

71 Dresden Station NEI 12-01 Phase 2 Staffing Assessment RS-15-154 June 30, 2015

72 ANSI/ANS 3.5-2009, Nuclear Power Plant Simulators for use in Operator Training.

73 DOS 0010-43, Operations FLEX Equipment Inventory, Revision 001

74 DOA 0010-01, Dresden Lock And Dam Failure, Revision 34

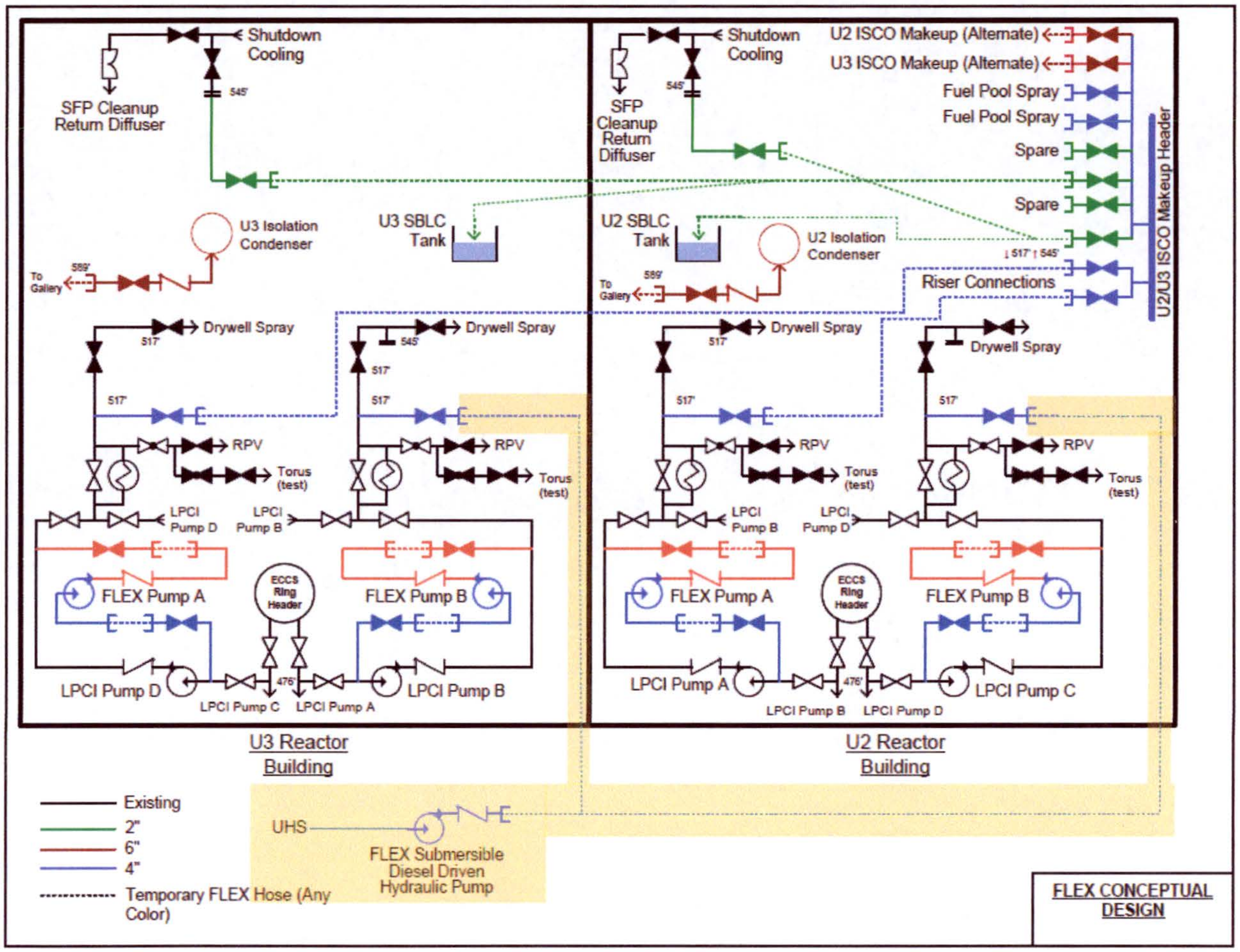


Figure 1: FLEX Hydraulic Conceptual

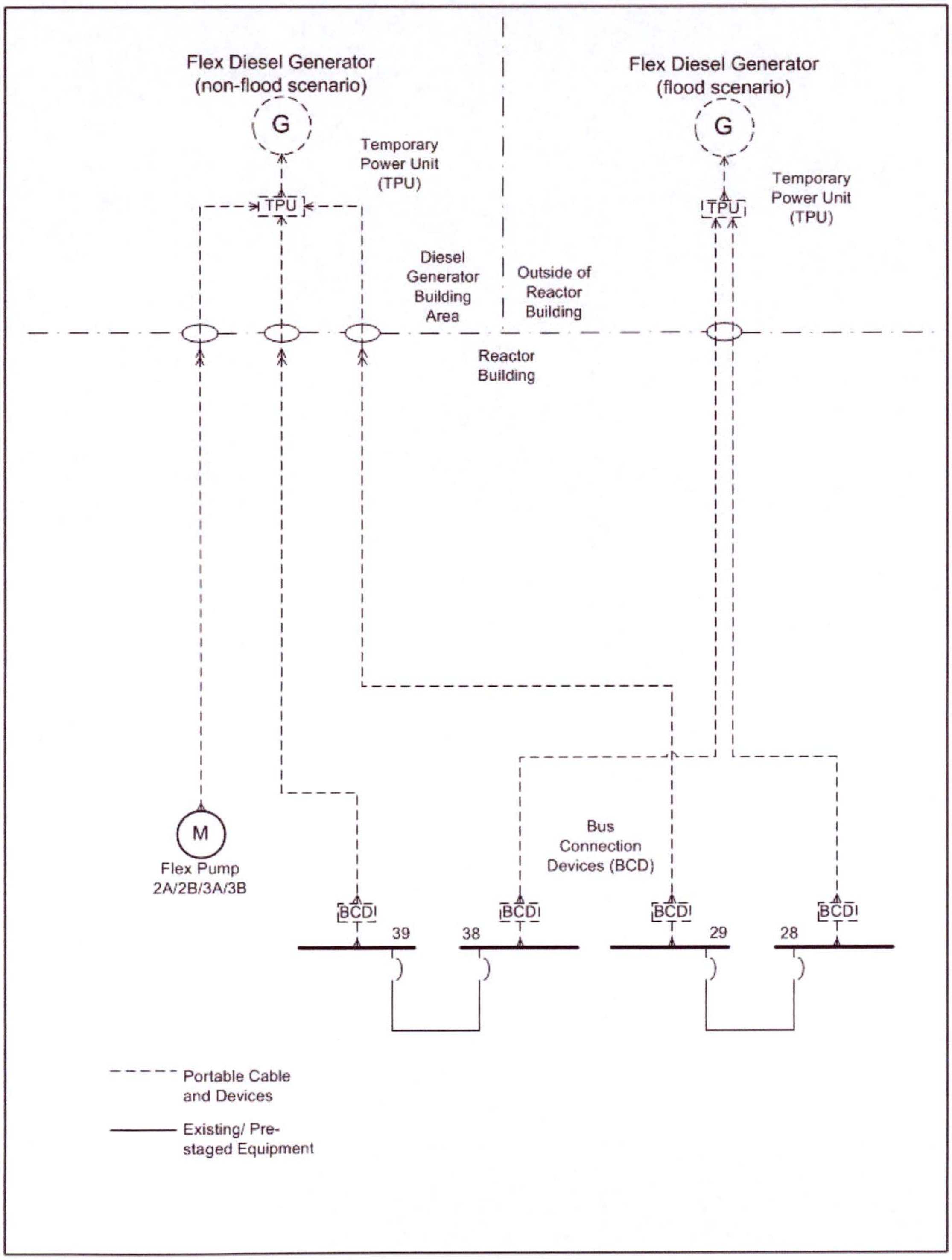


Figure 2: FLEX Electric Conceptual

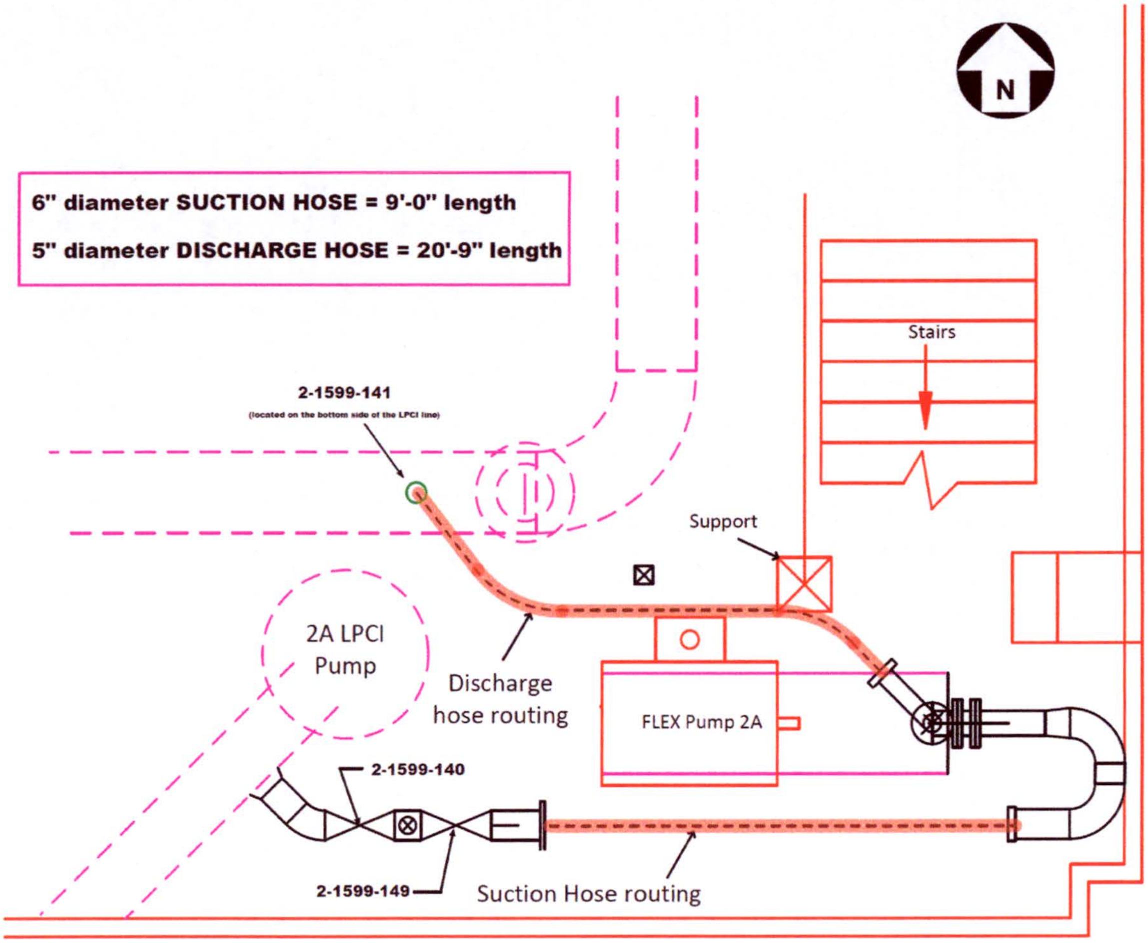


Figure 3: Corner Room Connection

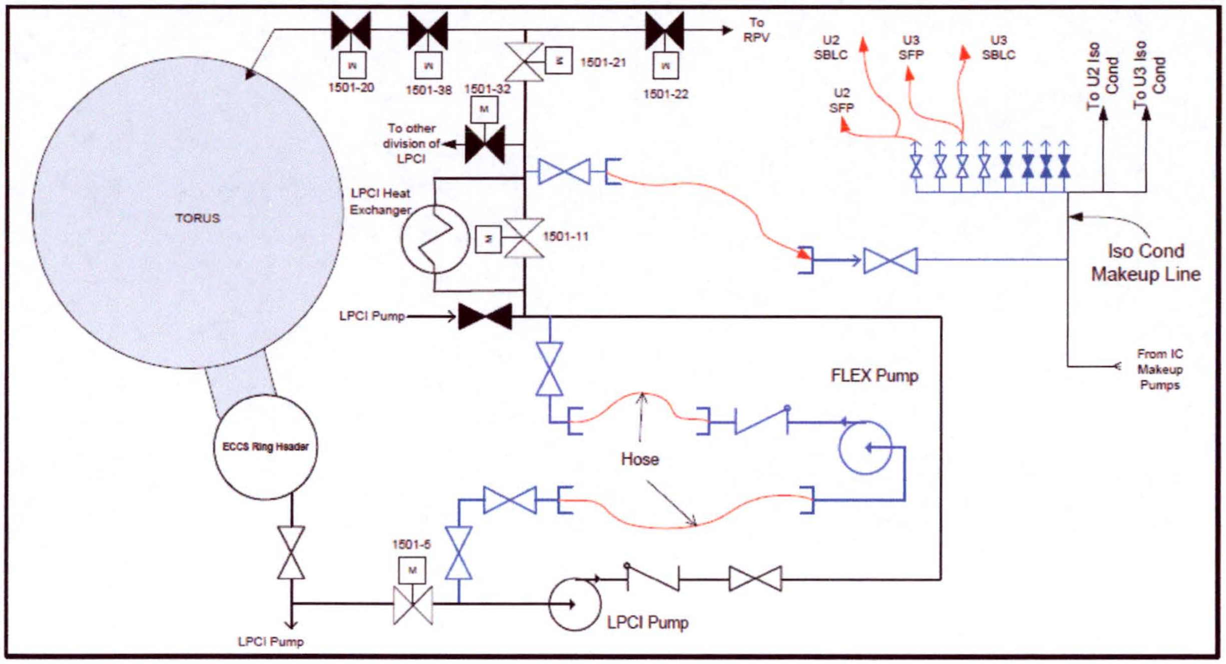


Figure 4: FLEX Hose Connections

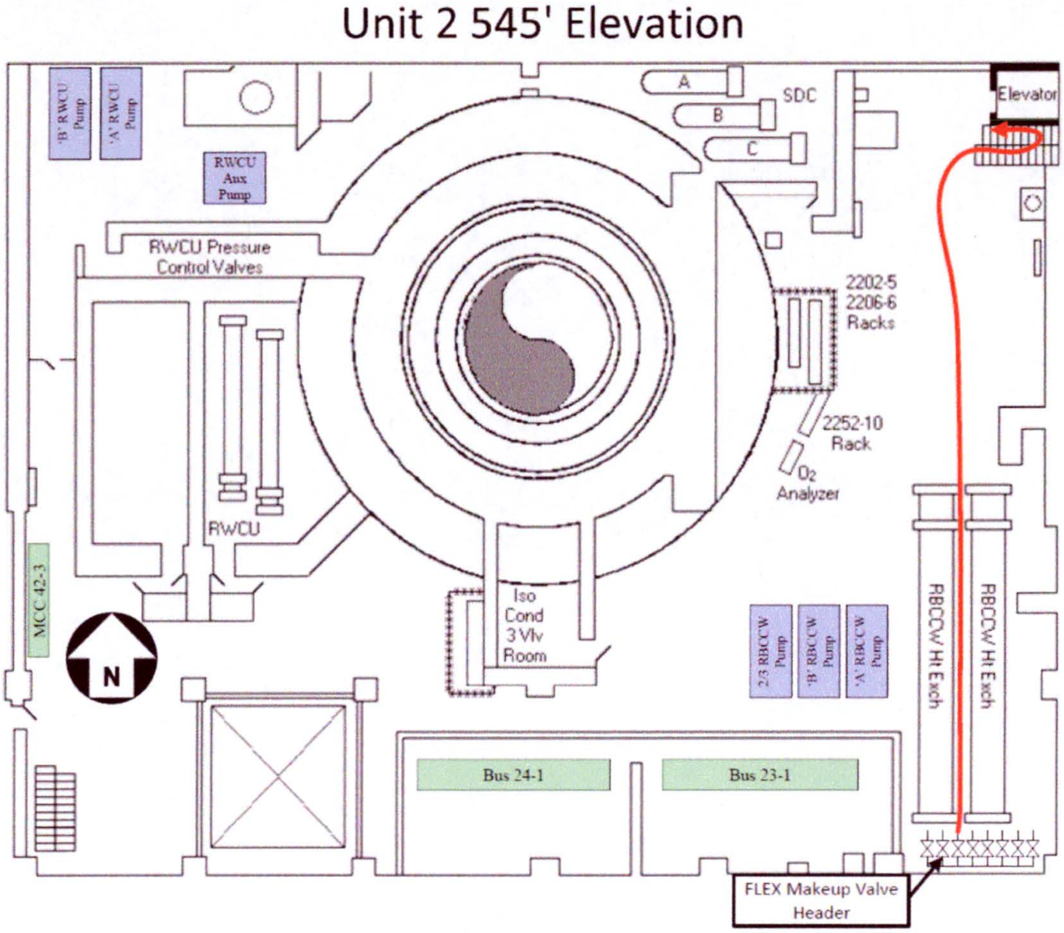


Figure 5: Unit 2 FLEX SBLC Hose Run 545

Unit 2 589' Elevation

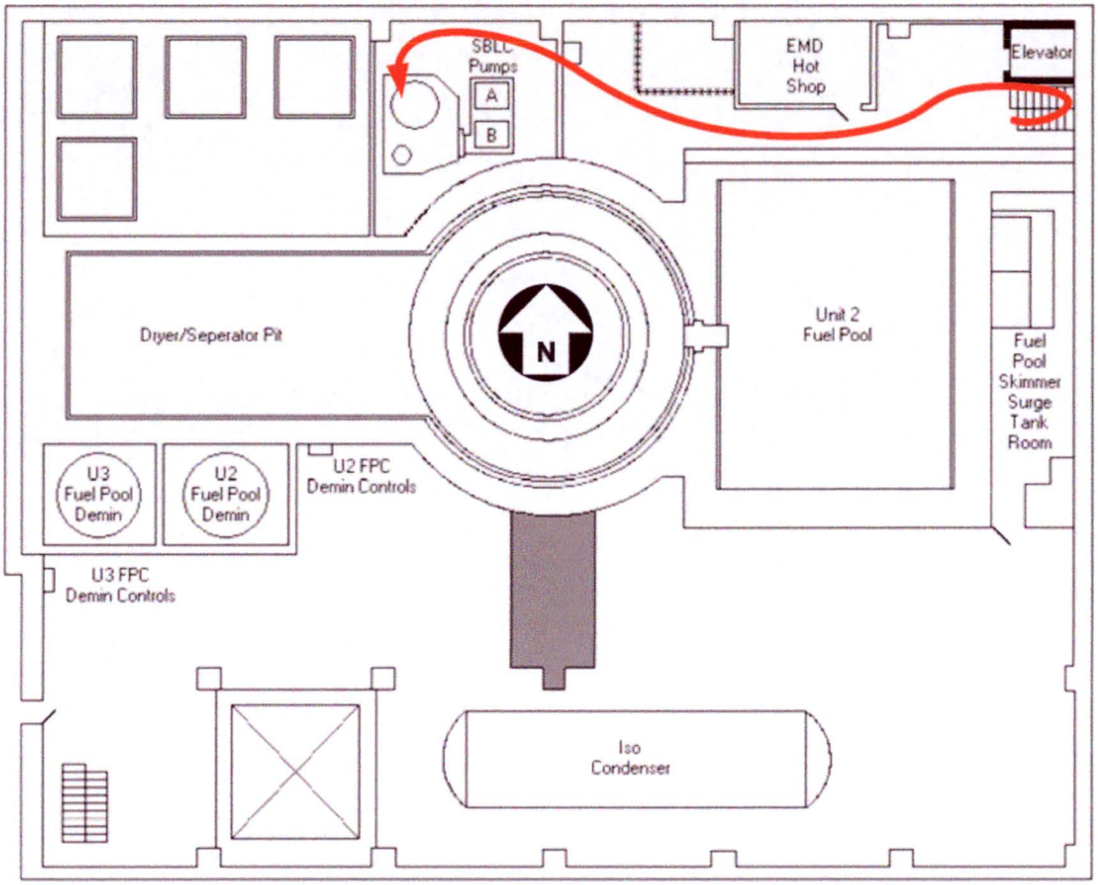


Figure 6: Unit 2 FLEX SBLC Hose Run 589

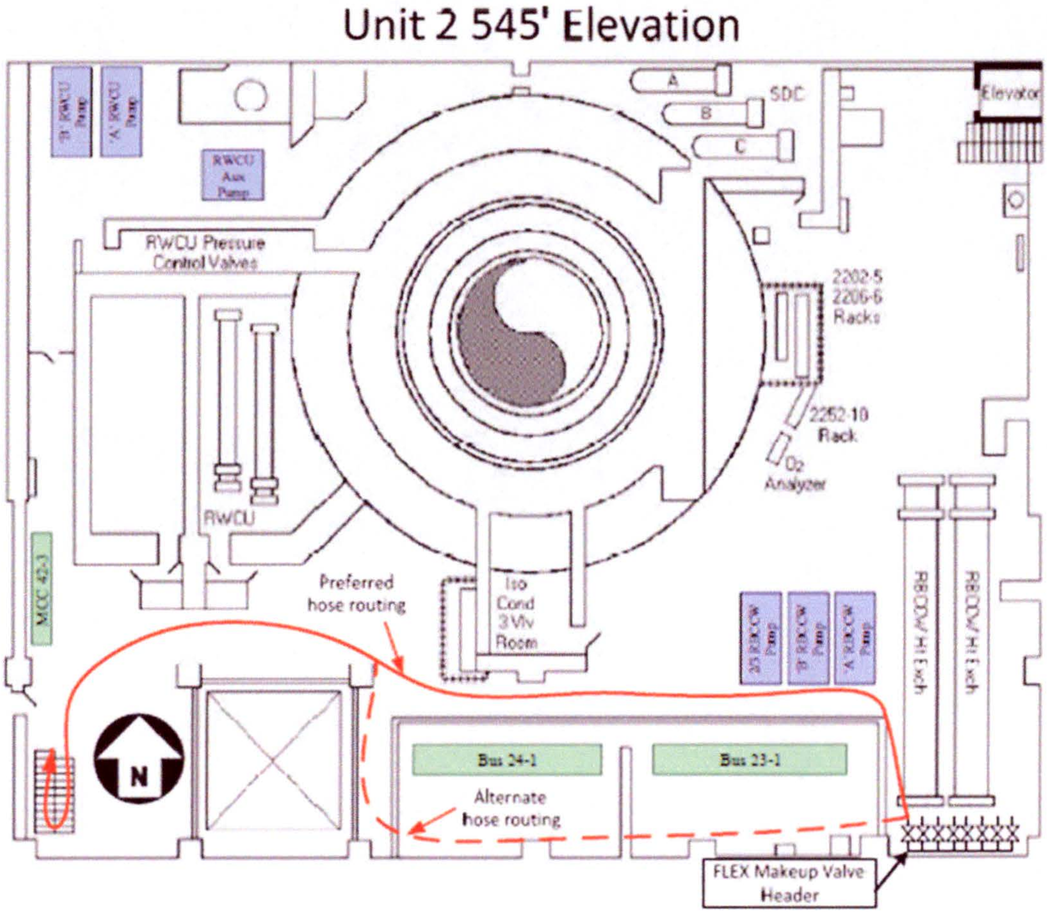


Figure 7: Unit 3 FLEX SBLC Hose Run 545

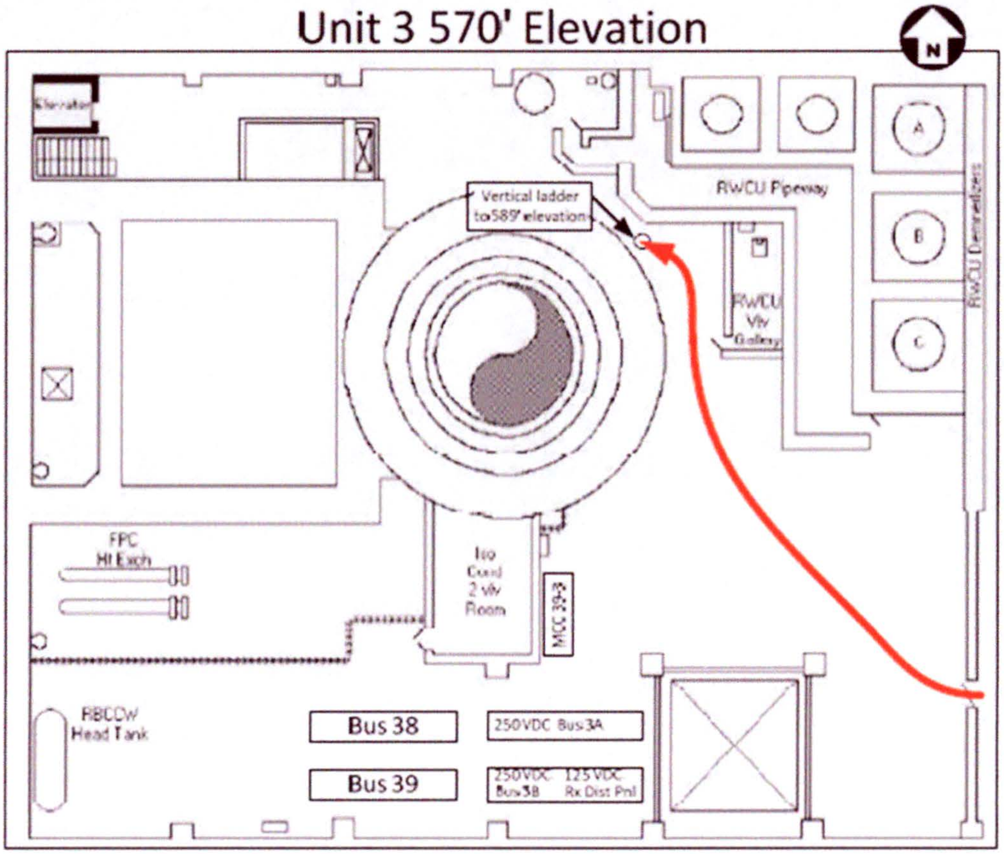
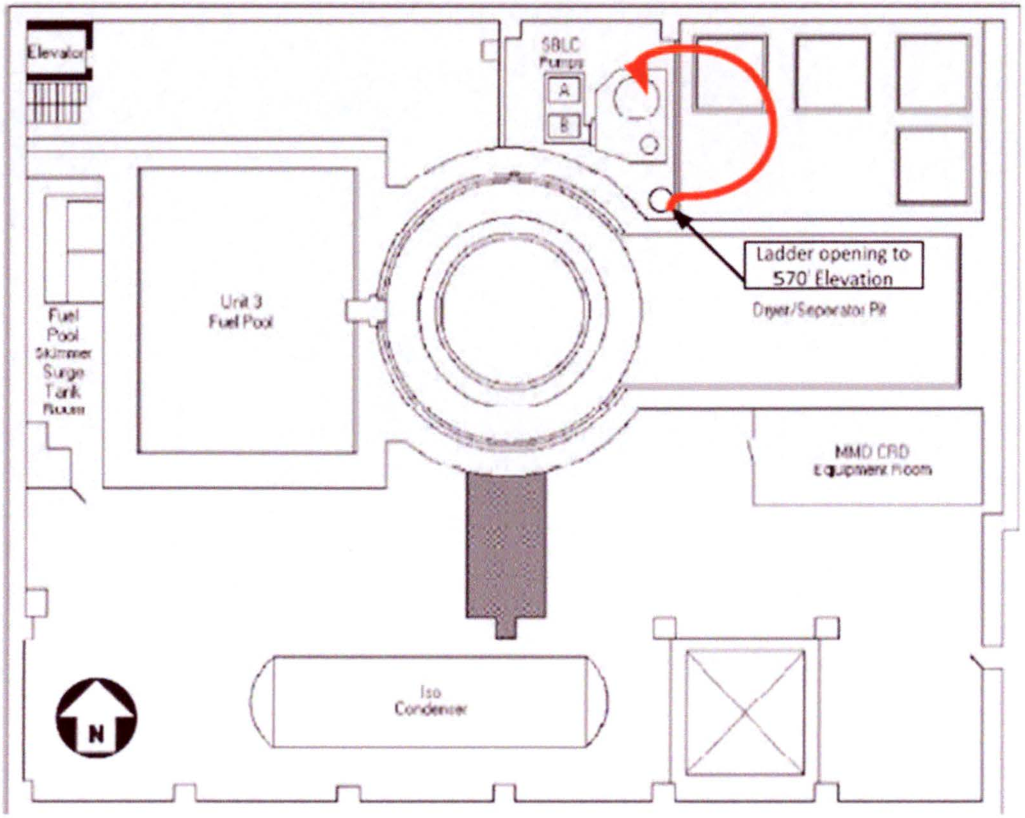


Figure 8: Unit 3 FLEX SBLC Hose Run 570



Unit 3 589' Elevation

Figure 9: Unit 3 FLEX SBLC Hose Run 589

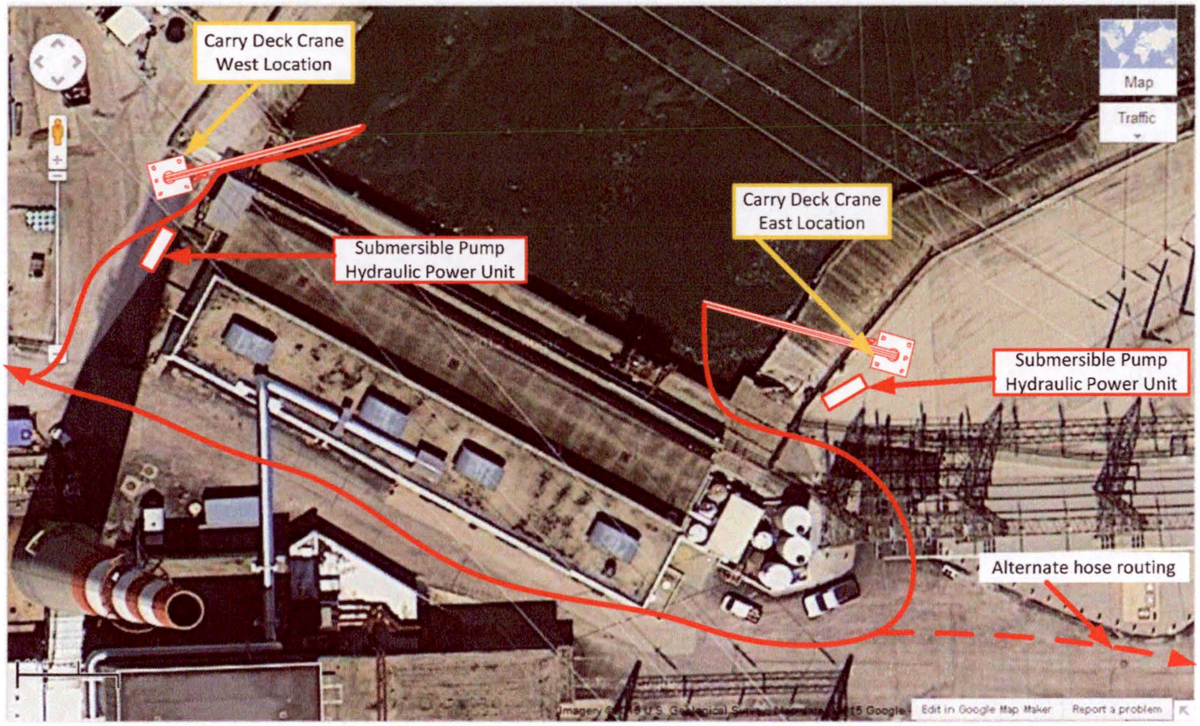


Figure 10: Ultimate Heat Sink Equipment Layout

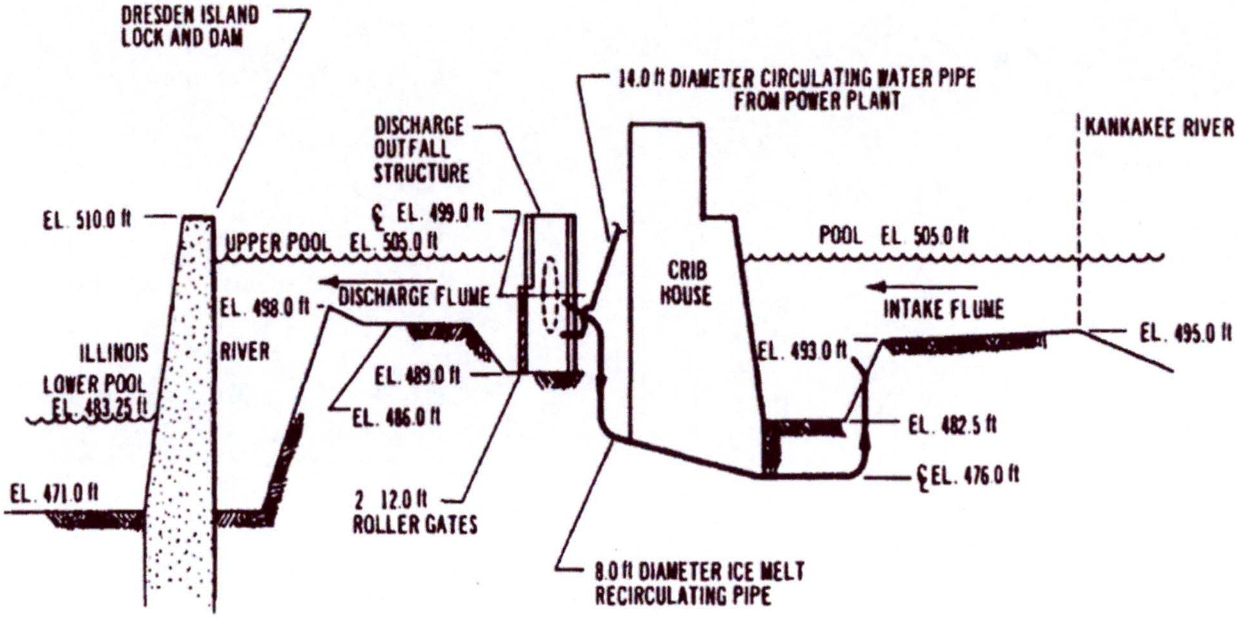
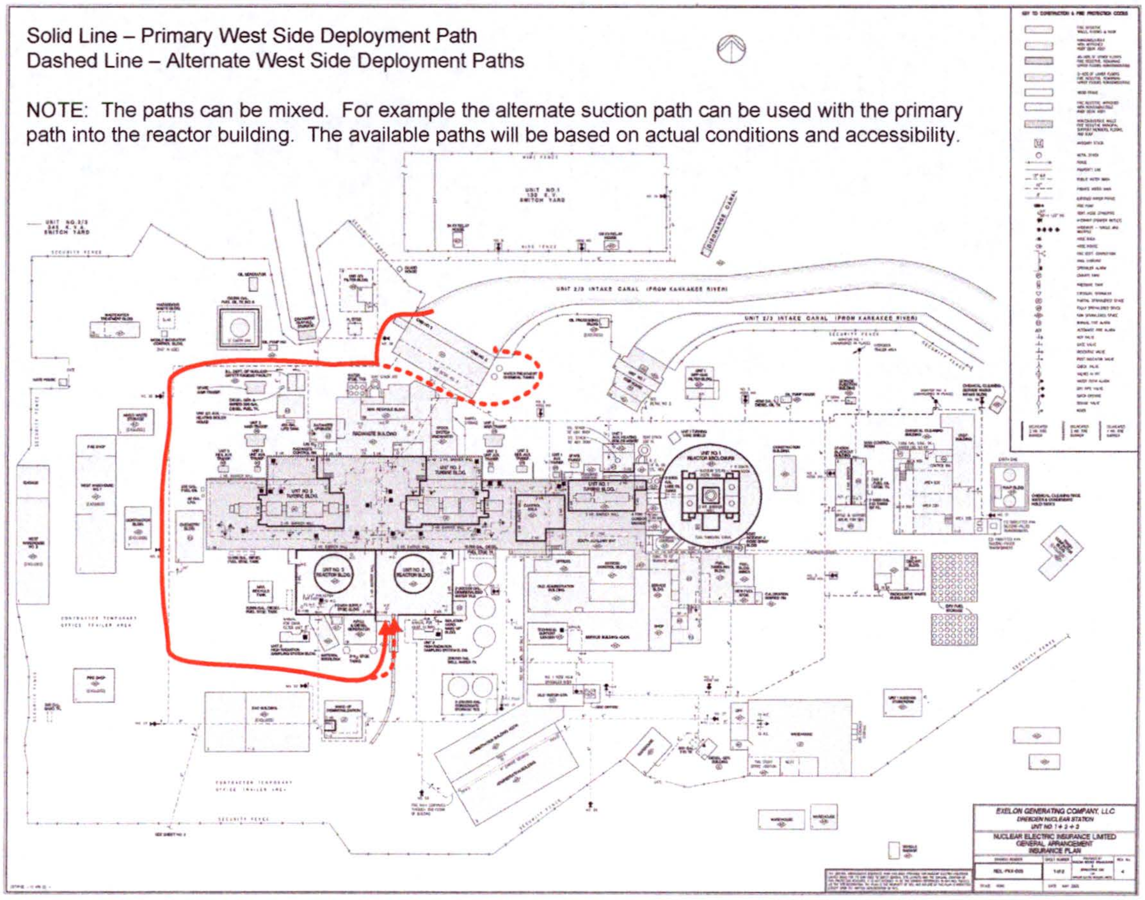


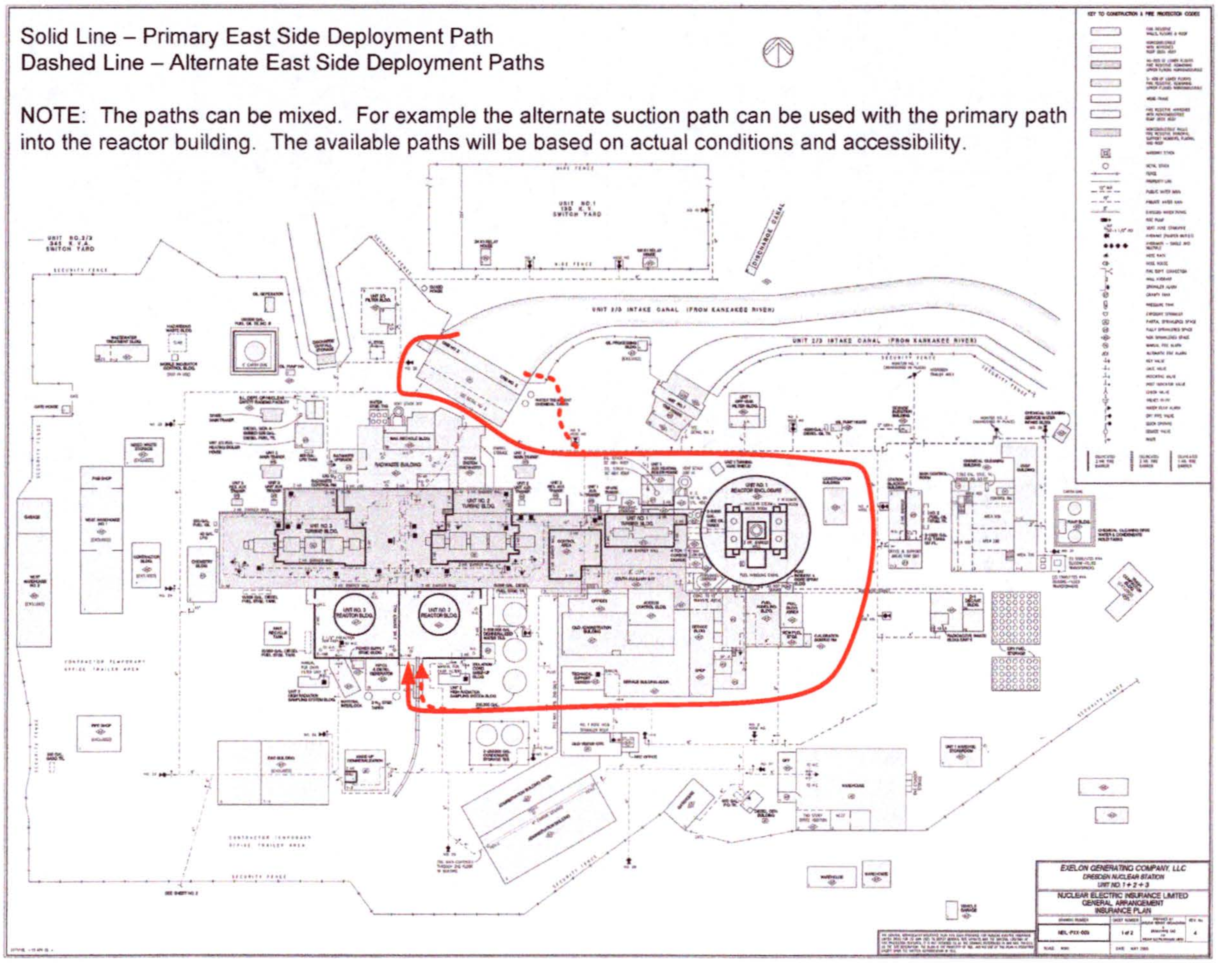
Figure 11: Ultimate Heat Sink



Solid Line – Primary West Side Deployment Path
Dashed Line – Alternate West Side Deployment Paths

NOTE: The paths can be mixed. For example the alternate suction path can be used with the primary path into the reactor building. The available paths will be based on actual conditions and accessibility.

Figure 12: West Side Deployment Paths



Solid Line – Primary East Side Deployment Path
Dashed Line – Alternate East Side Deployment Paths

NOTE: The paths can be mixed. For example the alternate suction path can be used with the primary path into the reactor building. The available paths will be based on actual conditions and accessibility.

Figure 13: East Side Deployment Paths

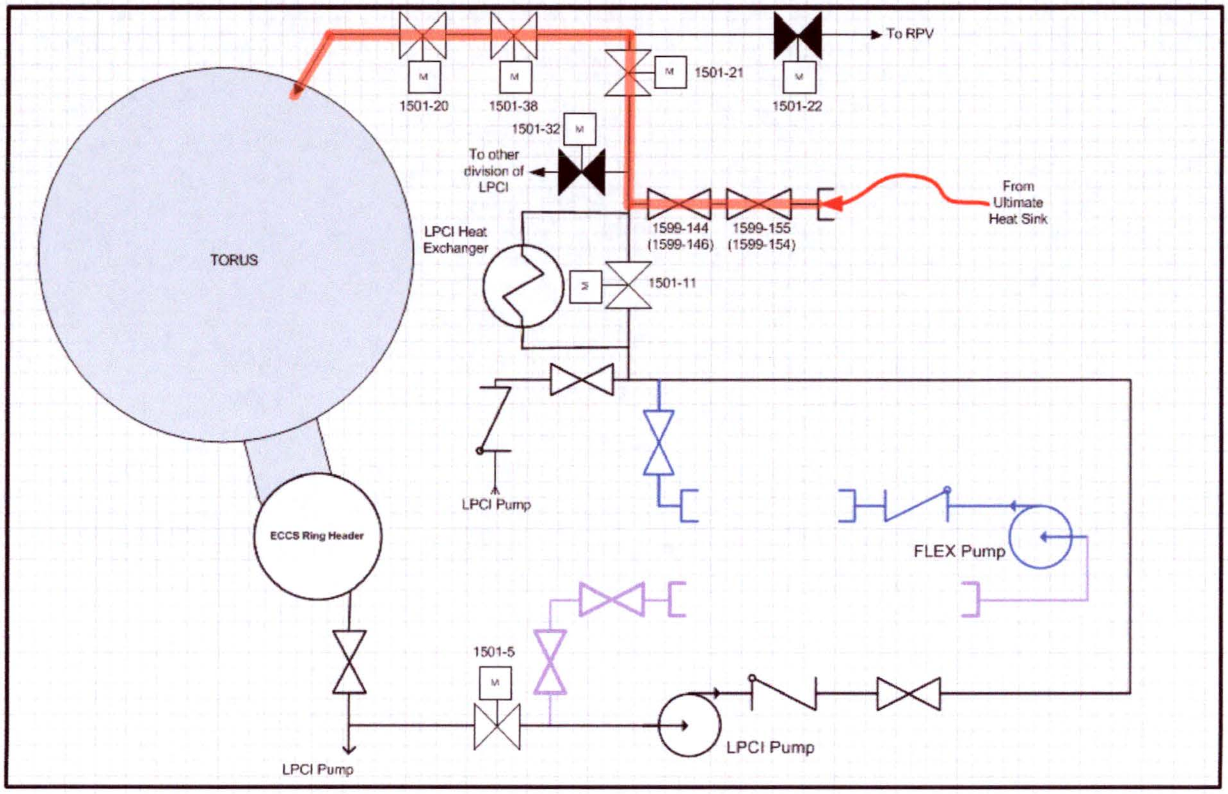


Figure 14: Suppression Pool Make-up Typical

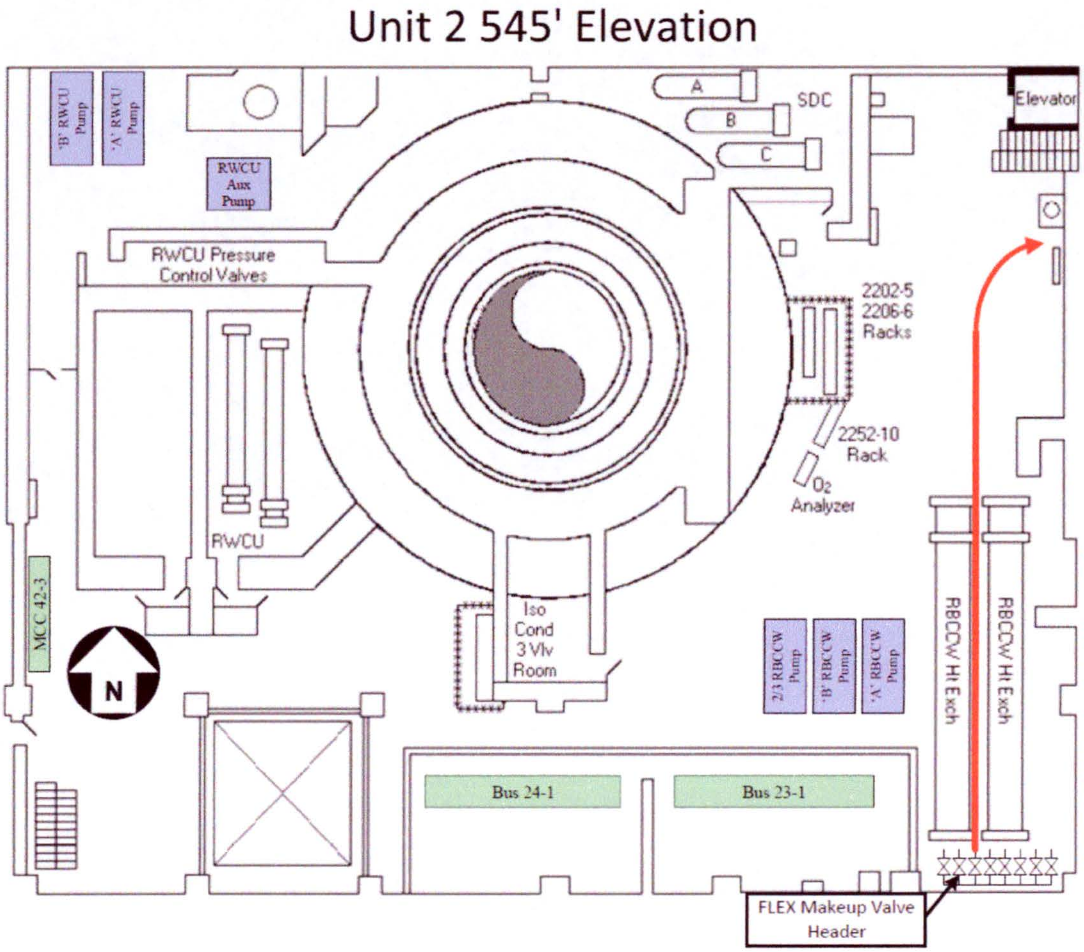


Figure 15: U2 Spent Fuel Pool Connection

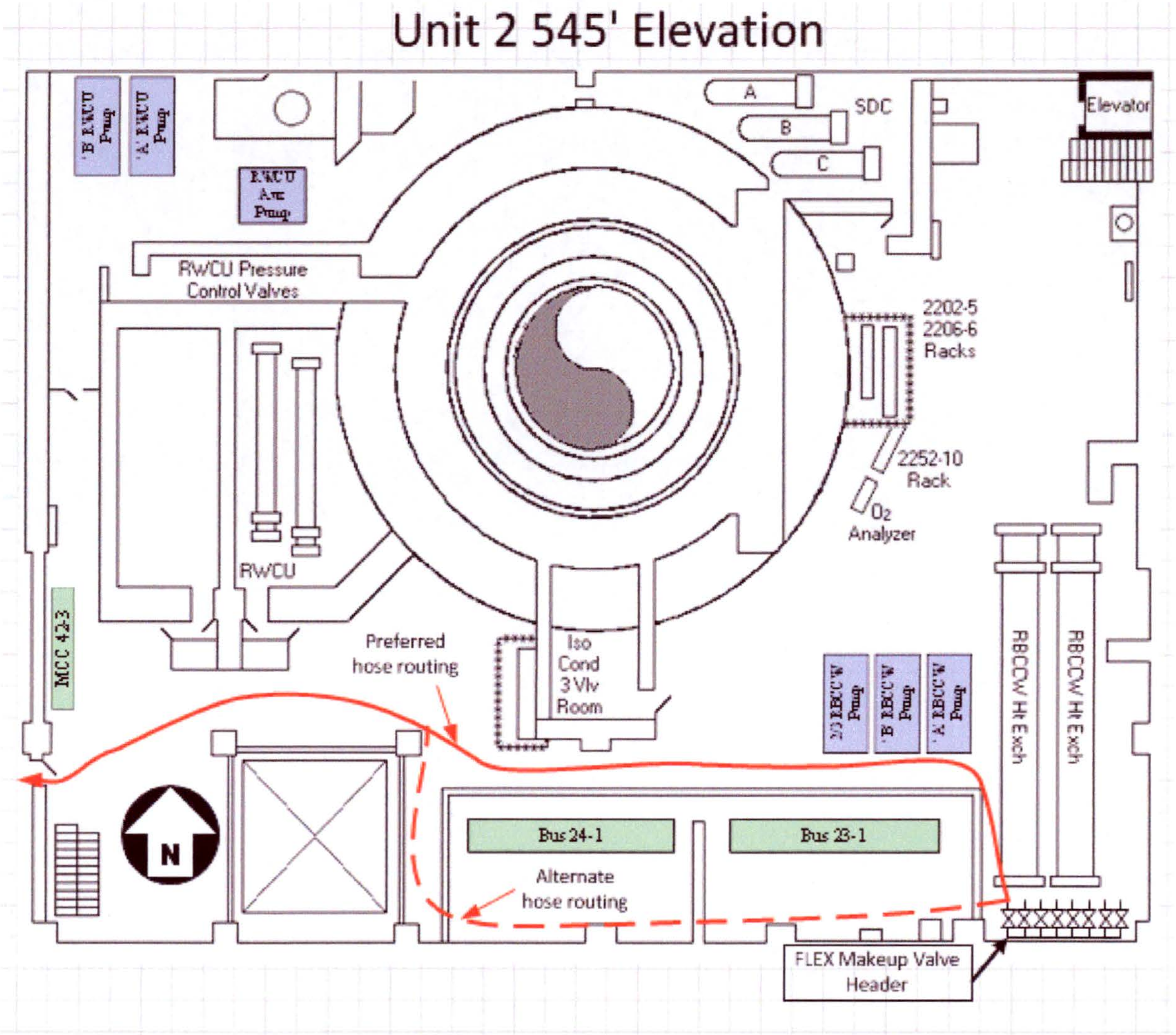


Figure 16: U3 Spent Fuel Pool Connection 545

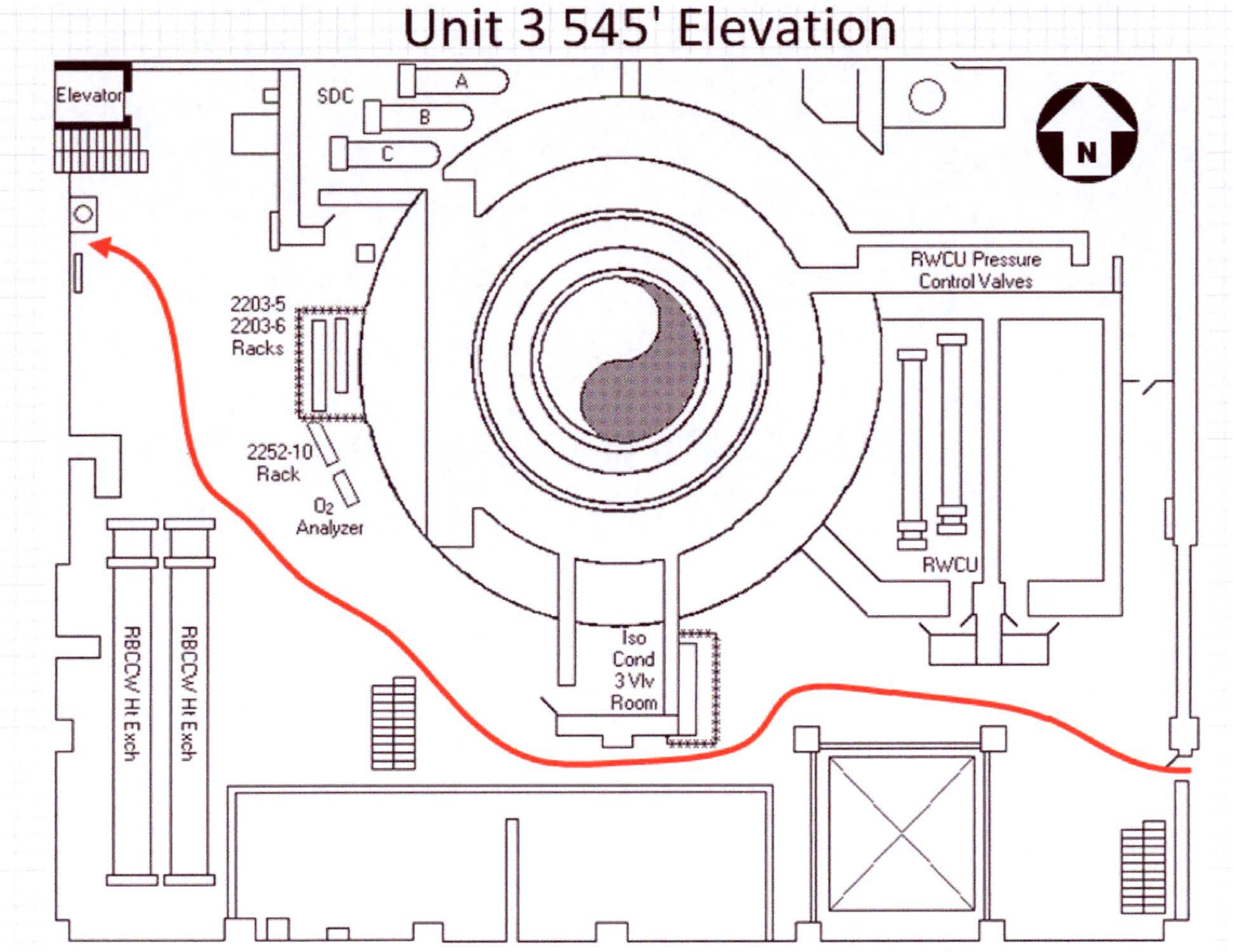
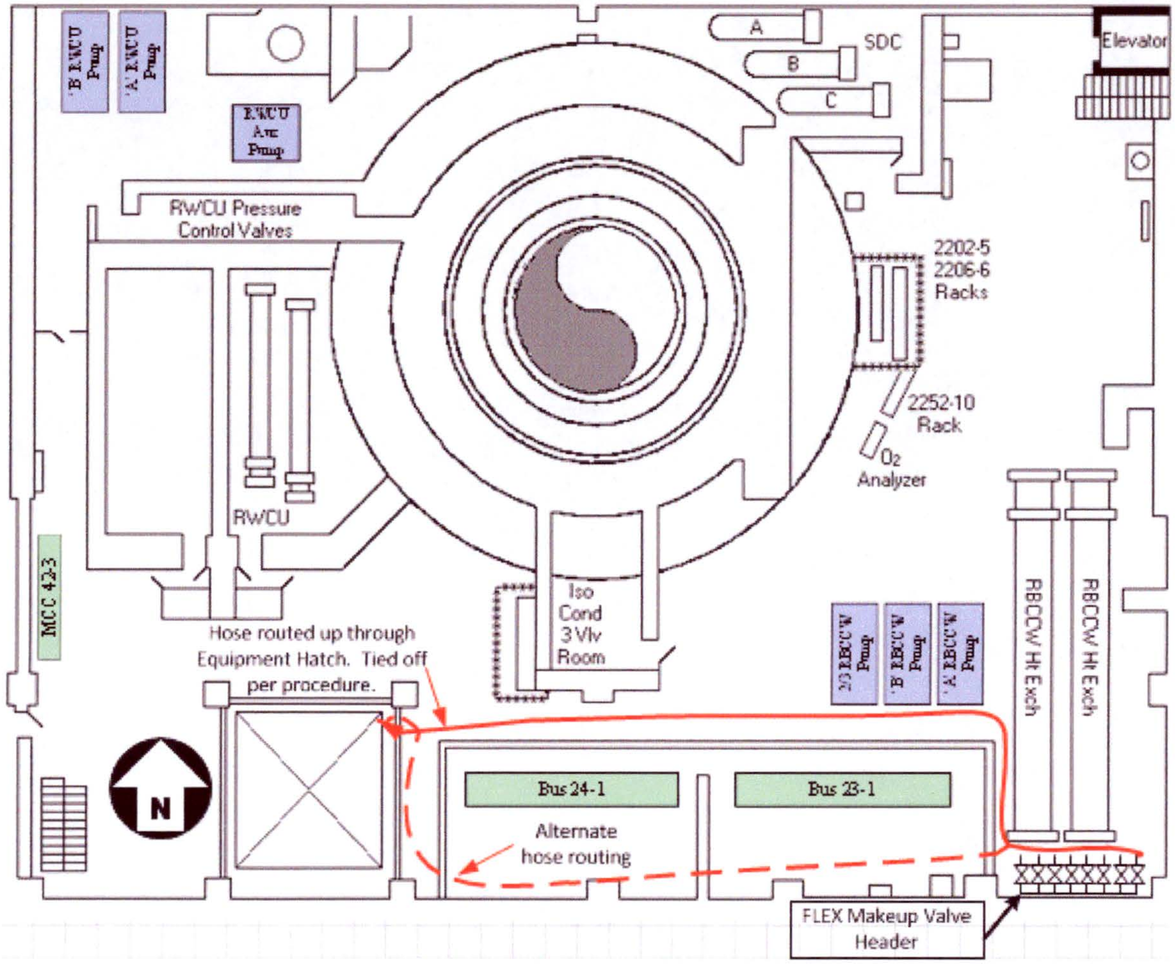
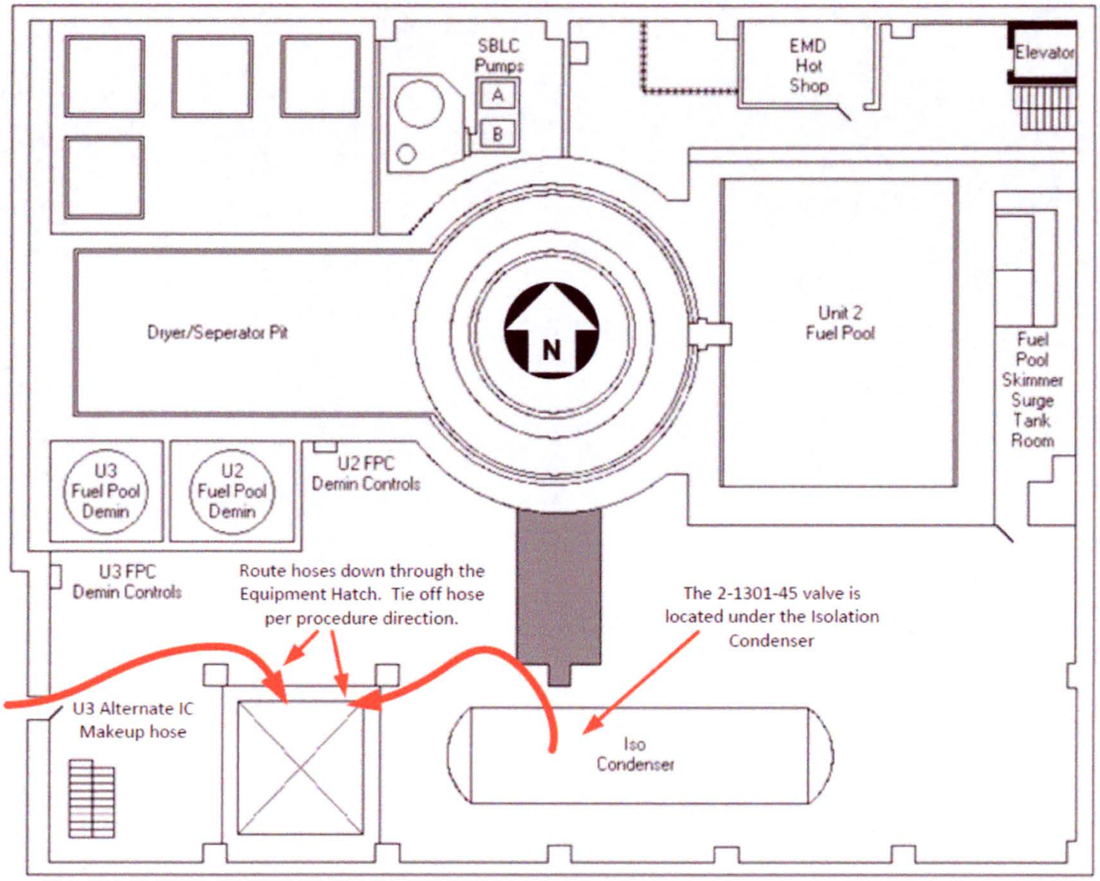


Figure 17: U3 Spent Fuel Pool Connection



Unit 2 545' Elevation

Figure 18: Alternate IC Make-up



Unit 2 589' Elevation

Route hoses down through the Equipment Hatch. Tie off hose per procedure direction.

The 2-1301-45 valve is located under the Isolation Condenser

U3 Alternate IC Makeup hose

Figure 19: U2 Alternate IC Make-up

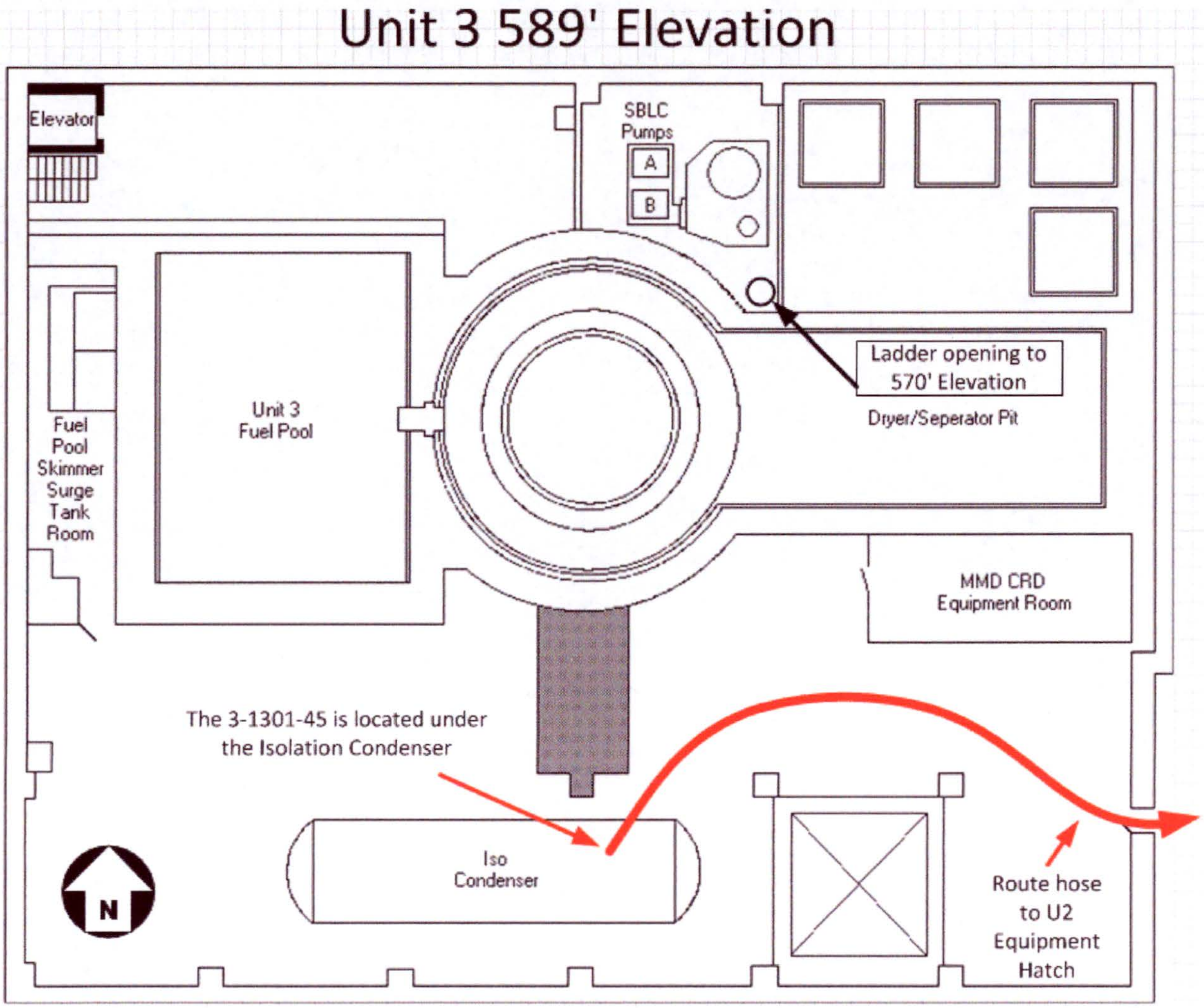


Figure 20: U3 Alternate IC Make-up

U3 Turbine Building 517' elevation

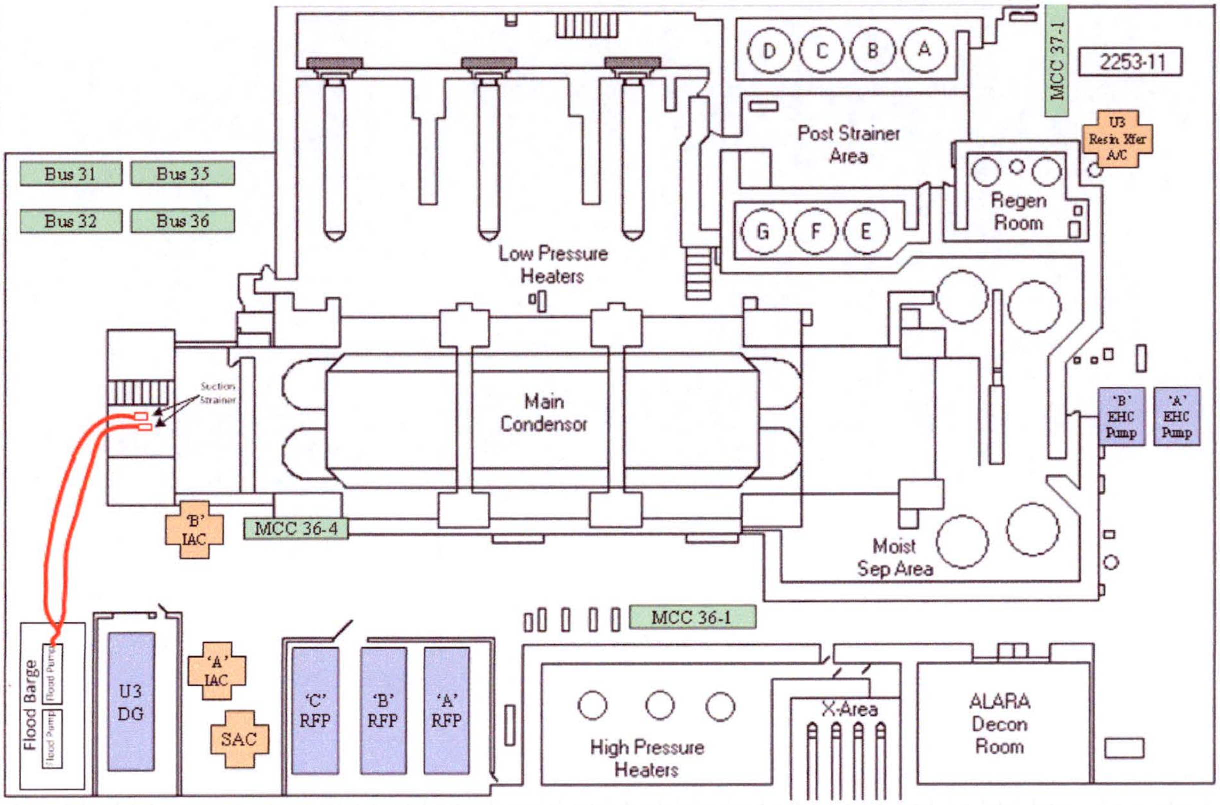


Figure 21: Flood Barge Location

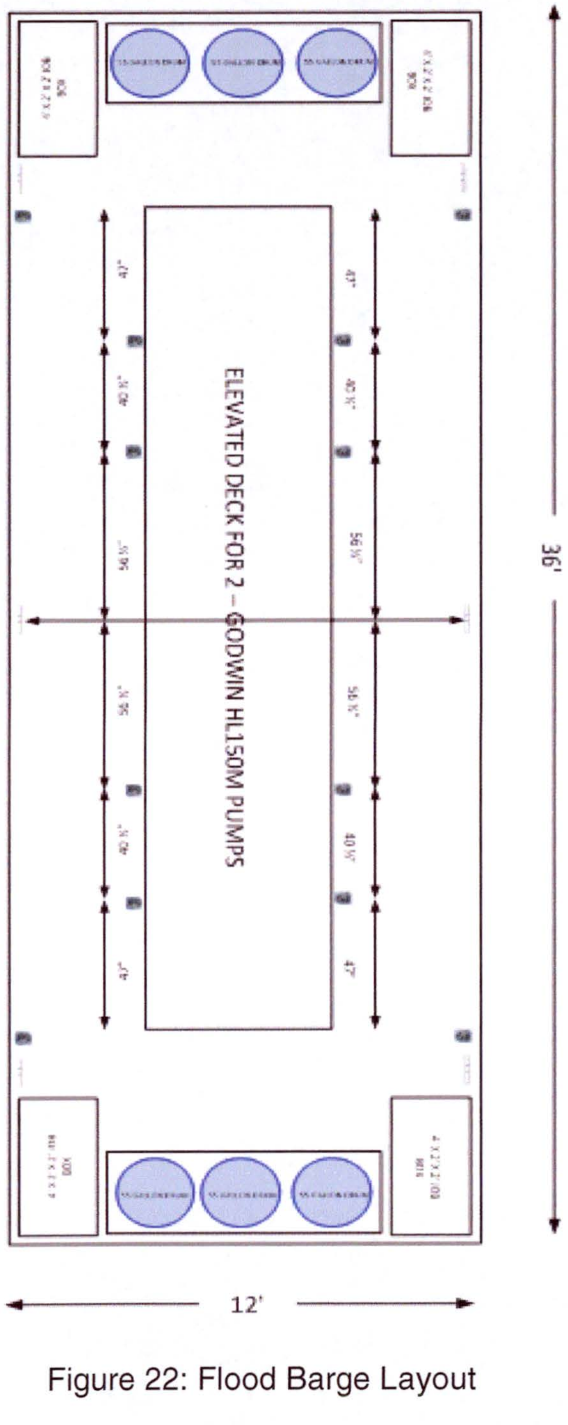


Figure 22: Flood Barge Layout

Figure 23: FLEX Building Locations

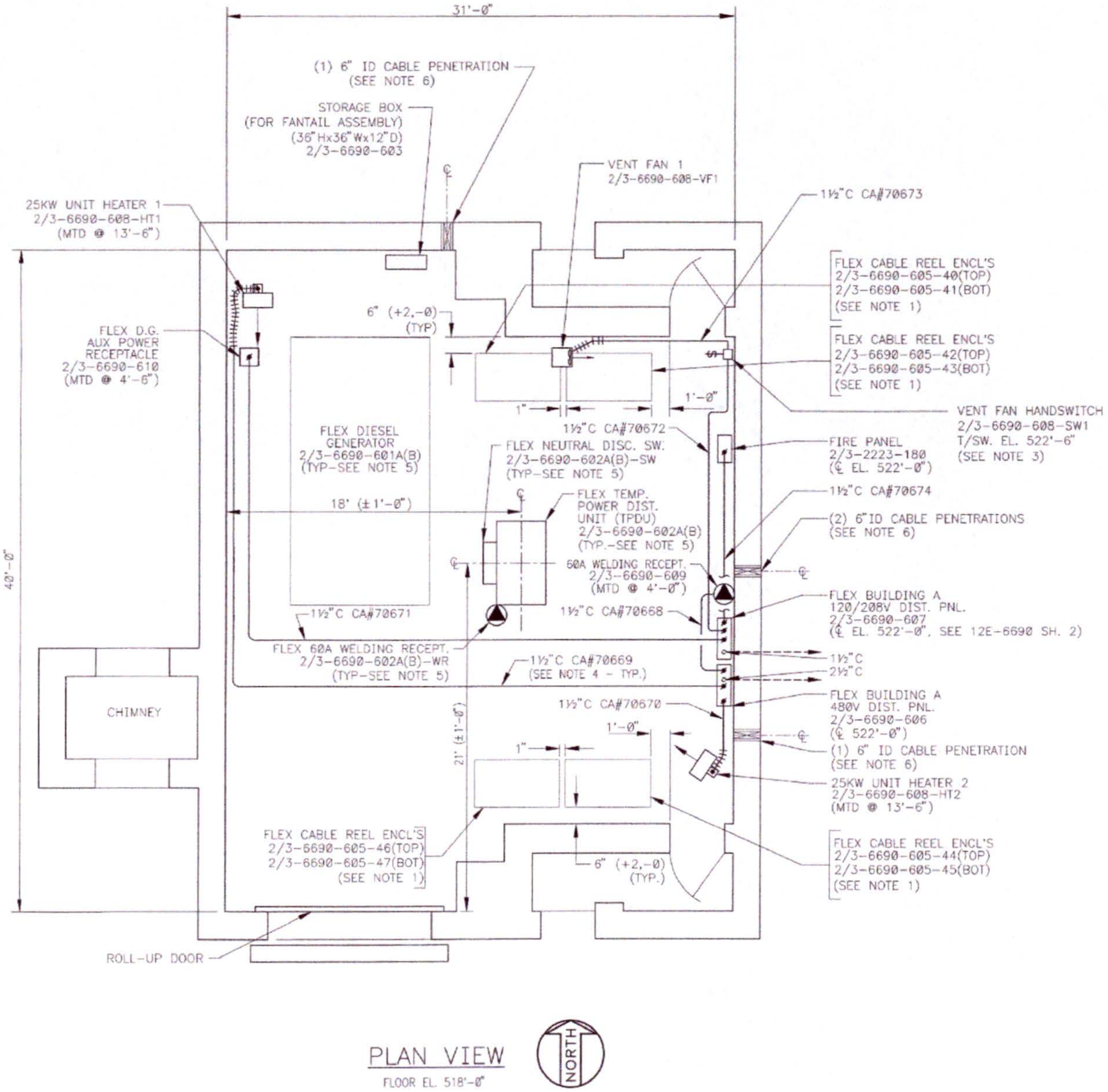


Figure 24: FLEX Building A Robust Enclosure Typical Layout

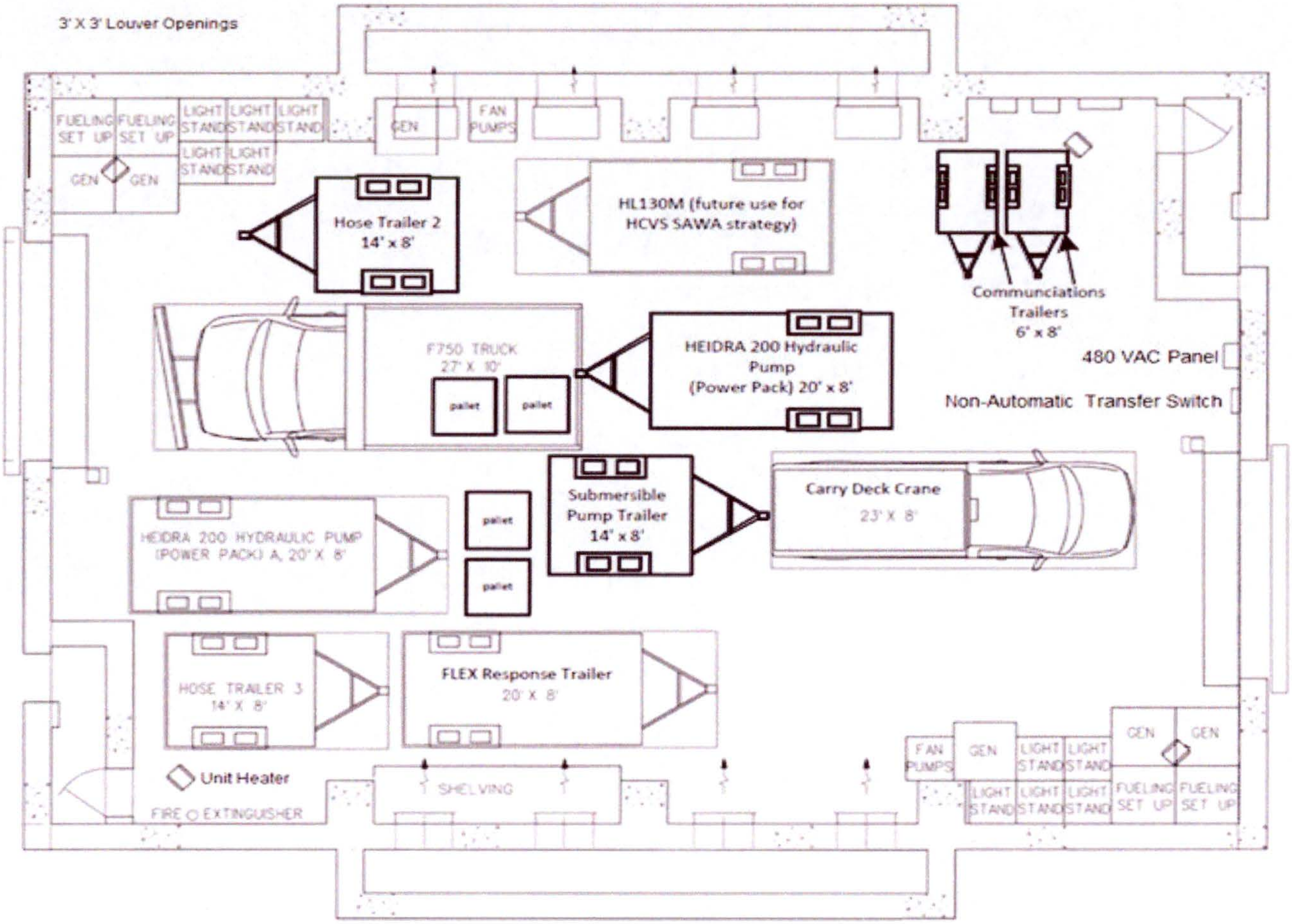


Figure 25: FLEX Building B Robust Enclosure Typical Layout

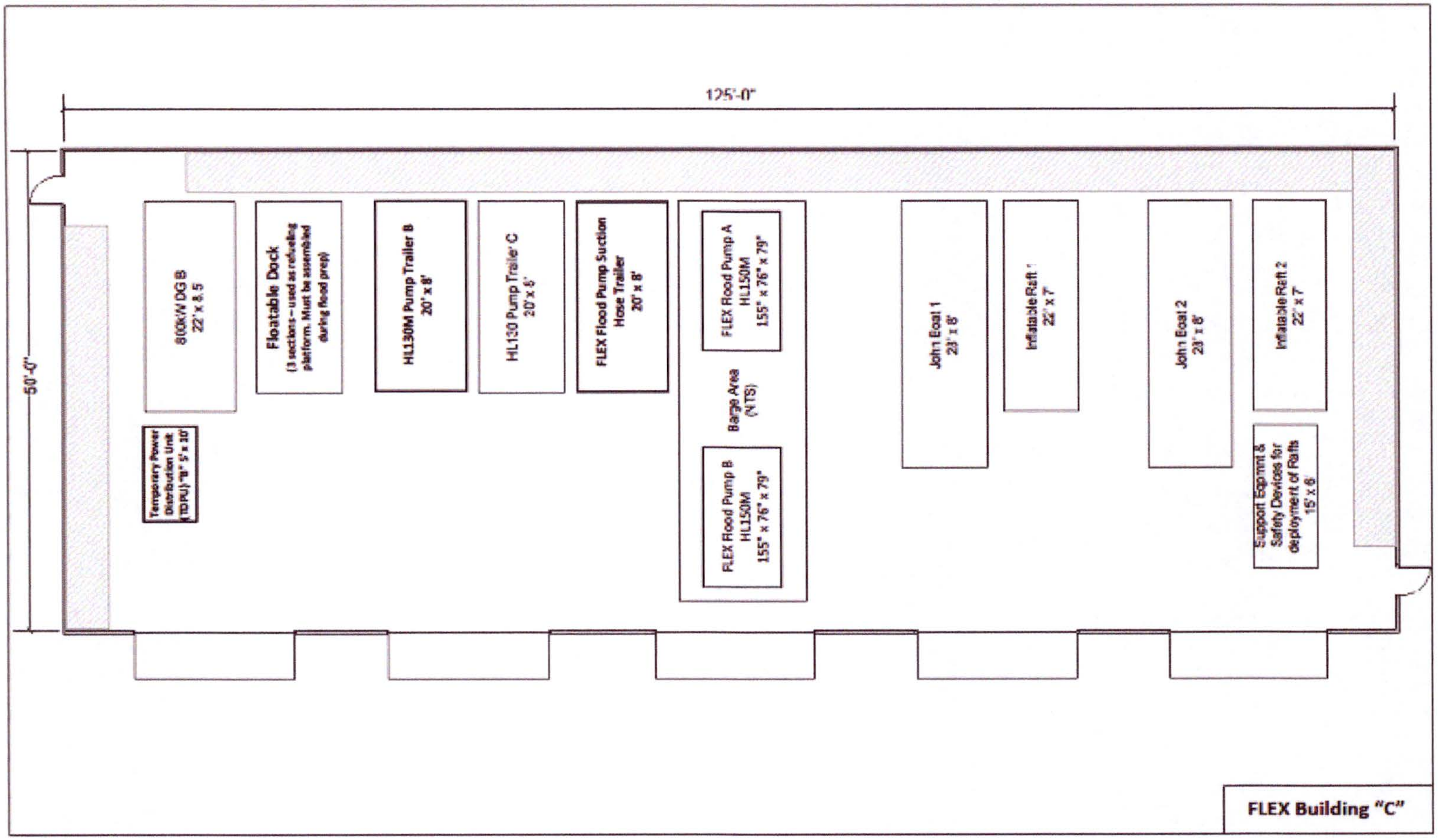


Figure 26: FLEX Building C Commercial Building Typical Layout

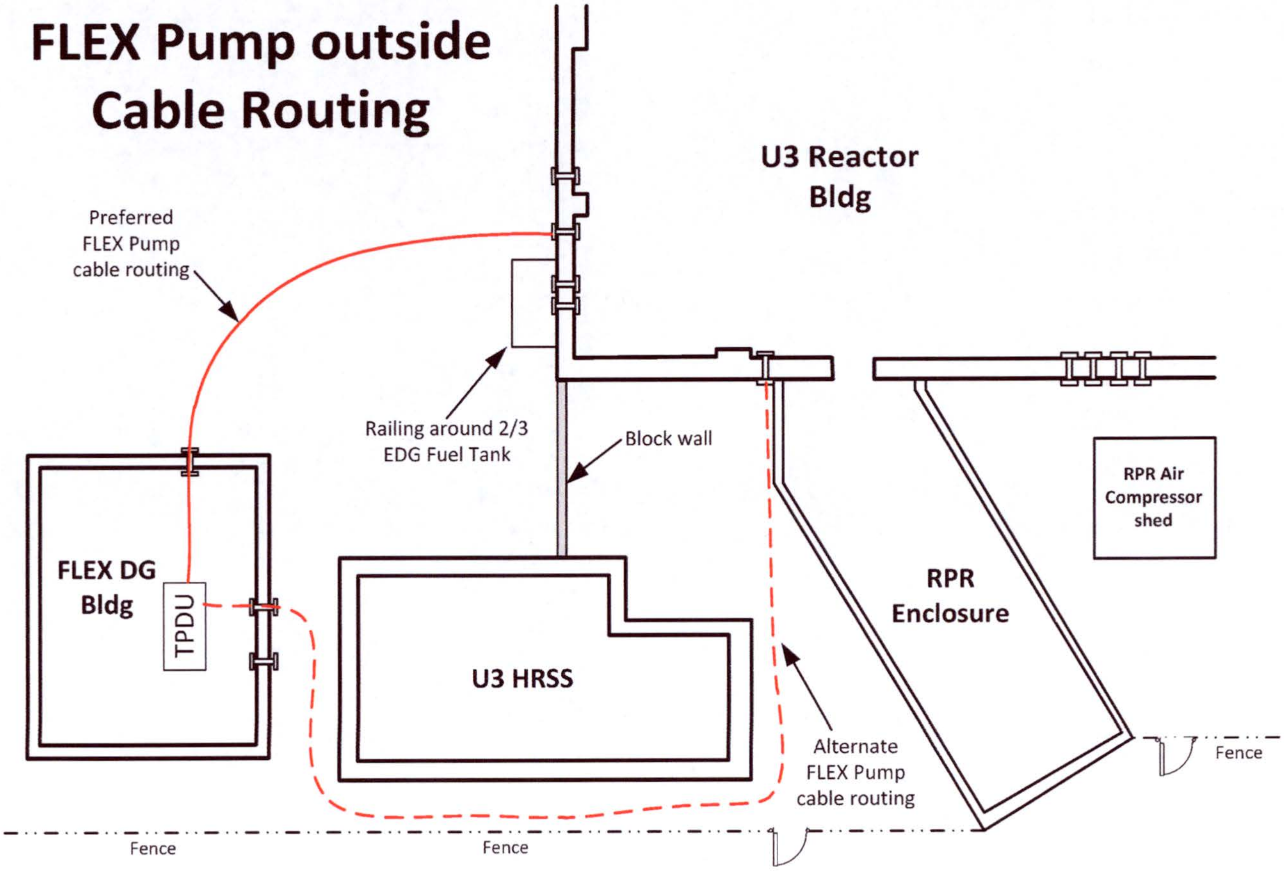


Figure 27: FLEX DG Cable Routing to Reactor Building

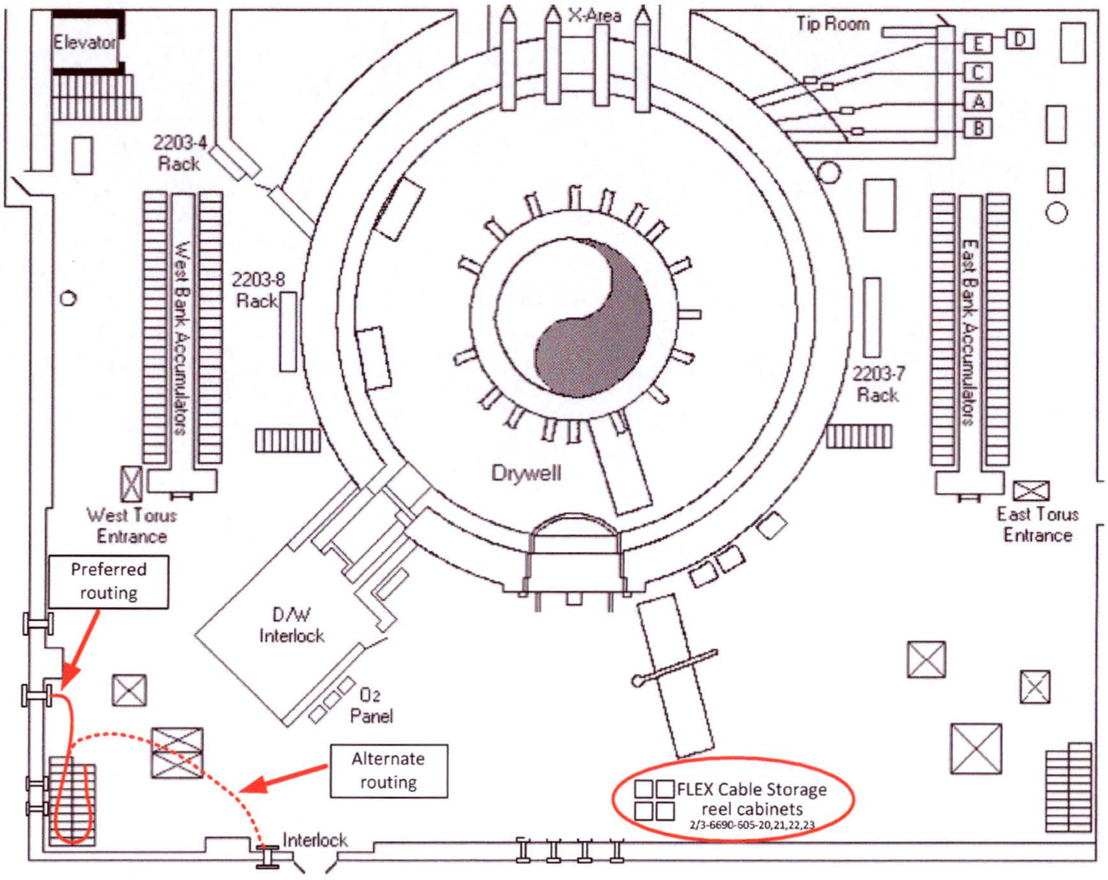


Figure 28: Unit 3A FLEX Pump Cable Routing

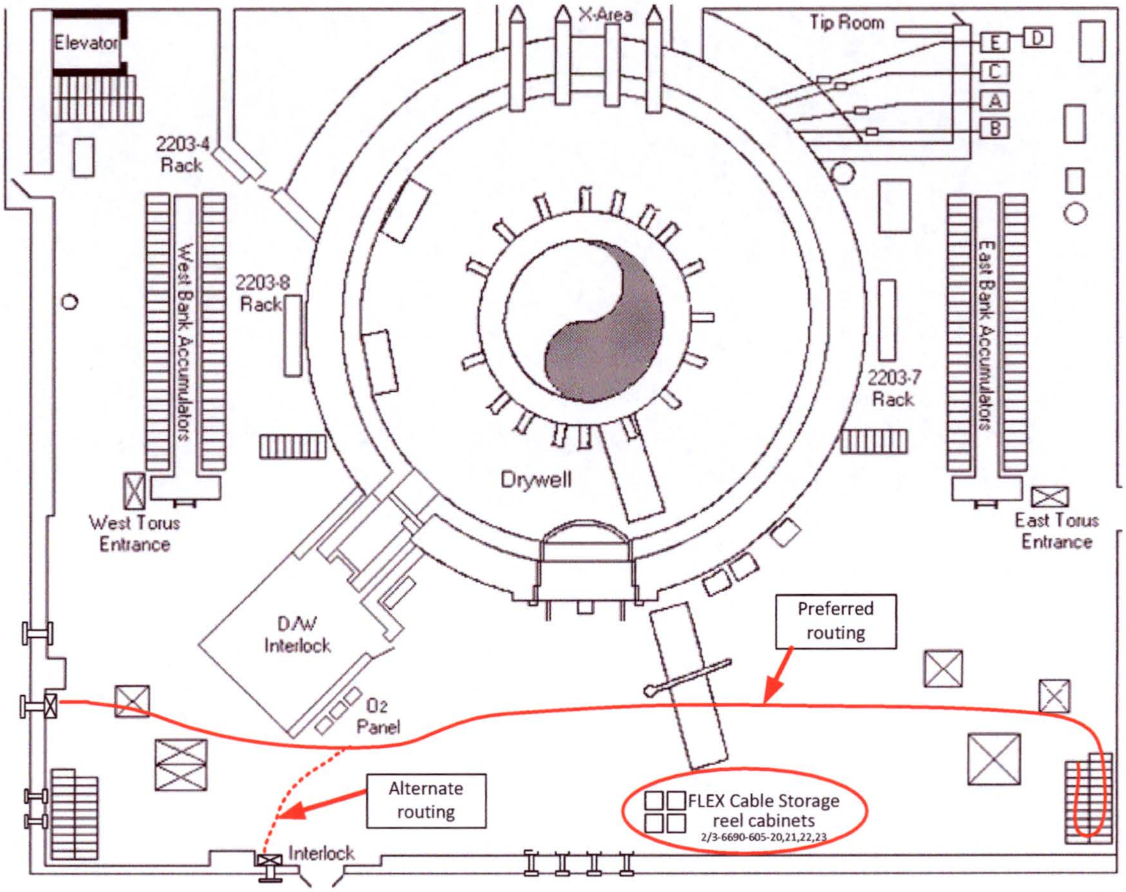


Figure 29: Unit 3B FLEX Pump Cable Routing

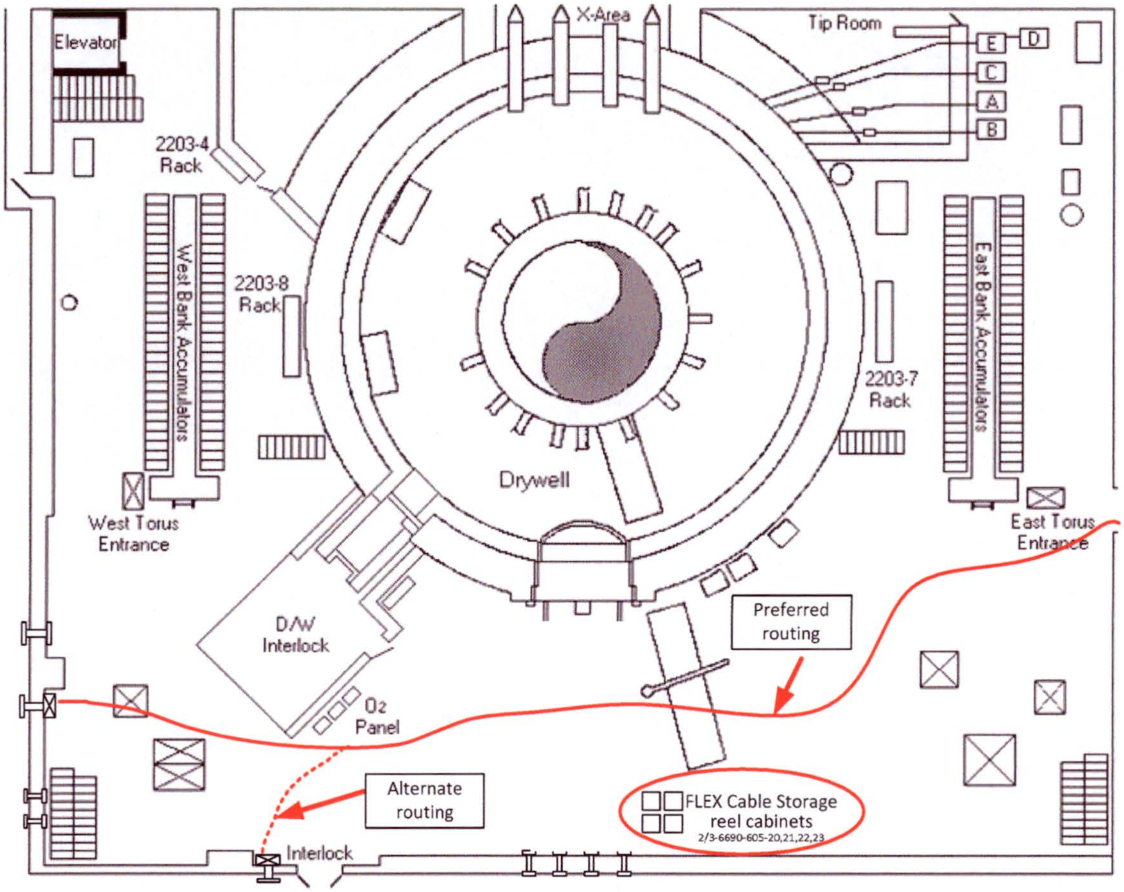


Figure 30: Unit 2A(B) FLEX Pump Cable Routing

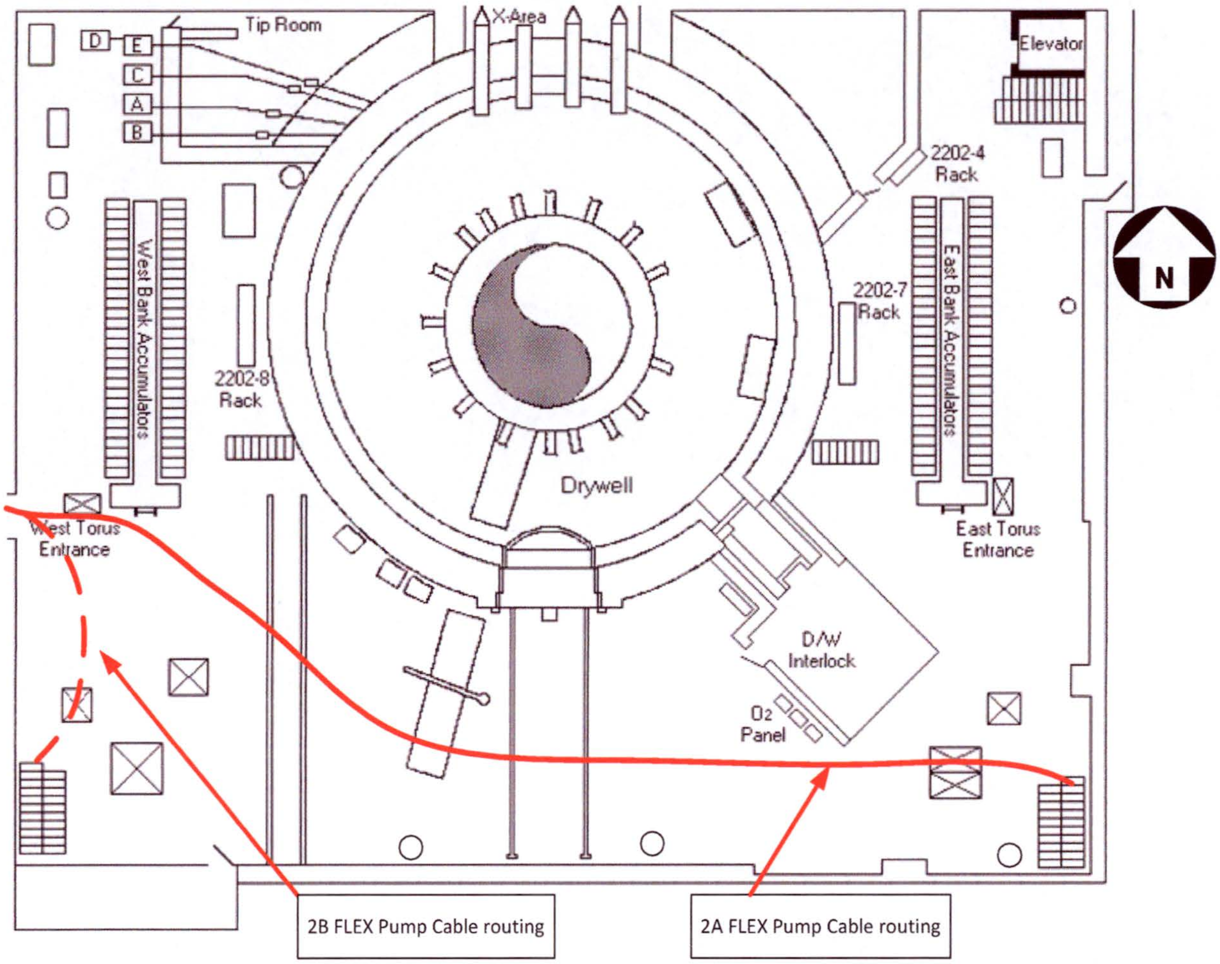


Figure 31: Unit 2A(B) FLEX Pump Cable Routing

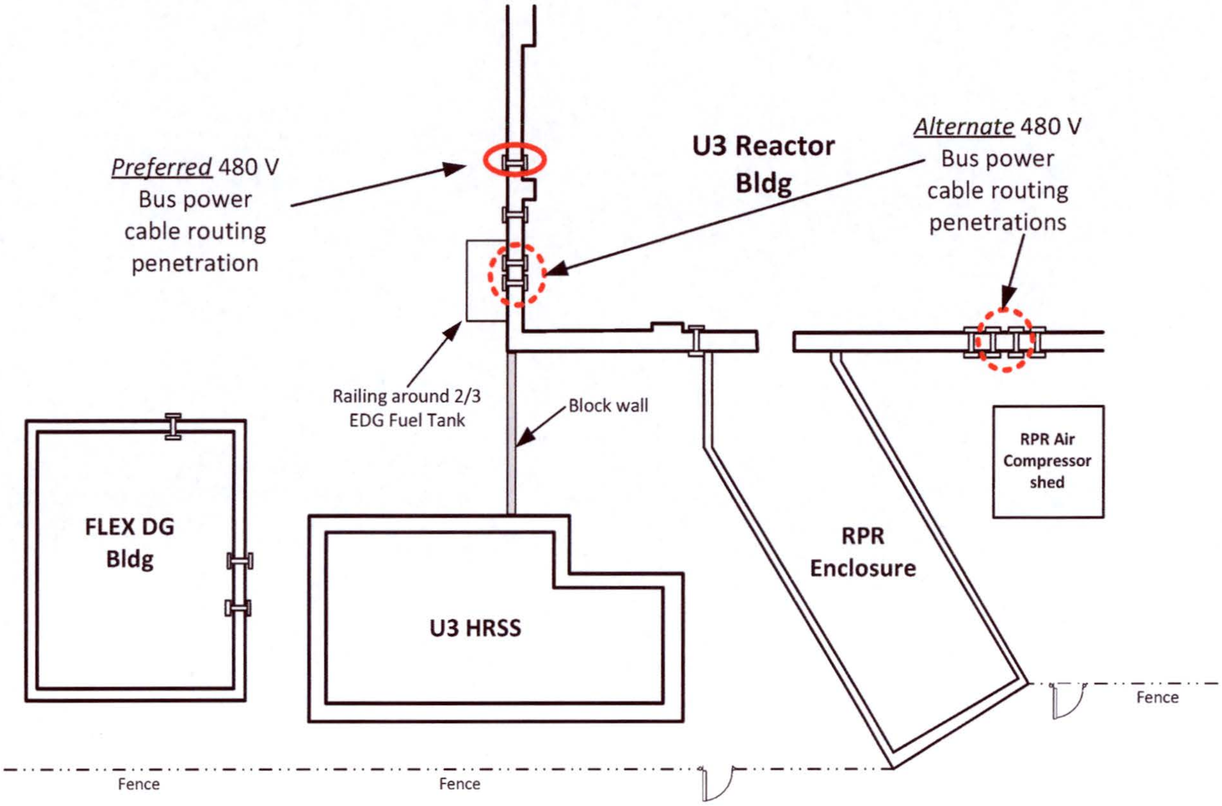
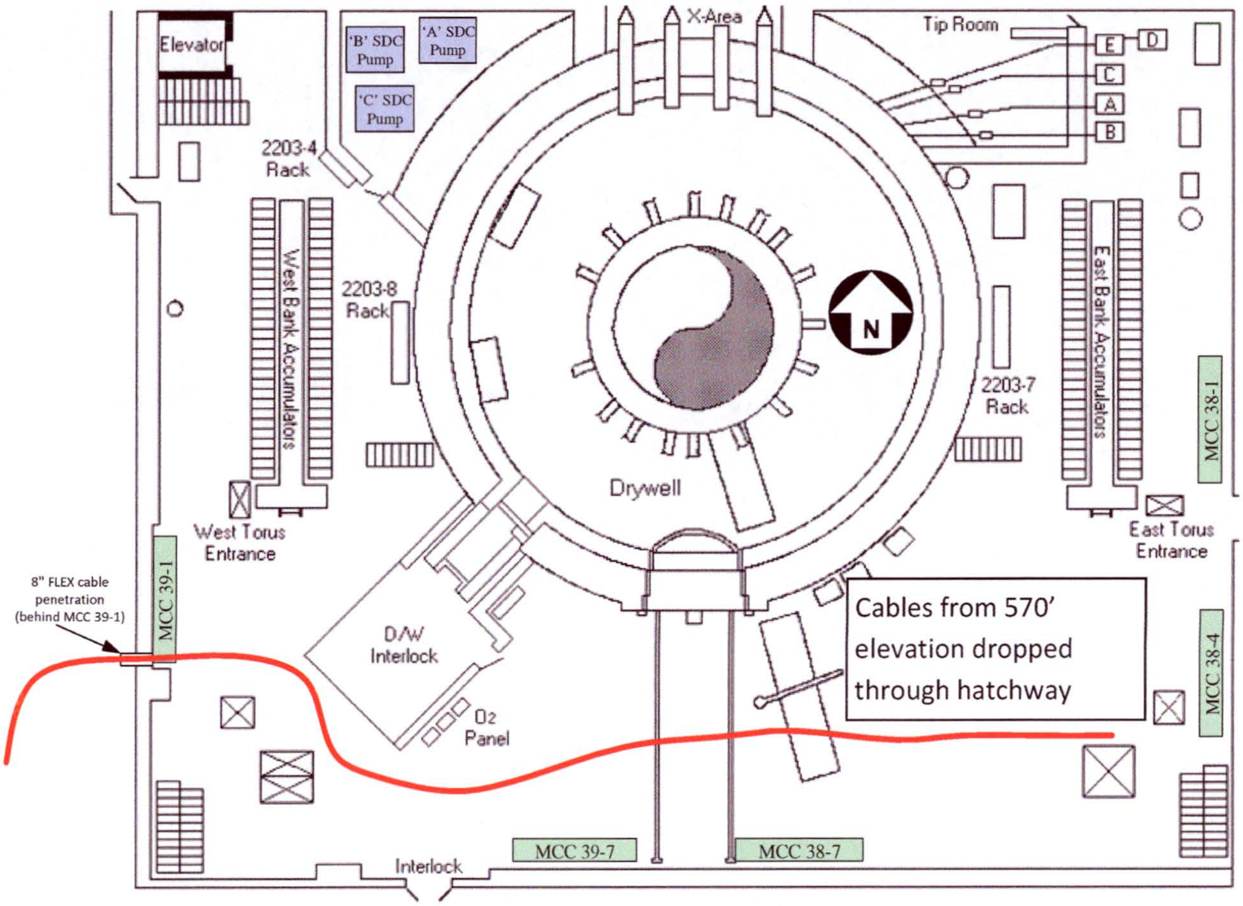


Figure 32: Bus Cable Routing Reactor Building Penetrations

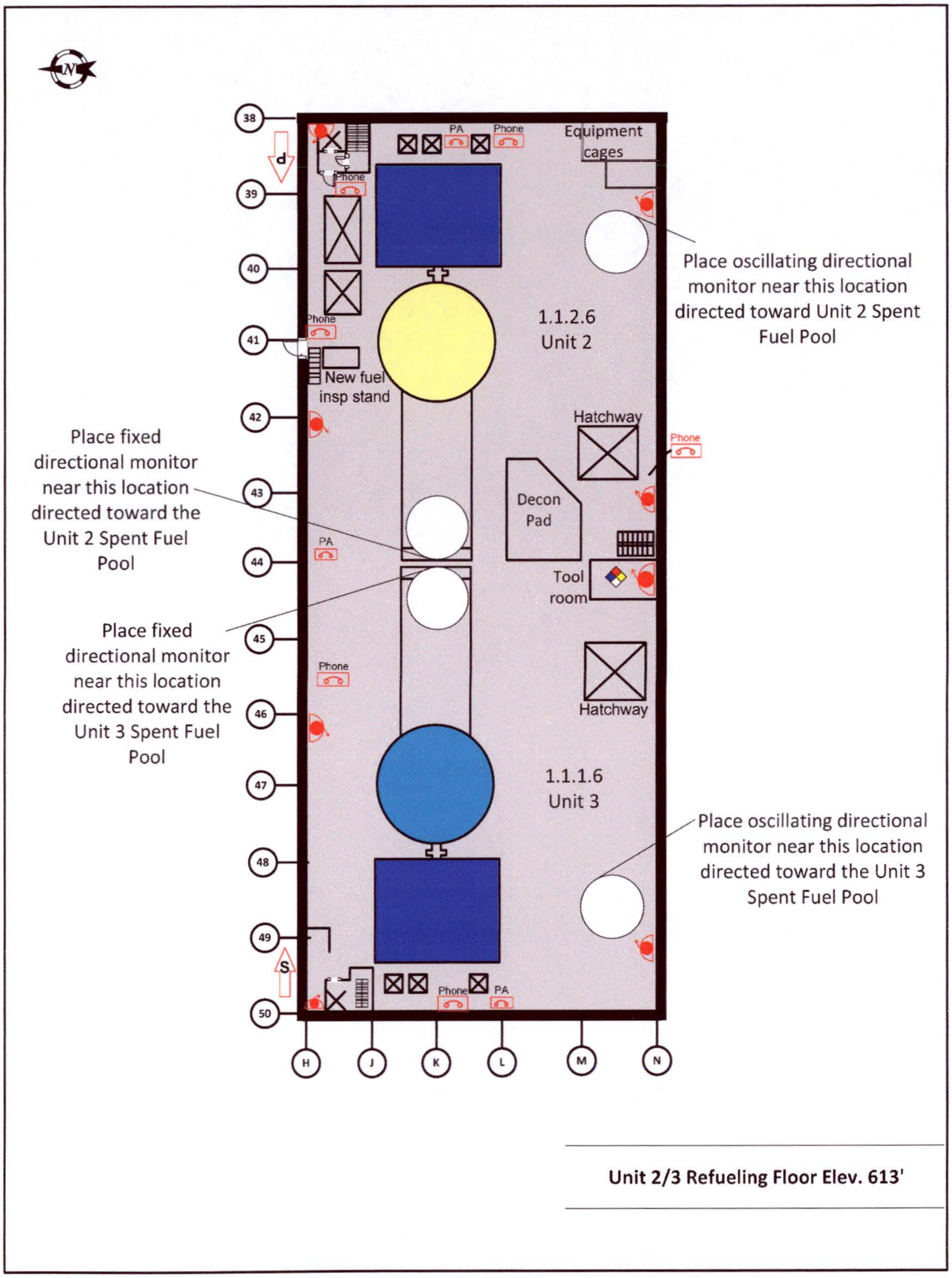
Unit 3 517' Elevation



8" FLEX cable penetration (behind MCC 39-1)

Cables from 570' elevation dropped through hatchway

Figure 33: Bus Cable Routing



Place oscillating directional monitor near this location directed toward Unit 2 Spent Fuel Pool

Place fixed directional monitor near this location directed toward the Unit 2 Spent Fuel Pool

Place fixed directional monitor near this location directed toward the Unit 3 Spent Fuel Pool

Place oscillating directional monitor near this location directed toward the Unit 3 Spent Fuel Pool

Figure 34: Refuel Floor Sprays

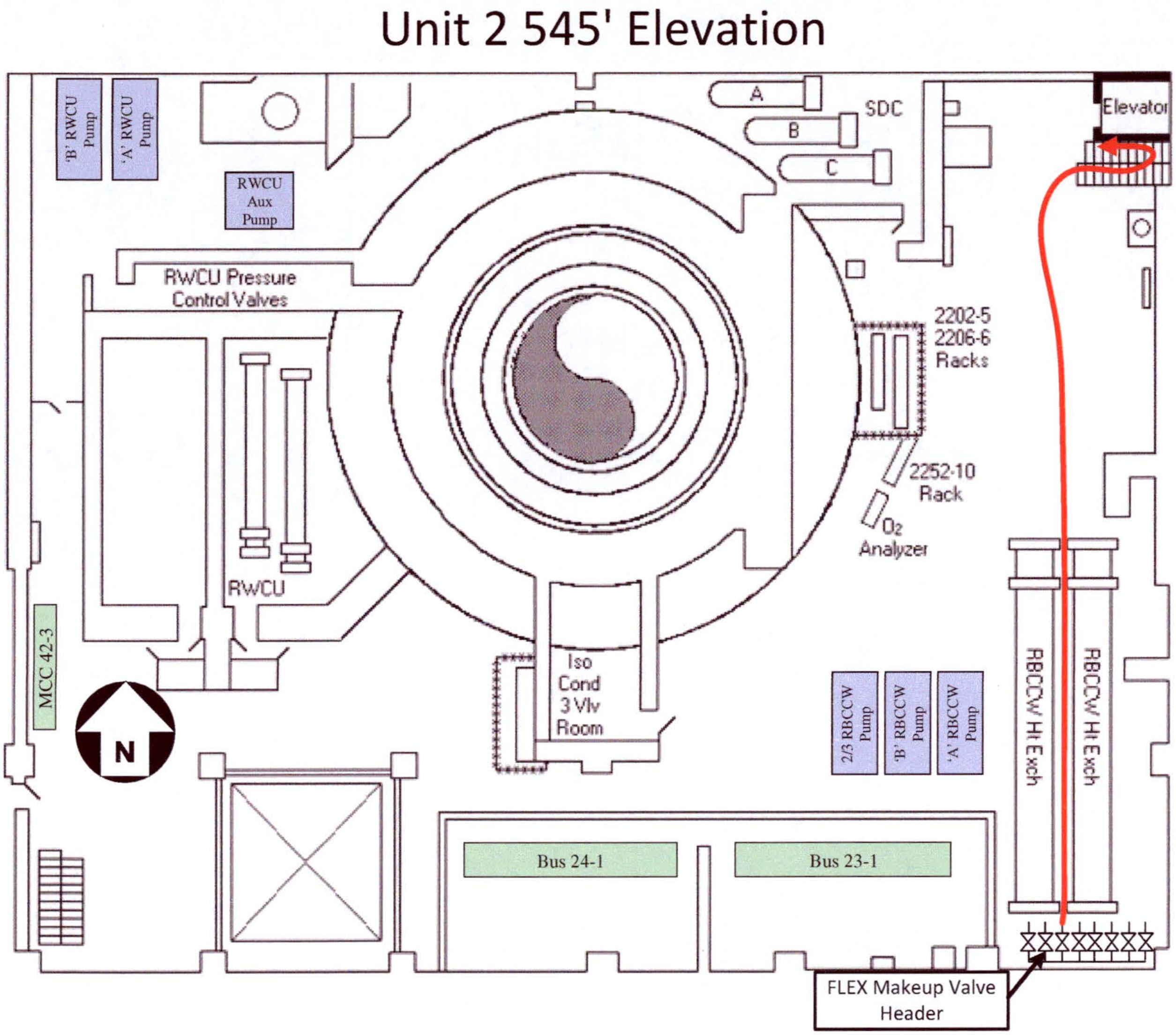
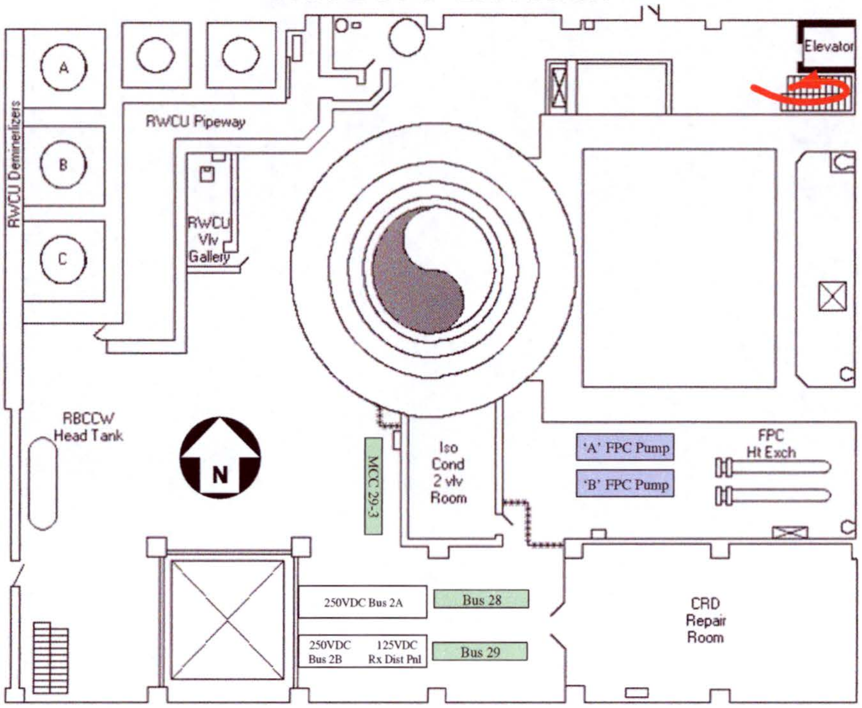


Figure 35: Unit 2 Alternate Hose Run For FLEX Fuel Pool Make-Up

Unit 2 570' Elevation



Unit 2 589' Elevation

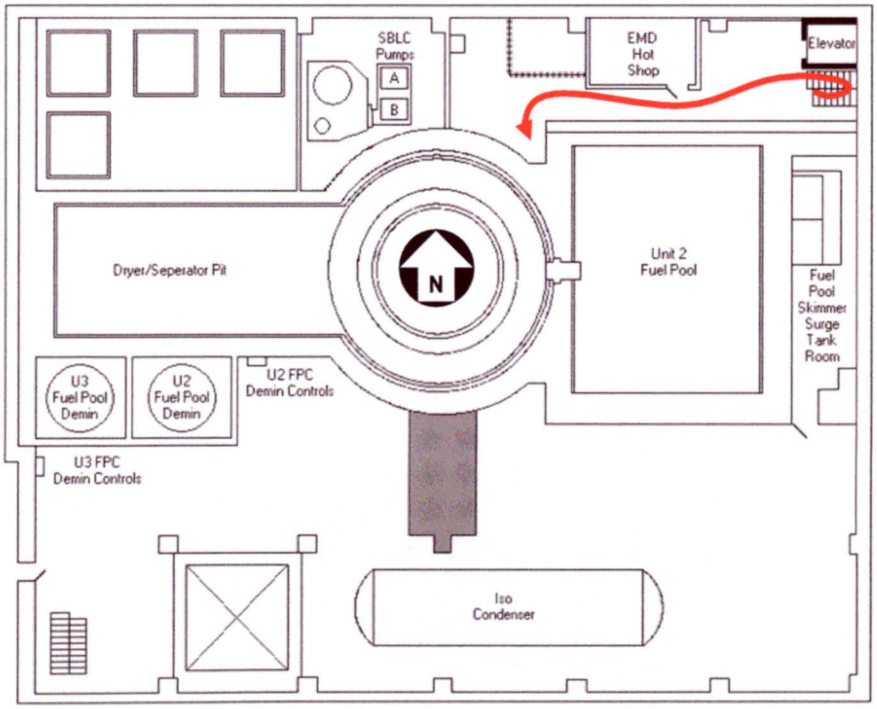


Figure 36: Unit 2 Alternate Hose Run For FLEX Fuel Pool Make-Up

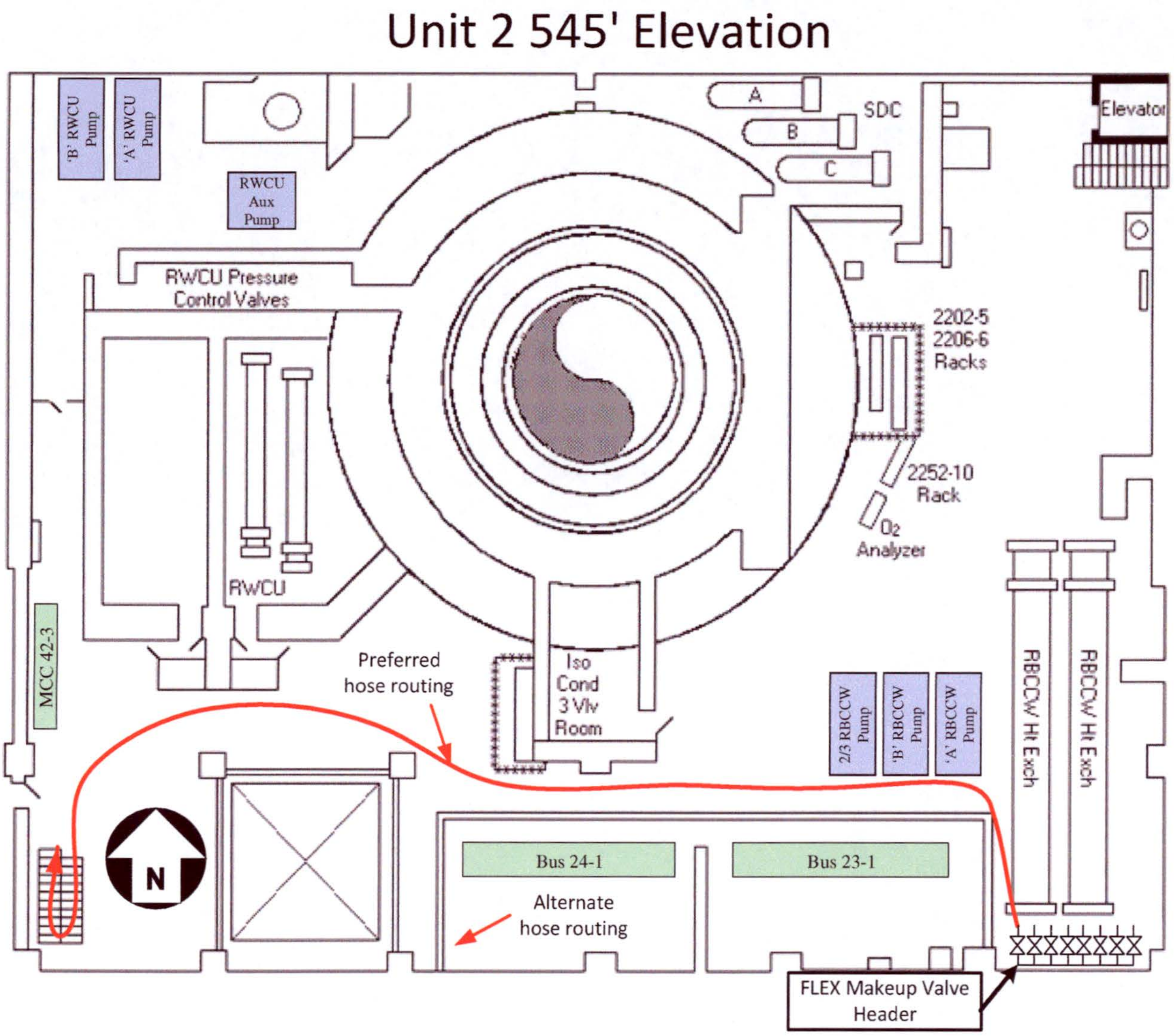
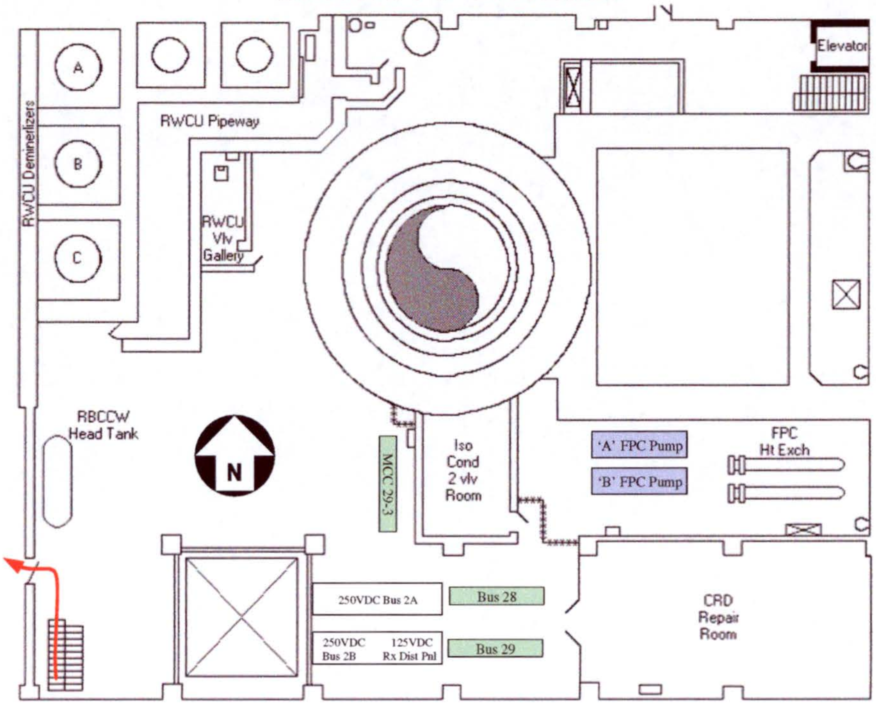


Figure 37: Unit 3 Alternate Hose Run For FLEX Fuel Pool Make-Up

Unit 2 570' Elevation



Unit 3 570' Elevation

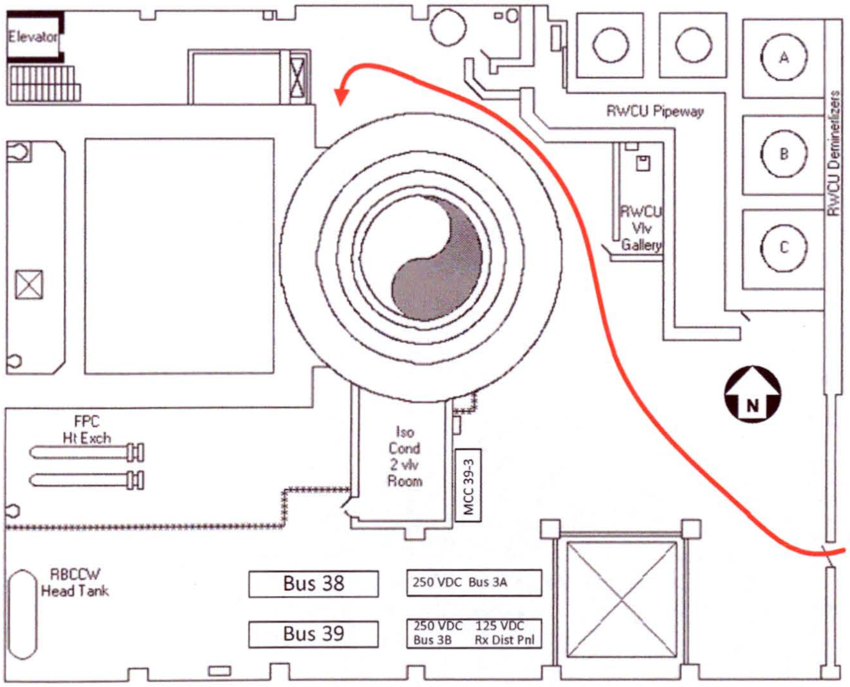


Figure 38: Unit 3 Alternate Hose Run For FLEX Fuel Pool Make-Up

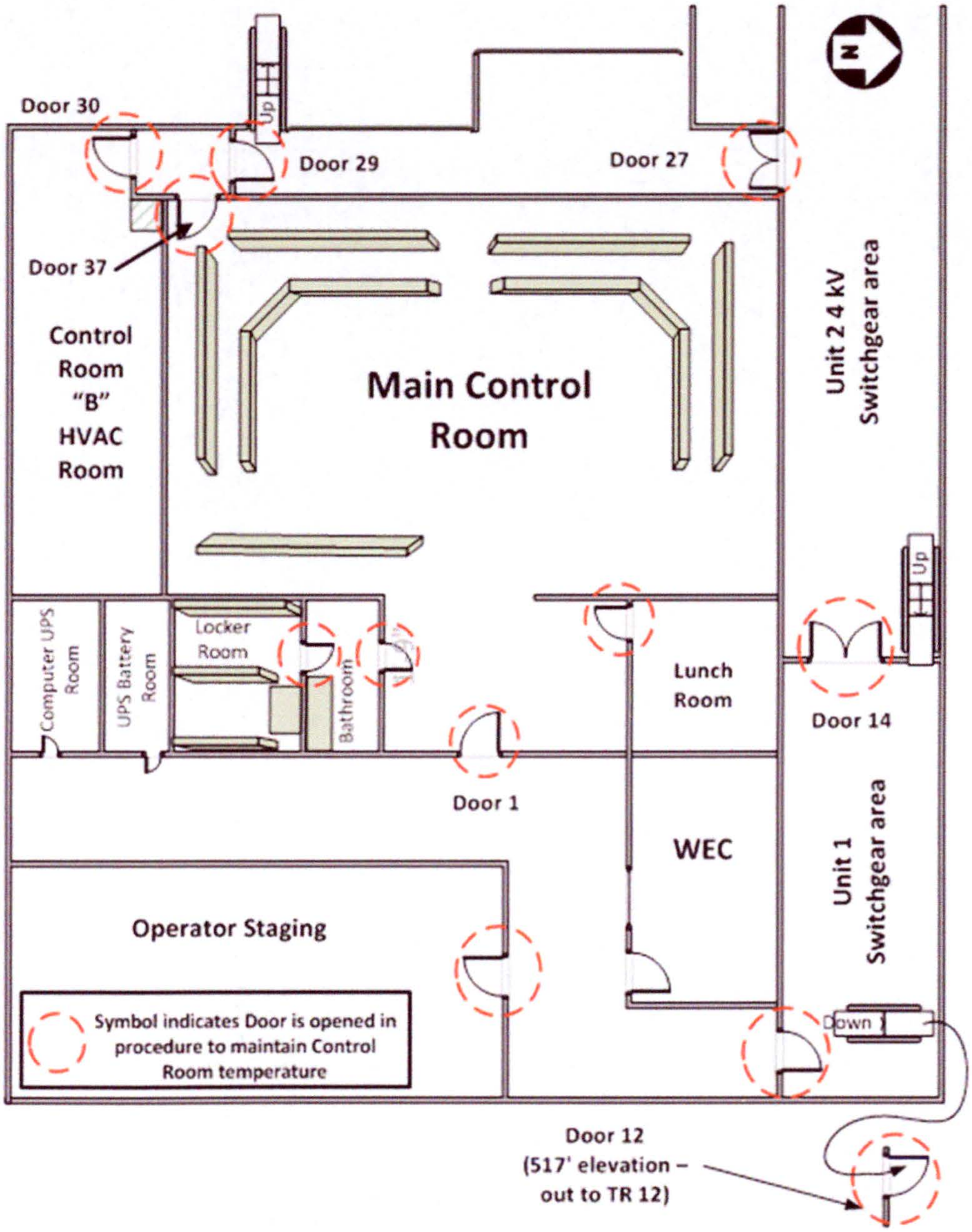


Figure 39: Control Room Venting - Doors to Be Opened

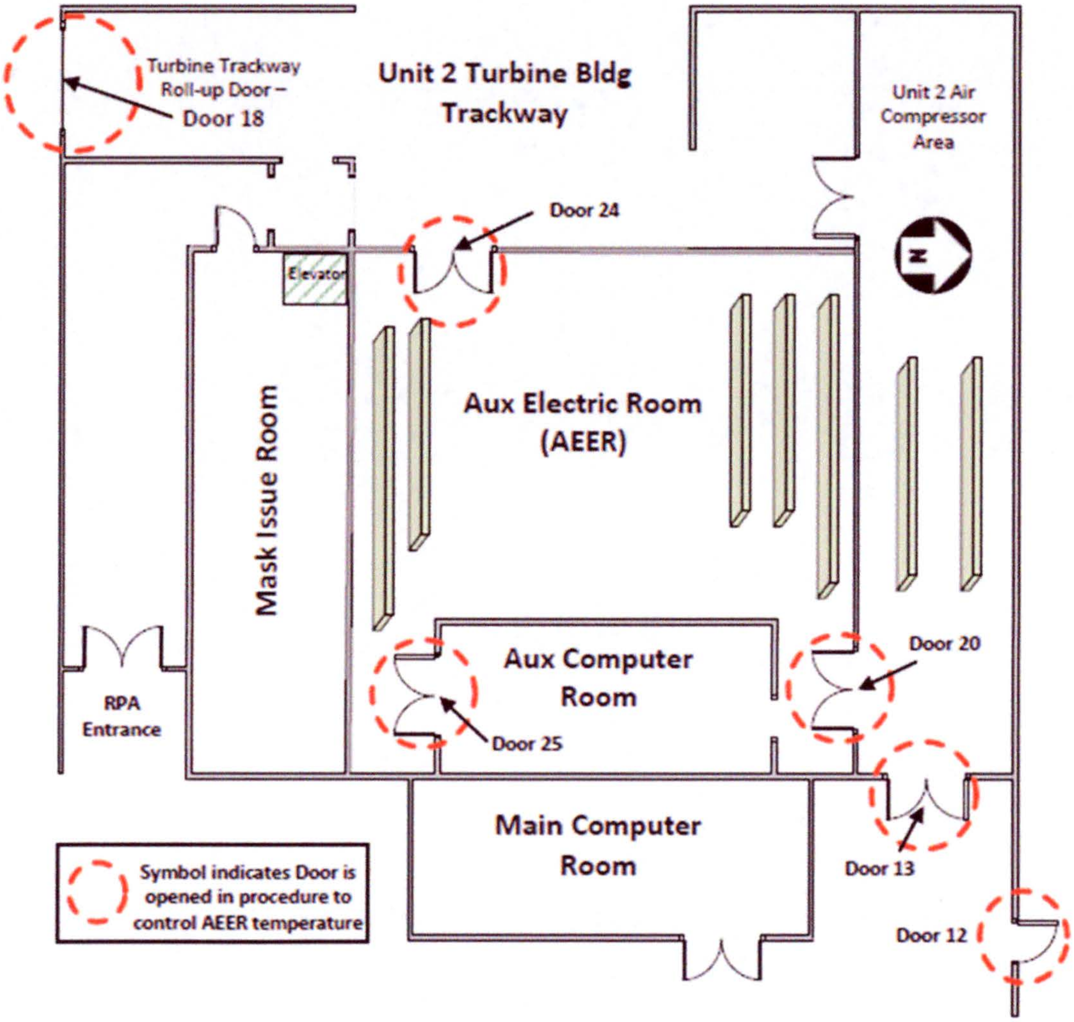


Figure 40: AEER Venting 517' Doors to Be Opened

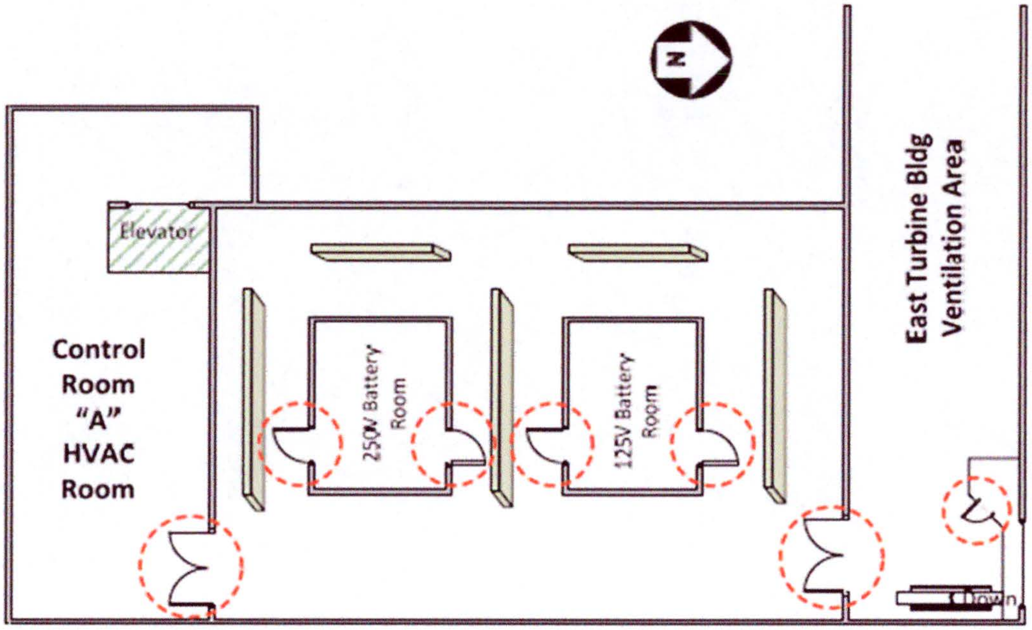


Figure 41: U2 Battery Room Venting Doors to Be Opened

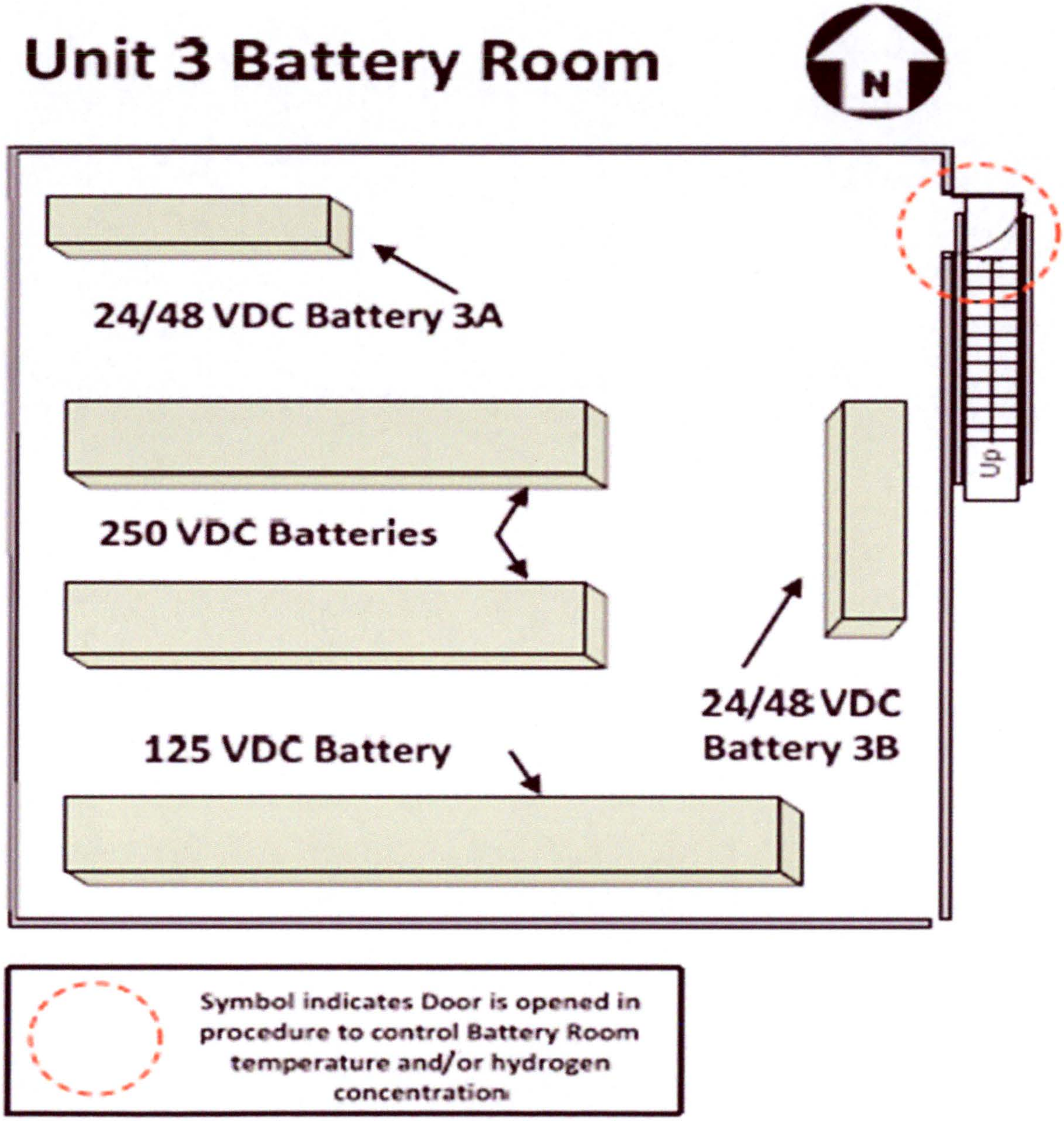


Figure 42: U3 Battery Room Venting Door to Be Opened

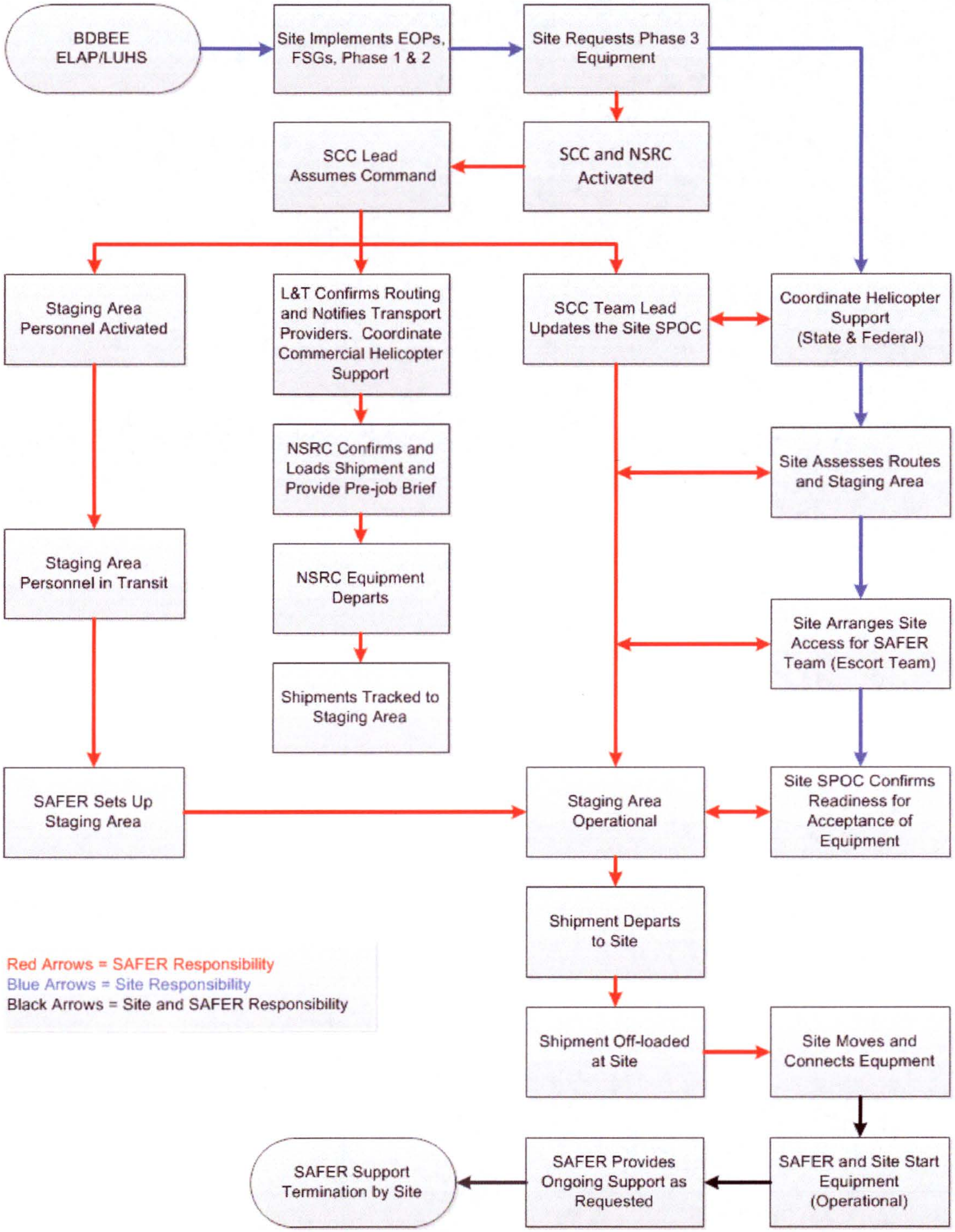


Figure 43: SAFER and Site Responsibilities Flowchart

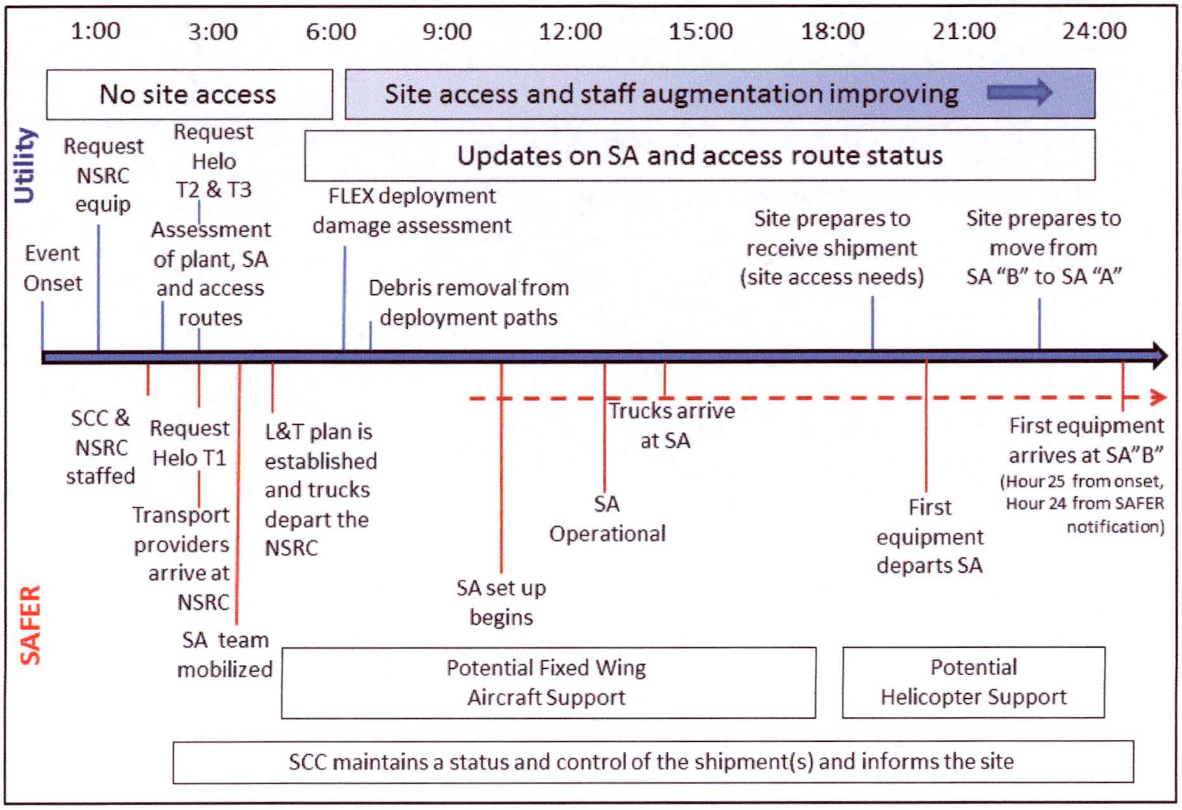


Figure 44: Generic SAFER and Site FLEX Phase 3 Timeline

Procedure	Title
FSG-01	EXTENDED LOSS OF AC POWER / LOSS OF ULTIMATE HEAT SINK FLOWCHART
FSG-02	FLEX STRATEGY HPCI OPERATION DURING AN ELAP EVENT
FSG-03	FLEX STRATEGY FOR SUPPLYING POWER TO FLEX PUMPS
FSG-04	ALIGNING FLEX PUMPS FOR OPERATION
FSG-05	FLEX ISOLATION CONDENSER MAKE-UP AND LEVEL CONTROL
FSG-06	FLEX STRATEGY FOR ALIGNING POWER TO U2(3) 480 VOLT SAFETY RELATED BUSSES 28(38)and 29(39)
FSG-07	FLEX STRATEGY FOR ISOLATING RECIRC LOOPS
FSG-08	FLEX HIGH PRESSURE AND LOW PRESSURE RPV LEVEL CONTROL USING SBLC
FSG-09	FLEX TORUS MAKE-UP
FSG-10	FLEX FUEL POOL MAKE-UP
FSG-11	FLEX INJECTION THROUGH LPCI
FSG-12	FLEX SPENT FUEL POOL SPRAY
FSG-13	FLEX DIESEL GENERATOR OPERATION
FSG-14	TRANSITION FROM PHASE 2 TO PHASE 3 EQUIPMENT
FSG-30	FLEX STRATEGY FOR OBTAINING ALTERNATE READINGS
FSG-31	FLEX VENTILATION STRATEGIES
FSG-32	FUELING FLEX PORTABLE EQUIPMENT
FSG-33	FLEX SMALL PORTABLE GENERATOR OPERATION
FSG-34	F-750 OPERATION
FSG-35	CARRY DECK CRANE OPERATION
FSG-36	BDBEE DAMAGE ASSESSMENT
FSG-37	FLEX GENERATOR HYDROGEN VENTING FOLLOWING AN ELAP EVENT
FSG-38	FLEX AUXILLIARY EQUIPMENT DEPLOYMENT
FSG-39	FLEX COMMUNICATION OPTIONS
FSG-40	FLEX DEPLOYMENT PATH AND DEBRIS REMOVAL
FSG-60	FLEX FLOOD PUMP DEPLOYMENT/OPERATION
FSG-61	FLEX FIRE SYSTEM OPERATION
FSG-62	FLEX GENERATOR DEPLOYMENT DURING A FLOOD

Figure 45: FSG Procedure List