VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

May 19, 2015

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

Serial No.: 14-394C
NLOS/DEA: R1
Docket Nos.: 50-338/339
License Nos.: NPF-4/7

VIRGINIA ELECTRIC AND POWER COMPANY
NORTH ANNA POWER STATION UNITS 1 AND 2
COMPLIANCE LETTER AND FINAL INTEGRATED PLAN IN RESPONSE TO THE MARCH 12, 2012 COMMISSION ORDER MODIFYING LICENSES WITH REGARD TO REQUIREMENTS FOR MITIGATING STRATEGIES FOR BEYOND-DESIGN-BASIS EXTERNAL EVENTS (ORDER NUMBER EA-12-049)

On March 28, 2012 the Nuclear Regulatory Commission (NRC) issued Order EA-12-049, "Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" [the Order]. The Order requires a three-phase approach for mitigating beyond-design-basis external events. The initial phase requires the use of installed equipment and resources to maintain or restore core cooling, containment, and spent fuel pool (SFP) cooling capabilities. The transition phase requires providing sufficient, portable, onsite equipment and consumables to maintain or restore functions until they can be accomplished with resources brought from offsite. The final phase requires obtaining sufficient offsite resources to sustain these functions indefinitely. Condition C.3 of the Order requires all Licensees to notify the Commission when full compliance with the requirements of the Order is achieved.

This letter provides notification that Virginia Electric and Power Company (Dominion) has completed the requirements of the Order and is in full compliance with the Order for North Anna Power Station Unit 1. Attachment 1 to this letter provides a summary of how the requirements of the Order were met for North Anna Unit 1. Dominion provided notification that the requirements of the Order were met for North Anna Power Station Unit 2 by Letter Serial No. 14-394A dated December 8, 2014. Accordingly, with both units in compliance with the Order, Attachment 2 provides the Final Integrated Plan (FIP) for North Anna Power Station Units 1 and 2.

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NRR

Should you have any questions or require additional information, please contact Margaret Earle at (804) 273-2768.

Respectfully,

Mark Sartain
Vice President - Nuclear Engineering

Vicki L. Hull
NOTARY PUBLIC
Commonwealth of Virginia
Reg. # 140542
My Commission Expires May 31, 2018

COMMONWEALTH OF VIRGINIA)
)
COUNTY OF HENRICO)

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by Mr. Mark D. Sartain, who is Vice President – Nuclear Engineering, of Virginia Electric and Power Company. He has affirmed before me that he is duly authorized to execute and file the foregoing document in behalf of that company, and that the statements in the document are true to the best of his knowledge and belief.

Acknowledged before me this 19TH day of MAY, 2015.

My Commission Expires: 5/31/18.

Vicki L. Hull
Notary Public

Attachments:

1. Order EA-12-049 Compliance Requirements Summary
2. Final Integrated Plan (FIP) for North Anna Power Station Units 1 and 2

Commitments contained in this letter:
None

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Attachment 1

Order EA-12-049 Compliance Requirements Summary

Virginia Electric and Power Company
North Anna Power Station, Units 1 and 2

North Anna Power Station, Unit 1
Order EA-12-049 Compliance Requirements
Summary

North Anna Power Station developed an Overall Integrated Plan (OIP) (Reference 1), documenting diverse and flexible strategies (FLEX) in response to Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," (Reference 2). The OIP for North Anna Power Station, Units 1 and 2 was submitted to the NRC on February 28, 2013 and was supplemented by Six-Month Status Reports (References 3, 4, 5 and 15), in accordance with Order EA-12-049, along with an additional supplemental letter that was submitted on April 30, 2013 (Reference 6). Full compliance with Order EA-12-049 for Unit 2 was completed on October 8, 2014 and documented in letter Serial No. 14-394A (Reference 14), dated December 8, 2014.

Full compliance with Order EA-12-049 for Unit 1 was completed on March 27, 2015. This date corresponds to the end of the second refueling outage after submittal of the OIP as required by Reference 2. The information provided herein documents full compliance with Order EA-12-049 for North Anna Power Station Unit 1.

Completion of the elements identified below, as well as References 1, 3, 4, 5, 6 and 15 document full compliance with Order EA-12-049 for North Anna Power Station, Unit 1.

NRC ISE AND AUDIT ITEMS COMPLETE

During the ongoing audit process (Reference 7), Dominion provided responses for the following items for North Anna:

- Interim Staff Evaluation (ISE) Open and Confirmatory Items (Reference 13)
- Licensee Identified Open Items (Reference 1)
- Audit Questions
- Safety Evaluation Review Items

The report "NRC North Anna Power Station, Units 1 and 2 – Report for the Onsite Audit Regarding Implementation of Mitigating Strategies and Reliable Spent Fuel Instrumentation Related to Orders EA-12-049 and EA-12-051" (Reference 8) delineated the items reviewed during the North Anna Power Station onsite audit. The report also identified additional audit items, specified as Safety Evaluation

Review Items, which were added following the audit and required supplemental information to address.

Dominion's responses, or references to the source document for responses, to Interim Staff Evaluation (ISE) Open and Confirmatory Items, Audit Questions, Safety Evaluation Review Items, and with the exception of Item 12, Licensee Identified Open Items, have been documented in References 8 and 14. Licensee Identified Open Item 12, "Plant modifications will be completed for permanent changes required for implementation of FLEX strategies" is addressed for Unit 1 in the section titled "Modifications," of this attachment. It is Dominion's position that no further actions are required related to the above items.

MILESTONE SCHEDULE - ITEMS COMPLETE

Unit 1 Milestone	Completion Date
Submit Integrated Plan	February 2013
Develop Strategies	October 2013
Develop Modifications	July 2014
Implement Unit 1 Modifications	March 2015
Develop Training Plan	April 2014
Implement Training	September 2014
Issue FSGs and Associated Procedure Revisions	September 2014
Develop Strategies/Contract with NSRC	August 2014
Purchase Equipment	February 2014
Receive Equipment	August 2014
Validation Walk-Throughs or Demonstrations of FLEX Strategies and Procedures	August 2014
Create Maintenance Strategies	August 2014
Unit 1 Outage Implementation	March 2015

STRATEGIES - COMPLETE

Strategy related Interim Staff Evaluation (ISE) Open and Confirmatory Items, Audit Questions, Safety Evaluation Review Items, and with the exception of Item 12, Licensee Identified Open Items, have been addressed as documented in References 8 and 14. Licensee Identified Open Item 12, "Plant modifications will be completed for permanent changes required for implementation of FLEX strategies," is addressed in the following section titled "Modifications". The North Anna Power Station, Unit 1 strategies are in compliance with Order EA-12-049.

MODIFICATIONS - COMPLETE

The modifications required to support the FLEX strategies for North Anna Power Station, Unit 1 have been completed in accordance with the station design control process. The plant modification design changes (DCs) implemented in support of the FLEX strategies for Unit 1 compliance are as follows:

Unit 1 Modifications: FLEX Mechanical Connections (NA-12-01217), FLEX Electrical Connections (NA-13-01017), Quench Spray (QS) Piping Connection (NA-13-00104), Primary Grade Water Tank Mechanical Connection (NA-13-00086), and Power Feeds to Support Pre-Stage 120VAC Generators (NA-13-00089). Also, the DC for Reactor Coolant Pump Seal Replacement (NA-12-01110) has completed the replacement of two of the three seals for Unit 1.

Modifications common to both Units 1 and 2: Spent Fuel Pool Mechanical Connections (NA-12-01218), Alternate RCS Injection Connection (NA-13-00085), Alternate Auxiliary Feedwater (AFW) Connection (NA-13-00083), Service Water Mechanical Connection (NA-13-00090), Concrete Pads and Grounding Connection for Pump Draft Locations (NA-14-00027), BDB Storage Building (NA-13-00061), BDB Offsite Communications (NA-14-01077), Spent Fuel Pool Level Instrumentation (NA-13-01043) and Condenser Hotwell Connections (NA-14-00035).

Copies of these DCs have previously been provided to the NRC staff and are available for their review.

EQUIPMENT - PROCURED AND MAINTENANCE & TESTING - COMPLETE

The equipment required to implement the FLEX strategies for North Anna Power Station, Unit 1 has been procured in accordance with NEI 12-06, Section 11.1 and 11.2, received onsite, 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 North Anna Power Station Preventative Maintenance Program such that equipment reliability is maintained and is in compliance with EPRI guidelines where applicable to the FLEX equipment.

PROTECTED STORAGE - COMPLETE

The storage facility required to protect BDB equipment has been completed for North Anna Power Station. The BDB equipment is protected from the applicable site hazards and will remain deployable to assure implementation of the FLEX strategies for North Anna Power Station, Unit 1.

PROCEDURES - COMPLETE

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

TRAINING - COMPLETE

Training of personnel responsible for the mitigation of beyond-design-basis events at North Anna Power Station, Unit 1 has been completed in accordance with an accepted training process as recommended in NEI 12-06, Section 11.6.

STAFFING - COMPLETE

The staffing study for North Anna Power Station has been completed in accordance with "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," Enclosure 5 pertaining to Recommendation 9.3, dated March 12, 2012 (Reference 9). The staffing assessment was submitted by letter dated May 7, 2014, "North Anna Power Station Units 1 and 2, March 12, 2012 Information Request, Phase 2 Staffing Assessment Report," (Reference 10), and in the response to a Request for Additional Information (RAI) (Reference 11) regarding the Phase 2 Staffing Assessment Report, Recommendation 9.3, dated September 22, 2014. As indicated in the RAI response, FSG strategies can be successfully implemented using the current minimum on-shift staffing. Revision 1 to the North Anna Phase 2 Staffing Assessment Report documenting this additional information was transmitted to the NRC in letter Serial No. 15-025 (Reference 16), dated January 30, 2015.

NATIONAL SAFER RESPONSE CENTERS - COMPLETE

Dominion 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 North Anna Power Station with Phase 3 equipment stored in the National SAFER Response Centers in accordance with the site-specific SAFER Response Plan (Reference 12).

VALIDATION - COMPLETE

Dominion has completed validation testing of the FLEX strategies for North Anna Power Station, Unit 1 in accordance with industry developed guidance. The validations assure that required tasks, manual actions, and decisions for FLEX strategies may be executed within the constraints identified in the Overall Integrated Plan (OIP)/Final Integrated Plan (FIP) for Order EA-12-049.

FLEX PROGRAM DOCUMENT - ESTABLISHED

The Dominion FLEX Program has been developed and documented in accordance with the requirements of NEI 12-06 and is in effect for North Anna Power Station.

REFERENCES

The following references support the North Anna Power Station, Unit 1 FLEX Compliance Summary:

1. North Anna Power Station Units 1 and 2, "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)," February 28, 2013 (ML13063A182).

2. NRC Order Number EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," dated March 12, 2012 (ML12229A174).

3. Letter from Dominion to NRC, "North Anna Power Station Units 1 and 2 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 23, 2013 (ML13242A012).

4. Letter from Dominion to NRC, “North Anna Power Station Units 1 and 2 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, 2014 (ML14069A012).

5. Letter from Dominion to NRC, “North Anna Power Station Units 1 and 2 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 (ML14251A024).

6. Letter from Dominion to NRC, "Supplement to 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 April 30, 2013 (ML13126A207).

7. NRC letter to All Operating Reactor Licensees and Holders of Construction Permits, "Nuclear Regulatory Commission Audits of Licensee Responses to Mitigation Strategies Order EA-12-049," dated August 28, 2013 (ML13234A503).

8. NRC letter from John Boska, Senior Project Manager, JLD, Office of NRR, to David A. Heacock, President and Chief Nuclear Officer, Virginia Electric and Power Company, “NRC North Anna Power Station, Units 1 and 2 – Report for the Onsite Audit Regarding Implementation of Mitigating Strategies and Reliable Spend Fuel Instrumentation Related to Orders EA-12-049 and EA-12-051,” dated September 24, 2014 (ML14259A458).

9. 10CFR50.54(f), "Request for Information Pursuant to Title 10 of the Code of Federal Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident," Recommendation 9.3, dated March 12, 2012 (ML2073A348).

10. Letter from Dominion to NRC, “North Anna Power Station Units 1 and 2, March 12, 2012 Information Request Phase 2 Staffing Assessment Report,” May 7, 2014 (ML14133A011).

11. Letter from Dominion to NRC, "North Anna Power Station Units 1 and 2, March 12, 2012 Response to Request for Additional Information Regarding Phase 2 Staffing Assessment Report Recommendation 9.3," dated September 22, 2014.

12. NRC letter from Jack Davis, JLD, Office of NRA, to Joseph E. Pollock, Vice President, Nuclear Operations, NEI, "Staff Assessment of National Safer Response Centers Established in Response to Order EA-12-049," September 26, 2014 (ML14265A107).

13. NRC letter from Jeremy S. Bowen, Chief, Mitigating Strategies Branch Office of NRR, to David A. Heacock, President and Chief Nuclear Officer, Virginia Electric and Power Company, "North Anna Power Station, Units 1 and 2 – Interim Staff Evaluation Related to Overall Integrated Plan in Response to Order EA-12-049 (Mitigating Strategies)," dated January 29, 2014 (ML13338A445).

14. Letter from Dominion to NRC, "North Anna Power Station Unit 2, Status of Required Actions for EA-12-049 Issuance of Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," Serial No. 14-394A, dated December 8, 2014.

15. Letter from Dominion to NRC, "North Anna Power Station Unit 1 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)," Serial No. 14-394B, dated March 2, 2015.

16. Letter from Dominion to NRC, "North Anna Power Station Units 1 and 2, March 12, 2012 Information Request, Revision to Phase 2 Staffing Assessment Report," Serial No. 15-025, dated January 30, 2015.

Attachment 2

FINAL INTEGRATED PLAN

Beyond Design Basis

FLEX Mitigation Strategies

Virginia Electric and Power Company

North Anna Power Station

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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 (AC) power (ELAP) in five of the six units on the site. The ELAP led to (1) the loss of core cooling, (2) loss of spent fuel pool cooling capabilities, and (3) a significant challenge to maintaining containment integrity. All direct current (DC) power was lost early in the event at Units 1 and 2 and after some period of time at the other units. Core damage occurred in three of the units along with a loss of containment integrity, resulting in a release of radioactive material to the surrounding environment.

The US Nuclear Regulatory Commission (NRC) assembled a Near-Term Task Force (NTTF) to advise the Commission on actions the US nuclear industry should take to preclude core damage and a release of radioactive material after a natural disaster such as that seen at Fukushima. The NTTF report (Reference 1) contained many recommendations to fulfill this charter, including assessing extreme external event hazards and strengthening station capabilities for responding to Beyond-Design-Basis external events.

Based on NTTF Recommendation 4.2, the NRC issued Order EA-12-049 (Reference 2) on March 12, 2012 to implement mitigation strategies for BDB external events. The Order included the following requirements:

1. Licensees shall develop, implement, and maintain guidance and strategies to maintain or restore core cooling, containment, and SFP cooling capabilities following a BDB external event.
2. Licensees shall develop strategies that are 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 BDB external events:

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

NRC Order EA-12-049 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 came first.

The Nuclear Energy Institute (NEI) developed NEI 12-06 (Reference 3), which provided 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 4), 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 5) required licensees to install reliable SFP instrumentation with specific design features for monitoring SFP water level. This Order was prompted by NTTF Recommendation 7.1 (Reference 1).

NEI 12-02 (Reference 6) provided guidance for compliance with Order EA-12-051. The NRC determined that, with the exceptions and clarifications provided in JLD-ISG-2012-03 (Reference 7), conformance with the guidance in NEI 12-02 was an acceptable method for satisfying the requirements in Order EA-12-051.

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

2.1 General Elements - Assumptions

The assumptions used for the evaluations of a North Anna 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 full power, unless there are procedural requirements to shut down due to an impending event. The reactors have been operating at 100% power for the past 100 days.
- Each reactor is successfully shut down when required (i.e., all rods inserted, no ATWS). Steam release to maintain decay heat removal upon shutdown functions normally, and reactor coolant system (RCS) overpressure protection valves respond normally, if required by plant conditions, and reseat.
- Onsite staff is at site administrative minimum shift staffing levels.
- No independent, concurrent events, e.g., no active security threat.
- All personnel onsite are available to support site response.
- The reactor and supporting plant equipment are either operating within normal ranges for pressure, temperature and water level, or available to operate, at the time of the event consistent with the design and licensing basis.

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

- No specific initiating event is used. The initial condition is assumed to be a loss of offsite power (LOOP) with installed sources of emergency onsite AC power and station blackout (SBO) alternate AC power sources unavailable with no prospect for recovery.
- Cooling and makeup water inventories contained in systems or structures with designs that are robust with respect to seismic events, floods, and high winds and associated missiles are available. Permanent plant equipment that is contained in structures with designs that are robust with respect to seismic events, floods, and high winds and associated missiles, are available. The portion of the fire protection system that is robust with respect to seismic events, floods, and high winds and associated missiles is available as a water source.
- Normal access to the ultimate heat sink 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 BDB equipment stored in structures with designs that are robust with respect to seismic events, floods and high winds and associated missiles, remains available.
- Installed Class 1E electrical distribution systems, including inverters and battery chargers, remain available since they are protected.
- No additional accidents, events, or failures are assumed to occur immediately prior to or during the event, including security events.
- Reactor coolant inventory loss consists of unidentified leakage at the upper limit of Technical Specifications, reactor coolant letdown flow (until isolated), and reactor coolant pump seal leak-off at normal maximum rate.
- For the spent fuel pool, the heat load is assumed to be the maximum design basis heat load. In addition, inventory loss from sloshing during a seismic event does not preclude access to the pool area.

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

- Exceptions for the site security plan or other requirements of 10 CFR may be required.
- Deployment resources are assumed to begin arriving at hour 6 and unlimited resources available after 24 hours.
- This plan defines strategies capable of mitigating a simultaneous loss of all alternating current (AC) power and loss of normal access to the ultimate heat sink resulting from a BDB external event by providing adequate capability to maintain or restore core cooling, containment, and spent fuel pool (SFP) cooling capabilities at all units on a site. Though specific strategies have been developed, due to the inability to anticipate all possible scenarios, the strategies are also diverse and flexible to encompass a wide range of possible conditions to protect the public health and safety. Each unit's Emergency Operating Procedures (EOPs) have been revised, in accordance with established EOP change processes, to clearly reference and identify appropriate entry and exit conditions for these pre-planned strategies. The EOPs retain overall command and control of the actions responding to a BDB external event. Also, the impact of these strategies on the design basis capabilities of the unit have been evaluated under 10 CFR 50.59.

- 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 external event may place the plant in a condition where it cannot comply with certain Technical Specifications and/or with its Security Plan, and, as such, may warrant invocation of 10 CFR 50.54(x) and/or 10 CFR 73.55(p). This position is consistent with the previously documented Task Interface Agreement (TIA) 2004-04, *Acceptability of Proceduralized Departures from Technical Specifications (TSs) Requirements at the Surry Power Station*, (TAC Nos. MC4331 and MC4332), dated September 12, 2006 (Accession No. ML060590273).

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 reactors, 2) maintain the containment function and 3) maintain cooling and prevent damage to fuel in the spent fuel pool (SFP) using installed equipment, onsite portable equipment, and pre-staged offsite resources. This indefinite coping capability will address an extended loss of all alternating current power (ELAP) (loss of offsite power, emergency diesel generators and any alternate AC source, but not the loss of AC power to buses fed by Class 1E batteries through inverters) with a simultaneous loss of normal access to the ultimate heat sink (LUHS). 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 with, existing plant 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 onsite resources.

- Phase 2 – Transition from installed plant equipment to onsite BDB equipment.
- Phase 3 – Obtain additional capability and redundancy from offsite equipment 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 both units at North Anna. Though specific strategies have been developed, due to the inability to anticipate all possible scenarios the FLEX strategies are also diverse and flexible to encompass a wide range of possible conditions. These pre-planned strategies which have been developed to protect the public health and safety are incorporated into the North Anna Emergency Operating Procedures (EOPs) in accordance with established EOP change processes, and their impact to the design basis capabilities of the unit evaluated under 10 CFR 50.59.

An overall diagram of the following FLEX strategies showing the staging locations of BDB equipment and general hose routing is provided in Figure 1.

2.3 Reactor Core Cooling Strategy

Reactor core cooling involves the removal of decay heat through the secondary side of the Nuclear Steam Supply System (NSSS) and maintaining sufficient RCS inventory to ensure the continuation of natural circulation in the primary side of the NSSS. The FLEX strategy for reactor core cooling and decay heat removal is to release steam from the Steam Generators (SG) using the SG Power Operated Relief Valves (PORVs) and the addition of a corresponding amount of Auxiliary Feedwater (AFW) to the SGs via the turbine driven AFW (TDAFW) pump. The AFW system includes the Emergency Condensate Storage Tank (ECST) as the initial water supply to the TDAFW pump. Operator actions to verify, re-align, and throttle AFW flow are required by the EOPs following an ELAP/LUHS event to prevent SG dryout and/or overfill.

RCS cooldown will be initiated within the first 2 hours following a BDB external event that initiates an ELAP/LUHS event.

DC bus load stripping will be initiated within the first hour following a BDB external event to ensure Class 1E battery life is extended to 8 hours. Portable generators will be used to repower instrumentation prior to battery depletion.

RCS makeup and boron addition will be initiated within 16 hours following a BDB external event to ensure natural circulation, reactivity control, and boron mixing is maintained in the Reactor Coolant System (RCS).

NOTE: The reactor core cooling strategy descriptions below are the same for both of the two North Anna units. Any differences and/or unit specific information is included where appropriate.

2.3.1 Phase 1 Strategy

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

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

Secondary Side - The Phase 1 FLEX strategy for reactor core cooling and heat removal relies on installed plant equipment and water sources for supplying AFW flow to the SGs and steam to the atmosphere. The TDAFW pump automatically starts on the loss of offsite power condition, and does not require either AC or DC electrical power to provide AFW to the SGs. In the event that the TDAFW pump does not start on demand or trips after start, an operator will locally reset the turbine and the pump will be restarted. Sufficient time (approximately 50 minutes) will be available to restart the TDAFW pump to prevent SG dry-out (Reference 8). The AFW system is normally aligned for the TDAFW pump to deliver flow to one SG. Therefore, operator action is required to manually align flow to all three SGs. Manual control of TDAFW pump flowrate to the SGs to establish and maintain proper water levels in the SGs will be performed locally in the AFW Pump House.

Steam release from the SGs will be controlled remotely from the Main Control Room (MCR) using air-operated SG PORVs equipped with local back-up compressed air bottles. Local manual operation of the SG PORVs, using the installed manual control handwheel, can be performed in the event that back-up compressed air is expended. In accordance with the existing procedure for response to loss of all AC power, an RCS cooldown will be initiated at a maximum rate of 100°F/hr to a minimum SG pressure of 290 psig, which corresponds to an RCS core inlet temperature of approximately 419°F. The rapid RCS cooldown minimizes the adverse effects of high temperature RCS coolant on Reactor Coolant Pump (RCP) shaft seal performance and reduces SG pressure to allow for eventual AFW injection from a portable pump in the event that the TDAFW pump becomes unavailable. The minimum established SG pressure is high enough to prevent nitrogen gas from the safety injection accumulators from entering the RCS.

Initially, AFW supply is provided by the installed Emergency Condensate Storage Tank (ECST). The tank has a minimum usable capacity of approximately 96,000 gallons and will provide a suction source to the TDAFW pump for a minimum of 4.2 hours of RCS decay heat removal concurrent with a 100°F/hr RCS cooldown to a minimum SG pressure of 290 psig (Reference 8). After depletion of the usable ECST inventory, the TDAFW pump suction will be aligned to the Seismic Category I, tornado missile protected portion of the Fire Protection (FP) system. The FP system, which is common to both units, will be pressurized by the Diesel Driven Fire Pump (DDFP), which provides water from the Service Water Reservoir at a sufficient flowrate and pressure to support TDAFW pump operation at both units. The DDFP has adequate diesel fuel storage to support operation until refueling can be provided from the onsite BDB equipment. The Service Water Reservoir provides approximately 22.5 million gallons of useable water volume to the FP system since the Service Water (SW) system would not be functional due to the ELAP/LUHS. The water volume from the Service Water Reservoir extends the AFW water supply time to depletion for several weeks.

Potential debris at the suction screen of the DDFP would not prevent an adequate flow to the DDFP. The trash screens on the SW Reservoir Intake Bay are designed to pass the full design flow of a SW pump and the DDFP pump. The SW pumps will not be operating due to the ELAP/LUHS. Since the 600 gpm required by the DDFP to provide a suction source for the TDAFW pump is a small fraction of the design flow rate of the trash screen, the calculated unblocked trash screen area required for passing the required flow rate is justifiable.

Primary Side (RCS) - The RCS will be cooled down and depressurized until SG pressure reaches 290 psig, which corresponds to a core inlet temperature of approximately 419°F. RCS isolation will be verified to have occurred automatically, and RCS leakage will be assumed to be through the RCP seals (See Section 2.3.8). Without additional RCS inventory, natural circulation will continue until at least the assumed onset of reflux cooling conservatively set at 17 hours (See Section 2.3.7.2). K_{eff} is calculated to be less than .99 at the described RCS conditions for approximately 37 hours (See Section 2.3.9).

Electrical/Instrumentation – Load stripping of all non-essential loads would begin within 1 hour after the occurrence of an ELAP/LUHS and completed within the next 30 minutes. With load stripping, the useable station Class 1E battery life has been calculated to be eight (8) hours for each unit (See Section 2.3.11).

2.3.2 Phase 2 Strategy

The Phase 2 FLEX strategy for reactor core cooling and heat removal provides an indefinite supply of water for feeding the SGs using the installed DDFP with suction from the SW Reservoir followed by use of a portable BDB High Capacity pump capable of drawing water from Lake Anna. Additionally, as required by NEI 12-06, SG water injection using a portable AFW pump is available through both primary and alternate connection locations.

RCS makeup will be initiated within 16 hours of the ELAP/LUHS event using a portable pump to replenish RCS inventory and re-establish RCS level in the pressurizer. Two portable diesel driven BDB RCS Injection pumps (one per unit) will be transported from the onsite BDB Storage Building and deployed for delivery of RCS inventory makeup and reactivity control from the Refueling Water Storage Tank (RWST) or from another borated suction source for the remainder of the event.

A hose will be connected to the Quench Spray (QS) pump suction elbow to provide borated water to the suction of the BDB RCS Injection pump from the RWST. A high-pressure hose will be routed from the discharge of the BDB RCS Injection pump to the primary RCS injection connection in the Safeguards Building or the alternate RCS injection connection in the basement of the Auxiliary Building to provide RCS inventory makeup for the remainder of the ELAP event (Figures 2 and 3 for Unit 1 and Figures 4 and 5 for Unit 2).

The Phase 2 FLEX strategy also includes re-powering of vital 120 VAC buses within eight (8) hours using a portable 120/240 VAC Diesel Generator (DG) stored onsite for each unit. Prior to depletion of the Class 1E batteries on each unit, selected vital 120 VAC circuits will be re-powered to continue to provide key parameter monitoring instrumentation. Portable 480 VAC DGs are available as alternates to the 120/240 VAC DGs.

The primary strategy for re-powering 120 VAC vital bus circuits is to use one 120/240 VAC DG per unit connected to the 120 VAC vital buses through pre-installed BDB receptacle panels, cabling, connections, and distribution panels. The portable 120/240 VAC DGs will be deployed to the alleyways east of the Auxiliary Building for Unit 1 and west of the Auxiliary Building for Unit 2 (Figure 6). The generators will be connected via cables to receptacle panels located in the Rod Drive Room of each unit. The 120/240 VAC cables for both units will be stored in the Hydrogen Recombiner Control Panel Vault on the Unit 2 side of the station. The BDB receptacle in each Rod Drive Room is connected to a BDB distribution panel via pre-installed cable and conduit. Each 120/240 VAC DG powers two BDB distribution panels which provide power to the vital 120 VAC buses and selected lighting circuits for that unit (Figure 7 and 8).

Preparation of the 120/240 VAC DGs for service will commence immediately after the declaration of an ELAP event. Placing the 120/240 VAC DGs into service can be completed within 5 hours (this includes an estimated two (2) hour time allotment for debris removal, two (2) hours transport and setup, and one (1) hour for Vital Bus switching). It is therefore reasonable to expect the 120/240 VAC generators to be supplying power to the key instrumentation within six (6) hours of a BDB external event which initiates an ELAP.

The alternate FLEX strategy for re-powering 120 VAC vital bus circuits is the deployment of one 480 VAC DG per unit connected to the Class 1E 480

VAC bus through pre-installed BDB cabling and connections. The 480 VAC DG allows for recharging the Class 1E batteries and restoring other AC loads in addition to the key parameter monitoring instrumentation. The portable 480 VAC DGs and the required color-coded power cables will be transported from the BDB Storage Building to their deployed positions in the alleyways on the west and east sides of the Auxiliary Building (Figure 6). The power cables will be connected to seismically-designed, tornado missile protected, BDB connection receptacles in the respective unit's Rod Drive Room.

The BDB connection receptacles in the Rod Drive Rooms are connected to the Class 1E 480 VAC bus via pre-installed cable and conduit to Class 1E 480 VAC MCC breakers (Figures 9 and 10).

Deployment of the 480 VAC DGs from the BDB Storage Building and placing the 480 VAC generators into service can be completed within four (4) hours after deployment has been initiated. However, this time does not include the estimated two (2) hour time allotment for debris removal, but does include additional time for transport from the BDB Storage Building due to the DG's larger size and the fact that a cable trailer must also be deployed to the staging location.

2.3.3 Phase 3 Strategy

The Phase 3 strategy for core cooling and decay heat removal includes additional equipment available from the National SAFER Response Center (NSRC) to provide backup to the BDB High Capacity pumps, BDB RCS Injection pumps, BDB AFW pumps, Boric Acid Mixing Tanks, and the 480 VAC DGs. Additionally, a Reverse Osmosis/Ion Exchanger water processing system will be provided from the NSRC to provide a method to remove impurities from alternate fresh water supplies to the TDAFW pump, the BDB AFW pumps, or the BDB RCS Injection pumps.

Use of the SGs for core cooling and decay heat removal is dependent on adequate reactor core decay heat generation if using the TDAFW pump and an available supply of clean water from onsite sources or from water processing units provided from the NSRC. The Phase 3 strategy for restoring RHR provides an alternate method for removing decay heat and/or RCS cooldown to Cold Shutdown.

Restoration of RHR requires the restoration of 4160 VAC power and portions of the Component Cooling, Service Water, and Containment Instrument Air systems.

Portable 4160 VAC generators will be provided from the NSRC for each unit in order to supply power to either of the two Class 1E 4160 VAC buses on each unit. Additionally, by restoring the Class 1E 4160 VAC bus, power can be restored to the Class 1E 480 VAC via the 4160/480 VAC transformers to power selected 480 VAC loads.

Two 1MW 4160 VAC generators will be connected to a distribution panel (also provided from the NSRC) in order to meet the required 4160 VAC load requirements for each unit. Due to the size of the equipment, the DGs will be deployed to areas either near the existing Emergency Diesel Generator (EDG) rooms (Figure 6) or by the large openings in the Unit 1 and 2 Turbine Buildings (Figure 11). The area near the existing EDG rooms affords the best configuration to connect to one of the two Class 1E 4160 VAC buses for each unit, but space is limited. Depending on the debris situation, the Turbine Building openings may be the more viable option for deployment. In this case, either the Emergency Switchgear Room or the normal Switchgear Room would be used to tie the 4160 VAC generators to one of the two Class 1E 4160 VAC buses for each unit. Necessary cable for any of the above connections are also provided from the NSRC.

2.3.4 Systems, Structures, Components

2.3.4.1 Turbine Driven Auxiliary Feedwater Pump

The TDAFW pump will automatically start and deliver AFW flow to the "A" SG following an ELAP/LUHS event. Two air-operated steam supply trip valves (TVs) supply steam to the TDAFW pump turbine. These TVs are normally closed. The TVs are actuated by DC solenoids in the air supply line. If the solenoids de-energize, air is vented to open the valves and admit steam to the turbine. During an ELAP, procedures ensure that the TVs are open by removing power from the solenoids to vent the actuators, and the TDAFW pump turbine steam flow will be controlled automatically by the governor valve or manually with the overspeed trip/throttle valve. In the event the TDAFW pump fails to start, procedures direct the operators to manually reset and start the pump (which does not require electrical power for motive force or control). Approximately 50 minutes are available to manually start the pump and initiate flow prior to steam generator dryout (Reference 8). The TDAFW pump is sized to provide more than the design basis AFW flow requirements and is located in a structure designed for protection from applicable design basis external hazards.

2.3.4.2 Steam Generator Power Operated Relief Valves (PORVs)

During an ELAP/LUHS event with the loss of all AC power and instrument air, reactor core cooling and decay heat will be removed from the SGs for an indefinite time period by manually opening/throttling the SG PORVs, which are equipped with backup air bottles. The SG PORVs are safety-related, missile protected, seismically qualified valves. Power to the SG PORV controllers in the MCR will be provided by the Class 1E batteries in Phase 1 and by the portable 120/240 VAC or 480 VAC diesel generators in Phases 2 and 3. Controlling the SG PORVs from the MCR will aid in minimizing field action and maximizing SG PORV control response. Operation of the SG PORVs from the MCR will continue until air supply from the respective back-up air receivers is depleted, at which time manual control will be initiated via local manual hand wheel control, or the backup air receivers will be recharged by a portable diesel driven air compressor stored in the BDB Storage Building.

2.3.4.3 Batteries

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

2.3.4.4 Diesel Driven Fire Pump and Fire Protection Piping

The Diesel Driven Fire Pump (DDFP) is located within a safety-related structure and is, therefore, protected against applicable design basis external hazards. The FP piping from the pump to the suction of the TDAFW pump is also Seismic Category I, tornado missile protected and therefore determined to be robust as defined in NEI 12-06. The FP system will be pressurized by the DDFP, which provides water from the SW Reservoir at sufficient flowrate and pressure to support TDAFW pump operation.

2.3.4.5 Emergency Condensate Storage Tank

The Emergency Condensate Storage Tank (ECST) provides an AFW water source at the initial onset of the event. The tank is a safety–related, seismic, tornado missile protected structure and is, therefore, designed to withstand the applicable design basis external hazards stated in NEI 12-06 (Reference 3). ECST volume is maintained greater than or equal to 110,000 gallons per Surveillance Requirement 3.7.6.1 of the North Anna Technical Specification (Reference 9) and is normally aligned to provide emergency makeup to the SGs. The ECST minimum usable volume is approximately 96,000 gallons.

2.3.4.6 Service Water Reservoir

The SW Reservoir has approximately 22.5 million gallons of storage capacity (Reference 15). Since the SW pumps are not available during a BDB ELAP event, the full volume of the SW Reservoir is available as a water source for the AFW system. Refer to Section 2.15 for discussion of water quality.

2.3.5 FLEX Strategy Connections

2.3.5.1 Primary AFW Pump Connection

The primary connection to supply AFW to the SGs is located on the TDAFW pump discharge line in the AFW Pump House (Figures 12 and 13). A flexible hose will be routed from the BDB AFW pump discharge to the primary connection inside the AFW Pump House. Hydraulic analysis of the flowpath from the BDB ECST refill connection to the primary BDB AFW pump discharge connection has confirmed that applicable performance requirements are met.

2.3.5.2 Alternate AFW Connection

In the event that the primary AFW connection is not available, an alternate connection location is provided. The alternate AFW connection for SG injection is located in the main feedwater system in the Mechanical Equipment Room located in the Service Building, which is separate from the AFW Pump House. The connection consists of a hose adapter that replaces the valve bottom flange connection on one of three main feedwater regulating bypass valves

(Figures 12 and 13). A flexible hose will be routed from the BDB AFW pump discharge to the alternate connection hose adapter. The main feedwater header will be pressurized. The flow to the SGs will be manually controlled by operating the main feedwater regulating bypass valve for each SG. Hydraulic analysis of the flowpath from the BDB ECST Refill connection to the alternate AFW Pump discharge connection confirmed that applicable performance requirements are met.

2.3.5.3 <u>ECST Connection (AFW Pump Suction)</u>

A suction and/or refill connection to the ECST is installed to provide a suction source to portable equipment or to facilitate refill of the ECST. The connection is seismically designed and located inside the AFW Pump House. The connection includes a hose coupling suitable for easy connection of a fire hose supplying water from the BDB High Capacity pump or one of the other sources of water to refill the ECST (Figures 14 and 15).

2.3.5.4 <u>Primary RCS Connection</u>

The primary connection for RCS makeup is a connection located downstream of the Low Head Safety Injection (LHSI) pump discharge motor operated valves to the RCS hot legs (Figures 2 and 3).

2.3.5.5 <u>Alternate RCS Connection</u>

The alternate RCS connection utilizes a connection to a standpipe located in the Auxiliary Building basement that extends to an accessible area in the Hydrogen Recombiner Vault (Figures 4 and 5). The BDB RCS Injection pump discharge connects, via a high pressure hose, to the inlet (upper end) of the standpipe connection. A spectacle flange is attached to the standpipe outlet (lower end) to a connection located on the Unit 2 normal charging header. The BDB RCS Injection pump can deliver borated water from the RWST or the portable boric acid mixing tank to the RCS via the normal charging header. This connection's location in the Auxiliary Building, along with the charging system flowpath utilized by the connection, provide the physical and train separation required per NEI 12-06 from the primary connection. The cross-ties in the normal charging system provide the capability to inject borated water into either unit from this location. In the event that only one RCS Injection pump is available, this alternate connection would be used to alternate RCS injection/makeup between the units.

2.3.5.6 RWST Suction Connection

The primary supply of water to the BDB RCS Injection pump is through a suction connection from the RWST via a permanent hose connection. The connection is installed in one of two quench spray pump's suction elbows for each unit, allowing borated water from the RWST to be supplied to a portable BDB RCS Injection Pump (Figures 2 and 3).

In the event that one unit's RWST is damaged, the suction hose to that unit's BDB RCS Injection pump can be routed from the opposite units RWST to provide a borated water source to the BDB RCS Injection pump.

Each hose connection is capable of providing flow to the suction of both BDB RCS Injection pumps through either RWST.

Alternately, if neither RWST is available, portable Boric Acid Mixing Tanks are available to batch borated water and provide borated water to the suction of the BDB RCS Injection pumps.

2.3.5.7 Primary Electrical Connection

A receptacle panel for the 120/240 VAC DG cable connections is located in the Cable Vault Rod Drive Room which provides connection to repower essential instrumentation from a portable 120/240 VAC DG (Figure 6). From the receptacle panel, cables are installed in seismically mounted raceways to two distribution panels, one for each of the 120/240 VAC DG output circuits. Each BDB distribution panel has branch circuit breakers sized to feed the required loads.

The cables required to connect the 120/240 VAC DG to the receptacle panel are stored in the Hydrogen Recombiner Control Panel Vault and are protected from seismic interactions, missiles, flood, snow and ice; and are operable within the outside temperature ranges applicable to the site.

2.3.5.8 Alternate Electrical Connection

The receptacle panel for the 120/240 VAC DG connections located in the Cable Vault Rod Drive Room also contains the 480 VAC DG cable connections to repower 480 VAC loads including battery chargers (Figure 6). From the receptacle panel, cables are installed in seismically mounted raceways to the Class 1E 480 VAC bus via pre-installed cable and conduit to Class 1E 480 VAC MCC breakers.

2.3.5.9 4160 VAC Electrical Connection

Two (2) 1-MW 4160 VAC generators delivered to the site from the NSRC will be connected to a distribution panel (also delivered from the NSRC) in order to meet the required Phase 3 4160 VAC load requirements for each unit. Due to the size of the equipment, the 4160 VAC generators will be deployed to areas either near the existing Emergency Diesel Generator (EDG) Rooms (Figure 6) or by the large openings in the Unit 1 and 2 Turbine Buildings (Figure 11). The area near the existing EDG rooms affords the simplest configuration to connect to one of the two Class 1E 4160 VAC buses for each unit, but space outside of these rooms is limited. Depending on the debris situation, the Turbine Building openings may be the more viable option for deployment. In this case, either the Emergency Switchgear Room or the normal Switchgear Room would be used to tie the 4160 VAC generators to one of the two Class 1E 4160 VAC buses for each unit (Figures 16 and 17).

2.3.6 Key Reactor Parameters

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

- FW Flowrate - AFW flowrate indication will be available in the Main Control Room (MCR). AFW flowrate indication will be available for SG A, B, and C throughout the event.
- SG Water Level - SG wide range (WR) water level indication will be available from the MCR, Auxiliary Shutdown (ASD) Panel, and locally within the AFW Pump House. SG narrow-range (NR) level indication will be available from the MCR and ASD Panel. SG WR and NR level indication will be available for SG A, B, and C throughout the event.

- SG Pressure - SG pressure indication will be available from the MCR, the ASD Panel, and locally in the Main Steam Valve House (MSVH). SG pressure indication will be available for SG A, B, and C throughout the event.
- RCS Temperature - RCS hot-leg and cold-leg temperature indication will be available from the MCR (recorder only), the ASD panel, and the Fuel Building. RCS hot-leg and cold-leg temperature indication will be available throughout the event, but only "A" and "B" loop temperatures will be indicated in the Fuel Building.
- RCS Pressure – RCS wide range pressure indication will be available for the MCR, the ASD panel, and the Fuel Building. RCS pressure indication will be available throughout the event.
- Core Exit Thermocouple Temperature – Core exit thermocouple temperature indication will be available in the MCR. This temperature indication will be available throughout the event.
- ECST Level - ECST water level indication will be available from the MCR, the ASD Panel, locally using pressure indication installed on the ECST refill connection, and locally using pump suction gauges.
- Pressurizer Level: Pressurizer level indication will be available from the MCR, ASD panel, and Fuel Building. Pressurizer level indication will be available throughout the event.
- Reactor Vessel Level Indication System (RVLIS): RCS level indication from the RVLIS will be available from the MCR. Train "A" of RVLIS will be also available on a recorder in the post accident monitoring (PAM) panel. RVLIS will be available throughout the event.
- Excore Nuclear Instruments: Indication of nuclear source range activity will be available from the MCR and in the Fuel Building. Indication will be available throughout the event.

Portable BDB 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 120 VAC Vital Bus infrastructure is damaged, FLEX strategy guidelines for alternately obtaining the critical parameters locally is provided in FSG-7, *Loss of Vital Instrumentation or Control Power.*

2.3.7 Thermal Hydraulic Analyses

2.3.7.1 Secondary Makeup Water Requirements

Calculations were performed to determine the inventory required for core decay heat removal, RCS cooldown, and to maintain steam generator levels and dryout times associated with the volumes of various onsite AFW water sources. The conclusions from this analysis showed that the existing Emergency Condensate Storage tank usable volume of approximately 96,000 gallons would be depleted in approximately 4.2 hours at which time another source of water would be required. The additional source at North Anna is the existing fire protection system with the Diesel Driven Fire Pump (DDFP) taking suction from the approximately 22.5 million gallon SW Reservoir. The additional 22.5 million gallons of water will be sufficient for several weeks of decay heat removal. Lake Anna provides an additional source of water to extend decay heat removal capability indefinitely, if required.

2.3.7.2 RCS Response

The model used for the determination of RCS response was the same model used in the generic analysis in Section 5.2.1 of WCAP-17601 (Reference 10), and updated for Westinghouse 3-loop plants in WCAP-17792 (Reference 11). Section 5.2.1 of WCAP-17601 provides a Reference Case which assumes standard Westinghouse OEM RCP seal packages to determine the minimum adequate core cooling time with respect to RCS inventory (i.e., core uncovery). The Reference Case models a Westinghouse 4-loop plant with a core height of 12 feet (i.e., a 412 plant), a T_{cold} upper head, at 3723 MWt, with Model F Steam Generators and Model 93A/A-1 Reactor Coolant Pumps.

PWROG-14064 (Reference 12) indicates that the initiation time for reflux cooling will be set to 17.0 hours for the WCAP-17601, Section 5.2.1, Westinghouse 4-loop T_{cold} Reference Case. PWROG-14064 also indicates that 17.0 hours can be used, as a conservative basis, for Westinghouse 3-loop T_{hot} plants (i.e., for North Anna Units 1 and 2).

RCS inventory makeup will begin within 16 hours following the onset of the ELAP condition. Based on information from WCAP-17601 and WCAP-17792, reflux cooling is conservatively set at 17.0 hours with assumed leakage rates for Westinghouse OEM equivalent seals. North Anna has replaced the OEM equivalent seals on 2 of 3 RCPs with Flowserve N-9000 seals. An evaluation demonstrated that the integrated RCS leakage, with at least 2 of 3 Westinghouse OEM equivalent seals replaced with Flowserve N-9000 seals, is less than the value used in WCAP-17792; therefore additional margin to reflux cooling is available for North Anna units.

Since RCS inventory makeup will begin within 16 hours following the onset of the ELAP condition at 45 gpm makeup capacity, the reflux cooling condition will be avoided.

2.3.8 Reactor Coolant Pump Seals

North Anna Units 1 and 2 are Westinghouse 3-loop plants with Westinghouse RCP pumps and originally with Westinghouse OEM RCP seals. The original seals were replaced with an equivalent seal supplied by AREVA. North Anna intends to replace all the RCP seals with Flowserve N-9000 seals and has completed 2 of the 3 seal replacements on each unit as of the required FLEX implementation date. As stated in Section 2.3.7, an evaluation was performed comparing the integrated leakage for the North Anna configuration with the analyzed values used in WCAP-17792. Leakage from the Flowserve seals is based on the Flowserve White Paper (Reference 13). Leakage from the Westinghouse OEM equivalent seals is based on information provided in PWROG-14015, Revision 1 (Reference 14). Based on the comparative evaluation, the integrated leakage for the post-implementation North Anna RCP seal configuration (i.e., 2 of 3 seals replaced on each unit) is bounded by the analyzed values used in WCAP-17601 and WCAP-17792.

2.3.9 Shutdown Margin Analysis

A Shutdown Margin (SDM) Analysis was performed for the reactor core from North Anna Unit 1, Cycle 23 (which was determined to be representative of a typical North Anna unit reload core) and determined that at least 1% SDM (Keff <0.99) is available up to 37 hours following a reactor trip from full power. However, due to xenon decay, additional core boron is needed after 37 hours in order to continue at the target (290 psig) SG pressure. Calculations show that injection of approximately 4600 gallons of 2600 ppm borated water from the RWST will be adequate to meet shutdown reactivity requirements at the limiting End-of-Cycle condition and the core inlet temperature as low as 366°F. This additional boron requirement is met at less than 2 hours of RCS inventory makeup at 45 gpm. This makeup volume can easily be accommodated by RCS volume shrink without venting the RCS.

Since the RCS inventory makeup is initiated no later than 16 hours following an ELAP/LUHS event, the borated water injected into the RCS for inventory makeup is adequate to maintain core reactivity shutdown margin of 1% following an ELAP/LUHS.

Dominion's Nuclear Analysis and Fuel Department performs checks for every reload core to verify that the FLEX inventory management and reactivity control strategy remains adequate to maintain k-eff < 0.99 throughout the ELAP event.

The SDM calculation assumes a uniform boron mixing model. Boron mixing was identified as a generic concern by the NRC and was addressed by the Pressurized Water Reactor Owner's Group (PWROG). The NRC endorsed the PWROG boron mixing position paper (Reference 15) with the clarification that a one hour mixing time was adequate provided that the flow in all loops is greater than or equal to the corresponding single-phase natural circulation flow rate (Reference 16). For 3-loop plants, such as North Anna, the time to reach this condition (two-phase natural circulation flow is less than single-phase natural circulation flow) is conservatively set at 17.0 hours (See Section 2.3.7.2). Since RCS makeup will be initiated within 16 hours, and the pump capacity of 45 gpm is greater than the maximum RCS leakage at 16 hours, the NRC clarification regarding single-phase flow has been addressed and a one hour mixing time is acceptable. Since additional boron is not required until 37 hours after the ELAP event, the SDM of at least 1% is maintained.

If one of the two BDB RCS Injection pumps stored in the onsite BDB Storage Building is unavailable, the available BDB RCS Injection pump may be used to supply RCS inventory makeup to both units by alternating RCS injection between the units. RCS injection would begin with the BDB RCS Injection pump supplying one of the two units for 1 hour. Then the pump would be aligned to the opposite unit for the next 1 hour period. This would be done using the normal charging header cross-tie lines so the BDB RCS Injection pump would not need to be repositioned. The alternating RCS injection process would be repeated until RCS level is indicated in the pressurizer(s), or until such time as a RCS Injection pump could be received from the NSRC and deployed for RCS makeup to one of the two units. Since the BDB RCS Injection pump flow rate is more than double the RCP seal leak rate associated with the North Anna RCP seal configuration (two Flowserve and one Westinghouse OEM equivalent seals), the approach of sharing the RCS Injection pump ensures adequate boron mixing which, therefore, maintains the required SDM previously discussed.

2.3.10 FLEX Pumps and Water Supplies

2.3.10.1 Beyond-Design-Basis (BDB) High Capacity Pump

The BDB High Capacity pump is a nominal 150 psid at 1200 gpm pump that is shared between several functions. The pump is sized to provide AFW water supply of 300 gpm to each unit and 500 gpm Spent Fuel Pool makeup simultaneously. Hydraulic analysis of the flowpath from each water source to the SFP and to the ECST or to the BDB AFW pump suction for both units has confirmed that applicable performance requirements are met.

The BDB High Capacity pump is a trailer-mounted, diesel driven centrifugal pump that is stored in the BDB Storage Building. The pump is deployed by towing the trailer to a designated draft location near the selected water source. One BDB High Capacity pump is required to implement the reactor core cooling and heat removal strategy for both units. Two high capacity pumps are available to satisfy the N+1 requirement.

The station's 50.54(hh)(2) high capacity pump can meet the flow requirements for both the FLEX core cooling and SFP cooling strategies that credit the BDB High Capacity pump. Therefore, the 50.54(hh)(2) high capacity pump will meet the N+1 requirement. The 50.54(hh)(2) high capacity pump will be stored in Warehouse 10, which is reasonably protected from flooding, extreme heat, and extreme cold hazards.

2.3.10.2 BDB AFW Pump

Consistent with NEI 12-06, Appendix D, SG water injection capability is provided using a portable AFW pump through a primary and alternate connection. The BDB AFW pump is a nominal 450 psid 300 gpm pump. The BDB AFW pump is a trailer-mounted, diesel engine driven centrifugal pump that is stored in the BDB Storage Building. The portable, diesel-driven BDB AFW pump will provide a back-up method for SG injection in the event that the TDAFW pump can no longer perform its function due to insufficient turbine inlet steam flow from the SGs. Hydraulic analyses has confirmed that the BDB AFW pump is sized to provide the minimum required SG injection flowrate to support reactor core cooling and decay heat removal. Three BDB AFW pumps are available to satisfy the N+1 requirement.

2.3.10.3 BDB RCS Injection Pump

The PWROG Core Cooling Position Paper (issued in conjunction with WCAP-17601) recommends that the RCS Injection pump required delivery pressure be established at the saturation pressure of the reactor vessel head +100 psi driving head to allow RCS injection. Following the formula in the position paper, the required delivery pressure for the RCS Injection pump at North Anna is approximately 1886 psia. Accordingly, the BDB RCS Injection pump is capable of delivering a minimum flow of 45 gpm at a discharge pressure of greater than 2000 psig. Hydraulic analysis of the BDB RCS Injection pump with the associated hoses and installed piping systems confirm that the BDB RCS Injection pump minimum flow rate and head capabilities exceed the FLEX strategy requirements for maintaining RCS inventory.

One BDB RCS Injection pump is available for each North Anna unit. However, in the event of a failure of one of the pumps, the pump design capacity is such that a single pump can be shared between the units, thus meeting the N+1 requirement with two pumps.

2.3.10.4 AFW Water Supplies

Emergency Condensate Storage Tank (ECST)

The ECST provides the source of AFW at the onset of the event. The tank is a safety-related, seismically designed, tornado missile protected structure and is, therefore, designed to withstand applicable design basis external hazards. ECST volume is maintained with greater than or equal to 110,000 gallons per Surveillance Requirement 3.7.6.1 of the Technical Specification (Reference 9) and aligned to provide emergency makeup to the SGs. The minimum usable volume is approximately 96,000 gallons.

Service Water Reservoir

The SW Reservoir has approximately 22.5 million gallons of storage capacity of which 600,000 gallons is allocated in the design basis of the SW Reservoir volume for fire protection using the DDFP. However, since the SW pumps are not available during a BDB ELAP event, the full volume of the SW Reservoir (22.5 million gallons of water) would be available to the Fire Protection system as a water source for the AFW system. Refer to Section 2.15 for discussion of water quality.

Lake Anna

Lake Anna is a source of water for the ultimate heat sink. Refer to Section 2.15 for a discussion of water quality.

2.3.10.5 Borated Water Supplies

Two sources of borated water have been evaluated for use during a Beyond-Design-Basis event. Each borated water source is discussed below, in order of usage preference.

- **Refueling Water Storage Tank:** Each unit is equipped with one RWST located at grade level just outside of its respective Safeguards Building. The tanks are stainless steel, safety-related, seismically qualified storage tanks, but are not protected from missiles. During "at power" operations each operating unit's RWST borated volume is maintained greater than 466,200 gallons at a boron concentration between 2600 and 2800 ppm. The RWST is the preferred borated water source for the RCS Injection strategies.
- **Portable Boric Acid Mixing Tank**: In the event that both RWSTs are unavailable or become depleted, portable Boric Acid Mixing

Tanks are available to provide a suction source for the BDB RCS Injection pumps. These mixing tanks will be transported from the onsite BDB Storage Building and positioned near the respective BDB RCS Injection pump. Dilution water will be added to the mixing tank by either a portable transfer pump, the BDB AFW pump, or from the BDB High Capacity pump header taking suction from a clean water source. Bags of powdered boric acid will be mixed with dilution water to achieve the proper concentration for maintaining adequate shutdown margin while making up RCS inventory. Each tank is equipped with an agitator to facilitate mixing of the boric acid although complete dissolution of the powdered boric acid is not required since agitation will be continued throughout the injection process. The maximum boron concentration that will be mixed is below the level at which precipitation concerns occur, even at temperatures down to 32°F; however, a heater is also available to prevent tank freezing, if necessary.

2.3.11 Electrical Analysis

The Class 1E battery duty cycle of eight (8) hours for North Anna was calculated in accordance with the IEEE-485 methodology using manufacturer discharge test data applicable to the FLEX strategy as outlined in the NEI white paper on Extended Battery Duty Cycles (Reference 17). The time margin between the calculated battery duration for the FLEX strategy and the expected deployment time for FLEX equipment to supply the DC loads is approximately two (2) hours for North Anna.

The strategy to re-power the stations vital AC/DC buses requires the use of diesel powered generators. For this purpose, each unit requires one 120/240 VAC portable diesel generator. One 480 VAC portable diesel generator per unit is available as an alternate re-powering option.

The 120/240 VAC DGs are 40 KW, single phase, 60Hz, generators that are trailer-mounted with a 100 gallon double-walled diesel fuel tank built into the trailer.

The 480 VAC diesel generators are 350 KW generators that are trailer-mounted with a 500 gallon double-walled diesel fuel tank built into the trailer.

Additional replacement 480 VAC generators and 4160 VAC diesel powered generators are available from the National SAFER Response Center (NSRC) for the Phase 3 strategy. The specifications and ratings for this equipment are listed in Table 2.

2.4 Spent Fuel Pool Cooling/Inventory

The North Anna Spent Fuel Pool (SFP) is a common pool designed for both Unit 1 and Unit 2. The basic FLEX strategy for maintaining SFP cooling is to monitor SFP level and provide sufficient makeup water to the SFP to maintain the normal SFP level.

2.4.1 Phase 1 Strategy

Evaluations estimate that with no operator action following a loss of SFP cooling at the maximum design heat load, the SFP will reach 212°F in approximately 9 hours and boil off to a level 10 feet above the top of fuel in 43 hours from initiation of the event. The Phase 1 coping strategy for spent fuel pool cooling is to monitor spent fuel pool level using instrumentation installed as required by NRC Order EA-12-051 (Reference 5).

2.4.2 Phase 2 Strategy

The Phase 2 strategy is to initiate SFP makeup using either the BDB High Capacity pump or the existing fire protection (FP) system through the BDB SFP makeup connection. The BDB High Capacity pump would be deployed from the BDB Storage Building to an area near one of several available draft points (Figure 1). The discharge of the pump would be connected to the BDB SFP makeup hose connection outside of the Fuel building (Figure 18). Required hose lengths and fittings are also located in the BDB Storage Building. The BDB High Capacity pump is trailer mounted and will be towed to the draft point, along with the necessary hoses and fittings, by tow vehicles also located within the protected BDB Storage Building.

No deployment is required for use of the FP system as a SFP makeup source.

Additionally, as required by NEI 12-06, spray monitors and sufficient hose length required for the SFP spray option are located in the BDB Storage Building.

2.4.3 Phase 3 Strategy

Additional Low Pressure/High Flow pumps will be available from the NSRC as a backup to the onsite BDB High Capacity pumps.

2.4.4 Structures, Systems, and Components

2.4.4.1 Primary Connection

The hose connection for the permanent, seismically designed primary BDB SFP makeup connection is located on the outside wall of the Fuel Building. The BDB SFP makeup connection is sufficiently sized to restore SFP level long-term after the loss of SFP cooling at a makeup rate of 500 gpm for SFP boil off.

The new BDB SFP makeup connection line is a 4-inch line that tees into the existing 6-inch emergency SFP makeup line (Figure 18). The existing line runs vertically along the south inside (concrete) wall of the Fuel Building between the 265-foot and the 270-foot elevations. The new seismically supported 4-inch line is routed from the new tee along and through the south inside wall to the exterior connection location. The new connection is supported from the outside wall of the Fuel Building at the 274-foot elevation near the Unit 1 Containment above the vicinity where the buried emergency SFP makeup header from the FP system enters the Fuel Building at elevation 265-foot. A new check valve is installed inside the Fuel Building in the 6-inch line upstream of the tee to prevent back flow through the FP piping from the connection. A check valve in the new 4-inch line inside the Fuel Building will prevent flow out of the new connection line in the event that the existing emergency SFP makeup connection is in use (supplied from the FP header). The new connection is a standard fire hose connection and is located outside the Fuel Building at approximately the 274-foot elevation.

Use of the primary BDB SFP makeup connection will not require entry into the Fuel Building.

2.4.4.2 Alternate Connection

The alternate Phase 2 strategy for providing makeup water to the SFP is to use the SFP refill equipment that is already in place. The FP system feeds the emergency SFP makeup line from the yard fire main loop. The emergency SFP makeup line extends above the SFP so that water can be discharged directly into the pool (Figure 18).

The water source for the alternate strategy is the pressurized fire main, which can be pressurized by the Diesel Driven Fire Pump

(DDFP) or the BDB High Capacity pump. The yard fire main is buried and seismically qualified, and is expected to be able to provide water during a flooding event.

2.4.4.3 Spray Option Connection

An additional alternate strategy utilizes a spray option to achieve SFP makeup. The spray strategy (as required by NEI 12-06 Table D-3 for providing spray at 250 gpm/unit) is to provide 500 gpm flow through portable spray monitors set up on the deck next to the SFP (Figure 18). A hose will be run from the fire main or the discharge of the BDB High Capacity pump, through the Fuel Building door, and up to the SFP operating deck. From there, the hose may be run directly over the side of the pool or to portable spray monitors. When deployed, the two spray monitors will be connected via a wye that splits the pump discharge into two hoses. The two spray monitor hoses will be routed from the new fuel storage area to the SFP. The oscillating spray monitors will be set up approximately 30 feet apart and 16 feet back from the SFP. These spray monitors will spray water into the SFP to maintain water level.

2.4.4.4 Fuel Building Ventilation

Ventilation requirements to prevent excessive steam accumulation in the Fuel Building are included in an existing site Abnormal Procedure (AP). The AP directs operators to open several rollup doors in the Fuel Building to establish a natural circulation flowpath. Airflow through these doors provides adequate vent pathways through which steam generated by SFP boiling can exit the Fuel Building. BDB FLEX Support Guidelines (FSGs) implement this method of ventilation for the Fuel Building.

2.4.5 Key Reactor Parameters

The key parameter for the SFP makeup strategy is the SFP water level. The SFP water level is monitored by the instrumentation that was installed in response to Order EA-12-051, *Reliable Spent Fuel Pool Level Instrumentation* (Reference 5).

2.4.6 Thermal-Hydraulic Analyses

An analyses was performed that determined, with the maximum expected SFP heat load immediately following a core offload, that the SFP will reach a bulk boiling temperature of 212°F in approximately 9 hours and boil off to a level 10 feet above the top of fuel in 43 hours unless additional water is supplied to the SFP. A flow of 101 gpm will replenish the water lost due to boiling. Deployment of the SFP hose connection from the BDB High Capacity pump within 24 hours with a design flow of 500 gpm for the SFP will provide for adequate makeup to restore the SFP level and maintain an acceptable level of water for shielding purposes.

2.4.7 FLEX Pump and Water Supplies

2.4.7.1 BDB High Capacity Pump (Refer to 2.3.10.1)

The BDB High Capacity pump is a nominal 150 psid at 1200 gpm pump that is shared between several functions. The BDB High Capacity pump is a trailer-mounted, diesel driven centrifugal pump that is stored in the BDB Storage Building. The pump is deployed by towing the trailer to a designated draft location near the selected water source. One BDB High Capacity pump is sized to provide an AFW water supply of 300 gpm each to Unit 1 and Unit 2 and 500 to gpm Spent Fuel Pool makeup simultaneously.

2.4.7.2 Service Water Reservoir

The SW Reservoir has approximately 22.5 million gallon of storage capacity of which 600,000 gallons is allocated in the design basis of the SW Reservoir volume for fire protection using the DDFP. However, since the SW pumps are not available during a BDB ELAP event, the full volume of the SW Reservoir (22.5 million gallons of water) would be available to the Fire Protection system as a water source for emergency SFP makeup. Refer to Section 2.15 for discussion of water quality.

2.4.7.3 Lake Anna

Lake Anna is a source of water for the ultimate heat sink. Refer to Section 2.15 for discussion of water quality.

2.4.8 Electrical Analysis

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

2.5 Containment Integrity

With an extended loss of all alternating current power (ELAP) initiated while either North Anna unit is in Modes 1-4, Containment cooling for that unit is also lost for an extended period of time. Therefore, Containment temperature and pressure will slowly increase. Structural integrity of the reactor containment building due to increasing Containment pressure will not be challenged during the first several weeks of a BDB ELAP event. However, with no cooling in the Containment, temperatures in the Containment are expected to rise and could reach a point where continued reliable operation of key instrumentation might be challenged.

Conservative evaluations have concluded that Containment temperature and pressure will remain below Containment design limits and that key parameter instruments subject to the Containment environment will remain functional for a minimum of seven days. Therefore, actions to reduce Containment temperature and pressure and to ensure continued functionality of the key parameters will not be required immediately and will utilize offsite equipment during Phase 3.

NOTE: The containment integrity strategy descriptions below are the same for both of the two North Anna units. Any differences and/or unit specific information is included where appropriate.

2.5.1 Phase I

The Phase 1 coping strategy for Containment involves verifying Containment isolation per ECA-0.0, *Loss of All AC Power*, and monitoring Containment temperature and pressure using installed instrumentation. Control room indication for "A" and "B" train Containment wide range pressure and "A" train Containment temperature will be available for the duration of the ELAP.

2.5.2 Phase 2

The Phase 2 coping strategy is to continue monitoring Containment temperature and pressure using installed instrumentation. Phase 2 activities to repower key instrumentation (Section 2.9.3) are required to continue Containment monitoring.

Containment temperature will be procedurally monitored and, if necessary, Containment temperature will be reduced to ensure that key instruments inside Containment will remain within analyzed limits for equipment qualification. The choice of equipment qualification as a temperature limit is conservative. Containment temperature reduction will require the implementation of a Containment cooling strategy utilizing equipment provided in Phase 3. The various Containment cooling strategy options are discussed in Section 2.5.3.

2.5.3 Phase 3

Necessary actions to reduce Containment temperature and ensure continued functionality of the key parameters will utilize existing plant systems powered by offsite equipment during Phase 3. 4160 VAC power will be needed to operate various station pumps. This capability will be provided by two 1 MW 4160 VAC portable generators per unit provided from the NSRC. The portable 4160 VAC generators and a distribution panel for each unit will be brought in from the National SAFER Response Center (NSRC) in order to supply power to either of the two Class 1E 4160 VAC buses on each unit. Additionally, by restoring the Class 1E 4160 VAC bus, power can be restored to the Class 1E 480 VAC buses via the 4160/480 VAC transformers to power selected 480 VAC loads.

If the Service Water (SW) pumps are not available, then Low Pressure/High Flow diesel driven pumps (up to 5,000 gpm) from the NSRC will be available to provide flow to existing site heat exchangers to facilitate heat removal from the Containment atmosphere.

Several options were evaluated to provide operators with the ability to reduce the Containment temperature. Each of these options require the restoration of multiple support systems to effectively remove heat from the Containment and reduce Containment temperature and pressure.

Ventilation Cooling Option (Preferred)

The ventilation option for Phase 3 Containment cooling is to establish Containment ventilation by either:

- Establishing Containment Air Recirculation Fan (CARF) cooling

OR

- Establishing Control Rod Drive Mechanism (CRDM) cooling

To implement this option, the 4160 VAC generators from the NSRC will be aligned to power a Class 1E 4160 VAC bus and a 480 VAC bus as described in Section 2.3.3. The 4160 VAC generators will provide power to the existing Component Cooling (CC) Water system and the SW pumps (if available), an Instrument Air (IA) system compressor, and either the CARF or the CRDM fan motors. Containment ventilation flow would be established by starting the CARF, cooling with air flow through the CARF cooling coil unit, and recirculating within the Containment. IA system pressure will be restored to remotely operate valves inside Containment, as required. SW system flow will be established through a CC heat exchanger to provide a heat sink, and CC flow will be established through the CARF cooling coil unit and the CC heat exchanger to transfer heat to the SW system. In this manner, heat from the Containment atmosphere will be rejected to the ultimate heat sink via the recirculation of Containment air through the CARF cooling coil unit. Restoration of the CRDM fan cooling involves essentially the same steps involved in the restoration of the CARF cooling capability. The CRDM fans and the Containment Air Recirculation fans are both 480 VAC motors.

In the event that the SW system pumps are unavailable, the SW system can be pressurized by the site Diesel Driven Fire Pump (DDFP) drawing from the SW Reservoir. Alternately, a portable NSRC Low Pressure / High Flow pump (or two NSRC Low Pressure/Medium Flow pumps) will be located near the SW pumphouse to draw from the SW Reservoir and discharge to the SW system via a flanged opening in the 36" piping in the Service Water Pump House Expansion Joint Vault using a hose adapter (Figure 19).

<u>Spray Option</u>

A spray option is available to spray water into the Containment using the Containment Recirculation Spray (RS) system utilizing clean water from the Casing Cooling Tank (CCT) and the RWST (Figures 20 and 21).

To utilize this option, the 4160 VAC generators from the NSRC will be aligned to power one of the Class 1E 4160 VAC and 480 VAC buses on each unit as described in Section 2.3.3, which will provide power to the RS pump 480 VAC (or 4160 VAC, depending upon the selected pump) motor.

The Containment sump must be filled to provide a suction water source for the RS pump. The CCT would be gravity drained to the Containment sump.

Since the volume of water from the CCT is not sufficient to adequately fill the Containment sump, water from the RWST can be pumped through the Quench Spray (QS) ring header nozzles into Containment using either the NSRC Low Pressure / Medium Flow pump (up to 2500 gpm) or the BDB High Capacity pump connected to the BDB RCS Quench Spray (QS) pump suction connection, located in the Quench Spray Pump House (QSPH), and discharging to the pre-fabricated BDB QS blind flange hose adapter connection located in the Safeguards Building.

The CCT and RWST are not high wind and associated missile protected, and if unavailable as water sources to fill the Containment sump, adequate sump inventory can be provided from the Service Water Reservoir or Lake Anna. Suction strainers are provided for this use to prevent clogging of the QS ring header nozzles (Figure 22).

This initial spray flow will fill the Containment sump in preparation for initiation of RS flow. When the sump level is adequate, either an inside or outside RS pump will be started to draw water from the sump and recirculate flow through the RS heat exchangers and the spray nozzles. SW system flow will be established through the RS heat exchangers to provide a heat sink. In this manner, Containment atmosphere heat will be rejected to the ultimate heat sink via the sump water recirculation spray flowpath.

In the event that the SW system pumps are unavailable, cooling water flow to the RS heat exchanger will be established by pressurizing the SW system as described for the Containment cooling ventilation option.

2.5.4 Structures, Systems, Components

2.5.4.1 Ventilation Cooling Strategy

No mechanical equipment connections are required for the Containment ventilation cooling option if the SW pumps are available. If the SW pumps are not available, a Low Pressure/High Flow pump from the NSRC will be connected to a flanged opening in the 36" piping in the Service Water Pump House Expansion Joint Vault using a pre-fabricated hose adapter.

2.5.4.2 Spray Strategy

The Containment spray option requires connections of BDB equipment to transfer water from the RWST (or Lake Anna) into the

Containment sump. The RWST suction connection for a Low Pressure/Medium Flow NSRC pump is located in the QSPH. The discharge connection is to the pre-fabricated BDB QS blind flange hose adapter connection located in the Safeguards Building.

The existing site equipment required to implement the Containment cooling options discussed above are components of safety-related systems and are both seismic category I structures and are also protected from high wind generated missiles, floods, and extreme high and low temperatures.

The Seismic Category 1 SW Pump House Expansion Joint Vault is designed to withstand missiles and high wind. The system connection points are located inside the structure and are protected from flooding, extreme cold, ice and snow, and extreme high temperature.

The remaining equipment required to implement the Containment cooling options discussed above is delivered to the site from the NSRC and is not subject to the site BDB hazards initiating the ELAP.

2.5.5 Key Containment Parameters

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

- Containment Pressure: Containment pressure indication is available in the main control room (MCR) throughout the event (Trains A and B).
- Containment Wide Range Temperature: Containment wide range temperature indication is available in the MCR throughout the event (Train A only).
- Containment Sump Level: Containment sump level indication is available in the MCR throughout the event (Train B only). Although this key parameter is available for all phases of the Containment cooling strategy, it is only credited in Phase 3, specifically for the Containment cooling spray option.

2.5.6 Thermal-Hydraulic Analyses

Conservative evaluations have concluded that Containment temperature and pressure will remain below Containment design limits and that key parameter instruments subject to the Containment environment will remain functional for a minimum of seven days. The Containment temperature will be procedurally monitored and, if necessary, the Containment temperature will be reduced using the options available to ensure that key Containment instruments will remain within their analyzed limits for equipment qualification.

2.5.7 FLEX Pump and Water Supplies

The NSRC is providing a Low Pressure/High Flow pump (nominal 5,000 gpm) which will be used if required to provide cooling loads to the SW system. A Low Pressure/Medium Flow (nominal 2,500 gpm) pump is also available from the NSRC, if needed. Water supplies are as described in Section 2.3.10 (i.e. SW Reservoir and Lake Anna).

2.5.8 Electrical Analysis

One (1) of the two (2) Class 1E 4160 VAC buses is required for each unit to repower the Containment cooling options described above. The 4160 VAC equipment being supplied from the NSRC will provide adequate power to perform the Phase 3 Containment cooling strategies. The necessary components to implement the various Containment cooling options have been included in the calculations to support the sizing of the 4160 VAC generators being provided by the NSRC. Accordingly, two (2) 1-MW 4160 VAC generators and a distribution panel (including cable and connectors) are provided from the NSRC per unit.

2.6 Characterization of External Hazards

2.6.1 Seismic

Per NEI 12-06 (Reference 2), seismic hazards must be considered for all nuclear sites. As a result, the credited FLEX equipment has been assessed based on the current NAPS seismic licensing basis to ensure that at a minimum, N sets of credited BDB equipment remains accessible and functional after a Beyond Design Basis external event. The North Anna seismic hazard is considered to be the earthquake magnitude associated with the design-basis seismic event. Per Section 2.5.2.6 of the North Anna UFSAR (Reference 18), the design-basis earthquake for structures founded on rock is 0.12g for horizontal ground motion and .08g for vertical ground motion. For structures founded on soil, the design-basis earthquake is 0.18g for horizontal motion and 0.12g for vertical motion.

As described in UFSAR Section 2.5.2.5.1, a magnitude 5.8 earthquake occurred on August 23, 2011, with an epicenter approximately 11 miles from the site. The Peak Ground Acceleration (PGA) values developed from recorded motions as a result of this earthquake exceeded the horizontal and vertical design basis PGA values. However, evaluations performed following the earthquake have concluded that there was no significant physical or functional damage to seismically designed Structures, Systems, and Components (SSCs) and only limited effects on non-seismic plant structures and equipment.

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. NAPS subsequently re-evaluated the seismic hazard and developed a Ground Motion Response Spectra (GMRS) for the site based upon the most recent seismic data and methodologies, and has found that the existing SSE does not envelop the new GMRS over the entire frequency range. This reevaluated seismic hazard is being addressed in the industry initiative referred to as the Augmented Approach (EPRI Report 3002000704). 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 evaluates 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 32.

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

North Anna Power Station is located on Lake Anna, which has a nominal water level at the 250 foot MSL elevation. The watershed for Lake Anna is 343 square miles. The release of any upstream body of impounded water, due to a seismic event or dam failure, would not have a significant impact on lake level and thus would not cause flooding at the site (UFSAR Section 2.4.4). A potential cause of flooding at the site would be from high lake level due to runoff from an extreme precipitation event in the watershed.

An evaluation was performed to determine the highest potential lake level due to runoff of precipitation in the watershed. The probable maximum flood was generated using the unit hydrograph of April 1973 and the 48-hour probable maximum precipitation (PMP) of 27.04 inches. The standard project storm of 13.54 inches in 48 hours (approximately one-half of the PMP), is used for antecedent precipitation. The antecedent precipitation is assumed to occur 5 days before the main storm, with 3 rainless days between the storms. The resultant probable maximum flood still-water level is elevation 264.2 feet. When wind surge and wave run-up, due to a 40 mph wind blowing in the most critical direction, are added to this height, there is an increase of 2.9 feet, plus a backwater allowance of 0.2 foot. The resultant upper-bound flood stage is at elevation 267.3, which is 3.7 feet below typical plant grade (UFSAR Section 2A.2.1).

A potential source of flooding is the local accumulation of water due to precipitation. UFSAR Section 2.4.2.2 states: "The site is relatively flat, and no concentration of runoff is expected on the flat areas. The drainage area that will contribute to runoff on the site is not much larger than the site. The area west of the site will receive runoff from approximately 35 acres; however, the drainage facilities in this area have been designed for a 50-year storm." In this discussion, the site refers to the area around the Turbine Buildings and reactor Containments.

Since the site is not located on an estuary or open coast, surge flooding is not a concern. Tsunami flooding is not a concern for the site because of its inland location.

Per NEI 12-06 (Reference 3), North Anna is considered a "wet" site because the site is maintained "dry" by a permanently installed dike. The design-basis flood level is based on the maximum potential lake level of 267.3 feet MSL resulting from a PMP event over the Lake Anna watershed causing a significant rise in lake level. Although the majority of the site grade is above the design base flood level, the western portion of the Unit 2 Turbine Building is protected by a dike to prevent flooding during the design-basis flood. There is no deployment of FLEX equipment in the area west of the Unit 2 Turbine Building; therefore, there are no deployment limitations due to flooding from the design-basis flood.

Since the original submittal of the Overall Integrated Plan, Dominion has completed and submitted the Flood Hazard Reevaluation Report (FHRR) (Reference 19) for North Anna as requested by the 10 CFR 50.54(f) letter dated March 12, 2012. The reevaluation represents the most current flooding analysis for North Anna Units 1 and 2. The reevaluation results were mostly bounded by the original North Anna UFSAR site flooding vulnerabilities and characteristics, in that the non-events such as seiche and dam failures continued to be non-events. The maximum flood level due to elevated lake levels resulting from a PMP event over the Lake Anna watershed exceeded the UFSAR value by 0.1 foot. This difference is insignificant since the plant grade is nearly 4 feet above this flood level. The only significant difference identified from the UFSAR was the local intense precipitation (LIP) event. Using conservative drainage assumptions and current-day PMP rates, some areas of the site were subject to short term flooding which required minimal protective actions. Details of the LIP event are provided in Section 2.1 of the FHRR (Reference 19). Consistent with Enclosure 2 of the March 12, 2012, letter, North Anna has implemented interim actions to address the higher LIP event levels relative to the current licensing basis. Additionally, North Anna will complete an Integrated Assessment and will prepare a report for the NRC. Submittal of the report is currently scheduled for September 2015 but is subject to extension by the NRC.

2.6.3 Severe Storms with High Wind

The current plant design basis addresses the storm hazards of hurricanes, high winds and tornados.

For hurricanes, a total of 51 tropical storms or hurricane centers were recorded between 1871 and 1987 as passing within 100 nautical miles of the North Anna site. North Anna UFSAR Section 2.3.1 stated that an average of approximately two tropical storms or hurricanes pass within 100 nautical miles of the North Anna plant site every 5 years. With the site being approximately 100 miles from the Atlantic Ocean, hurricanes and tropical storms tend to weaken before reaching the site.

For extreme straight winds – the extreme 1-mile wind speed is defined as the 1-mile passage of wind with the highest speed for the day. The extreme 1-mile wind speed at 30 feet above the ground, which is predicted to occur once in 100 years, is 80 mph. The fastest wind speed recorded at Richmond, based on the 1951-1987 period, was 68 mph from the southeast in October 1954.

For tornados and tornado missiles, the North Anna UFSAR indicates that between January 1916 and December 1987, there were a total of 65 tornadoes reported within a 50-mile radius of the site (UFSAR Section 2.3.1). The tornado model used for design purposes has a 300 mph rotational velocity and a 60 mph translational velocity (UFSAR Section 3.3.2).

2.6.4 Ice, Snow and Extreme Cold

Snowfalls of 4 inches or more occur, on average, once a year, and snow usually only remains on the ground from 1 to 4 days at a time. Richmond averages about 14.6 inches of snow a year. The UFSAR states that an examination of the period between 1977 and 1987, indicates that there were only six documented cases of ice storms in Louisa and the immediately surrounding counties. Of these, two were reported to have caused serious damage (including damage to power lines and trees).

Temperatures in the site region rarely fall below 10°F (UFSAR Section 2.3.1). The lowest temperature recorded in Richmond was minus 12°F in January 1940 and the lowest recorded in Charlottesville was minus 9°F in January 1985 (UFSAR Table 2.3-2). Such low temperatures could adversely affect access to and the flowpath from Lake Anna or the Service Water Reservoir. Ice could form on the surface of Lake Anna or the Service Water Reservoir and impact FLEX strategies. However, capabilities are available to break through the ice, if needed, to provide access and a flowpath.

The UFSAR information is limited to data prior to 1987. Therefore, the high and low temperature data presented above has been confirmed to be accurate based on published data for the southeast region of the United States through 2012.

2.6.5 High Temperatures

Temperatures in the site region rarely exceed 95 °F (UFSAR Section 2.3.1). The peak temperature recorded in Richmond was 105°F in July 1977 and the peak temperature recorded in Charlottesville was 107°F in September 1954 (UFSAR Table 2.3-2).

The UFSAR information is limited to data prior to 1987. Therefore, the high and low temperature data presented above has been confirmed to be accurate based on published data for the southeast region of the United States through 2012.

2.7 Protection of FLEX Equipment

BDB equipment is stored in a single 10,000 sq. ft. concrete building that meets the plant's design-basis for both seismic and tornado-missile protection. The BDB Storage Building was evaluated for the effect of local seismic ground motions consistent with the NAPS Ground Motion Response Spectrum (GMRS) developed for the site as a result of the seismic hazard reevaluation (See Section 2.6.1) and found to have adequate structural margin to remain functional (i.e., collapse is not expected and access to the interior retained).

The BDB Storage Building is located in the parking lot west of Warehouse #5 (Figure 22). This location is above the flood elevation from the most recent site flood analysis. The BDB Storage Building was designed and constructed to prevent water intrusion and designed to protect the equipment from the other hazards identified in Section 2.6.

Analysis of component stored in the BDB Storage Building have been performed to determine appropriate measures to prevent seismic interaction. The fire protection and HVAC systems in the BDB Storage Building are seismically installed. The lighting, conduits, electrical, and fire detection components are not seismically installed, but are considered insignificant and not able to damage BDB equipment.

The debris removal equipment required to support the implementation of the FLEX strategies is also stored inside the BDB Storage Building in order to protect them from the applicable external hazards. Therefore, the equipment will remain functional and deployable to clear obstructions from the pathway between the BDB equipment's storage location and its deployment location(s). This debris removal equipment includes mobile equipment such as a front end loader and tow vehicles (tractors).

Deployment of the debris removal equipment and the Phase 2 BDB equipment from the BDB Storage Building is not dependent on offsite power. The building equipment doors are hydraulically operated with a battery backup and can also be opened manually.

The 50.54(hh)(2) high capacity pump can meet the flow requirements for both the FLEX core cooling and SFP cooling strategies cooling strategies that credit the BDB High Capacity pump and serves to meet the N+1 requirement. The 50.54(hh)(2) high capacity pump is stored in Warehouse 10, which is reasonably protected from flooding, extreme heat, and extreme cold hazards.

2.8 Planned Deployment of FLEX Equipment

2.8.1 Haul Paths

Pre-determined, preferred haul paths have been identified and documented in the FLEX Support Guidelines (FSGs). Figure 22 shows the haul paths from the BDB Storage Building to the various deployment locations. These haul paths have been reviewed for potential soil liquefaction and have been determined to be stable following a seismic event. Additionally, the preferred haul paths minimize travel through areas with trees, 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 BDB Storage Building 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 BDB Storage Building and its deployment location(s).

The deployment of onsite BDB equipment in Phase 2 requires that pathways between the BDB Storage Building(s) and various deployment locations be clear of debris resulting from BDB seismic, high wind (tornado), or flooding events. The stored BDB debris removal equipment includes tow vehicles (tractors) equipped with front end buckets and rear tow connections in order to move or remove debris from the needed travel paths. A front end loader will also be available to deal with more significant debris conditions.

Phase 3 of the FLEX strategies involves the receipt of equipment from offsite sources including the NSRC and various commodities such as fuel and supplies. Delivery of this equipment can be through airlift or via ground transportation. Debris removal for the pathway between the site and the

NSRC receiving "Staging Areas" locations and from the various plant access routes may be required. The same debris removal equipment used for onsite pathways may also be used to support debris removal to facilitate road access to the site once necessary haul routes and transport pathways onsite are clear.

2.8.2 Accessibility

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

Doors and gates serve a variety of barrier functions on the site. One primary function, security, is discussed below. However, other barrier functions include fire, flood, radiation, ventilation, tornado, and HELB. These doors and gates are typically administratively controlled to maintain their function as barriers during normal operations. Following a 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. The Security force will initiate an access contingency upon loss of the Security Diesel and all AC/DC power as part of the Security Plan. Access to the Owner Controlled Area, site Protected Area, and areas within the plant structures will be controlled under this access contingency as implemented by Security personnel. Access authorization lists are prepared daily and copies are protected from the various BDB external events for use post-ELAP event. The plant MCR contains a duplicate set of security keys for use by plant Operations personnel in implementing the FLEX strategies.

Vehicle access to the Protected Area is via the double gated sally-port at the Security Building. As part of the Security access contingency, the sally-port gates will be manually controlled to allow delivery of BDB equipment (e.g., generators, pumps) and other vehicles such as debris removal equipment into the Protected Area.

2.9 Deployment of Strategies

2.9.1 AFW Makeup Strategy

Lake Anna provides an indefinite supply of water, as makeup to the Emergency Condensate Storage Tank (ECST) for supply to the Turbine Driven Auxiliary Feedwater (TDAFW) pump or directly to the suction of the portable diesel driven BDB AFW pump. Lake Anna will remain available for any of the external hazards listed in Section 2.6. Additionally, the Service Water (SW) Reservoir is a safety-related, seismic Category I earthen structure and will also remain available for any of the external hazards listed in Section 2.6.

The portable, diesel driven BDB High Capacity pump will be transported from the BDB Storage Building to a draft location near the selected water source. A flexible hose will be routed from the pump suction to the water source where water will be drawn through a suction strainer and discharged through a strainer sized to limit solid debris size and prevent damage to the TDAFW or the BDB AFW pump. A flexible hose will be routed from the BDB High Capacity pump discharge to the BDB ECST Refill connection or to the suction of the portable BDB AFW pump. Water from the selected water source can also be pumped to the Spent Fuel Pool.

Both the primary BDB AFW pump discharge connection and the BDB ECST Refill connection are located within the seismic Category I, tornado missile protected AFW Pump House above the 272 foot floor elevation. Portable heating will be provided in the event of an ELAP and extended extreme cold hazard to protect the connection from freezing. The connection is protected from the external hazards described in Section 2.6.

The alternate BDB AFW pump discharge connection is located within the non-seismic Category I, non-missile protected portion of the Service Building. As such, this connection point may not be available following a seismic event or extreme high wind condition. The connection is protected from the other external hazards described in Section 2.6

Figure 1 provides a diagram of the flowpath and equipment utilized to facilitate this FLEX strategy.

2.9.2 RCS Makeup Strategy

The RCS Injection pumps are stored in the BDB Storage Building and are protected against all external hazards described in Section 2.6.

The primary RCS Injection pump discharge connection is located inside of the Safeguards Building of each unit and provides a path to the RCS hot legs of that unit. Accordingly, these connections are protected against all BDB external hazards.

The alternate RCS Injection pump discharge connection for both units is located inside of the Hydrogen Recombiner Vault and provides a path to the RCS hot legs and cold legs of both units. Accordingly, these connections are protected against all BDB external hazards.

The primary supply connection from the RWST for the RCS Injection pump is located in the Quench Spray Pump House of each unit. Accordingly, these connections are protected against all BDB hazards. Should the RWST become unavailable, an alternate supply of borated water is available from the portable Boric Acid Mixing tanks stored in the BDB Storage Building.

Figure 1 provides a diagram of the flowpath and equipment utilized to facilitate this strategy.

2.9.3 Spent Fuel Pool Makeup Strategy

The SFP makeup strategy will initiate makeup by deploying the BDB High Capacity pump from the BDB Storage Building or by using the existing FP system installed emergency SFP makeup piping. The discharge of the BDB High Capacity pump will be connected to a hose connection outside of the Fuel Building. No deployment is required for use of the FP system emergency SFP makeup piping as a SFP makeup source.

The BDB SFP makeup hose connection is located on the outside wall of the Fuel Building and is seismically designed and missile protected. The BDB SFP makeup connection is sufficiently sized to restore SFP level long term following the loss of SFP cooling with a makeup rate of 500 gpm.

Figure 1 provides a diagram of the flowpath and equipment utilized to facilitate this strategy.

2.9.4 Electrical Strategy

The 120/240 VAC diesel generators (DGs) are stored in the BDB Storage Building and are, therefore, protected from the BDB external hazards identified in Section 2.6.

One (1) 120/240 VAC DG for each unit will be deployed to the east or west alleyway (depending on the unit) adjacent to the Auxiliary Building. The 120/240 VAC DGs each have two output circuits. Each circuit on the 120/240 VAC DG includes an adjustable output breaker, weatherproof receptacle, flexible and weatherproof cable with weatherproof connectors at both ends which connects to a receptacle panel located in the associated unit's Rod Drive Room. The connecting cables for both units are pre-staged in the Hydrogen Recombiner Control Panel Vault and are, therefore, protected from the BDB external event hazards identified in Section 2.6.

The receptacle panel for the 120/240 VAC DG cables is seismically mounted, protected from missiles, flood, snow and ice, and operable within the outside temperature ranges specified for the site. From the receptacle panel, cables in seismically mounted raceways have been installed to two new BDB distribution panels, one for each output circuit. Each BDB distribution panel has branch circuit breakers sized to feed the required loads.

The 480 VAC DGs are stored in the BDB Storage Building and are, therefore, protected from the BDB external event hazards identified in Section 2.6.

The 480 VAC DGs will be deployed to the east or west alleyway (depending on the unit) adjacent to the locations of the 120/240 VAC DG deployment. The 480 VAC DGs each have a set of color coded cables which connect from the deployed generators to a receptacle panel located in the associated unit's Rod Drive Room. The color coded cables from each generator output circuit will be connected with proper phase rotation to the color coded mating receptacles in the receptacle panel located in the Rod Drive Room. In addition to color coding, a phase rotation meter is provided in the receptacle panel for each 480 VAC circuit.

The protection for the 480 VAC DG connections is the same as for the primary connections with the exception that the 480 VAC DG cables are stored in the BDB Storage Building with the generator and are, therefore, protected from the BDB external event hazards identified in Section 2.6.

2.9.5 Fueling of Equipment

FLEX equipment is stored in the fueled condition. Fuel tanks are typically sized to hold 24 hours of fuel. Once deployed during a BDB external event, a fuel transfer truck will refuel this equipment in the first 24 hours or sooner as required. The general coping strategy for supplying fuel oil to diesel driven portable equipment being utilized to cope with an ELAP/LUHS is to draw fuel oil out of any available existing diesel fuel oil tanks on the North Anna site. The following onsite fuel sources will be used to refuel the FLEX equipment via the fuel transfer truck (or portable containers) as required.

The primary source of diesel fuel for portable equipment is the emergency diesel generator (EDG) Fuel Oil Day Tanks. These four tanks contain 800 gallons of diesel fuel each (a total of 3200 gallons) and are seismically mounted and housed in the tornado protected EDG rooms. Fuel can be obtained using the tank drain valve and a flexible hose. Fuel can be gravity fed to suitable fuel containers for transport to BDB equipment. No pumps are necessary.

A second source for diesel fuel is the two EDG underground Diesel Fuel Oil Storage Tanks. Each tank has a 45,000 gallon capacity. These tanks are protected from high wind tornado missiles by virtue of the underground location and are also protected from seismic and flooding events. Fuel can be obtained using a fuel pump and attaching the pump suction to any of the eight (8) EDG fuel transfer pump suction strainer drain valves and pumping the diesel fuel to suitable fuel containers for transport.

A third source is the EDG above ground Diesel Fuel Oil Storage Tank that has a 275,000 gallon capacity. This tank is protected from flooding, but is not seismic or tornado protected. Fuel can be obtained using the tank drain valve located inside the flood wall. Fuel can be gravity fed to containers for transport to BDB equipment or pumped from the tank fill.

Diesel fuel in the fuel oil storage tanks is routinely sampled and tested to assure fuel oil quality is maintained to ASTM standards. This sampling and testing surveillance program also assures the fuel oil quality is maintained for operation of the station Emergency Diesel Generators (EDGs).

Portable equipment powered by diesel fuel are designed to use the same low sulfur diesel fuel oil as the installed EDGs.

The above fuel oil sources will be used to fill the fuel transfer truck that is stored in the BDB Storage Building. The fuel transfer truck has a capacity of approximately 1,000 gallons and has a self-powered transfer pump. The fuel transfer truck will be deployed from the BDB Storage Building facility to refill the diesel fuel tanks of BDB equipment and to the various diesel fuel tank storage locations where it will be refueled by either gravity fill or pumped full.

Based on a fuel consumption study, a conservative combined fuel consumption rate was determined to be 120 gal/hr. The fuel transfer truck has sufficient capacity to support continuous operation of the major BDB equipment expected to be deployed and placed into service following a BDB external event. At this conservative fuel consumption rate, the two 45,000 gallon underground Fuel Oil Storage Tanks, which are protected from the BDB external hazards, have adequate capacity to provide the onsite BDB equipment with diesel fuel for >30 days. The NSRC will also be able to provide diesel fuel for diesel operated equipment, thus providing additional margin.

Continuous operation of the Diesel Driven Fire Pump (DDFP) will require replenishment of approximately 300 gallons of diesel fuel at a minimum of 22 hour intervals. If the DDFP is not operating, then diesel fuel for the BDB High Capacity pump will require replenishment of approximately 500 gallons of diesel fuel at a minimum of 30 hour intervals.

The diesel fuel consumption information above does not include diesel fuel requirements for the portable 4160 VAC diesel generators (DGs) to be received from the NSRC. More than adequate diesel fuel is available on site for these generators if the above ground 275,000 gallon Fuel Oil Storage Tank is available. If not, provisions for receipt of diesel fuel from offsite sources are in place to facilitate the Phase 3 re-powering strategy with the portable 4160 VAC DGs.

The BDB external event response strategy includes a very limited number of small support equipment that is powered by gasoline engines (chain saws, chop saws, and small electrical generator units). These components will be re-fueled using portable containers of fuel. Gasoline will be obtained from the station's two (2) 8,500 gal underground gasoline fuel storage tanks or, if necessary, from private vehicles on site. Oil for the 2-cycle engines is also available in the BDB Storage Building.

2.10 Offsite Resources

2.10.1 National SAFER Response Center

The industry has established two (2) National SAFER Response Centers (NSRCs) to support utilities during BDB events. Dominion has established contracts with the Pooled Equipment Inventory Company (PEICo) to participate in the process for support of the NSRCs as required. Each NSRC will hold five (5) sets of equipment, four (4) of which will be able to be fully deployed when requested, the fifth set will have equipment in a maintenance cycle. In addition, onsite 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. From there, equipment can be taken to the North Anna site and staged at the SAFER onsite Staging Area "B" near the BDB Storage Building by helicopter if ground transportation is unavailable. Communications will be established between the North Anna 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. The order in which equipment is delivered is identified in the North Anna's *SAFER Response Plan* (Reference 20).

2.10.2 Equipment List

The equipment stored and maintained at the NSRC for transportation to the local assembly area to support the response to a BDB external event at North Anna is listed in Table 2. Table 2 identifies the equipment that is specifically credited in the FLEX strategies for North Anna, but also lists the equipment that will be available for backup/replacement should onsite equipment be unavailable. Since all the equipment will be located at the local assembly area, the time needed for the replacement of a failed component will be minimal.

2.11 Equipment Operating Conditions

2.11.1 Ventilation

Following a BDB external event and subsequent ELAP/LUHS event at North Anna, ventilation providing cooling to occupied areas and areas containing

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

The key areas identified for all phases of execution of the FLEX strategy activities are the Main Control Room (MCR), Emergency Switchgear Room (ESGR), Main Steam Valve House (MSVH) (Steam Generator - PORV area), Turbine Driven Auxiliary Feedwater (TDAFW) Pump Room, Quench Spray Pump House, Auxiliary Building, and the Mechanical Equipment Room in the Turbine Building. These areas have been evaluated to determine the temperature profiles following an ELAP/LUHS event. With the exception of the TDAFW pump room, results of the calculation have concluded that temperatures remain within acceptable limits based on conservative input heat load assumptions for all areas with no actions being taken to reduce heat load or to establish either active or passive ventilation (e.g., portable fans, open doors, etc.) In the case of the TDAFW Pump Room, an alternate ventilation method will be initiated within 4 hours of the ELAP to ensure that the temperatures remain within the acceptable range for equipment and personnel habitability. The alternate ventilation method will be required to be in effect as long as the TDAFW pump is in service.

The temperatures expected in the MSVH for local operation of the SG PORV (Section 2.3.1) are similar to conditions experienced during normal station operations, testing, and maintenance. Therefore, actions performed for FLEX activities will be essentially the same as those performed for the current site procedure ECA-0.0, *Loss of All AC Power*, which also addresses local operation of the SG PORVs.

An additional ventilation concern applicable to Phase 2 is the potential buildup of hydrogen in the battery rooms. Off-gassing of hydrogen from batteries is only a concern when the batteries are charging. Once a 480 VAC power supply is restored in Phase 2 and the station Class 1E batteries begin re-charging, power is also restored to the battery room ventilation fans to prevent any significant hydrogen accumulation.

2.11.2 Heat Tracing

Major components for FLEX strategies are provided with cold weather packages and small electrical generators to protect the equipment from damage due to extreme cold weather and help assure equipment reliability as well as to power additional heat tape circuits, if necessary. In addition, the Emergency Condensate Storage Tank refill connection pressure gauge instrument tubing credited for BDB and subject to freezing conditions in an ELAP event, will be protected with the use of portable heaters which can be powered from small generators that have been procured and designated for FLEX strategies or from the small generators that are included as part of the large BDB pump skids.

2.12 Habitability

Habitability was evaluated as discussed in Section 2.11.1 in conjunction with equipment operabilty and determined to be acceptable.

2.13 Lighting

In order to validate the adequacy of supplemental lighting and the adequacy and practicality of using portable lighting to perform FLEX strategy actions, a lighting study was completed. Tasks evaluated included traveling to/from the various areas necessary to implement the FLEX strategies, making required mechanical and electrical connections, performing instrumentation monitoring, equipment operation, and component manipulation.

Except for the Unit 1 and Unit 2 Mechanical Equipment Rooms (MERs), the areas reviewed contain emergency lighting fixtures (Appendix "R" lighting) consisting of a battery, battery charger and associated light fixtures. These emergency lights are designed and periodically tested to insure the battery pack will provide a minimum of eight (8) hours of lighting with no external AC power sources. Therefore, these currently installed emergency lighting fixtures provide adequate lighting to light pathways and implement the BDB strategies for Phase 1 mitigation strategy activities for 8 hours.

Prior to the depletion of the Appendix "R" lighting (and in the MERs), portable battery powered Remote Area Lighting Systems (RALS) would be deployed to support the FLEX strategy tasks. These RALSs are rechargeable LED lighting systems designed to power the LED lights for a minimum of 7 hours at 6000 lumens or a maximum of 40 hours at 500 lumens.

There are no emergency lighting fixtures in the yard outside of the protected area to provide necessary lighting in those areas where portable BDB equipment is to be deployed. Therefore, the large portable BDB pumps and diesel generators are outfitted with light plants that are powered from either their respective diesel generators or batteries in order to support connection and operation. In addition to the lights installed on the portable BDB equipment, portable light plants are included in the FLEX strategies. These portable diesel powered light plants can be deployed from the BDB Storage Building as needed to support night time operations.

In addition to installed Appendix "R" lighting, the RALS, and the portable light plants, the BDB Storage Building also includes a stock of flashlights and headband lights to further assist the staff responding to a BDB event during low light conditions.

2.14 Communications

In the event of a BDB external event and subsequent ELAP, communications systems functionality could be significantly limited. A standard set of assumptions for a BDB ELAP event is identified in NEI 12-01, Guideline for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities, May 2012.

Communications necessary to provide onsite command and control of the FLEX strategies and offsite notifications at North Anna can be effectively implemented with a combination of sound powered phones, satellite phones, and hand-held radios.

Onsite:

Dedicated sets of sound-powered phone headsets and cords are available for the implementation of the FLEX strategies between the control room, the Technical Support Center (TSC), and areas which implement the FLEX strategies (e.g., TDAFW pump, SG PORVs, etc.). The operation of this sound-powered phone subsystem is not dependent on the availability of the electric power system.

Indoor and outdoor locations where temporary BDB equipment is used may also be served with either hand-held radios, satellite phones, or sound-powered phone headsets connected with extension cords to nearby jacks.

There are dedicated hand-held radios available for the implementation of onsite FLEX strategies. Sufficient batteries and chargers are also available. Use of the hand-held radios is somewhat limited (on a point to point basis); however, a portable repeater mounted on a communications trailer will enhance the effectiveness of the radios when the trailer is deployed.

Offsite:

Satellite phones are the only reasonable means to communicate offsite when the telecommunications infrastructure surrounding the nuclear site is non-functional. They connect with other satellite phones as well as normal communications devices.

NEI 12-01, Section 4.1 outlines the minimum communication pathways to the federal, state, and local authorities. Several handheld satellite phones are available for initial notifications. These phones are distributed between the Main Control Room, the Technical Support Center, the Emergency Operations Facility, Security, and Radiological Protection Office. Additionally, all of the local Offsite Response Organizations (OROs) that normally receive licensee notifications of an emergency declaration or a Protective Action Recommendation are being provided with a satellite phone if they are within a 25 mile radius of the North Anna site.

The MCR and TSC satellite phones are installed units. The antennae setup is a deployable system with fiber optics cable from the inside "desk sets" to an outdoor, battery powered, portable dish antennae. This portion of the communications strategy is intended to function on batteries beyond the first 6 hours. If necessary, the portable dish antennae can be powered by a small portable electric generator available from the BDB Storage Building. Once augmented staff arrives on site a self-powered, mobile communications trailer designed to handle both satellite voice and data traffic, as well as to function as a radio repeater to enhance onsite communications, will be deployed from the BDB Storage Building.

2.15 Water Sources

2.15.1 Water Sources – Secondary Side

Table 3 provides a list of potential water sources that may be used to provide cooling water to the Steam Generators (SGs), their capacities, and an assessment of availability following the applicable hazards identified in Section 2.6. Descriptions of the preferred water usage sources identified in Table 3 are provided below and are in sequence in which they would be utilized, based on their availability after an ELAP/LUHS event. As noted in Table 3, at least three water sources would survive all applicable hazards for North Anna and are credited for use in FLEX strategies.

The water sources have a wide range of associated chemical compositions. Therefore, extended periods of operation with the addition of these various water sources to the SGs were evaluated for impact on SG performance resulting from SG material (e.g., tube) degradation and potential impact on the heat transfer capabilities of the SGs. Use of the available clean water sources, tanks and condenser, are limited only by their quantities. The water supply from Lake Anna and the SW reservoir/system is essentially unlimited by quantity, but is limited in quality, specifically the concentration of total suspended solids (TSS).

The evaluation shows that the water from Lake Anna could be used for approximately 25 days after Emergency Condensate Storage Tank (ECST) depletion before the SG design corrosion limit would be expected to be reached. If a conservative TSS level of 500 ppm is assumed, the limiting SG precipitation level would be expected to be reached about 10 days after ECST depletion. Water from the Service Water Reservoir could be used for about 11 days after ECST depletion before the SG design corrosion limit would be expected to be reached. If a conservative TSS level of 500 ppm is assumed, the limiting SG precipitation level would be expected to be reached about 9 days after ECST depletion.

Exceeding the expected time to reach the SG design corrosion limit would have an insignificant impact on the ability of the SGs to remove core decay heat from the RCS at its reduced temperature/pressure conditions. However, reaching the limiting SGs precipitation levels could potentially impact/reduce the SGs heat transfer capabilities.

The results of the water quality evaluation show that the credited, fully protected, onsite water sources provide an adequate AFW supply source for a much longer time than would be required for the delivery and deployment of the Phase 3 NSRC reverse osmosis (RO)/ion exchange equipment to remove impurities from the onsite natural water sources. The RO units have a capacity of up to 300 gpm. Once the reverse osmosis/ion exchange equipment is in operation, the onsite water sources provide for an indefinite supply of purified water.

2.15.2 Water Sources – Primary Side

Two credited sources for borated water are available onsite: the Refueling Water Storage Tanks (RWSTs) (one per unit) and the BDB Boric Acid Mixing Tanks that are stored in the BDB Storage Building. These sources are discussed in Section 2.3.10.5. Borated water may also be available from the non-credited Boric Acid Storage Tank.

Clean water sources for use in batching borated water in the Boric Acid Mixing Tanks would be used in the same order of preference provided in Table 3 for the AFW sources, dependent on availability.

2.15.3 Spent Fuel Pool (SFP)

At North Anna, any water source available is acceptable for use as makeup to the SFP, however, the primary source would be from Lake Anna via the BDB High Capacity pump or the Service Water (SW) Reservoir via the Diesel Driven Fire Pump. Water quality is not a significant concern for makeup 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

North Anna Power Station is abiding by the Nuclear Energy Institute position paper entitled "Shutdown/Refueling Modes," dated September 18, 2013, addressing mitigation strategies in shutdown and refueling modes (Reference 21). This position paper has been endorsed by the NRC staff (Reference 22).

The reactor core cooling and heat removal strategies previously discussed in Section 2.3 are effective as long as the Reactor Coolant System (RCS) is intact and the steam generators (SGs) are available for use. The window between the loss of natural circulation availability (i.e., the SGs are isolated) and when the refueling cavity is flooded (at approximately 50-100 hours), is considered in the Modes 5 and 6 core cooling strategy development. During this window the reactor coolant loops are isolated and the RCS is vented with the removal of at least one Pressurizer Safety Valve (PSV).

Should an ELAP occur in this window, the immediate response to a loss of shutdown cooling will be to dispatch an operator to initiate gravity feed to the RCS cold legs from the outage unit's Refueling Water Storage Tank (RWST). This gravity feed injection path will utilize MOVs in the Safety Injection (SI) system that can be manually operated to initiate RCS injection by gravity feed. The SI system is seismically qualified and located in missile protected facilities; therefore, providing assurance it would survive a BDB event and be available to support gravity feed from the RWST. The gravity feed to the RCS cold legs strategy is expected to provide adequate RCS cooling until forced feed can be established.

Unit shutdown procedures require the pre-deployment of a BDB AFW pump with supply and discharge hoses to serve as a low pressure RCS Injection pump, which will provide a means to establish forced feed of borated water to the RCS cold legs from the RWST during an ELAP event with a unit in either Modes 5 or 6. When forced RCS injection is established by the BDB AFW pump, gravity feed to the RCS cold legs will no longer be necessary. It is the intent of this strategy to transition from gravity feed to forced feed prior to the loss of gravity feed effectiveness.

The RWST is not protected from all hazards (i.e. tornado missiles). In the unlikely event that a tornado missile damages the RWST, procedures will direct the operators to use the opposite unit's RWST. If both RWSTs are damaged the procedures will direct injection of available clean water sources in the order specified in Table 3. In this case, the flowrate will be reduced to match the boil-off rate of the RCS to minimize dilution of the RCS when adding unborated water. The water supply from Emergency Condensate Storage Tank (ECST) would be available following a tornado event, thus providing a method for restoring core cooling for all hazards during Modes 5 and 6.

If an ELAP event results in a loss of RHR, the Operations staff is directed to establish "Containment Closure." This activity directs the evacuation of the containment and the closure of all open containment penetrations including the personnel access hatch and the equipment access hatch. Directions are also provided to secure the Containment Ventilation System. The Modes 5 and 6 core cooling strategy will cause water/steam to "spill" into Containment causing the Containment pressure to slowly increase. In order to maintain the Containment within its design pressure limits, a vent path is necessary and will be procedurally established following an ELAP event while in Modes 5 or 6.

With the Containment Purge system operating (or aligned to operate), a Containment vent path can be manually established through the "B" vent stack. The adequacy of this vent path for stopping containment pressurization and depressurizing the containment has been confirmed by analysis.

2.17 Sequence of Events

The Table 4 presents a Sequence of Events (SOE) Timeline for an ELAP/LUHS event at North Anna. Validation of each of the FLEX time constraint actions has been completed in accordance with the FLEX Validation Process document issued by NEI and includes consideration for staffing. Time to clear debris to allow equipment deployment is assumed to be 2 hours. This time is considered to be reasonable based on site reviews and the location of the BDB Storage Building. Debris removal equipment is stored inside the BDB Storage Building and is, therefore, protected from the external hazards described in Section 2.6.

2.18 Programmatic Elements

2.18.1 Overall Program Document

A Dominion nuclear fleet procedure provides a description of the Diverse and Flexible Coping Strategies (FLEX) Program for Surry, North Anna and Millstone Power Stations. The key elements of the program include:

- Maintenance of the FSGs including any impacts on the interfacing procedures (EOPs, APs, etc.)
- Maintenance and testing of BDB equipment (i.e., SFP level instrumentation, emergency communications equipment, portable BDB equipment, BDB support equipment, and BDB support vehicles)
- Portable equipment deployment routes, staging areas, and connections to existing mechanical and electrical systems
- Validation of time sensitive operator actions
- The BDB Storage Building and the National SAFER Response Center
- Hazards considerations (Flooding, Seismic, High Winds, etc.)
- Supporting evaluations, calculations and BDB drawings
- Tracking of commitments and equipment unavailability
- Staffing, Training, and Emergency Drills
- Configuration Management
- Program Maintenance

In addition, the program description references (1) a list of the BDB FLEX basis documents that will be kept up to date for facility and procedure changes, (2) a historical record of previous strategies and their bases, and (3) the bases for ongoing maintenance and testing activities for the BDB equipment.

The instructions required to implement the various elements of the FLEX Program and thereby ensure readiness in the event of a Beyond-Design-Basis External Event are contained in a nuclear fleet administrative procedure.

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

Future changes to the FLEX strategies may be made without prior NRC approval provided 1) the revised FLEX strategies meet the requirements of NEI 12-06, and 2) an engineering basis is documented that ensures that the change in FLEX strategies continues to ensure the key safety functions (Containment, core and SFP cooling) 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 FLEX Support Guidelines (FSGs) provide guidance that can be employed for a variety of conditions. Clear criteria for entry into FSGs ensures that FLEX strategies are used only as directed for BDB external event conditions, and are not used inappropriately in lieu of existing procedures. When BDB equipment is needed to supplement EOPs or Abnormal Procedures (APs) strategies, the EOP or AP directs the entry into and exit from the appropriate FSG procedure.

FLEX support guidelines have been developed in accordance with Pressurized Water Reactor Owner's Group (PWROG) guidelines. The FSGs provide instructions for implementing available, pre-planned FLEX strategies to accomplish specific tasks in the EOPs or APs. FSGs are used to supplement (not replace) the existing procedure structure that establishes command and control for the event.

Procedural Interfaces have been incorporated into 1/2-ECA-0.0, *Loss of All AC Power*, to the extent necessary to include appropriate reference to FSGs and provide command and control for the ELAP. Additionally, procedural interfaces have been incorporated into the following APs to include appropriate reference to FSGs:

- 0-AP-27, *Malfunction of Spent Fuel Pit System*
- 0-AP-10, *Loss of Electrical Power*
- 0-AP-11, *Loss of Residual Heat Removal (RHR)*

Additionally, a new abnormal procedure, 0-AP-10.1, *Loss of All AC Power While on RHR*, was prepared to provide the command and control function for the ELAP while on RHR since 1/2-ECA-0.0 does not apply in this operating mode.

FSG maintenance is performed by the Station Procedures group via the Procedure Action Request in the Dominion nuclear fleet document AD-AA-100, *Technical Procedure Process Control.* In accordance with site administrative procedures, NEI 96-07, Revision 1 (Reference 23), and NEI 97-04, Revision 1 (Reference 24) are to be used to evaluate changes to current procedures, including the FSGs, to determine the need for prior NRC approval. However, per the guidance and examples provided in NEI 96-07, Revision 1, changes to procedures (EOPs, APs, or FSGs) that perform actions in response events that exceed a site's design-basis should screen out. Therefore, procedure steps which recognize the BDB ELAP/LUHS has occurred and which direct FLEX strategy actions to ensure core cooling, containment, or SFP cooling should not require prior NRC approval.

FSGs have been reviewed and validated by the involved groups to the extent necessary to ensure that implementation of the associated FLEX strategy is feasible. Specific FSG validation was accomplished via table top evaluations and walk-throughs of the guidelines when appropriate.

2.18.3 Staffing

Using the methodology of (Nuclear Energy Institute) NEI 12-01, *Guideline for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities* (Reference 25), an assessment of the capability of the North Anna Power Station on-shift staff and augmented Emergency Response Organization (ERO) to respond to a BDB external event was performed. The results were provided to the NRC in a letter dated May 7, 2014 (Reference 26).

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

A. An extended loss of AC power (ELAP)

B. An extended loss of access to ultimate heat sink (LUHS)

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

D. Impeded access to the units by offsite responders as follows:

- 0 to 6 Hours Post Event – No site access.
- 6 to 24 Hours Post Event – Limited site access. Individuals may access the site by walking, personal vehicle, or via alternate transportation capabilities (e.g., private resource providers or public sector support).
- 24+ Hours Post Event – Improved site access. Site access is restored to a near-normal status and/or augmented transportation resources are available to deliver equipment, supplies and large numbers of personnel.

A team of subject matter experts from Operations, Maintenance, Radiation Protection, Chemistry, Security, Emergency Preparedness, and Industry Consultants performed tabletop exercises in December 2013 and January 2014 to conduct the on-shift portion of the assessment. The participants reviewed the assumptions and applied existing procedural guidance, including applicable FLEX Support Guidelines (FSGs) for coping with a BDB external event using minimum on-shift staffing. Particular attention was given to the sequence and timing of each procedural step, its duration, and the on-shift individual performing the step to account for both the task and time motion analyses of NEI 10-05, *Assessment of On-Shift Emergency Response Organization Staffing and Capabilities* (Reference 27). The staffing analysis concluded that there were no task overlaps for the activities that were assigned to the on-shift personnel.

The expanded ERO analysis portion of the staffing assessment concluded that sufficient personnel resources exist in the current North Anna augmenting ERO to fill positions for the expanded ERO functions. Thus, the ERO resources and capabilities necessary to implement Transition Phase coping strategies performed after the end of the "no site access" 6-hour time exist in the current program.

The staffing assessments noted above were performed in conjunction with the development of procedures and guidelines that address NRC Order EA-12-049. Once the FSGs were developed, a validation assessment of the FSGs was performed using communication equipment determined available post-BDB external event and the staff deemed available per the staffing studies. The validation process was performed and documented in accordance with NEI Guidance (Reference 28).

2.18.4 Training

Dominion's Nuclear Training Program has been revised to assure personnel proficiency in utilizing FSGs and associated BDB equipment for 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.

Initial training has been provided and periodic training will be provided to site emergency response leaders on BDB emergency response strategies and implementing guidelines. Personnel assigned to direct the execution of the FLEX mitigation strategies for BDB external events have received the necessary training to ensure familiarity with the associated tasks, considering available job aids, instructions, and mitigation strategy time constraints.

Care has been taken to not give undue weight (in comparison with other training requirements) to Operator training for BDB external event accident mitigation. The testing/evaluation of Operator knowledge and skills in this area has been similarly weighted.

In accordance with Section 11.6 of NEI 12-06, ANSI/ANS 3.5, *Nuclear Power Plant Simulators for use in Operator Training* (Reference 29), certification of simulator fidelity is considered to be sufficient for the initial stages of the BDB external event scenario until the current capability of the simulator model is exceeded. Full scope simulator models will not be upgraded to accommodate FLEX training or drills.

Where appropriate, integrated FLEX drills will be organized on a team or crew basis and conducted periodically; with all time-sensitive actions to be evaluated over a period of not more than eight years. It is not required to connect/operate equipment during these drills.

2.18.5 Equipment List

The equipment stored and maintained at the North Anna BDB Storage Building necessary for the implementation of the FLEX strategies in response to a BDB external event is listed in Table 1. Table 1 identifies the quantity, applicable strategy, and capacity/rating for the major BDB equipment components only, as well as various clarifying notes. Specific details regarding fittings, tools, hose lengths, consumable supplies, etc. are not provided in Table 1.

2.18.6 N+1 Equipment Requirement

NEI 12-06 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 existing 50.54(hh)(2) pump is counted toward the N+1, since it meets the functional and storage requirements outlined in NEI 12-06.

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. 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 a fleet administrative procedure and are subject to inventory checks, requirements, and any maintenance and testing that are needed to ensure they can perform their required functions.

2.18.7 Equipment Maintenance and Testing

Initial Component Level Testing, consisting of Factory Acceptance Testing and Site Acceptance Testing, was conducted to ensure the portable FLEX equipment can perform its required FLEX strategy design functions. Factory Acceptance Testing verified that the portable equipment performance conformed to the manufacturers rating for the equipment as specified in the Purchase Order. Verification of the vendor test documentation was performed as part of the receipt inspection process for each of the affected pieces of equipment and included in the applicable Vendor Technical Manuals. Site Acceptance Testing confirmed Factory Acceptance Testing to ensure portable FLEX equipment delivered to the site performed in accordance with the FLEX strategy functional design requirements.

The portable BDB equipment that directly performs a FLEX mitigation strategy for the core cooling, containment, or SFP cooling is subject to periodic maintenance and testing in accordance with NEI 12-06 (Reference 3) and INPO AP 913, *Equipment Reliability Process*, (Reference 30), to verify proper function. Additional FLEX support equipment that requires maintenance and testing will have Preventive Maintenance to ensure it will perform its required functions during a BDB external event.

EPRI has completed and has issued *Preventive Maintenance Basis for FLEX Equipment – Project Overview Report* (Reference 31). 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 – Monthly walkdown
- Fluid analysis - Annually
- Periodic operational verifications
- Periodic performance tests

Preventive maintenance (PM) procedures and test procedures are based on the templates contained within the EPRI Preventive Maintenance Basis Database, or from manufacturer provided information/recommendations when templates were not available from EPRI. The corresponding maintenance strategies were developed and documented. The performance of the PMs and test procedures are controlled through the site work order process. FLEX support equipment not falling under the scope of INPO AP 913 will be maintained as necessary to ensure continued reliability. Performance verification testing of FLEX equipment is scheduled and performed as part of the Dominion PM process.

A fleet procedure was established to ensure the unavailability of equipment and applicable connections that directly perform a FLEX mitigation strategy for core cooling, containment, and SFP cooling will be managed such that risk to mitigation strategy capability is minimized. Maintenance/risk guidance conforms to the guidance of NEI 12-06 as follows:

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

3. References

1. Letter to All Power Reactor Licensees, *Request for Information Pursuant to Title 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 Daiichi Accident*, March 12, 2012, U.S. Nuclear Regulatory Commission.

2. NRC Order Number EA-12-049, *Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events*, dated March 12, 2012.

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

4. NRC Interim Staff Guidance JLD-ISG-2012-01, *Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events*, Revision 0, dated August 29, 2012.

5. NRC Order Number EA-12-051, *Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation*, dated March 12, 2012.

6. NEI 12-02, Revision 1, *Industry Guidance for Compliance with NRC Order EA-12-051, 'To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation'*, Nuclear Energy Institute, August 2012.

7. NRC Interim Staff Guidance JLD-ISG-2012-03, *Compliance with Order EA-12-051, Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation*, Revision 0, dated August 29, 2012.

8. *Virginia Electric and Power Company's Supplement to 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 April 30, 2013 (Serial No. 12-162C).

9. North Anna Power Station Technical Specifications.

10. WCAP-17601, Revision 0, Reactor Coolant System Response to the Extended Loss of AC Power Event for Westinghouse, Combustion Engineering and Babcock & Wilcox NSSS Designs, August 2012.

11. WCAP-17792-P, Revision 0, *Emergency Procedure Development Strategies for the Extended Loss of AC Power Event for all Domestic Pressurized Water Reactor Designs.*

12. PWROG-14064-P, Revision 0, *Application of NOTRUMP Code Results for PWRs in Extended Loss of AC Power Circumstances*, September 2014.

13. *White Paper on the Response for the N-Seal Reactor Coolant Pump (RCP) Seal Package to Extended Loss of AC Power (ELAP)*, Revision 0, dated February 11, 2014 (Proprietary).

14. Pressurized Water Reactor Owner's Group Report, PWROG-14015-P, Revision 1, *No. 1 Seal Flow Rate for Westinghouse Reactor Coolant Pumps Following Loss of All AC Power, Task 2: Determine Seal Flow Rates,* September 2014.

15. "Westinghouse Response to NRC Generic Request for Additional Information (RAI) on Boron Mixing in Support of the Pressurized Water Reactor Owners Group (PWROG)," dated August 16, 2013 (ML13235A135).

16. Letter to Mr. J. Stringfellow (Westinghouse) from Mr. J. R. Davis (NRC) dated January 8, 2014 endorsing the Westinghouse Position Paper on Boron Mixing (ML13276A183).

17. Letter to Mr. J. E. Pollock (NEI) from Mr. J. R. Davis (NRC) endorsing NEI White Paper entitled "Battery Life Issue," dated September 16, 2013 (ML13241A182).

18. North Anna Power Station Updated Final Safety Analysis Report (UFSAR), Revision 50.

19. *Virginia Electric and Power Company North Anna Power Station Units 1 and 2 Flood Hazard Reevaluation Report in Response to March 12, 2012 Information request Regarding Flooding Aspects of Recommendation 2.1*, dated March 11, 2014, (ML13318A090).

20. *SAFER Response Plan for North Anna Power Station, Rev. 003*, dated September 25, 2015 (Document #38-9229807-000).

21. NEI Position Paper: "Shutdown/ Refueling Modes," dated September 18, 2013 (ML13273A514).

22. 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).

23. NEI Guideline 96-07, Revision 1, *Guidelines for 10CFR50.59 Implementation*, November 2000.

24. NEI Guideline 97-04, Revision 1, *Design Basis Program Guidelines*, February 2001.

25. NEI 12-01, Rev. 0, *Guidelines for Assessing Beyond Design Basis Accident Response Staffing and Communications.*

26. Letter from D. A. Heacock to the USNRC transmitting *North Anna Power Station Phase 2 Staffing Report*, dated May 7, 2014, (Serial No. 14-199).

27. NEI 10-05, Rev. 0, *Assessment of On-Shift Emergency Response Organization Staffing and Capabilities,* June 2011.

28. NEI guidance document FLEX *(Beyond Design Basis) Validation Process.*

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

30. INPO AP 913, Revision 3, *Equipment Reliability Process Description*, Institute of Nuclear Power Operations, March 2011.

31. *Preventive Maintenance Basis for FLEX Equipment – Project Overview Report* (EPRI Report 3002000623), September 2013.

32. 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 (ML13114A949).

Table 1 – PWR Portable Equipment Stored Onsite

List Portable Equipment	Use and (Potential / Flexibility) Diverse Uses					Performance Criteria
	Core	Containment	SFP	Instrumentation	Accessibility	
BDB High Capacity diesel-driven pump (2)[1] and associated hoses and fittings	X	X	X			150 psid at 1200 gpm
BDB AFW pump (3) and associated hoses and fittings	X					450 psid at 300 gpm
BDB RCS Injection pump (2)[2] and associated hoses and fittings	X					3000 psid at 45 gpm
120/240 VAC generators (3) and associated cables, connectors and switchgear				X		40 kW
120/240 VAC generators (9)[4] and associated cables, connectors and switchgear (to power support equipment)					X	5.5-6.5 kW

Table 1 – PWR Portable Equipment Stored Onsite						
List Portable Equipment	Use and (Potential / Flexibility) Diverse Uses					Performance Criteria
	Core	Containment	SFP	Instrumentation	Accessibility	
480 VAC generators (2)[3] and associated cables, connectors and switchgear (to re-power battery chargers, inverters, and Vital Buses)		X		X		350 kW
Portable boric acid batching tank (3)	X					1000 gal
Light plants (2) + Light strings (15)[4]					X	
Front end loader (1)[4]					X	
Tow vehicles (2)[4]	X	X	X		X	
Hose trailer (2) and Utility vehicle (1)[4]	X	X	X		X	
Fans/blowers (10)[4]					X	
Air compressors (7)[4]	X	X			X	

Table 1 – PWR Portable Equipment Stored Onsite						
List Portable Equipment	Use and (Potential / Flexibility) Diverse Uses					Performance Criteria
	Core	Containment	SFP	Instrumentation	Accessibility	
Fuel transfer truck (1) with 1,000 gal. tank and pumps	X	X	X	X	X	
Fuel carts with transfer pumps (2)[4]	X	X	X	X	X	
Communications equipment (Section 2.14)	X	X	X	X	X	
Misc. debris removal equipment[4]					X	
Misc. Support Equipment[4]					X	

Table 1 – PWR Portable Equipment Stored Onsite

List Portable Equipment	Use and (Potential / Flexibility) Diverse Uses					Performance Criteria
	Core	Containment	SFP	Instrumentation	Accessibility	

NOTES:

1. One BDB High Capacity pump is needed to implement both the FLEX core cooling and SFP cooling strategies. This pump is stored in the BDB Storage Building and protected from the hazards identified in NEI 12-06. The 50.54(hh)(2) high capacity pump is credited to meet the N+1 requirement as a backup to the BDB High Capacity pump. This pump is stored onsite in a location other than the BDB Storage Building.

2. One BDB RCS Injection pump can be shared between units if necessary. A BDB RCS Injection pump from the NSRC will be deployed from the NSRC by 28 hours, if required, to replace an unavailable onsite BDB RCS Injection pump.

3. 480 VAC generators are an alternate strategy to the 120/240 VAC generators. Therefore, only N is required.

4. Support equipment. Not required to meet N+1.

Table 2 – PWR Portable Equipment From NSRC

List Portable Equipment	Quantity Req'd /Unit	Quantity Provided / Unit	Power	Use and (Potential / Flexibility) Diverse Uses					Performance Criteria		Notes
				Core Cooling	Cont. Cooling/ Integrity	Access	Instrumentation	RCS Inventory			
Medium Voltage Generators	2	2	Jet Turb.	X	X		X		4160 VAC	1 MW	(1)
Low Voltage Generators	0	1	Jet Turb.		X		X	X	480 VAC	1100 KW	(2)
High Pressure Injection pump	0	1	Diesel					X	3000 psig	60 GPM	(2)
S/G RPV Makeup pump	0	1	Diesel	X				X	500 psid	500 GPM	(2)
Low Pressure / Medium Flow pump	0	1	Diesel		X	X			300 psid	2500 GPM	(2)

Table 2 – PWR Portable Equipment From NSRC

List Portable Equipment	Quantity Req'd /Unit	Quantity Provided / Unit	Power	Use and (Potential / Flexibility) Diverse Uses					Performance Criteria		Notes
				Core Cooling	Cont. Cooling/ Integrity	Access	Instrumentation	RCS Inventory			
Low Pressure / High Flow pump	1	1	Diesel	X	X				150 psid	5000 GPM	(3)
Lighting Towers	0	1	Diesel			X				40,000 Lu	(4)
Diesel Fuel Transfer	0	As Requested	N/A	X	X	X	X	X		264 Gal	(2)
Mobile Water Treatment	0	2	Diesel	X				X		150 GPM	(2)
Mobile Boration Skid	0	1	N/A					X		1000 Gal	

Notes:

(1) - NSRC 4160 VAC generator supplied in support of Phase 3 for core cooling, containment cooling, and instrumentation FLEX strategies.

(2) - NSRC Generic Equipment – Not required for FLEX strategy – Provided as Defense-in-Depth.

(3) - NSRC Low Pressure/High Flow pump supplied in support of Phase 3 for core cooling and containment cooling FLEX strategies.

(4) - NSRC components provided for low light response plans.

Table 3 – Water Sources								
Water Sources and Associated Piping that Fully Meet All BDB Hazards and Are Credited in FLEX Strategies								
Water Sources	**Usable Volume (Gallons)**	**Applicable Hazard**					**Time Based on Decay Heat[1]**	**Cumulative Time Based on Decay Heat[1]**
		Satisfies Seismic	**Satisfies Flooding**	**Satisfies High Winds**	**Satisfies Low Temp**	**Satisfies High Temp**		
ECST (Phase 1)	96,649	Y	Y	Y	Y	Y	4.2 hr.	4.2 hr.
Service Water Piping (Phase 1 alt.)	82,000 shared between Unit 1 and Unit 2	Y	Y	Y	Y	Y	4.2 hr.	8.3 hr.
Fire Main – Diesel fire pump > from SW Reservoir (Phase 1)	22.5 Million shared between Unit 1 and Unit 2	Y	Y	Y	Y	Y	46 hr.[2]	55 hr.
Lake Water (Phases 2 and 3)	---	Y	Y	Y	Y	Y	Indef.	Indef.

Table 3 – Water Sources

Water Sources	Usable Volume (Gallons)	Applicable Hazard					Time Based on Decay Heat[1]	Cumulative Time Based on Decay Heat[1]
		Satisfies Seismic	Satisfies Flooding	Satisfies High Winds	Satisfies Low Temp	Satisfies High Temp		
Water Sources that Partially Meet BDB Hazards and Are Not Credited in FLEX Strategies.								
CST (2)	300,000 ea	N	Y	N	Y	Y	66 hr.	121 hr.
Primary Grade Water Storage Tanks (2)	178,238 ea	N	Y	N	Y	Y	49hr.	170 hr
Condenser	71,000 ea	N	N	Y	Y	Y	21 hr.	191 hr.

Notes:

[1] Includes cooldown to a SG pressure of 290 psig beginning at 2 hours.

[2] Based on using 300,000 gallons/unit allotted for Fire Protection.

Table 4 – Sequence of Events Timeline

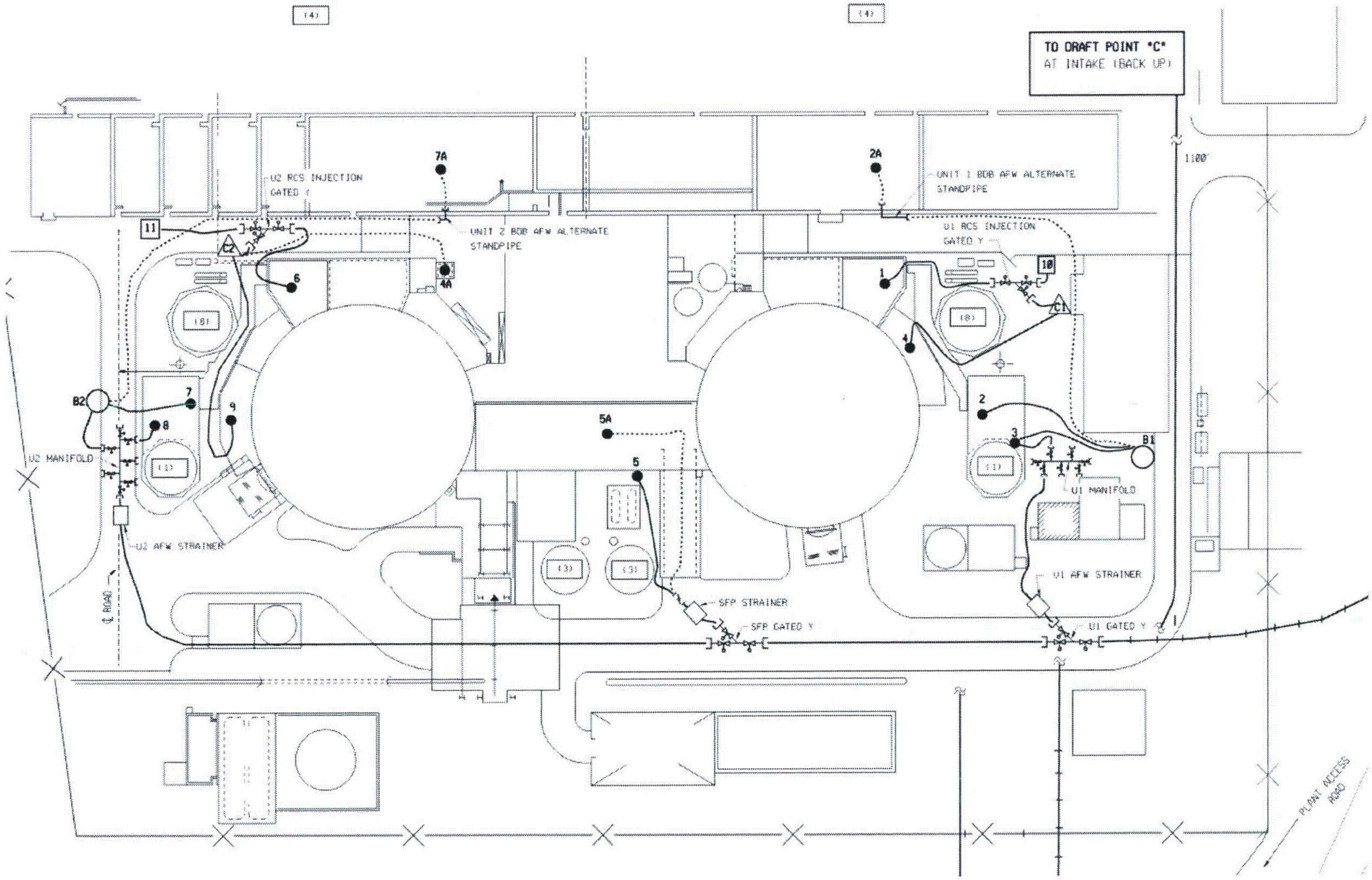
Action Item	Personnel	Activity	Start	Duration	Time Constraint Y/N	Requirement
N/A		Event Starts.	0		N	Plant @ 100% power
1	RO – U1 RO – U2	TDAFW pump starts. Verify flow to "A" SG.	15 sec.	1 min.	N	Original design basis for SBO event. 50 min to "A" SG dryout.
2	RO – U1 RO – U2	ECA-0.0, Loss of All Power, procedure is entered.	15 sec.		N	SBO event required response (1)
3	RO – U1 RO – U2	Verify RCS Isolation.	15 min.	5 min.	N	Preserve inventory in the RCS
4	AO #1 AO #2	Re-Align AFW to all SGs and control AFW flows.	20 min.	30 min.	Y	50 min (to "B" and "C" SG dryout, 1 hr to "A" SG overfill)
5	AO #5 AO #6	Open Condenser Vacuum Breaker and vent hydrogen from Main Generators.	30 min.	30 min.	N	Prior to shutdown of DC oil pumps.
6	RO – U1 RO – U2	Shutdown DC Oil Pumps.	≤ 60 min.	1 min.	Y	Extends station Class 1E battery capacity.
7	SRO	ELAP declared	≤ 60 min.		Y	
8	AO #5 AO #6 RO #3 RO #4	Load strip 120 volt DC and Vital AC buses.	≤ 60 min.	≤ 30 min.	Y	90 min (extends station Class 1E battery capacity to 8 hours)

Action Item	Personnel	Activity	Start	Duration	Time Constraint Y/N	Requirement
9	Security #1 Security #2	Transport 120 VAC diesel generators to staging area.	60 min.	4hrs. (2 hrs. to clear haul path and 2 hrs. to transport and deploy generators.)	Y	8 hrs. (station Class 1E batteries depleted)
10	AO #1 AO #2	Verify/Start diesel driven fire pump and align to AFW pump suction.	90 min.	60 min.	Y	4.2 hrs (reach minimum ECST level)
11	AO #1 AO #2	Block open door to TDAFW pump room.	90 min	5 min	Y	Required within 4 hours for long term equipment operation.
12	AO #3 AO #4	Initiate RCS cooldown by controlling SG PORVs.	< 2 hrs.	~ 2 hrs. For cooldown with limited ongoing control for decay heat removal	Y	Decay heat removal, cooldown of RCS. Initiation within 2 hrs meets the requirements of Generic ELAP analysis.
13	AO #5 AO #6	Re-power 120 VAC vital buses.	5 hr.	1 hr.	Y	8 hrs. (station Class 1E batteries depleted)
14	Augmented Staff	Augmented staff arrive on site.	6 hrs.	On-going	N	6 hrs (Ref. NEI 12-01)
15	3 people – (Aug. Staff)	Transport and deploy BDB High Capacity pump (Drafting). Alternate connection for AFW suction and SFP Make-up water source.	6 hrs.	2 hrs.	N	8.3 hours of AFW suction supply if DDFP is not available

Action Item	Personnel	Activity	Start	Duration	Time Constraint Y/N	Requirement
16	4 people – (Aug. Staff)	Transport and deploy 480 VAC diesel generators.	7 hrs.	4 hours	N	Back-up to 120 volt generators for re-powering Vital buses
17	4 people – (Aug. Staff)	Transport and deploy communication equipment.	10 Hrs	2 hrs	N	Off-site communications
18	3 people – (Aug. Staff)	Transport and deploy BDB RCS Injection pump.	12 hrs.	3 hrs.	Y	17.0 hours – Prior to reflux cooling and ensure adequate boron mixing. Reactivity control: Not required for the first 37 hours if SG pressure >290 psig.
19	3 people – (Aug. Staff)	Route BDB High Capacity pump (Drafting) hose and add inventory to SFP.	15 hrs.	4 hrs. On-going (Batch)	Y	9 hours to boiling. 43 hours to water level at 10 feet above fuel
20	3 people – (Aug. Staff)	Transport and deploy BDB AFW pumps.	19 hrs.	5 hrs.	N	BDB AFW pumps are deployed in standby as a backup to the TDAFW pump
21	Augmented Staff	ECST Make-up.	20 hrs.	4 hrs.	N	Provide higher quality water sources for Steam Generator make-up water.
22	3 people – (Aug. Staff)	Transport and deploy additional portable light plants as needed. (Supplemental lighting)	24 hrs.	2 hrs	N	Supplemental lighting as needed – (lighting towers are installed on large portable equipment)

Action Item	Personnel	Activity	Start	Duration	Time Constraint Y/N	Requirement
23	Augmented Staff	Initiate Containment cooling strategy to reduce temperature in Containment.	24 hours	24 hours	Y	Restore containment temperature to <120 °F within 7 days to prevent affecting the function of key parameter monitoring instrumentation

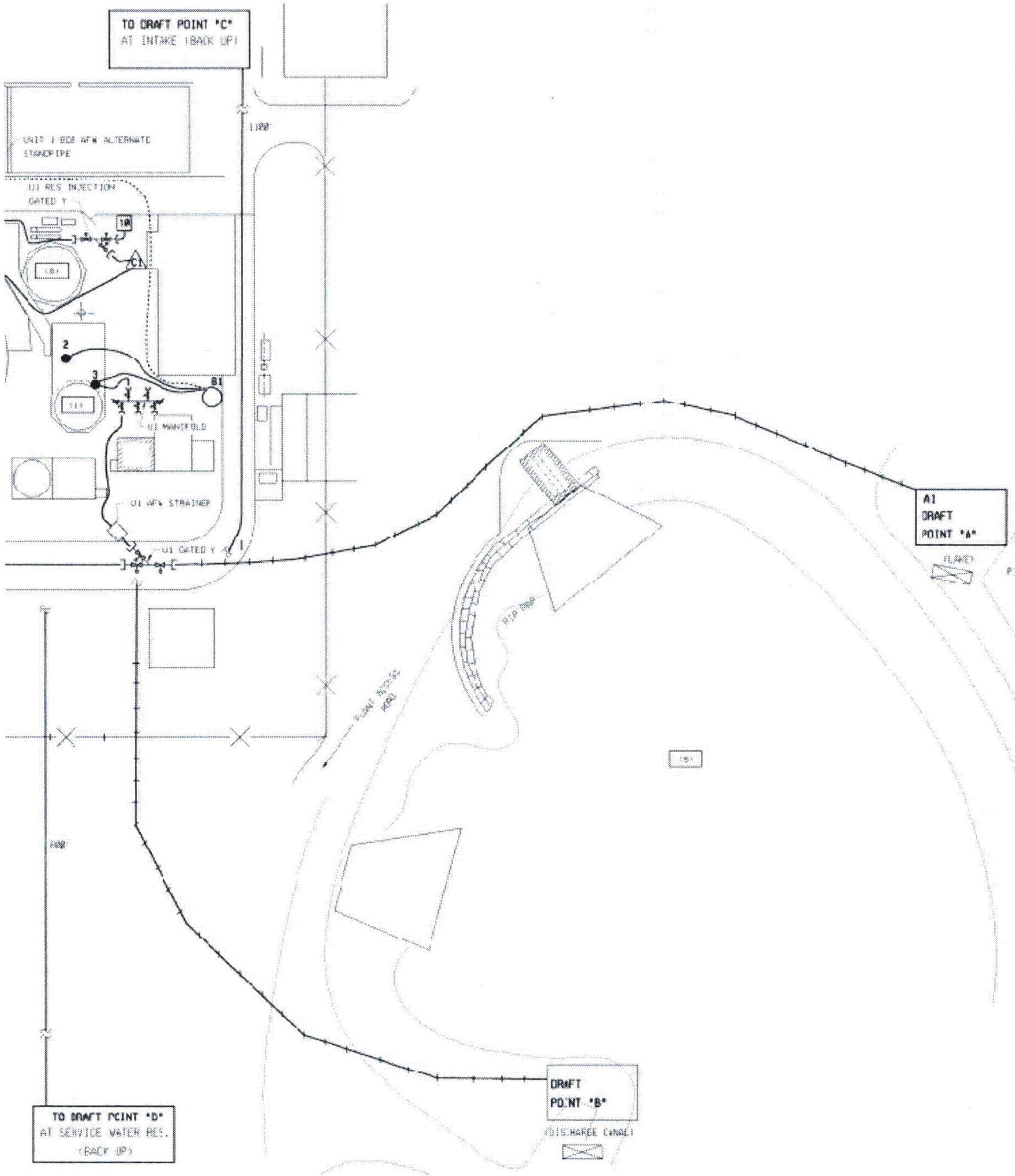
RO - Reactor Operator, **AO** - Auxiliary Operator



(Main Plant Site)

Figure 1: BDB FLEX Strategy Equipment and Hose Layout

(Page 1 of 3)



(Draft Locations)

Figure 1: BDB FLEX Strategy Equipment and Hose Layout
(Page 2 of 3)

LEGEND

1- RWST REFILL/SUCTION CONNECTION (U-1)
2- AFW TO MOV HEADER (U-1)
2A- ALT.S/G FEED (U-1)
3- ECST REFILL (U-1)
4- LHSI INJECTION (U-1)
4A- ALT. RCS INJECTION (U1 & U2)
5- SFP REFILL
5A- ALT. SFP FILL
6- RWST REFILL/SUCTION CONNECTION (U-2)
7- AFW TO MOV-HEADER (U-2)
7A- ALT. S/G FEED (U-2)
8- ECST REFILL (U-2)
9- LHSI INJECTION (U-2)
9A- ALT. RCS INJECTION (U-2)
10- PORTABLE BATCH TANK (U-1)
11- PORTABLE BATCH TANK (U-2)
A1- U-1 BDB HIGH CAPACITY PUMP
B1- U-1 BDB AFW PUMP
B2- U-2 BDB AFW PUMP
C1- U-1 BDB RCS INJECTION PUMP
C2- U-2 BDB RCS INJECTION PUMP

WATER SOURCES

(1) ECST
(2) CST (NOT SHOWN)
(3) PG TANK
(4) U1/U2 CONDENSER HOTWELL
(5) LAKE ANNA
(6) SERVICE WATER RESEVOIR (NOT SHOWN)
(7) SERVICE WATER PIPING (NOT SHOWN)
(8) RWST

SYMBOLS

Y- CONNECTION
ABOVE GROUND HOSE LAY
ALT. ABOVE GROUND HOSE LAY
ABOVE GROUND HOSE
BDB HIGH CAPACITY PUMP
PORTABLE BATCH TANK
BDB RCS INJECTION PUMP
BDB AFW PUMP PUMP
BALL VALVE
BUTTERFLY VALVE

Figure 1: BDB FLEX Strategy Equipment and Hose Layout (Page 3 of 3)

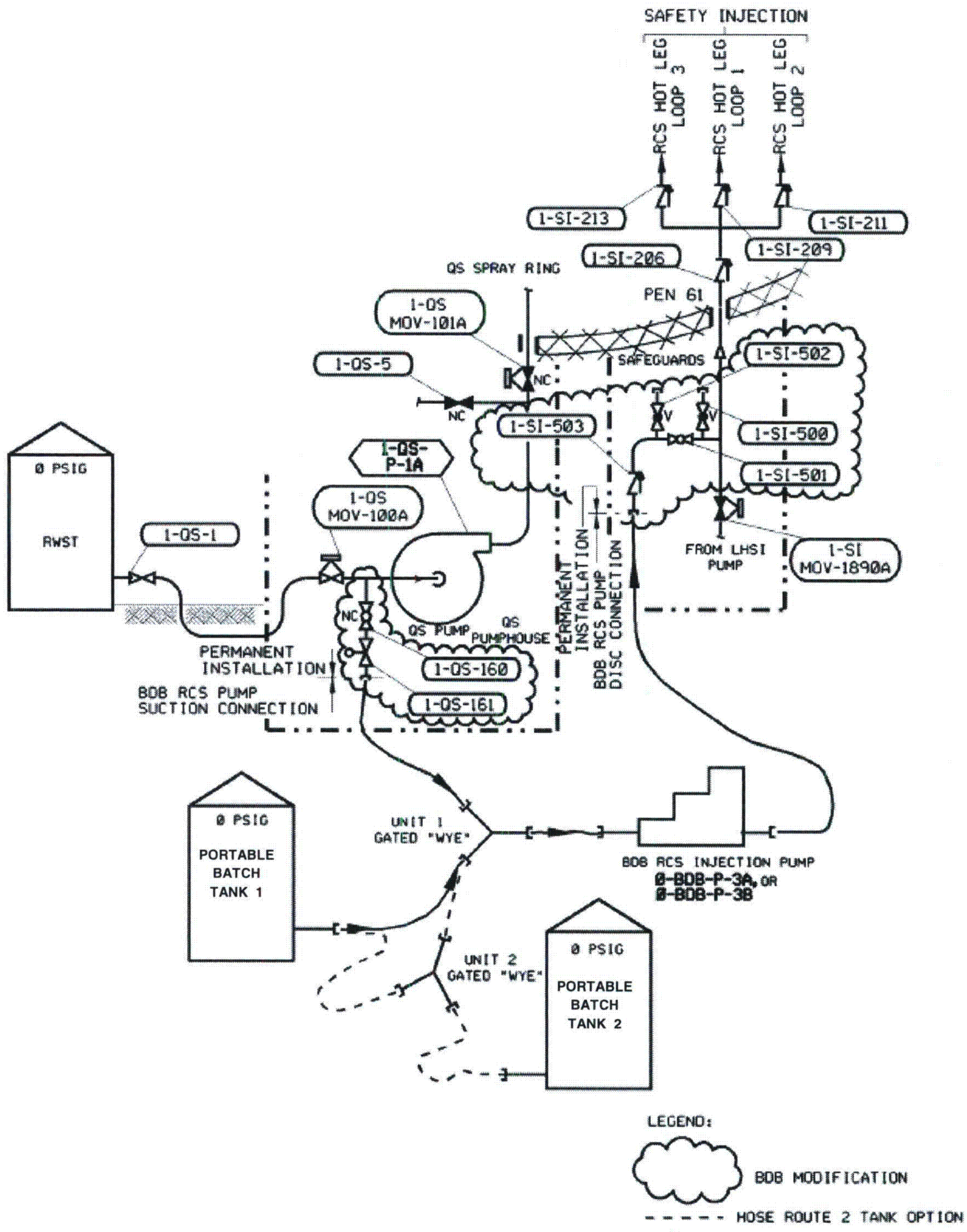


Figure 2: RCS Makeup Primary Mechanical Connection
North Anna Unit 1

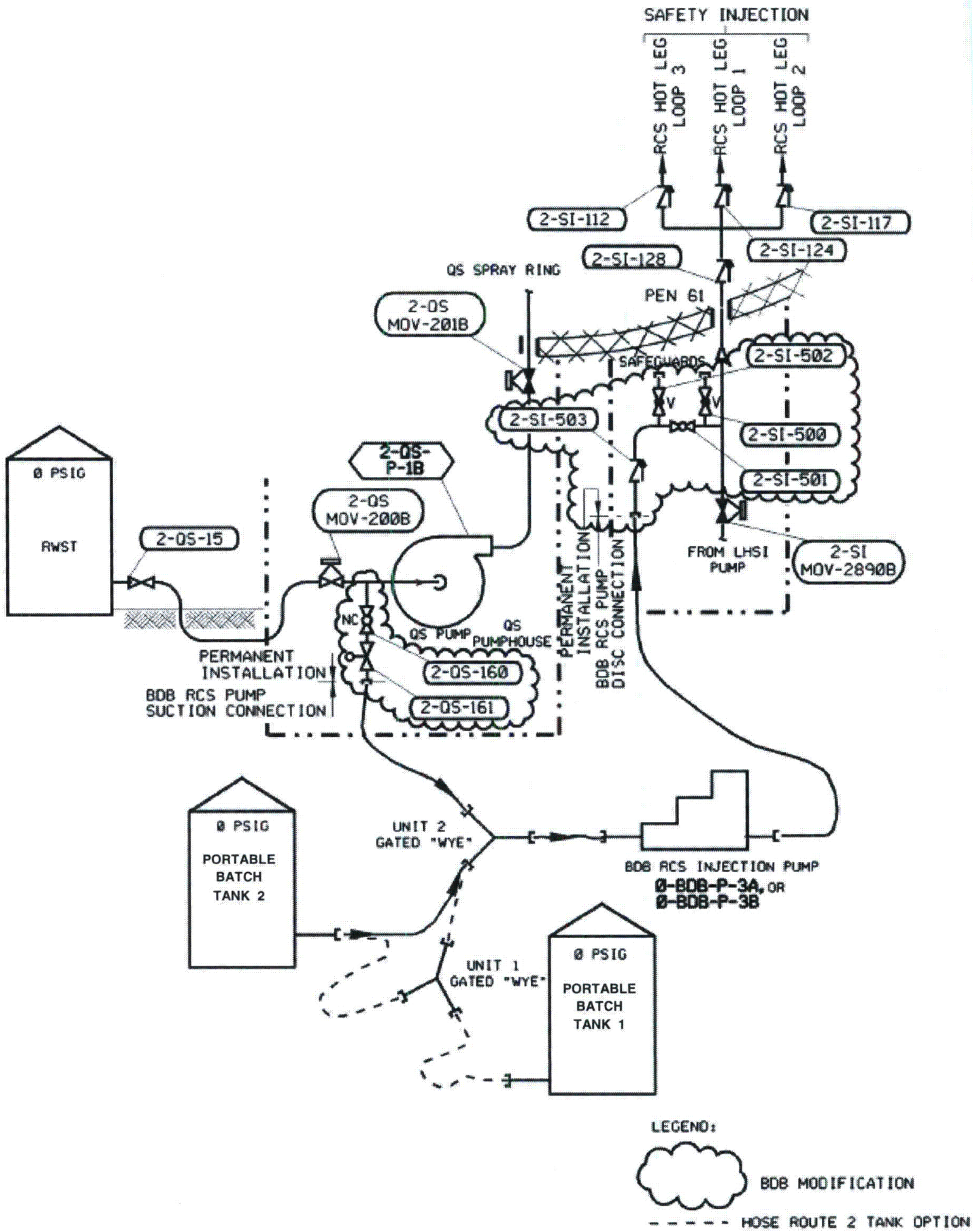


Figure 3: RCS Makeup Primary Mechanical Connection
North Anna Unit 2

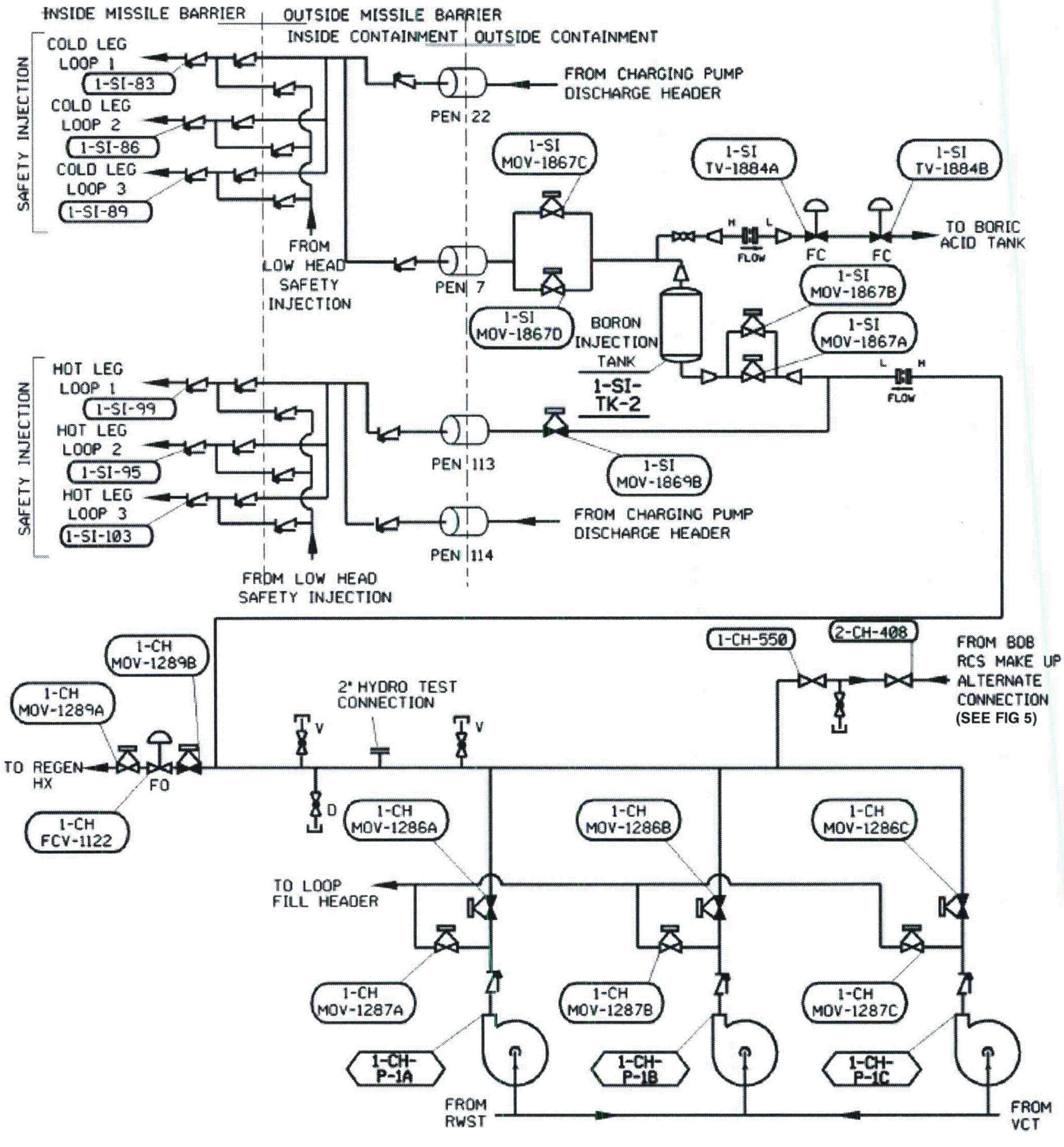


Figure 4: RCS Makeup Alternate Mechanical Connection
North Anna Unit 1

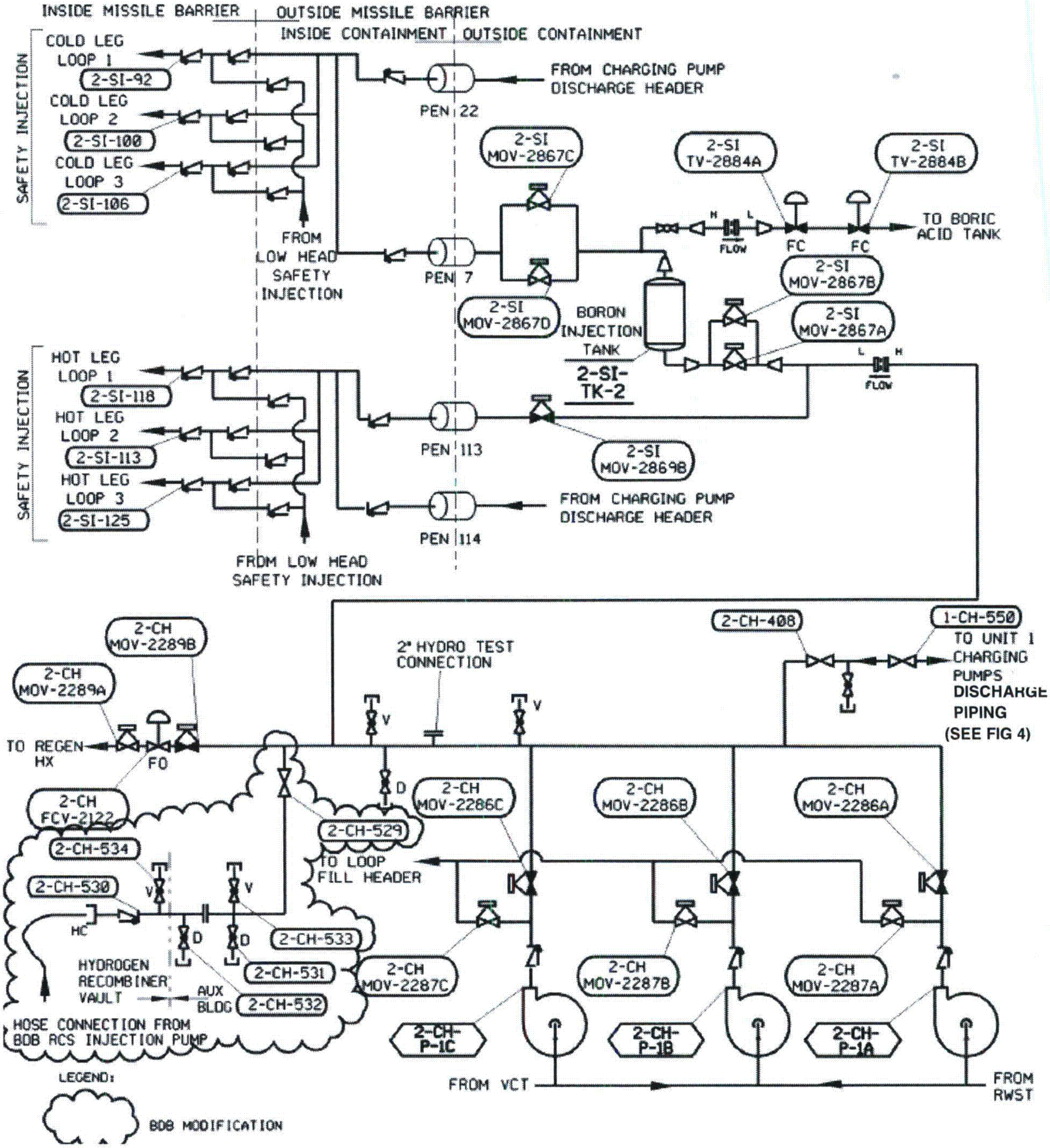


Figure 5: RCS Makeup Alternate Mechanical Connection
North Anna Unit 2

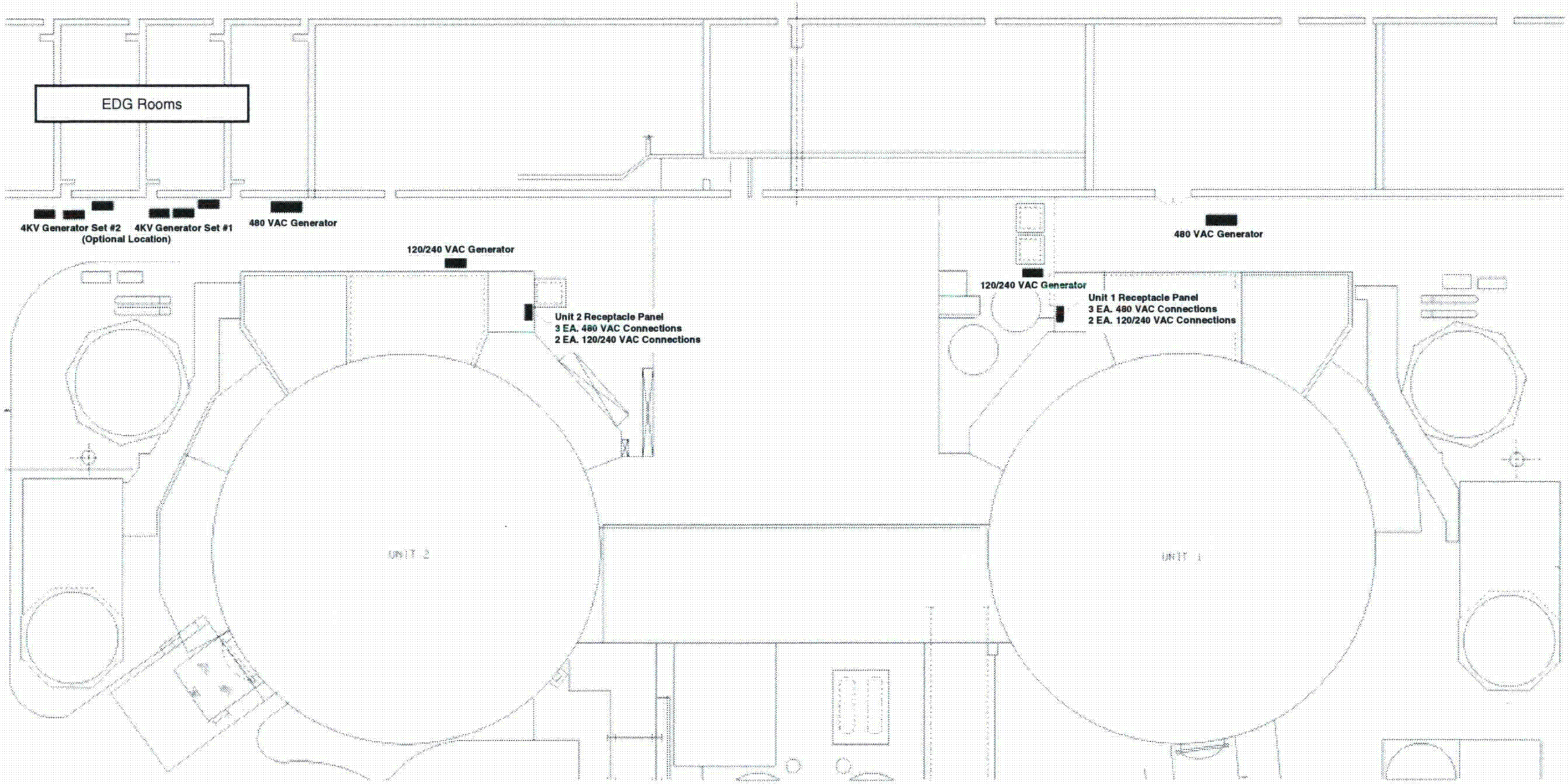


Figure 6: BDB Electrical Connection 120 VAC, 480 VAC, & 4160 VAC General Layout

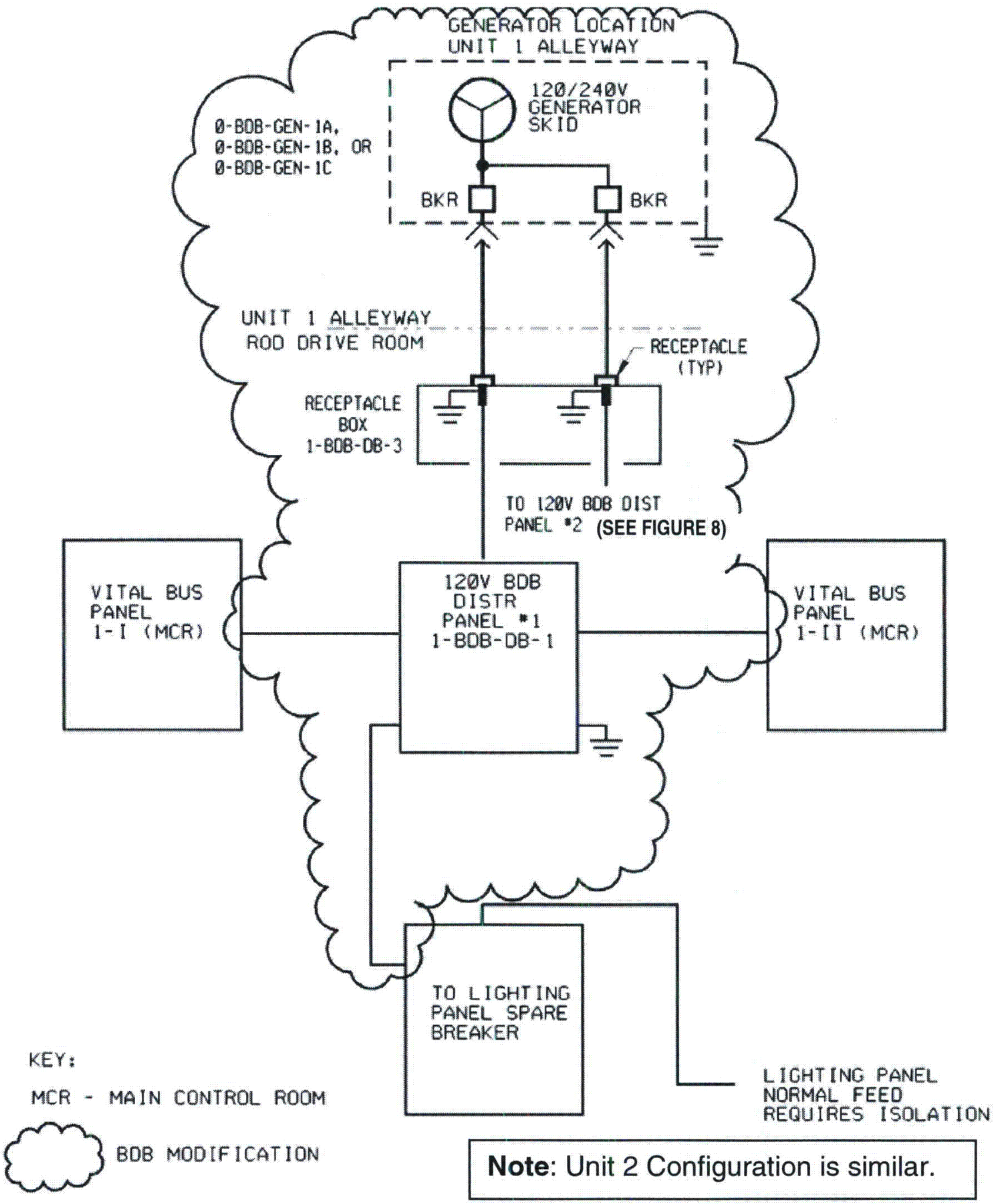
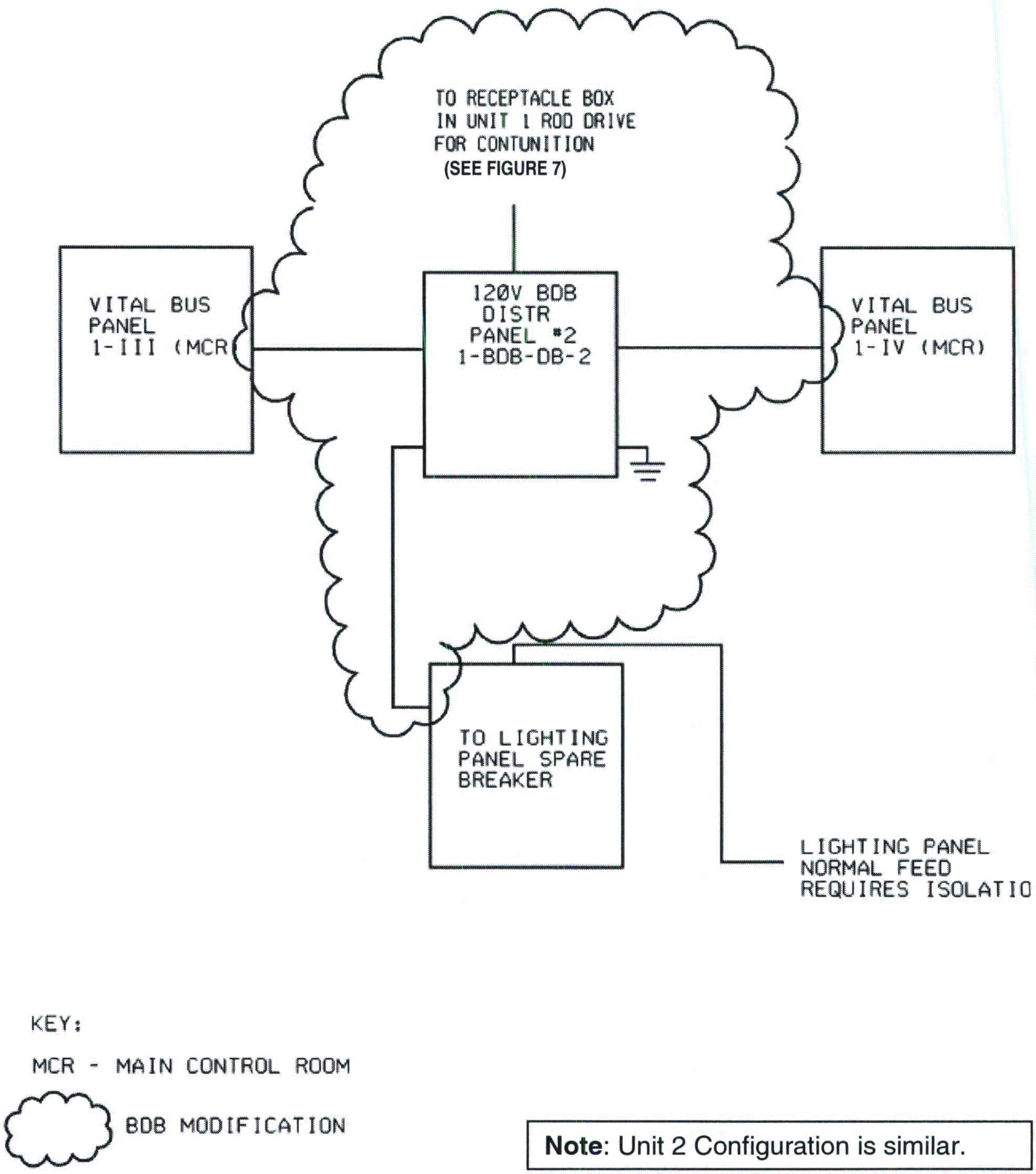


Figure 7: 120/240 VAC Portable Generator (BDB) Electrical Connection
Panel #1 – North Anna Unit 1



Note: Unit 2 Configuration is similar.

Figure 8: 120/240 VAC Portable Generator (BDB) Electrical Connection
Panel #2 – North Anna Unit 1

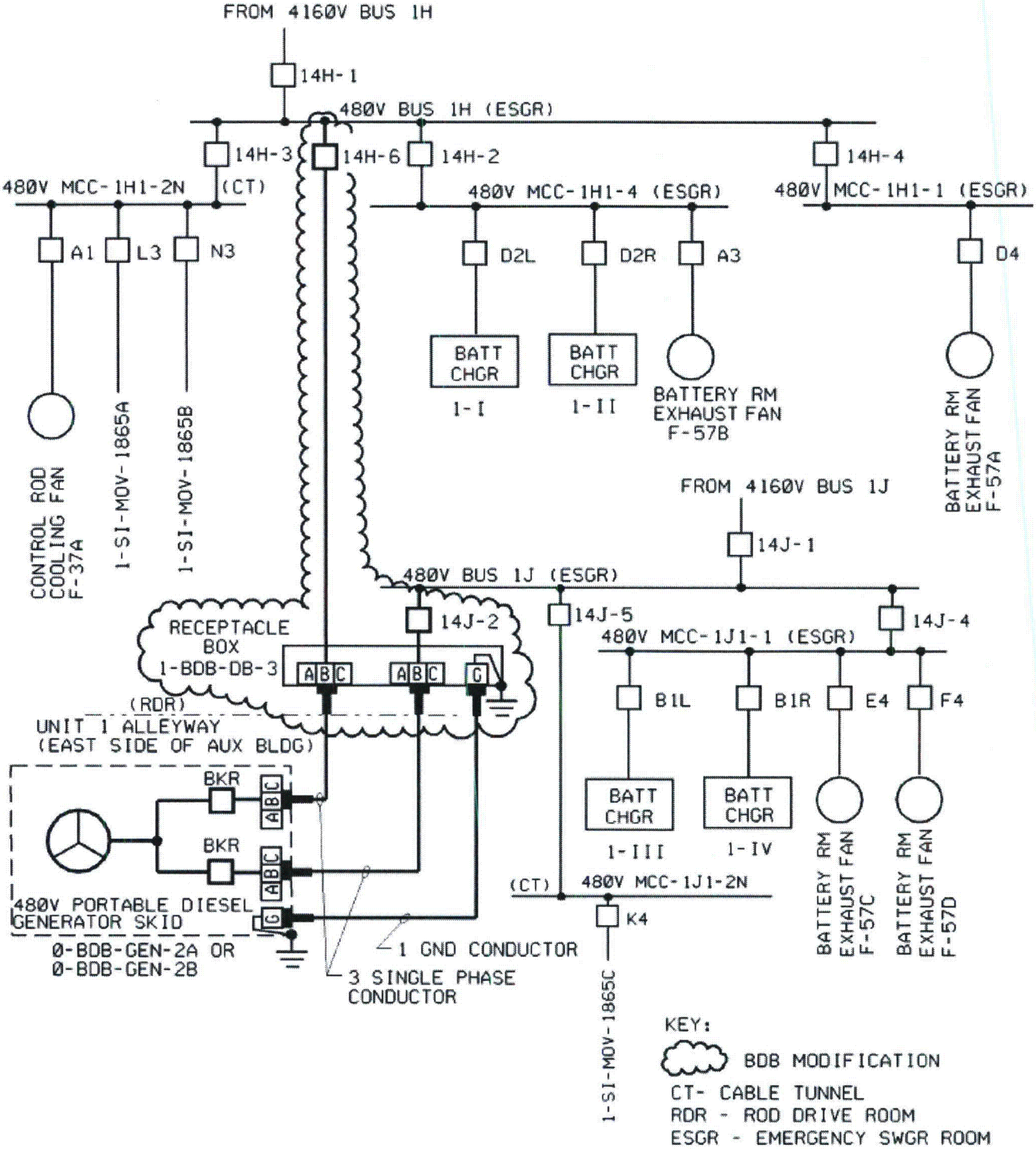


Figure 9: 480 VAC Portable Generator (BDB) Electrical Connections to 480 VAC MCC 1H and 1J – North Anna Unit 1

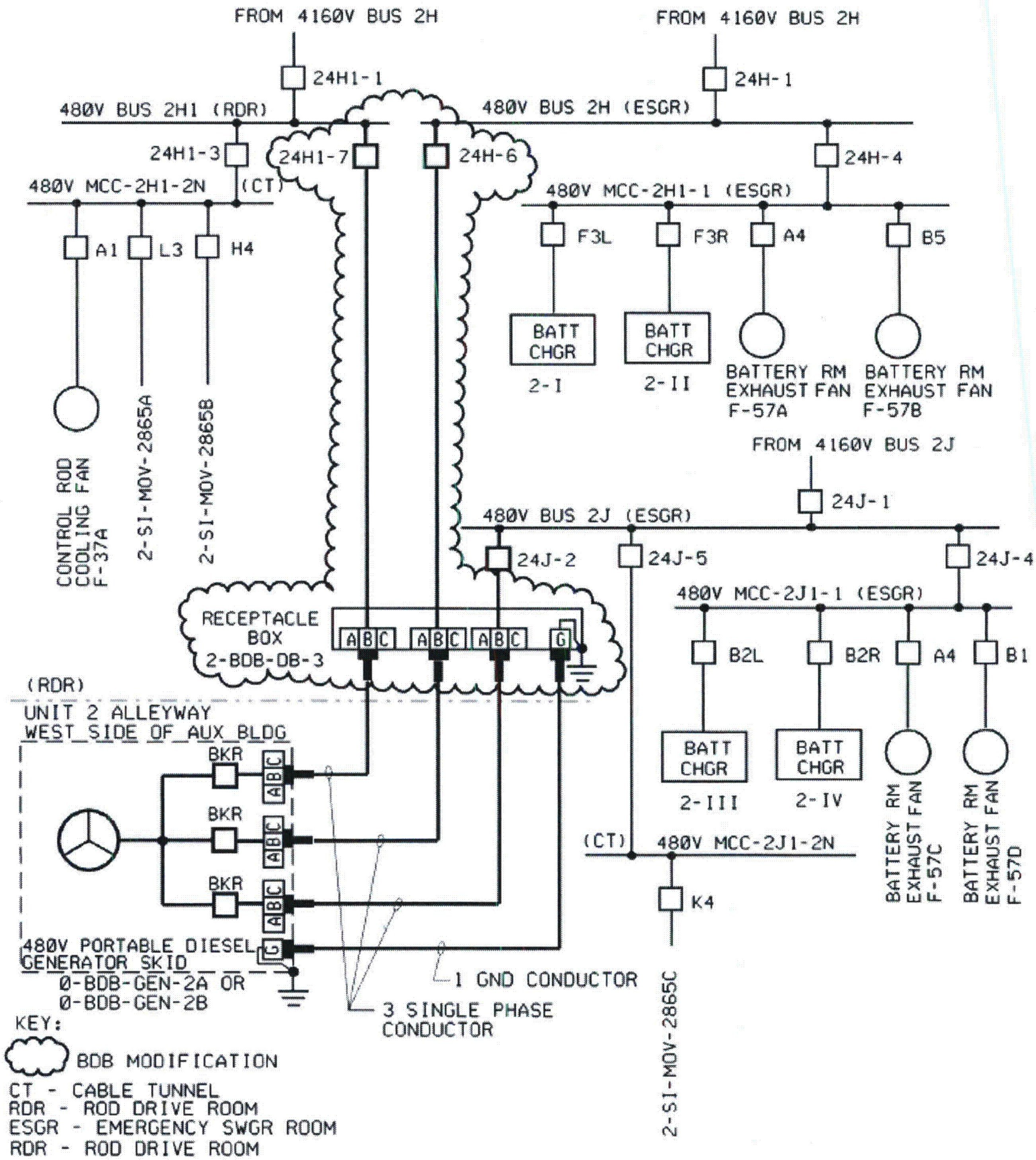


Figure 10: 480 VAC Portable Generator (BDB) Electrical Connections to 480 VAC MCC 2H and 2J – North Anna Unit 2

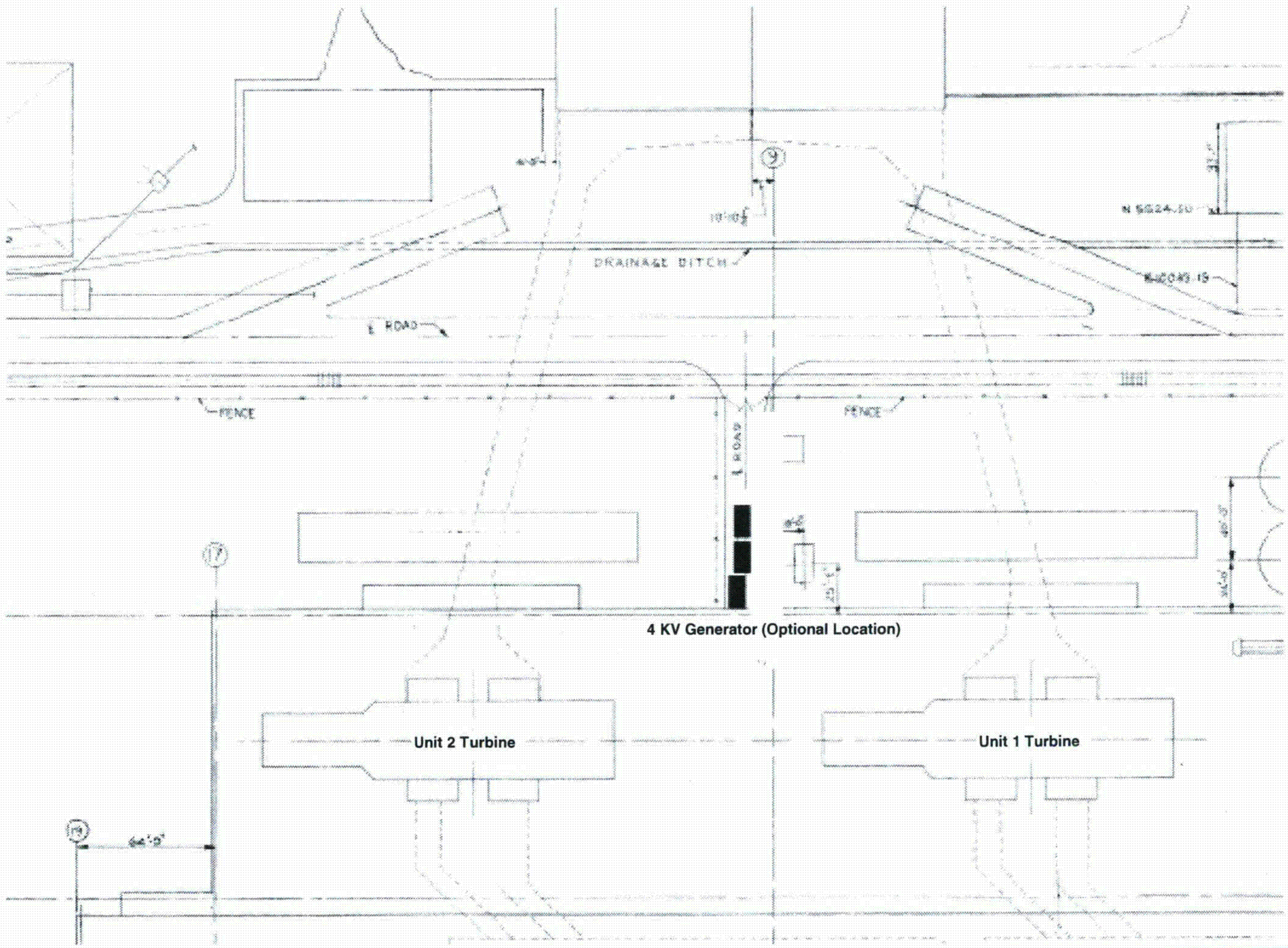


Figure 11: 4160 VAC Generator (NSRC) Electrical Connection General Layout

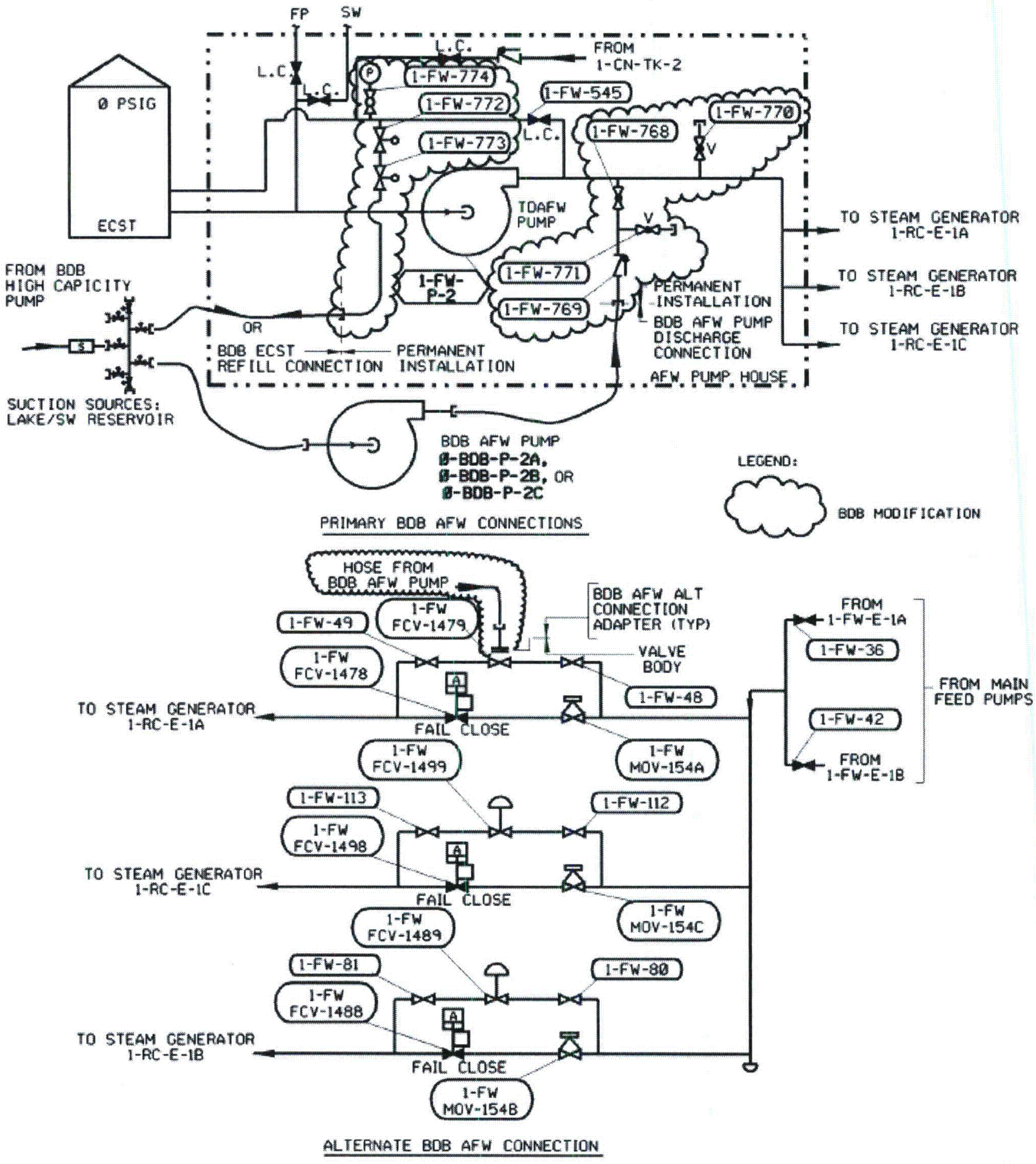


Figure 12: Core Cooling and Decay Heat Removal AFW Primary and Alternate Mechanical Connections – North Anna Unit 1

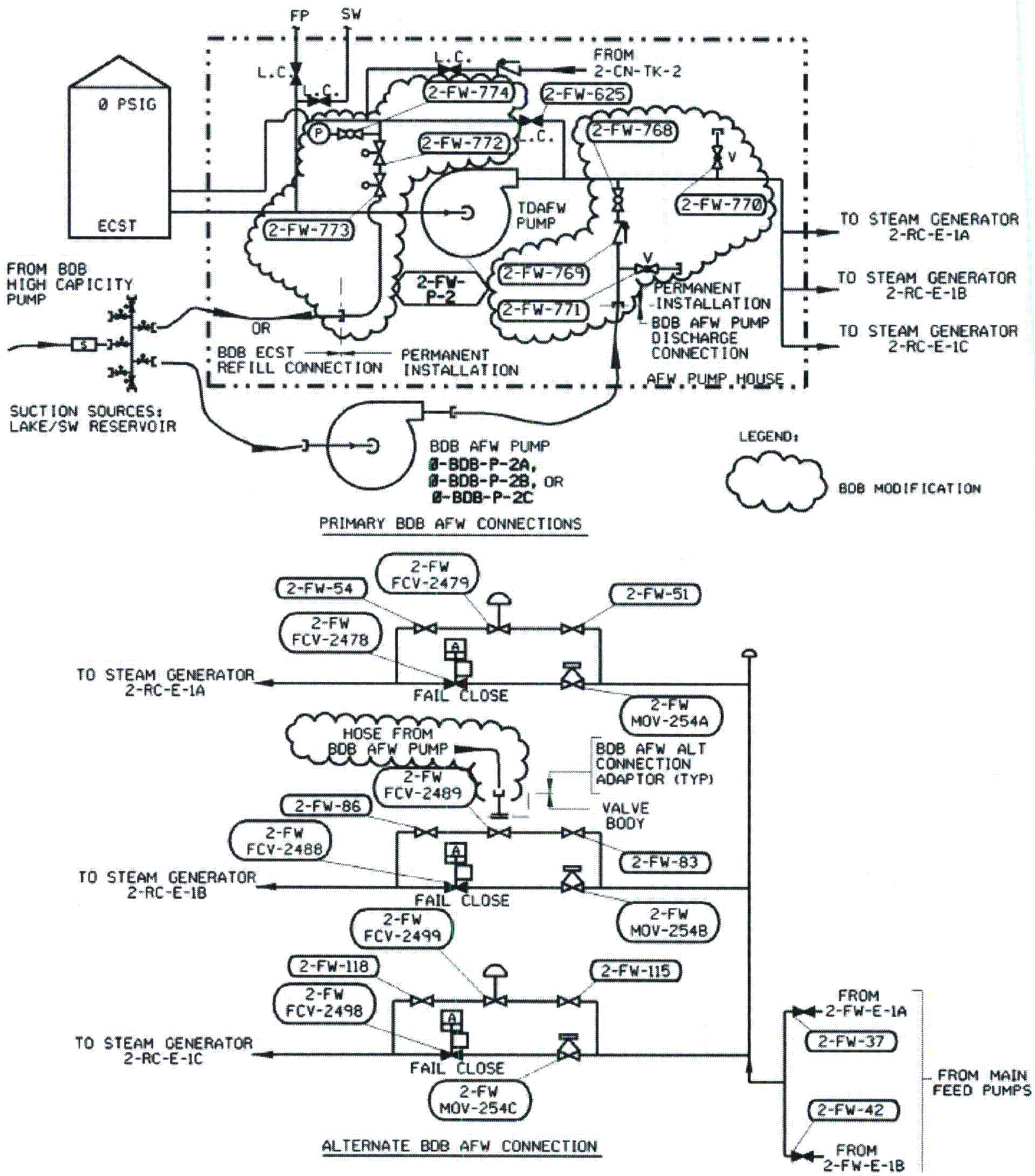


Figure 13: Core Cooling and Decay Heat Removal AFW Primary and Alternate Mechanical Connections – North Anna Unit 2

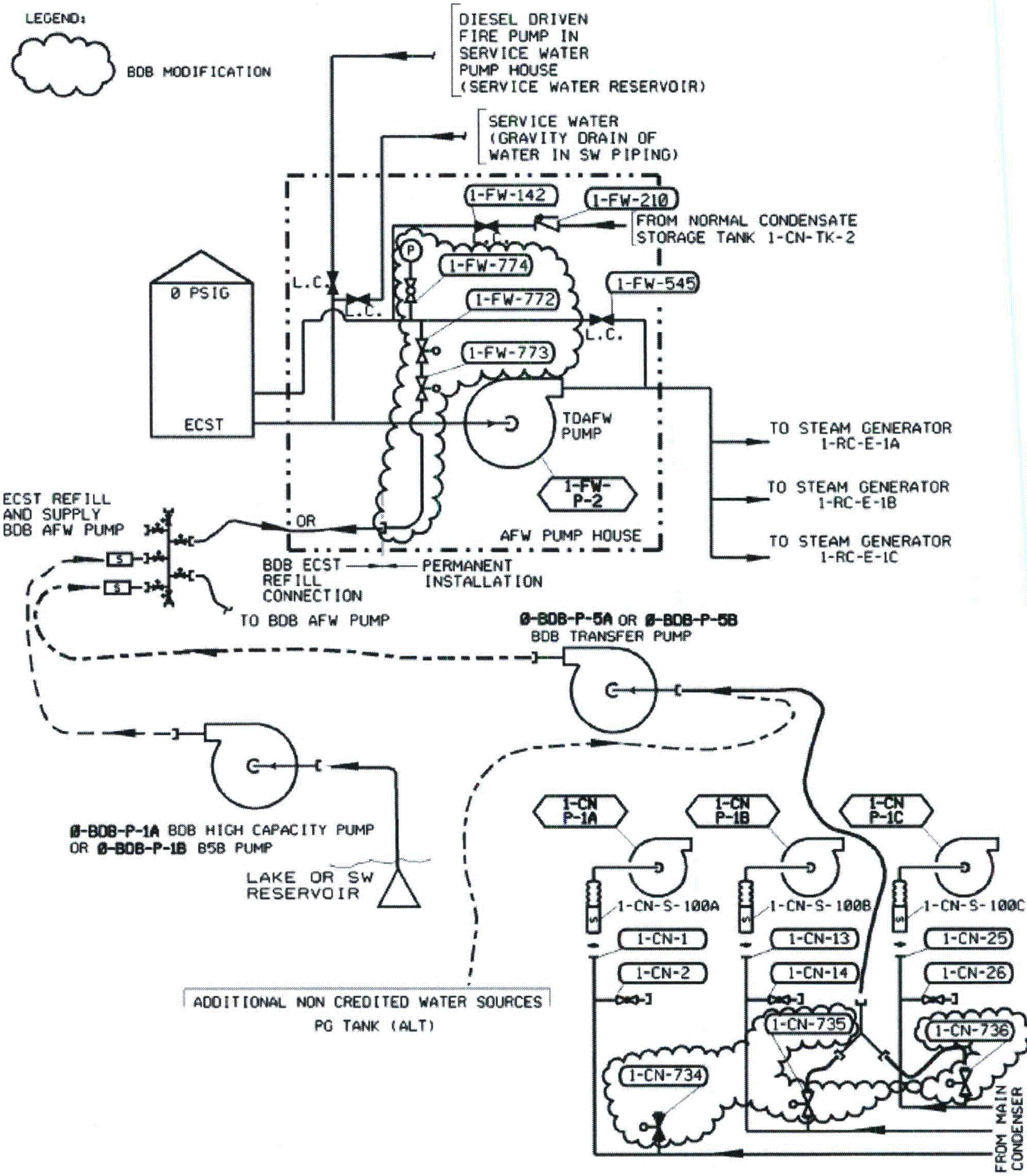


Figure 14: ECST Refill Mechanical Connections, Paths, and Sources
North Anna Unit 1

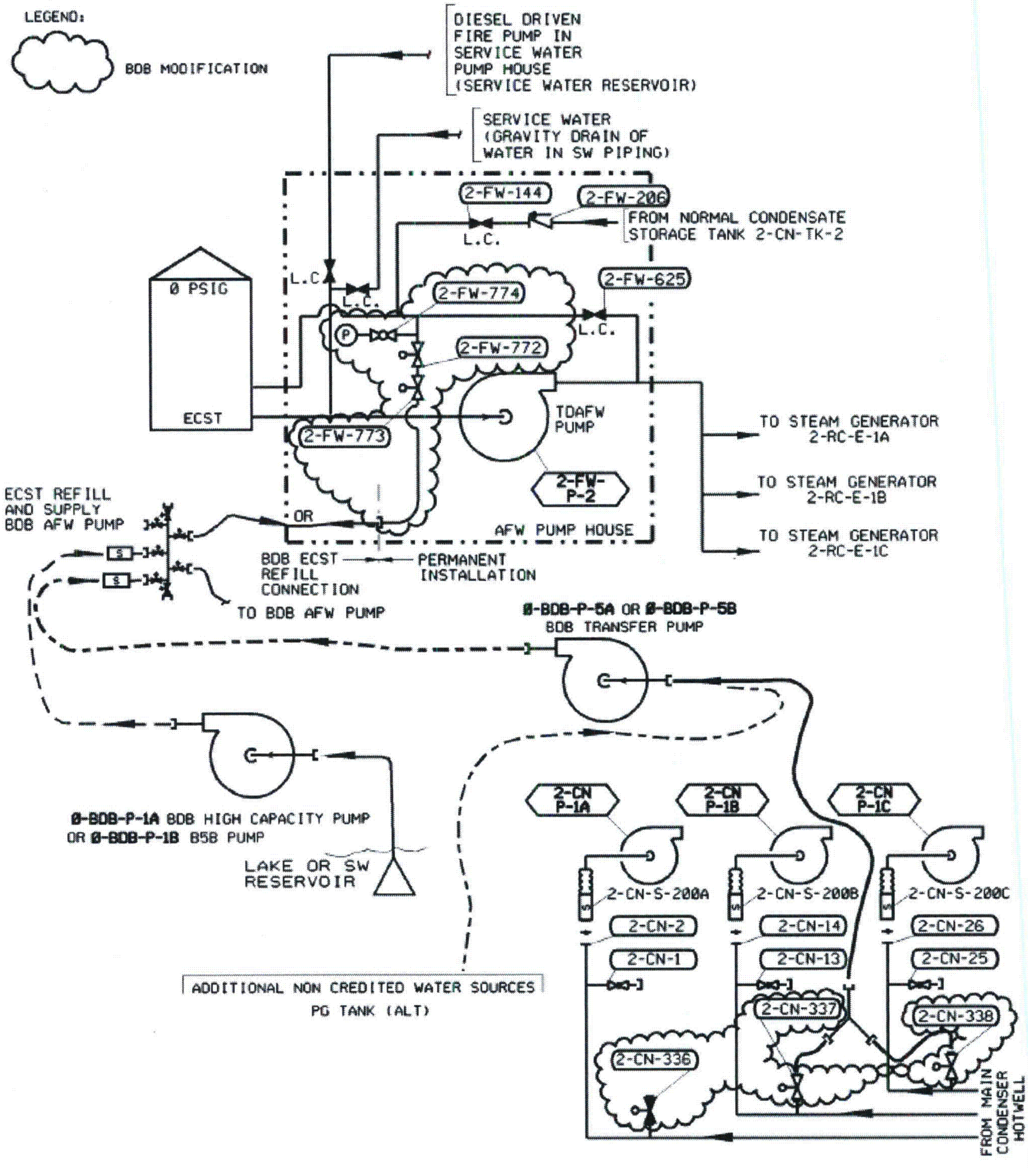


Figure 15: ECST Refill Mechanical Connections, Paths, and Sources
North Anna Unit 2

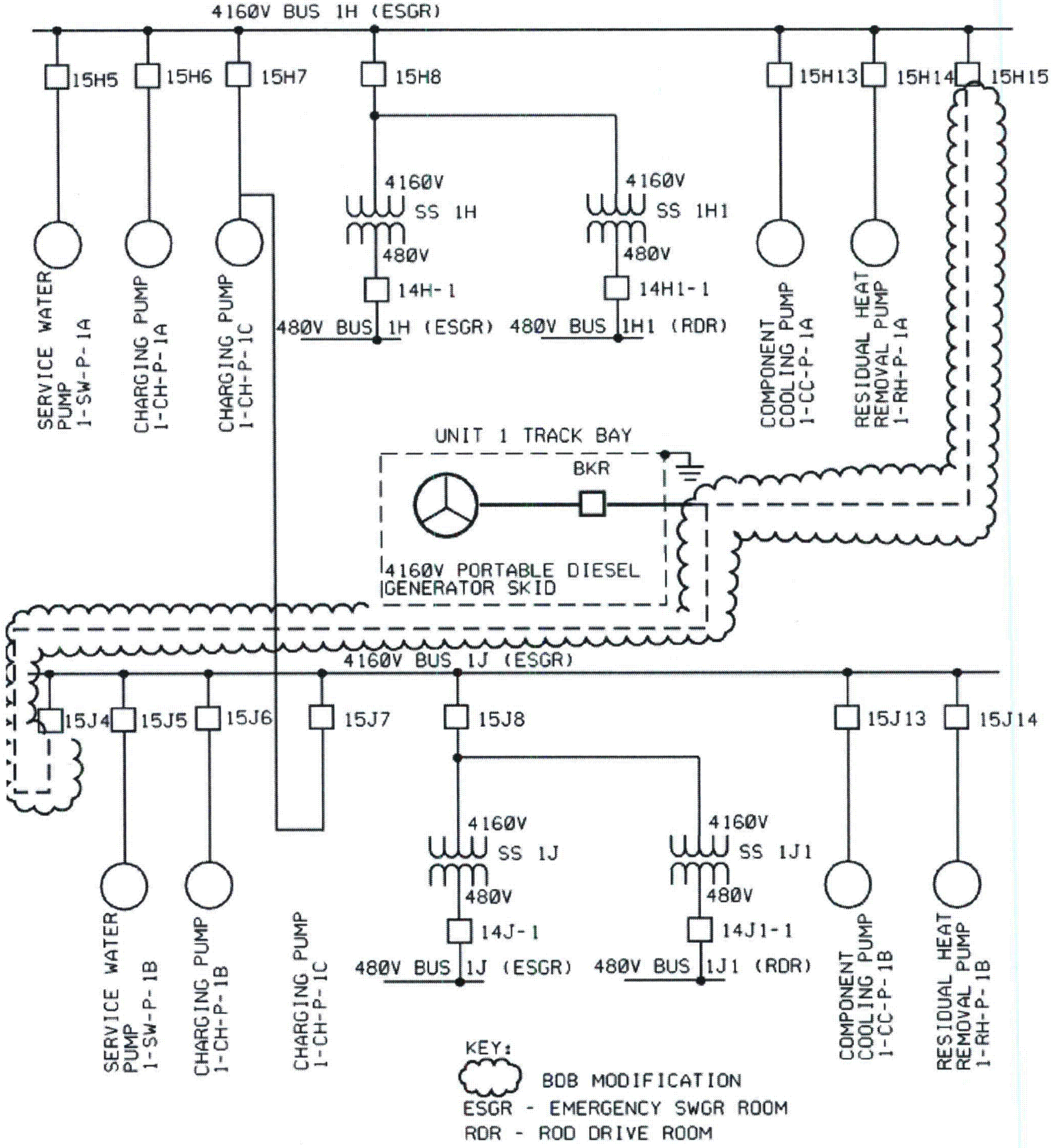


Figure 16: 4160 VAC Generator (NSRC) Electrical Connections to 4160 VAC MCC 1H and 1J – North Anna Unit 1

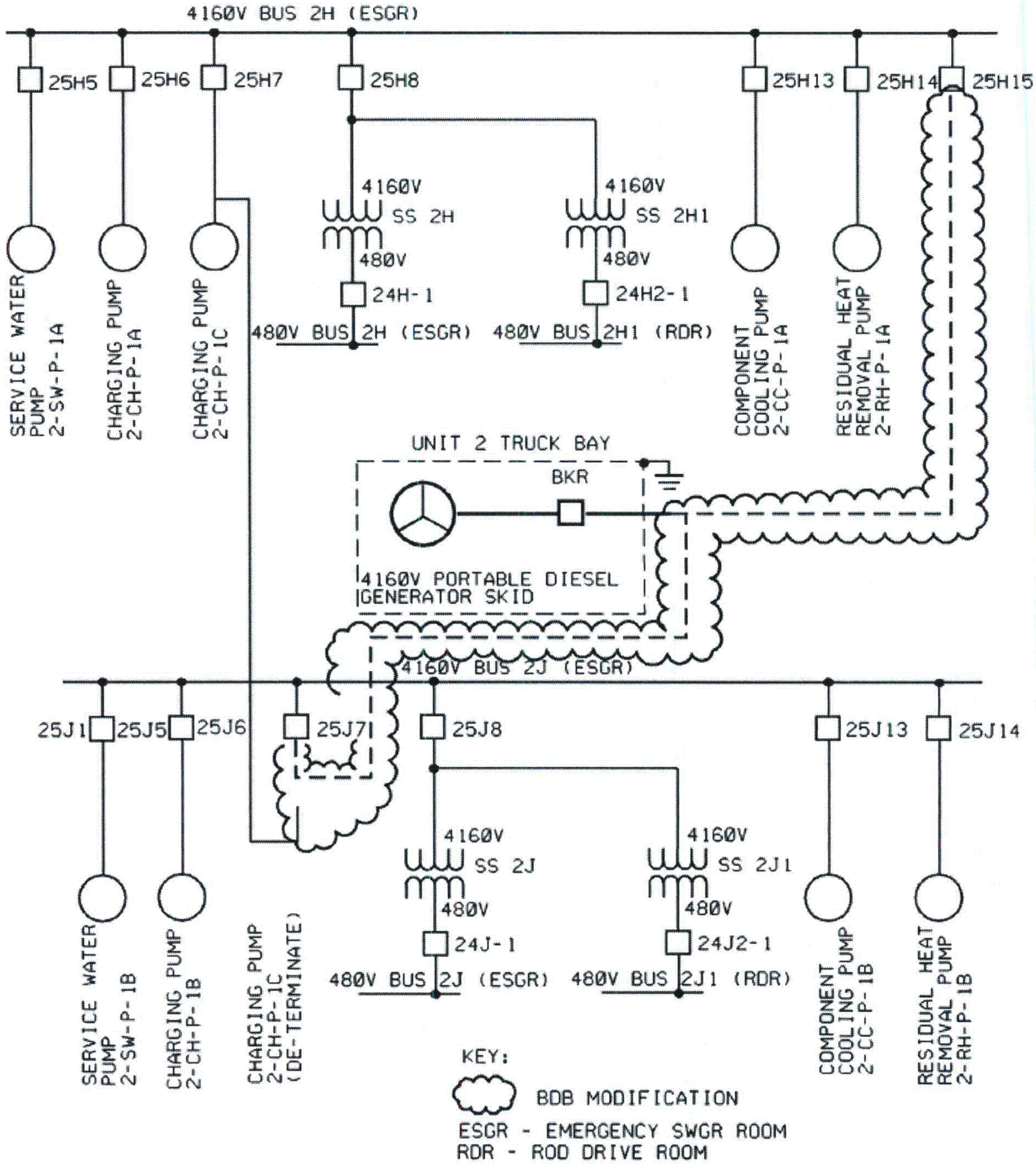


Figure 17: 4160 VAC Generator (NSRC) Electrical Connections to
4160 VAC MCC 2H and 2J – North Anna Unit 2

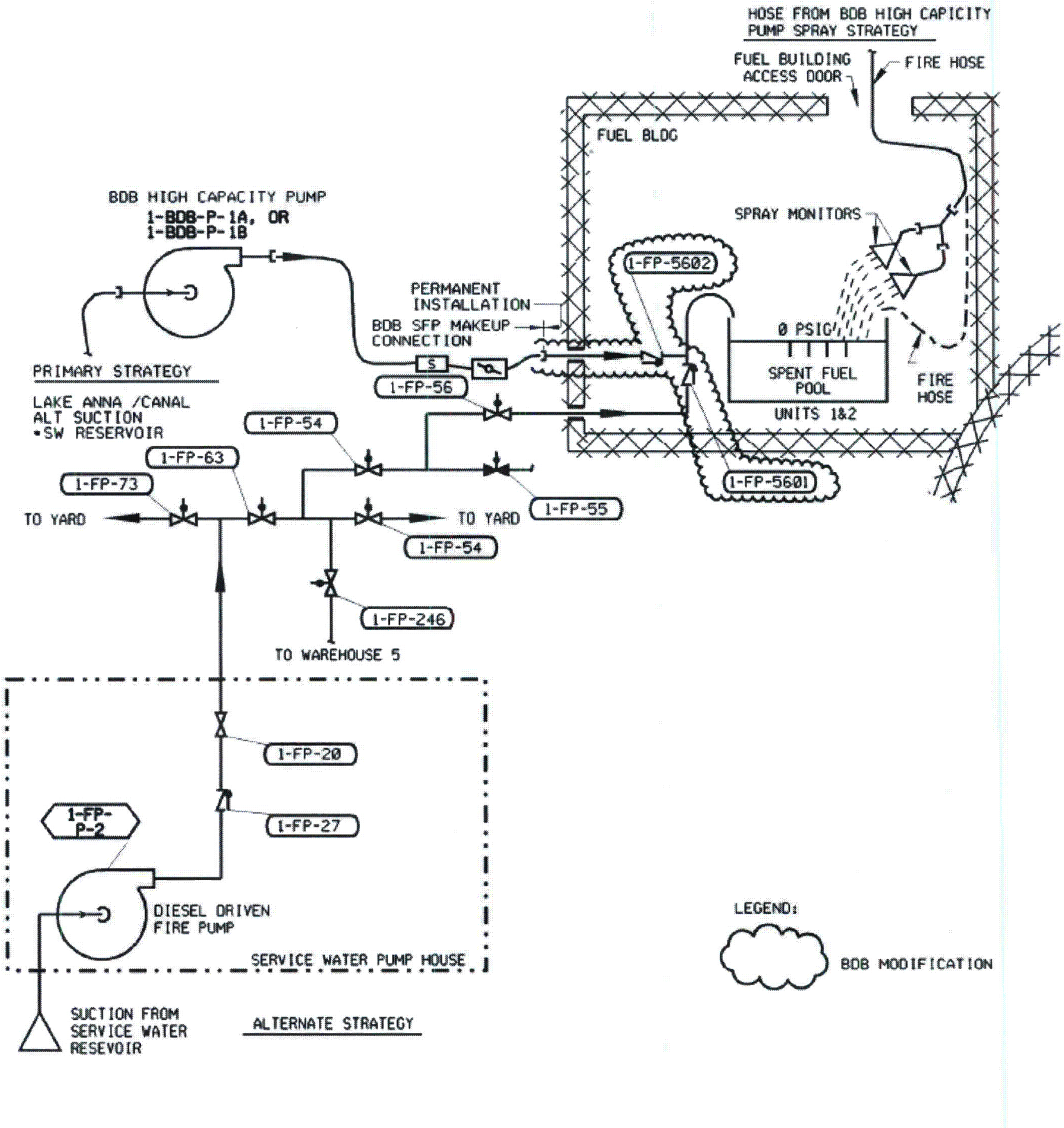


Figure 18: Spent Fuel Pool Cooling Primary and Alternate Mechanical Connections

NAPS Final Integrated Plan

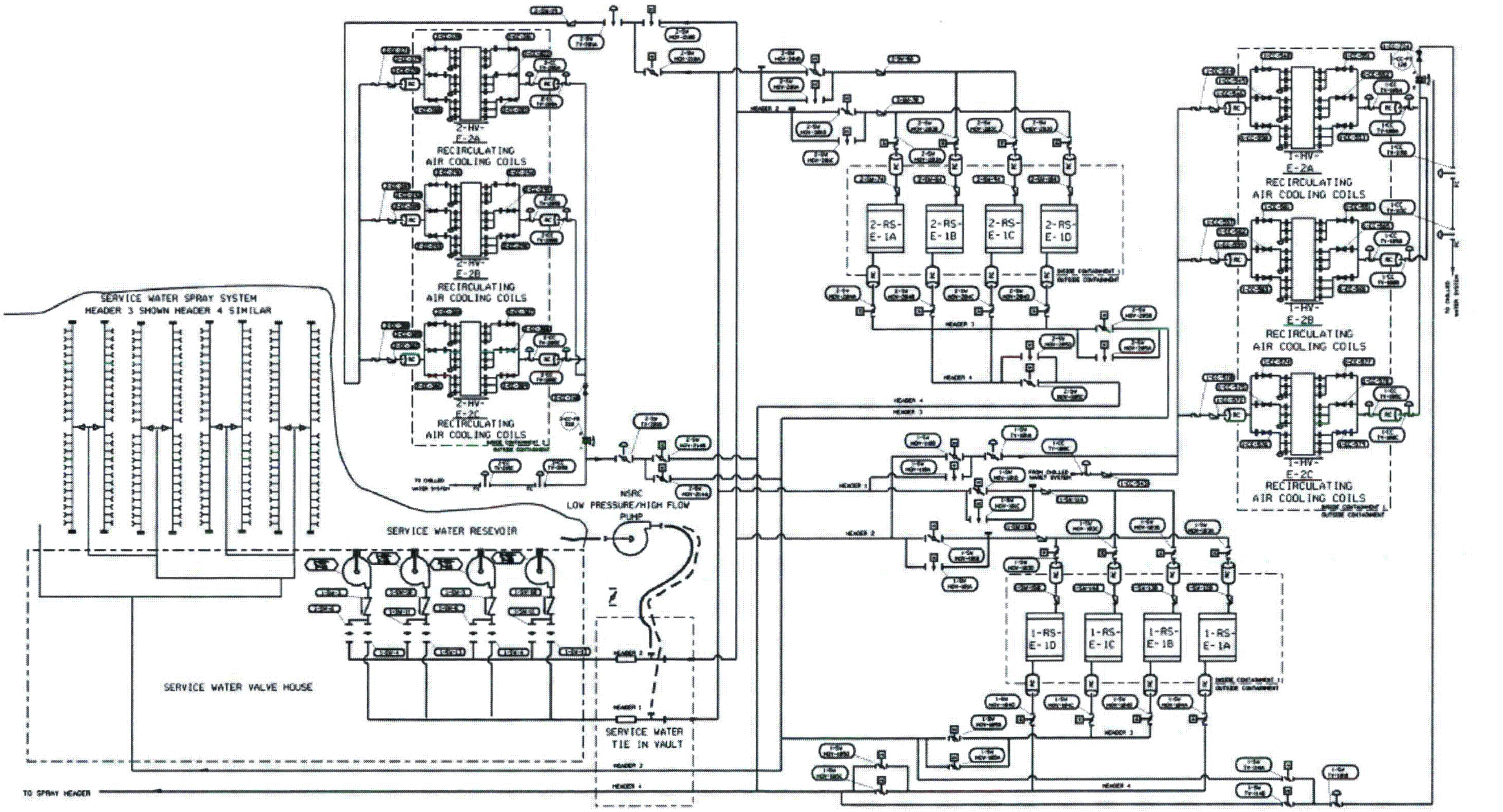


Figure 19: Phase 3 Containment Cooling Connections

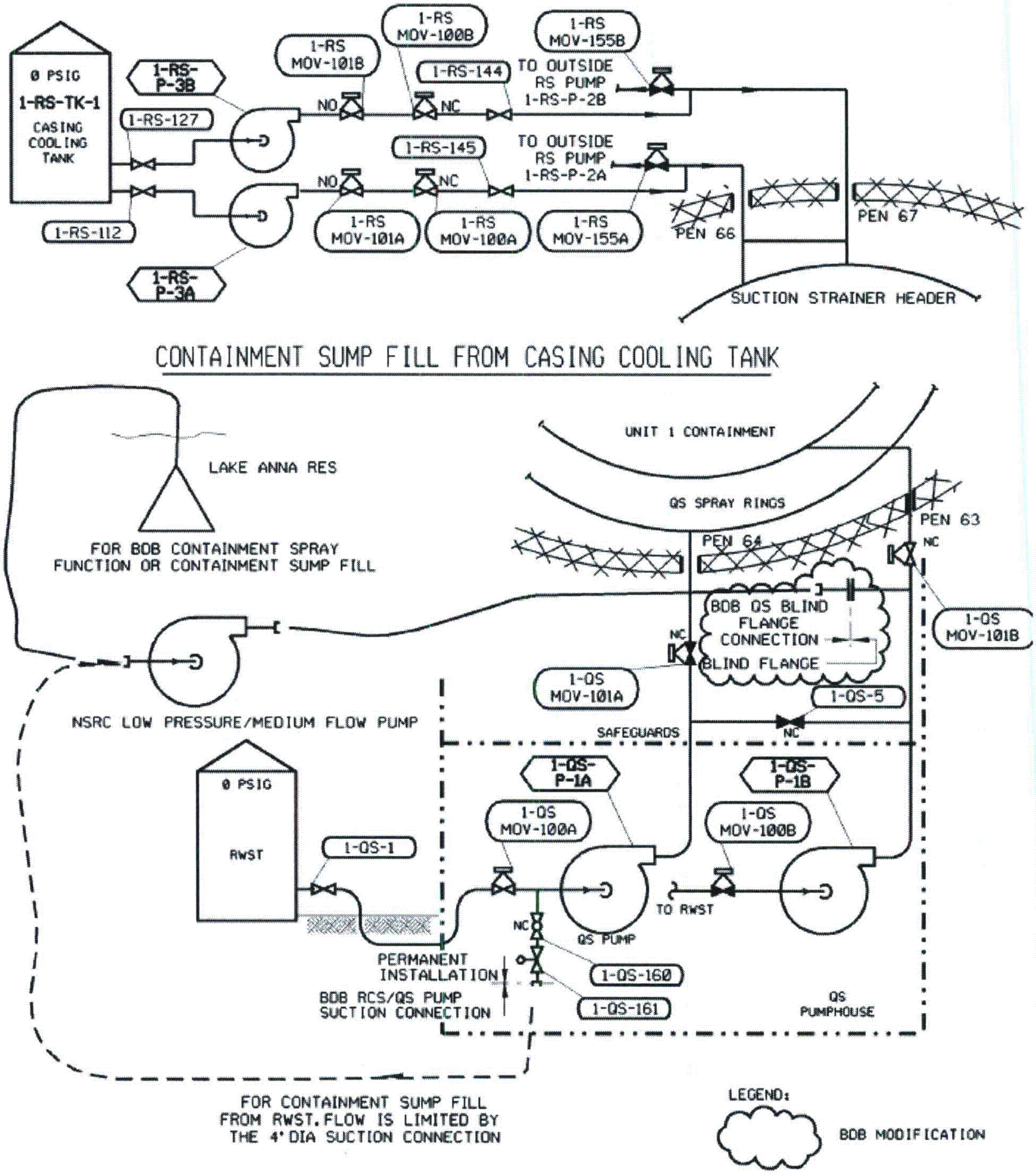


Figure 20: Containment Cooling Phase 3 Containment Spray Mechanical Connections North Anna Unit 1

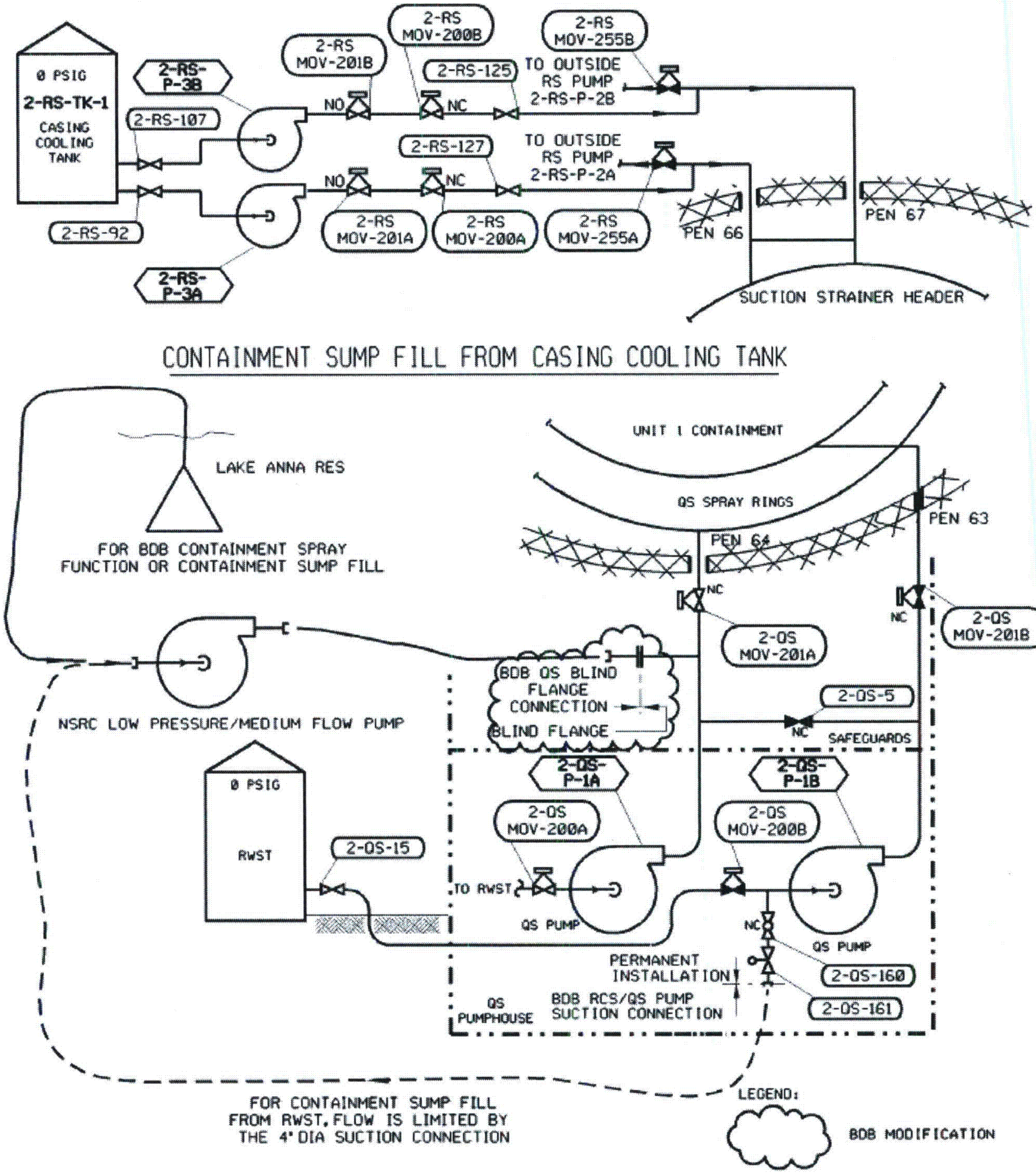


Figure 21: Containment Cooling Phase 3 Containment Spray Mechanical Connections North Anna Unit 2

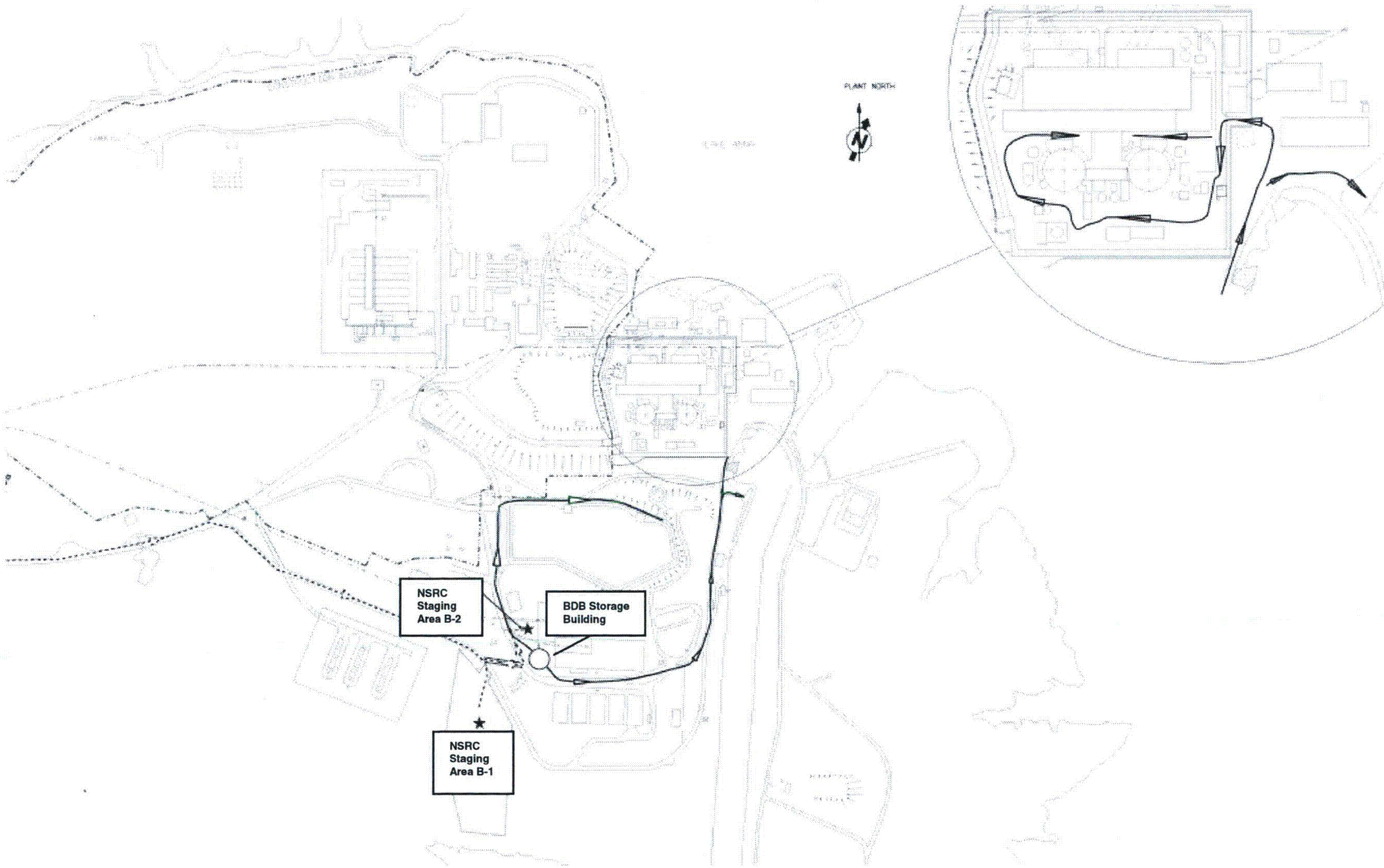


Figure 22: Haul Paths From BDB Storage Building and Staging Areas