Exelon Generation®

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December 14, 2015

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Clinton Power Station, Unit 1
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Subject: Revised Final Integrated Plan Document – Mitigating Strategies NRC Order EA-12-049

References:

1. Exelon Generation Company, LLC, Report of Full Compliance with March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049), dated July 15, 2015 (RS-15-138)
2. NRC Order Number EA-12-049, "Issuance of Order to Modify Licenses with Regard to Requirements For Mitigation Strategies For Beyond-Design-Basis External Events," dated March 12, 2012
3. NRC Email from J. Boska to D. Shelton, Clinton FLEX Issues to Address in Supplement to Final Integrated Plan, dated November 18, 2015

Reference 1 provided the Clinton Power Station, Unit 1 report of full compliance with the March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements For Mitigation Strategies For Beyond-Design-Basis External Events (Order Number EA-12-049) (Reference 2) pursuant to Section IV, Condition C.3 of the Order. Reference 1 included the Clinton Power Station, Unit 1 Final Integrated Plan for mitigating strategies.

The purpose of this letter is to provide the revised Clinton Power Station, Unit 1 Final Integrated Plan document for mitigating strategies. The enclosed Final Integrated Plan revision addresses the FLEX issues identified in Reference 3. Changes are shown with revision bars in the right margin.

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

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I declare under penalty of perjury that the foregoing is true and correct. Executed on the 14th day of December 2015.

Respectfully submitted,

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Enclosure:

Clinton Power Station, Unit 1 Revised Final Integrated Plan Document – Mitigating Strategies
NRC Order EA-12-049

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Enclosure

Clinton Power Station, Unit 1

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

December 2015

(104 pages)

Exelon Generation®

CLINTON
POWER STATION
UNIT 1

FINAL INTEGRATED PLAN DOCUMENT

MITIGATING STRATEGIES
NRC ORDER EA-12-049

December 2015

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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 on Units 1 & 2 and after some period of time at the other units. Core damage occurred in three of the units along with a loss of containment integrity resulting in a release of radioactive material to the surrounding environment.

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

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

1. Licensees shall develop, implement, and maintain guidance and strategies to maintain or restore core cooling, containment, and Spent Fuel Pool (SFP) cooling capabilities following a BDBEE.
2. These strategies must be capable of mitigating a simultaneous loss of all AC power and loss of normal access to the ultimate heat sink (LUHS) and have adequate capacity to address challenges to core cooling, containment and SFP cooling capabilities at all units on a site subject to the Order.
3. Licensees must provide reasonable protection for the associated equipment from external events. Such protection must demonstrate that there is adequate capacity to address challenges to core cooling, containment, and SFP cooling capabilities at all units on a site subject to the Order.
4. Licensees must be capable of implementing the strategies in all modes.
5. Full compliance shall include procedures, guidance, training, and acquisition, staging or installing of equipment needed for the strategies.

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

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

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

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

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

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

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

2.1 Assumptions

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

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

- The reactor is initially operating at power, unless there are procedural requirements to shut down due to the impending event. The reactor has been operating at 100% power for the past 100 days.

- The reactor is successfully shut down when required (i.e., all control 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. The emergency cooling system initiates and operates normally, providing decay heat removal, thus obviating the need for further overpressure protection valve operation.
- On-site staff is at site administrative minimum shift staffing levels.
- No independent, concurrent events, e.g., no active security threat.
- All personnel on-site are available to support site response.
- The reactor and supporting plant equipment are either operating within normal ranges for pressure, temperature and water level, or available to operate, at the time of the event consistent with the design and licensing basis.

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

- No specific initiating event is used. The initial condition is assumed to be a loss of off-site power (LOOP) with installed sources of emergency on-site AC power unavailable with no prospect for recovery.
- Cooling and makeup water inventories contained in systems or structures with designs that are robust with respect to seismic events, floods, and high winds and associated missiles are available. Permanent plant equipment that is contained in structures with designs that are robust with respect to seismic events, floods, and high winds and associated missiles, are available.
- Normal access to the ultimate heat sink is lost, but the water inventory in the ultimate heat sink (UHS) remains available and robust piping connecting the UHS to plant systems remains intact. The motive force for UHS flow, i.e., pumps, is assumed to be lost with no prospect for recovery.
- Fuel for FLEX equipment stored in structures with designs that are robust with respect to seismic events, floods and high winds and associated missiles, remains available.

- Installed Class 1E electrical distribution systems, including inverters and battery chargers, remain available since they are protected.
- No additional accidents, events, or failures are assumed to occur immediately prior to or during the event, including security events.
- Reactor coolant inventory loss at a rate of 100 gpm (pressure dependent), is assumed to bound the unidentified and identified leakage at the upper limit of Technical Specifications (30 gpm) and reactor recirculation pump seal leakage of 36 gpm.
- For the spent fuel pool, the heat load is assumed to be the maximum design basis heat load. In addition, inventory loss from sloshing during a seismic event does not preclude access to the pool area.

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

- Exceptions for the site security plan or other (license/site specific) requirements of 10CFR may be required.
- Site access is impeded for the first 6 hours, consistent with NEI 12-01 (Reference 7). Additional resources are assumed to begin arriving at hour 6 with limited site access up to 24 hours. By 24 hours and beyond, near-normal site access is restored allowing augmented resources to deliver supplies and personnel to the site.

This plan defines strategies capable of mitigating a simultaneous loss of all alternating current (AC) power and loss of normal access to the ultimate heat sink resulting from a BDB event by providing adequate capability to maintain or restore core cooling, containment, and spent fuel pool (SFP) cooling capabilities. Though specific strategies have been developed, due to the inability to anticipate all possible scenarios, the strategies are also diverse and flexible to encompass a wide range of possible conditions. These pre-planned strategies developed to protect the public health and safety have been incorporated into the unit emergency operating procedures in accordance with established emergency operating procedure (EOP) change processes, and their impact to the design and license bases capabilities of the unit evaluated under 10 CFR 50.59.

The plant Technical Specifications contain the limiting conditions for normal unit operations to ensure that design safety features are available to respond to a design basis accident and direct the required actions to be taken when the limiting conditions are not met. The result of the BDB event may place the plant in a condition where it cannot comply with certain Technical Specifications and/or with its Security Plan, and, as such, may warrant invocation of 10 CFR 50.54(x) and/or 10 CFR 73.55(p). This position is consistent with the previously documented Task Interface Agreement (TIA) 2004-04, "Acceptability of Proceduralized Departures from Technical Specification (TSs) Requirements at the Surry Power Station", (TAC Nos. MC42331 and MC4332), dated September 12, 2006 (Reference 8).

3 Strategies

The objective of the FLEX Strategies is to establish an indefinite coping capability in order to 1) prevent damage to the fuel in the reactor, 2) maintain the containment function and 3) maintain cooling and prevent damage to fuel in the spent fuel pool (SFP) using installed equipment, on-site portable equipment, and pre-staged off-site resources. This indefinite coping capability will address an extended loss of all AC power (ELAP) – loss of off-site power and emergency diesel generators, but not the loss of AC power to buses fed by station batteries through inverters – with a simultaneous loss of access to the ultimate heat sink (LUHS) and loss of motive force for UHS pumps, but the water in the UHS remains available and robust piping connecting the UHS to plant systems remains intact. This condition could arise following external events that are within the existing design basis with additional failures and conditions that could arise from a BDBEE.

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

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

- Phase 1 – Initially cope by relying on installed plant equipment and on-site resources.
- Phase 2 – Transition from installed plant equipment to on-site BDB equipment.

- Phase 3 – Obtain additional capability and redundancy from off-site equipment and resources until power, water, and coolant injection systems are restored.

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

The 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 Clinton Power Station. Though specific strategies have been developed, due to the inability to anticipate all possible scenarios, the strategies are also diverse and flexible to encompass a wide range of possible conditions. These pre-planned strategies developed to protect the public health and safety are incorporated into the Clinton Power Station emergency operating procedures in accordance with established EOP change processes, and their impact to the design basis capabilities of the unit evaluated under 10 CFR 50.59.

Before discussing the strategies that provide coping capability for reactor core cooling, containment integrity, and spent fuel pool cooling, a discussion of the fundamental strategies for restoring a source of AC power and a source of cooling water is provided below.

3.1 Electrical Strategies

3.1.1 480 VAC Power

The electrical support approach is an alternative to the conditions endorsed by the NRC in NEI 12-06 Revision 0. This is a robust design and will withstand the BDBEE hazards scoped in for Clinton Power Station.

The Clinton electrical strategy consists of the following components (Refer to Figure 1 FLEX Electrical Strategy):

- A permanent, seismically installed 500 KW diesel generator, with a N+1 portable generator in the FLEX Storage Building,
- A permanent, seismically installed electrical riser consisting of conduit and electrical connection boxes,
- Interconnecting cable stored on seismically mounted reels in permanent, seismically installed storage boxes. (Cable reels seismically mounted on Control Building 825' elevation are not in boxes due to size constraints. The purpose of the cabinets is to address fire loading in the associated areas, not for seismic protection. There are no hazards in the area surrounding the Control Building

825' elevation cable reels which would impact the cable reels in the event of a seismic event.),

- Permanent, seismically installed bus inserts in the 480 VAC substations that require power following a BDBEE.

Clinton has developed a primary and alternate strategy for supplying power to equipment required to provide core, containment, and spent fuel pool cooling using a combination of permanently installed, seismically robust components and cable reels stored in seismically robust cabinets (except Control Building 825' elevation as described above). The primary means uses Division 1 equipment and the alternate means uses Division 2 equipment. The alternate means also repowers the Division 1 DC Motor Control Center which supplies RCIC components using a separate seismically installed, safety-related battery charger; therefore both the primary and alternate means preserve RCIC for long term operation.

DC bus load shedding will ensure Division 1 battery life is extended to six (6) hours (Reference 9). DC load shed of all non-essential loads would begin when it is recognized that the station is in a Station Blackout (SBO) condition, and completed within sixty (60) minutes. The Clinton electrical strategy ensures that the Division 1 or safety-related swing battery charger is able to be energized prior to the batteries becoming exhausted.

In the Clinton electrical strategy, diversity is accomplished by providing a primary and alternate method to repower key equipment and instruments utilized in FLEX strategies. The electrical connection points in the Clinton strategy are the seismically installed bus inserts in the 480 VAC substations, and there are specific and separate inserts for the primary and alternate strategies. The electrical path from the FLEX generator to the primary or alternate connection points consists of a combination of seismically robust conduit and connection boxes (riser), and cables stored on reels in seismically robust storage boxes (except Control Building 825' elevation as described above). The location of the cable reels was chosen to facilitate cable deployment between the riser and the deployment destination.

The Clinton electrical strategy meets the requirements of the order. Clinton followed the guidance provided in NEI 12-06 to develop this alternate approach. This alternate approach uses newly installed components (diesel generator and electrical riser), a portable N+1 diesel generator and cables, and the installed electrical distribution system. This meets the order requirement to provide a three-phase approach for mitigating BDBEEs. The transition phase requires providing sufficient, portable, on-site equipment and consumables to maintain or restore these functions until they can be accomplished with resources brought from off-site. This is accomplished through use of the installed or portable diesel generator, the installed electrical riser, portable distribution cables and the installed electrical distribution system.

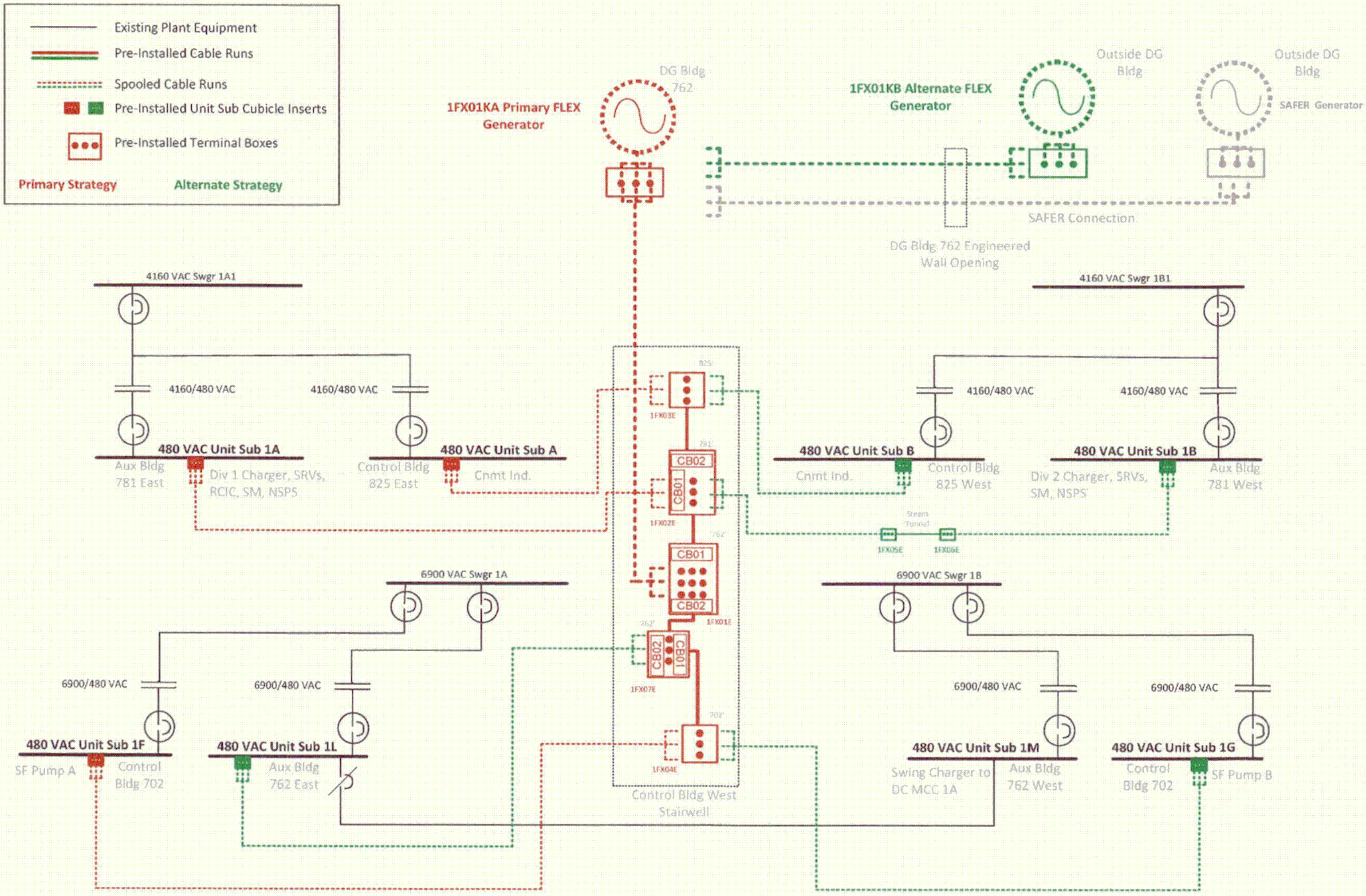

Figure 1 FLEX Electrical Strategy

3.1.2 DC Power

The Class 1E DC power system supplies 125 VDC power to unit Class 1E loads (Figure 2). The primary power sources are battery chargers. The system includes batteries, battery chargers, motor control centers, and DC distribution panels. The system is divided into four divisions, each with its own independent distribution network, battery, battery charger, and redundant load group. A safety-related swing battery charger is also part of the system that can be connected to the 125 VDC buses for supplying backup power during periods when the normal battery charger for the Division 1, 2 or 4 bus is being maintained. The RCIC system valves required for automatic and manual operation, one set of SRV solenoids, and an NSPS inverter are all supplied from the Division 1 Class 1E DC power system.

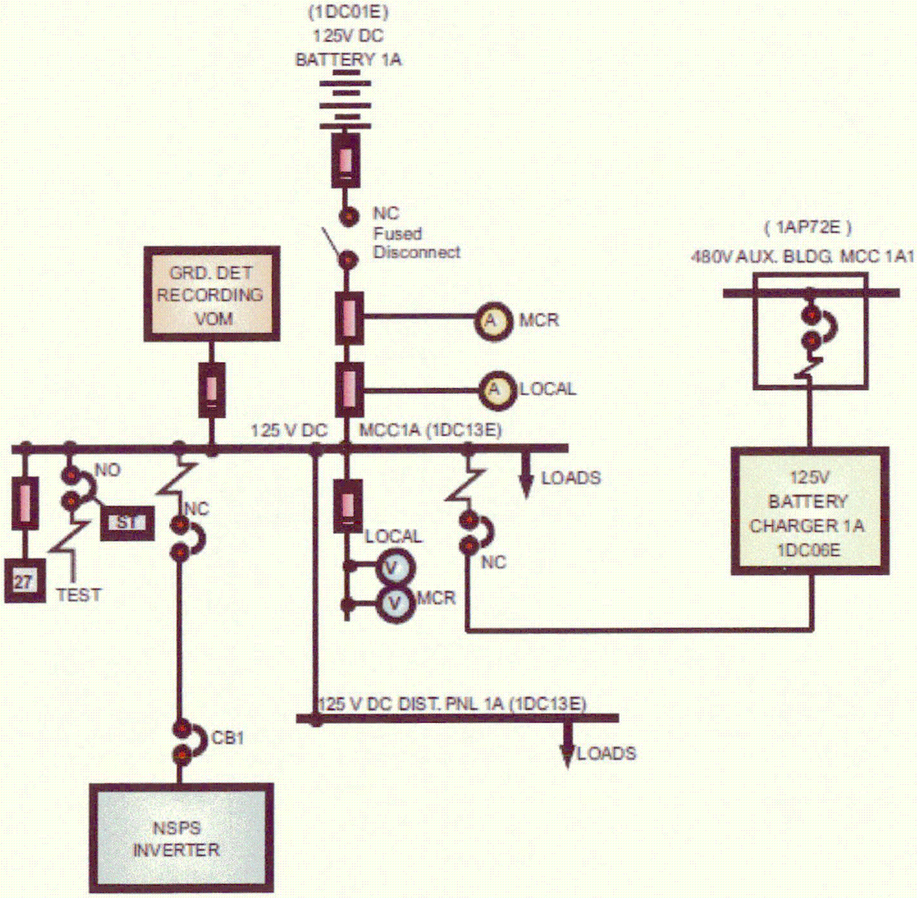

Figure 2 DC Power Supplies (Typical)

3.1.3 Nuclear System Protection System (NSPS) 120 VAC Power

The NSPS power supply system is designed to provide adequate uninterrupted power to all the NSPS loads during all modes of operation including abnormal and accident conditions. The purpose of the NSPS system as it applies to FLEX strategies is to supply power to the Analog Trip System (ATS), which in turn supplies power to instrument loops for determining key reactor and containment parameter values. These parameters can be read directly from Analog Trip Modules (ATMs) in the MCR. Additionally, the logic associated with SRV, ECCS, and RCIC operation is powered from NSPS.

The NSPS Distribution Panels are normally supplied from Class 1E Inverters supplied by the Class 1E DC systems (Figure 3). AC power can be automatically aligned to the distribution panels from an alternate AC source if an inverter failure is detected through a Solid State Transfer Switch (SSTS) inside the inverter cabinet. The SSTS can be manually bypassed to transfer the supply to the distribution panel to the alternate AC source. The NSPS distribution panels can also be powered directly from Class 1E AC power through a Maintenance Bypass Switch that bypasses the electronics associated with the Inverter and SSTS. The FLEX electrical strategy takes advantage of this built-in diversity by supplying power from the FLEX Generator to the busses that supply both the Inverter and the alternate source.

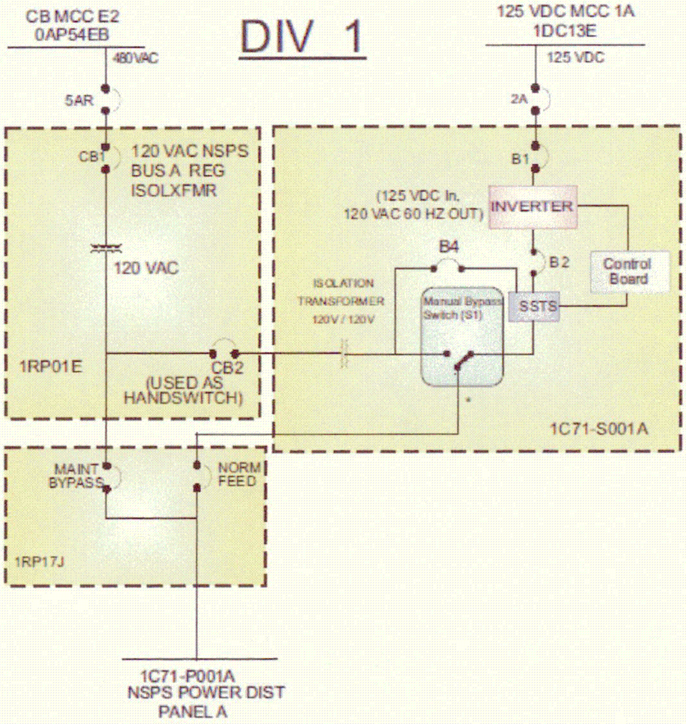

Figure 3 NSPS Power Supplies (Typical)

3.1.4 120/240 VAC Auxiliary Power

Clinton has staged four (4) portable power cart assemblies in strategic locations within the plant to provide a power supply for low voltage portable equipment. The power cart assemblies include a Motor Control Center (MCC) bucket insert that is pre-wired to the 480 VAC to 240/120 VAC transformer mounted on the cart. The MCC bucket insert can substitute for a spare or unneeded breaker in a MCC that is re-powered from the FLEX Generator, thus providing 120/240 VAC receptacles for equipment used in FLEX support strategies discussed in Section 4. Below are examples of the equipment requiring 120/240 VAC power:

- Portable fans
- Portable fuel transfer pump
- Submersible sump pumps
- Tripod lights
- Backup power to Spent Fuel Pool Level Indication
- Backup power to MCR satellite communications equipment

The power carts are staged in the vicinity of MCCs re-powered from the FLEX Generator. Extension cords are staged in FLEX tool boxes located near the equipment that requires 120/240 VAC power.

3.1.5 Electrical Analysis

Clinton has four (4) Class 1E station batteries in Divisions 1 through 4. Both the primary and alternate electrical strategies ensure the Division 1 battery charger is energized before the Division 1 battery coping time is exceeded. The Division 1 battery charger is the focus of both strategies because the RCIC controls and DC valves are powered from the Division 1 DC MCC, as well as the Division 1 SRV solenoids and Division 1 NSPS Inverter. The alternate strategy energizes the safety-related swing battery charger to supply the Division 1 DC bus, and also energizes the Division 2 battery charger providing redundant indication of key parameters from the Division 2 NSPS Inverter and power to the Division 2 SRV solenoids. Division 3 and 4 batteries provide some redundant indication of key parameters, but otherwise do not contribute the BDBEE response.

EC 391824 (Reference 9) performed a DC coping study for the Clinton Division 1 and 2 batteries under SBO conditions. The coping times established for Division 1 with the 60 minute SBO load shedding per Procedure 4200.01C002 (Reference 10) are 360 minutes with a 1.25 age factor, and 510 minutes with the age factor reduced to 1.00. The coping times for Division 2 with the 60 minute SBO load shedding per Procedure 4200.01C002 are 696 minutes with a 1.25 age factor, and 990 minutes with the age factor reduced to 1.00.

The strategy to sustain the station's safety-related DC bus requires the use of a 480 VAC diesel powered FLEX Generator to re-power the selected battery charger(s) via permanent connection points in the AC bus that supplies the battery charger. The circuit for supplying the bus connection points from the FLEX generator is described in section 3.1.1 and Figure 1 above.

The primary FLEX Generator is permanently installed in the seismic Category 1 Diesel Generator Building. The N+1 generator is trailer-mounted and stored in the FLEX Storage Building. Both are rated at 500 kW/625 kVA, 480 VAC, 3 phase, 60Hz, with integral 500 gallon fuel tank capable of supporting 14.5 hours of operation at full load. Per the FLEX diesel generator sizing calculation (Reference 11), the FLEX generator will be capable of supplying the loads required for either the primary (Division 1 loads) or the alternate (Division 2 loads plus the swing charger) strategy.

For FLEX Phase 3, the National SAFER Response Center (NSRC) will supply two (2) Turbine Marine 1.1 MW, 480 VAC, 3 phase 60 Hz generators. This NSRC equipment is a backup to on-site phase 2 equipment. NSRC generators come with the same style and size connectors as the on-site Phase 2 FLEX generators.

3.1.6 Impact of Elevated Temperature

The following is a discussion of the impact of loss of normal ventilation to the Division 1 and Division 2 Battery Rooms and NSPS Inverter Rooms.

3.1.6.1 Battery Rooms

The C&D type batteries used at Clinton for the Division 1 and 2 station battery systems have a robust design and extensive operating history. The qualification testing performed by C&D demonstrated excellent performance under elevated operating temperature environments. The testing results conservatively indicate that the battery cells will perform as required in excess of 200 days under the estimated 122°F operating temperature as identified in calculations VX-49 (Reference 12) and VX-50 (Reference 13).

The elevated temperature also has an impact by increasing the charging current required to maintain the float charging voltage set by the charger. The elevated charging current will in turn increase cell water loss through an increase in gassing. Based on guidance in EPRI TR-100248 (Reference 14), the electrolyte level will reach the top of the Division 1 battery cell plates in 56 days and the Division 2 battery cell plates in 45 days. Based on this, periodic water addition will be required or the float charging voltage reduced per the guidance contained in the C&D vendor manual. If battery cell plate uncovery were to occur, failure issues associated with plates being exposed would involve the potential development of sulfation and a subsequent reduction in capacity as discussed in IEEE-450 (Reference 15) and EPRI TR-100248 (Reference 14). Cell shorting due to plate exposure from accelerated water loss is not a credible concern.

Lastly, if loss or failure of a battery string were to occur, the battery charger has the capability to carry the anticipated loads indefinitely provided AC power remains available to support the charger.

3.1.6.2 NSPS Inverter Rooms

The temperature transient calculated in VX-50 (Reference 13) is bounding for both Division 1 and 2 NSPS Inverter Rooms and shown in Figure 4 below. Per the strategy assumed by this analysis, operators will open the Division 1 and 2 NSPS Inverter Room doors and power portable fans 8 hours after the occurrence of a BDBEE. The fans must have a 10,000 cfm or greater total capacity in order to maintain habitable conditions in the Division 1 and 2 NSPS Inverter Rooms, based on the results of this analysis. The fans draw air from the Unit 2 side of Control Building elevation 781' via staged flexible duct to ensure a sufficient reservoir of cool air.

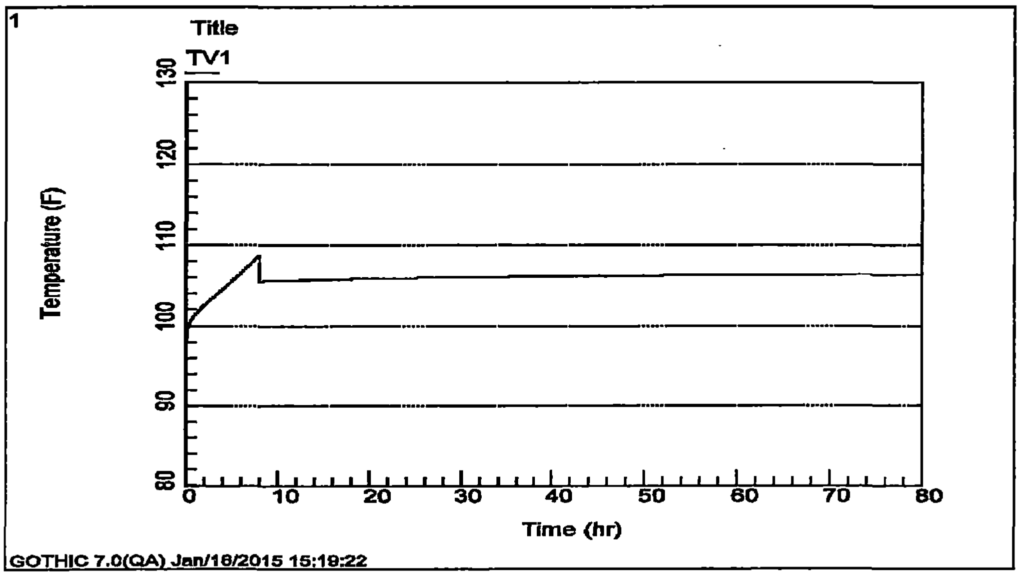

Figure 4 NSPS Inverter Room Temperature Transient

Should the NSPS inverter fail, continuity of power to the NSPS distribution panels is maintained, or could be readily restored. In section 3.1.3, two methods of supplying alternate AC power to the NSPS distribution panels was discussed and Figure 3 illustrates the diverse power supplies to the panels.

3.2 Ultimate Heat Sink Water Strategy

Water from the UHS used to accomplish the Phase 2 core cooling, containment heat removal, and SFP cooling strategies is supplied to the plant using a 3000 gpm diesel driven pump to supply a previously abandoned Unit 2 SX pump 30" supply line. The SX supply line is connected to a manifold in the FLEX Storage Building (FSB) with connection points for the FLEX pump. The SX supply line terminates at a manifold in the plant that distributes water to the various strategies (Figure 5). The Diesel Generator Building FLEX Manifold also includes a connection point for an external FLEX pump in the event of a flood that inundates the FLEX Storage Building (FSB) and the FLEX pump discharge manifold. In the unlikely event that the SX supply line is unavailable, Clinton will store sufficient hose (plus an additional length equal to the longest section) to connect the FLEX pump discharge to the Diesel Generator Building FLEX manifold. This hose and a portable manifold will be stored in a location protected from flooding and are currently stored in a sea-van located outside in an open area of the plant east of the station at the fire training area.

The FLEX pump is located in the FSB. The FSB is constructed on the foundation of the abandoned Unit 2 SX pump rooms at the Screen House. Access to the UHS is provided from within the FSB using either of two of the unused SX pump bays. Hauling of the FLEX pump from its storage location to its water source is not required in the Clinton strategy.

The use of the FLEX manifold is an alternate approach to meeting the order. This manifold is an alternative to the conditions endorsed by the NRC in NEI 12-06 Revision 0 (Reference 2). This is a robust design and will withstand the BDBEE hazards scoped in for Clinton Power Station.

The FLEX manifold is located on the 762' elevation of the Diesel Generator Building. According to the Clinton USAR Section 3.8 and Table 3.2-1, Rev 15, the Diesel Building is a Seismic Category 1 building and protected from tornadoes and missiles; thus the manifold is also projected from those external hazards. Additionally, the FLEX manifold will be protected from extreme cold and heat in the same manner as all other equipment located in the Diesel Generator Building. The Probable Maximum Flood (PMF) height for Clinton is 715' elevation; since the FLEX manifold piping taps in at approximately 726' level of the Diesel Generator Building and runs up to the 762' level (736' is site grade), the manifold is protected from flooding. The Diesel Generator Building FLEX manifold is reasonably protected from all applicable hazards and seismic protection is discussed below.

The Diesel Generator Building is a Seismic Category 1 structure as referenced in the Clinton USAR Rev 15; thus the building is considered robust in accordance with NEI 12-06. The location of the FLEX manifold is physically separated from non-seismically supported components that could potentially damage the manifold by seismic interaction. Calculation IP-M-0810, "Piping Analysis of FX Piping in the Diesel Generator Building," (Reference 16) analyzed pipe stresses, displacements, valve accelerations and support loads for the 12" FLEX branch line connecting the existing 30" Unit 2 SX piping to the manifold and the manifold itself. The following three cases were analyzed:

- a normal case with the system full of water (post event),
- an upset case (the Operational Basis Earthquake, piping empty), and
- the faulted case (Safe Shutdown Earthquake, piping empty).

The analysis found that the piping would survive all cases with the highest stress case using approximately 40% of its allowable stress. Also, the manifold is securely anchored to the concrete floor of the 762' level of the Diesel Generator Building and the analysis confirmed that all the supports would survive all seismic cases. Therefore, the FLEX manifold is reasonably protected from seismic hazards and is robust because the manifold won't be damaged by nearby non-seismically supported components. The manifold can withstand an SSE with margin and the manifold is anchored to the floor to prevent movement.

The Unit 2 SX supply line, 2SX02AB-30", has been analyzed to show there is reasonable assurance that the buried pipe will withstand design basis external events. Construction of the Unit 2 SX piping was completed in parallel with Unit 1 piping, but the pipe was abandoned in place when the decision was made to cancel Unit 2. Complete "N" stamping in support of this Unit 2 piping was not completed, lacking only the required ASME Section III pressure testing. The installation was done under the constructor's Safety Related program as evidenced by the Construction Travelers. Pipe 2SX02AB-30" was originally designated as ASME III, Class C, but was downgraded to "D" in 1985 based on the fact that the pipe was not going to be used. Piping design pressure is 200 psig. Since pipe 2SX02AB-30" has not been used for over 25 years, the integrity of the piping was validated by performing a pressure drop test by pressurizing the pipe with air to 120 psig (+/- 6 psig). A hold time of 10 minutes at this pressure was used to validate piping integrity. There was no pressure drop noted during the test. The analysis of the construction specification, installation travelers and the pressure drop test has shown that pipe 2SX02AB-30" meets the current plant design basis for the applicable external hazards and is considered robust per NEI 12-06.

Calculation IP-M-0815 (Reference 76) demonstrates that the manifold in the FLEX Storage Building is also designed to withstand an SSE with margin and the manifold is anchored to the floor to prevent movement.

Given that the FLEX manifold, including the Unit 2 SX supply line and manifold located in the FLEX Storage Building, is reasonably protected from all applicable external hazards, is seismically robust, only contains manual valves and has multiple flow paths downstream of the manifold, the FLEX manifold at Clinton will be available to support core, containment, and spent fuel pool cooling water following a BDBEE.

3.2.1 Hydraulic Analysis

The FLEX Pump is a Hale Model FP3000DJ-TCL diesel engine driven, trailer mounted 3000 gpm pump. The FLEX Pump is located in the FSB at the 701' elevation. The pump uses twin hydraulically driven submersible pumps for suction. The suction pumps are lowered by chain fall into the UHS from a portable gantry crane inside the FSB. The FLEX pump discharges through four (4) 6-inch discharge lines to a manifold inside the FSB connected to the Unit 2 SX supply line in a pipe tunnel below the FSB. The SX supply line terminates inside the Diesel Generator Building at the 762' elevation where the flow is distributed among the several strategies described later in this document.

The full hydraulic analysis is contained in IP-M-0809 Hydraulic Analysis for FLEX Pump Sizing (Reference 17). Below is a summary of the flow requirements per strategy:

Strategy	Flow	Basis
Suppression Pool Cooling	2000 gpm	CL-MISC-009 Case 18 (Reference 18)
RPV Makeup	300 gpm	NEDC 33771P Rev 1, Table 4.5.2-5 Required Vessel Inventory Makeup Rate vs Decay Heat (Reference 19)
Suppression Pool Makeup	100 gpm	CL-MISC-009 Case 18 bounding value to maintain Suppression Pool level band (Reference 18)
Spent Fuel Pool Makeup	100 gpm	USAR 9.1.3.3 bounding value for boil-off rate (Reference 20)
Spent Fuel Pool Spray	250 gpm	NEI 12-06 Rev 0 Table C-3 (Reference 2)

FLEX pump hydraulic analysis is provided in calculation IP-M-0809 (Reference 17). Rev. 1 documents that the FLEX pump will need a minimum of 330 ft of head at 3000 gpm to meet the flow requirements for the site FLEX strategy. As specified in TODI CPS-14-008, Rev. 2 (Reference 57), the pumps must provide 3000 gpm at a minimum of 343 ft of head, which is bounding for all flow scenarios analyzed in IP-M-0809.

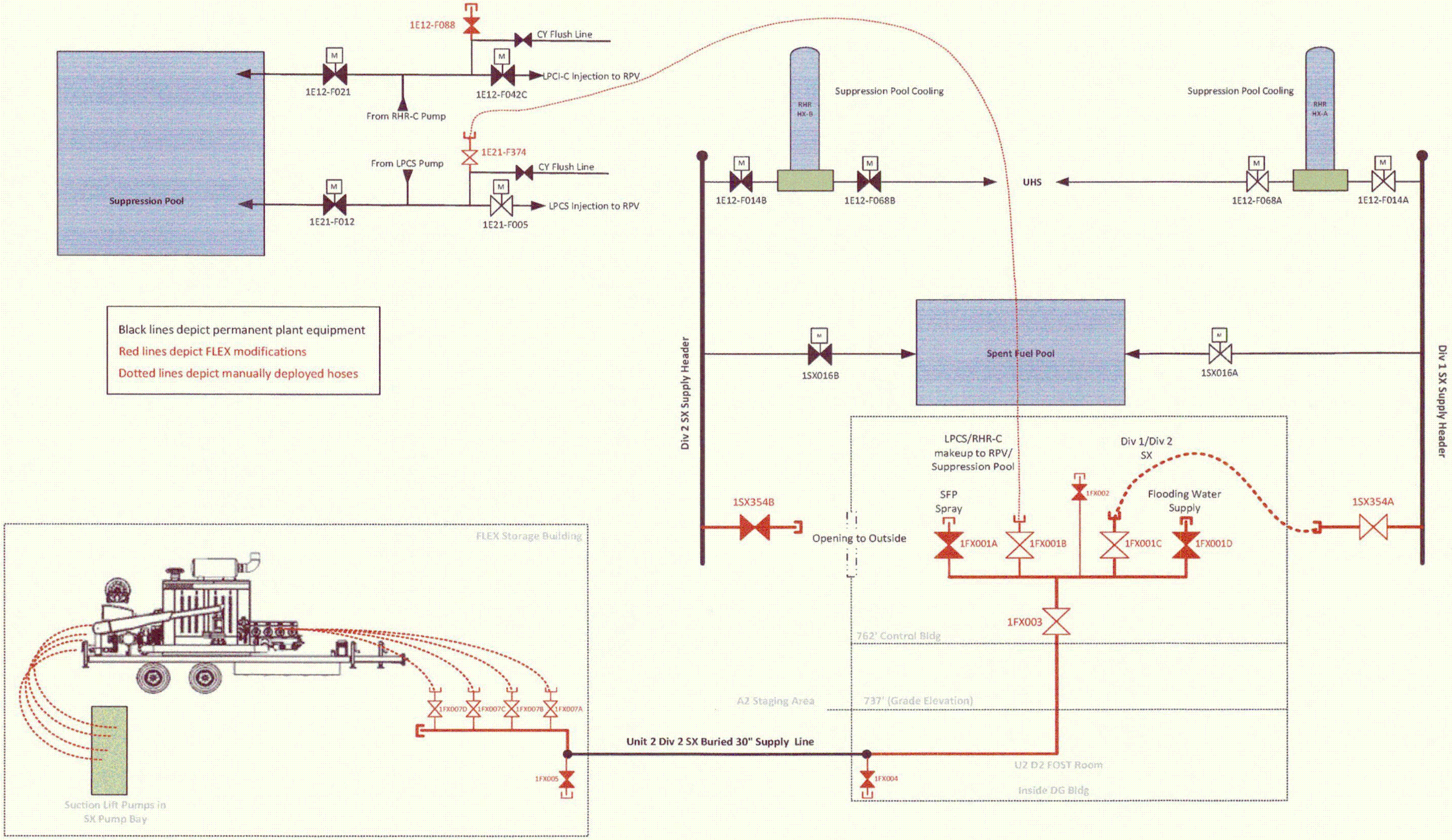

Figure 5 UHS Water Strategy

3.3 Reactor Core Cooling and Heat Removal

The FLEX strategy for reactor core cooling and decay heat removal is to run the RCIC system and provide makeup to the RPV for as long as decay heat can support RCIC operation. The RCIC injection source will be maintained for as long as possible, since it is a closed loop system using relatively clean suppression pool water.

The containment integrity section of this plan will discuss a suppression cooling lineup that provides a low pressure RPV makeup path from the suppression pool that will obviate the need to provide makeup from the UHS. However, low pressure RPV makeup from the UHS provided by the FLEX Pump will be available by t_0 + 6 hours to ensure that reactor water level will remain above the Top of Active Fuel (TAF).

3.3.1 Phase 1 Strategy

3.3.1.1 Power Operation, Startup, and Hot Shutdown

At t_0 in a Station Blackout (SBO) event the reactor will scram on a load reject signal. Following a reactor scram, steam generation will continue at a reduced rate due to core fission product decay heat. In the event the reactor vessel is isolated, and the feedwater supply unavailable, Safety Relief Valves (SRVs) will operate automatically to maintain reactor vessel pressure within desired limits. The water level in the reactor vessel will drop due to continued steam generation by decay heat. Upon reaching Reactor Vessel Water Level–Low Low, (Level 2) the RCIC System will be initiated automatically. RCIC can also be initiated manually from the Main Control Room or from the Remote Shutdown Panel.

After determination that installed emergency diesel generators cannot be restarted and off-site power cannot be restored for a period greater than the SBO coping time (4 hours), the operating crew determines the event is an ELAP. It is assumed that this determination is made less than one 1 hour into the event. Overall coping time for core cooling in Phase 1 is 6 hours.

Sixteen (16) SRVs are installed on the main steam lines inside the drywell. The valves can be actuated in two ways: 1) they will relieve pressure by a Nuclear System Protection System (NSPS) pressure transmitter and trip unit actuation with Class 1E DC power or 2) by mechanical actuation without power. The suppression pool provides a heat sink for steam relieved by these valves. SRV operation may be controlled manually from the control room to hold the desired reactor pressure. Each SRV can be actuated from one of two installed DC solenoid valves which open to supply pneumatic pressure to the valve operating piston.

Each SRV is provided with an air accumulator located in the drywell capable of providing for a total of thirty-seven (37) lifts without backup (Reference 28). Additionally, nine (9) of the SRVs are capable of being supplied with actuating air from Division 1 and Division 2 backup air bottles located in the Auxiliary Building. These bottles are sized to provide for an additional one-hundred (100) lifts per division (Reference 28). The backup air bottles can be lined up manually or remotely during Phase 2 after the FLEX generator has been placed in service. Since the number of SRV lifts that will be required during Phase 1, 2, and 3 is indeterminate, a strategy to provide an indefinite supply of air to the backup air bottles from the Division 1 or Division 2 Diesel Generator Air Starting Compressors was developed.

During Phase 1 reactor vessel makeup is provided from RCIC with suction from the suppression pool and reactor vessel pressure control is provided by the SRVs. Since these are loads on the Division 1 battery, shedding of non-essential loads on the battery is performed to extend the DC coping time to 6 hours.

A gradual cooldown of the reactor vessel will be performed with SRVs and reactor vessel pressure will be controlled between approximately 150 and 250 psig. RPV makeup will continue to be provided from RCIC until reactor vessel pressure requires a transition to Phase 2 methods.

3.3.1.2 Cold Shutdown and Refueling

The overall strategy for core cooling for Cold Shutdown and Refueling are, in general, similar to those for Power Operation, Startup, and Hot Shutdown.

If an ELAP occurs during Cold Shutdown, water in the reactor pressure vessel (RPV) will heat up. When temperature reaches 212°F the RPV will begin to pressurize. During the heat up, RCIC can be returned to service, or SRVs can be opened to prevent reactor heatup and re-pressurization. The primary strategies for Cold Shutdown are the same as those for Power Operation, Startup, and Hot Shutdown as discussed above for core cooling.

During Refueling, many variables impact the ability to cool the core. In the event of an ELAP during Refueling, there are no installed plant systems to provide makeup water to cool the core. Thus, the deployment of Phase 2 equipment will begin immediately. To accommodate the activities of RPV disassembly and refueling, water levels in the RPV and the reactor cavity are often changed. The most limiting condition is the case in which the reactor head is removed and water level in the RPV is at or below the reactor vessel flange. If an ELAP/LUHS occurs during this condition then (depending on the time after shutdown) boiling in the core may occur in a relatively short period of time.

Per NEI Shutdown/ Refueling Position Paper (Reference 21) endorsed by the NRC (Reference 22), pre-staging of FLEX equipment can be credited for some predictable hazards, but cannot be credited for all hazards per the guideline of NEI 12-06. Deployment of portable FLEX pumps to supply injection flow should commence immediately from the time of the event. This is possible because more personnel are on site during outages to provide the necessary resources. During outage conditions, sufficient area and haul paths should be maintained in order to ensure FLEX deployment capability is maintained.

3.3.2 Phase 2 Strategy

During Phase 2 high pressure RPV makeup is provided from RCIC and RPV pressure control is provided from RCIC and the SRVs. A pre-installed 480 VAC FLEX Generator will be lined up to the Division 1 AC distribution system to repower the Division 1 battery charger and enable the continued use of RCIC, SRVs, and vital instrumentation. Alternatively, the pre-installed generator can be lined up to a safety-related swing battery charger to energize the Division 1 DC bus for the same purpose.

To accomplish low pressure RPV makeup when RCIC is no longer available, two methods are available: (1) makeup to the RPV from the RHR loop performing suppression pool cooling using the Low Pressure Coolant Injection (LPCI) valve, (this method is described further in Section 3.4 Containment Integrity) and (2) makeup to the RPV using external water connections installed on the Low Pressure Core Spray (LPCS) and the Residual Heat Removal (RHR) C injection headers. Pre-staged hoses allow the connection from Diesel Generator Building FLEX Manifold to the injection header. The injection valves for these two systems are located outside the primary containment and can be operated manually with the handwheel or electrically via the FLEX generator. The water supply for the external LPCS and RHR C connections is described in Section 3.2 UHS Water Strategy.

RPV pressure will be further reduced with SRVs to achieve the flow rate necessary from the external water connection. The external connection is capable of meeting the decay heat boil-off rate at t_0 + 6 hours, plus the maximum allowable Technical Specification leakage and the pressure dependent system leakage from reactor recirc pump seals.

3.3.2.1 Preferred RPV Make Up

RCIC is the preferred RPV makeup system for as long as RCIC operation is viable. At Clinton the suppression pool peak temperature during the

ELAP/LUHS is 210°F, well below the temperature that challenges long-term RCIC operation. Additionally, the RCIC pump suction source will be swapped to the RHR heat exchanger outlet once suppression pool cooling begins. The outlet of the RHR heat exchanger is significantly cooler (≈138°F) and will ensure RCIC can provide RPV makeup for as long as decay heat can support its operation. Suppression Pool Cooling is described further in Section 3.4 Containment Integrity.

As part of the overall ELAP effort, the Boiling Water Reactor Owners Group (BWROG) had General Electric Hitachi (GEH) evaluate RCIC turbine and pump mechanical components assuming pump suction from the suppression pool at elevated temperatures (Reference 23). The evaluation concluded that except for the turbine journal bearings and the pump seal, the mechanical components would remain functional with a pool temperature up to 300°F and a seven (7) day mission time. In a separate document GEH concluded that there is no expectation of loss of functionality based on the babbitt material on the surface of the turbine journal bearings and the RCIC pump bearing with Suppression Pool (S/P) temperature below 215°F (Reference 24). The MAAP analysis (Reference 18) of the FLEX containment strategy shows a peak suppression pool temperature of 210°F when suppression pool cooling is started at t_0 + 8 hours.

The expanded RPV level control band of TAF to 101" in procedure EOP-1 RPV Control (Reference 25) encompasses a wide variety of circumstances, including ELAP. During an ELAP, RPV water level will normally be maintained between -30" and Level 8 (52") provided FLEX equipment is available and operates as expected. The primary phase 2 strategy discussed below is capable of providing makeup to the RPV before steam pressure to RCIC is lost, allowing for a controlled transition of RPV level control from RCIC to FLEX equipment.

When the RCIC system is no longer available, the preferred RPV makeup supply comes from the Suppression Pool Cooling lineup using a Suppression Pool Cleanup and Transfer (SF) Pump and the LPCI injection valve (Figure 6 RPV Makeup from SF Pump). This method is preferred since the suppression pool water is relatively clean. UHS water used to makeup to the suppression pool accounts for a small portion of the total volume of the suppression pool (Reference 18). Suppression Pool water quality is discussed further in section 9 Water Sources.

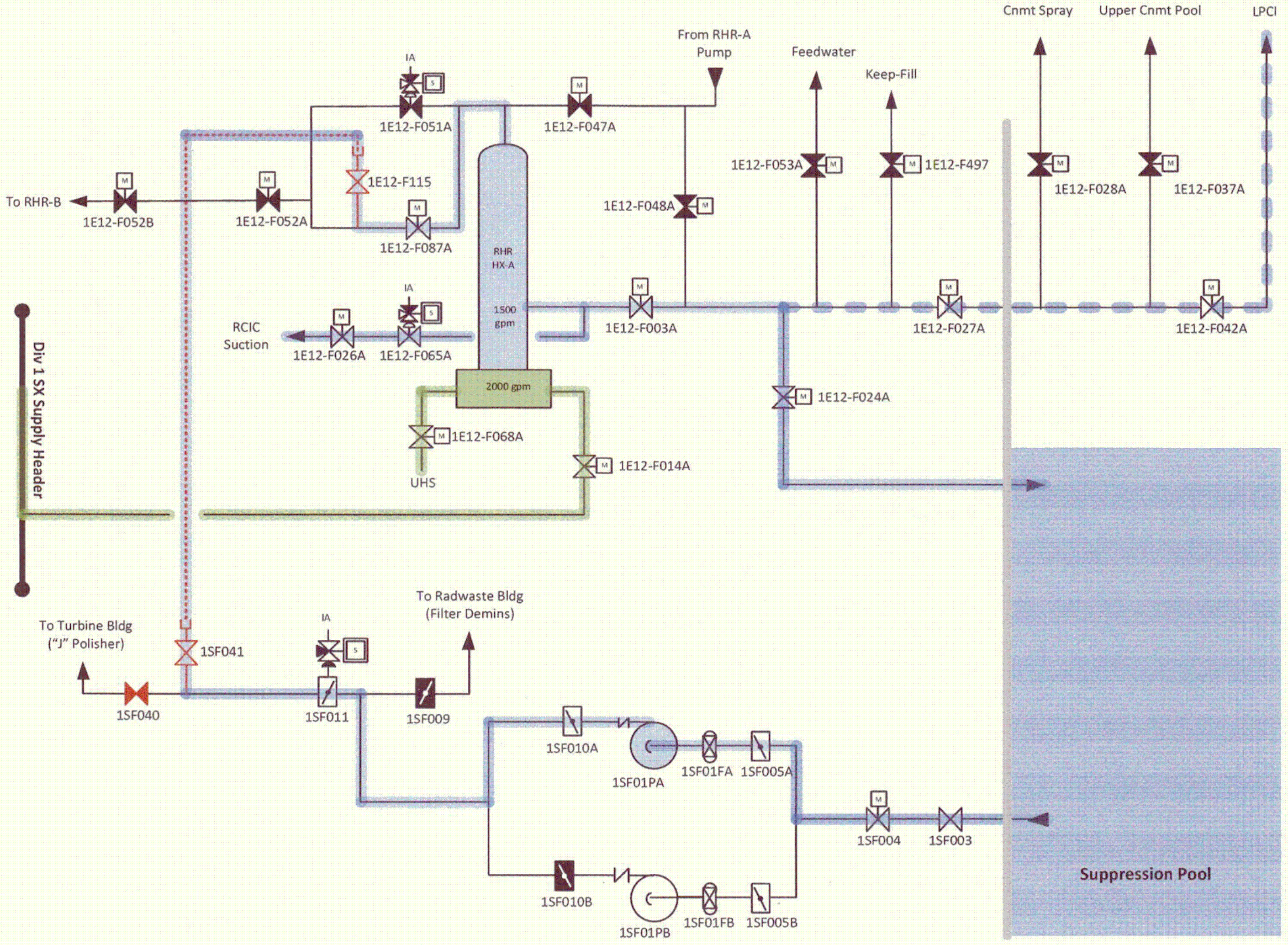

Figure 6 RPV Makeup from SF Pump

3.3.2.1 Alternate RPV Make Up

If RPV makeup from the UHS becomes necessary, external connections installed on the LPCS and RHR-C injection headers enable a hose connection from the Diesel Generator Building FLEX Manifold supplied from the FLEX pump. Hose reels on wheeled carts containing 100' lengths of 6" hose are staged in strategic locations to allow either of these connections to be used for RPV makeup. The Diesel Generator Building FLEX Manifold can supply the LPCS injection header or alternatively the RHR-C injection header, and water can be added as needed to the RPV using 1E21-F005 LPCS Injection Shutoff Valve or alternatively 1E12-F042C RHR Pump 1C LPCI Inj Spray Valve (Figure 5 UHS Water Strategy) These two valves are located outside the primary containment and can be operated manually with the handwheel or electrically via the FLEX generator.

3.3.3 Phase 3 Strategy

The Phase 3 strategy is to use the Phase 2 connections, both mechanical and electrical, but supply water using Phase 3 portable pumps and AC power using Phase 3 portable generators if necessary. The Phase 3 equipment will act as backup or redundant equipment to the Phase 2 portable equipment and is deployed from an off-site facility and delivered to Clinton Power Station. The off-site facility supplying this equipment is the National SAFER Response Center (NSRC) through executed contractual agreements with Pooled Equipment Inventory Company (PEICo). The NSRC will support initial portable FLEX equipment delivery to the site within 24 hours of a request for deployment per the Clinton SAFER Response Plan (Reference 26). The Clinton SAFER Response Plan defines the actions necessary to deliver pre-specified equipment to Clinton Power Station. Designated local staging areas have been selected to support deliveries of requested SAFER equipment from the NSRC to Clinton Power Station. Resources will be available, and sufficient, at the times required for Phase 3 implementation.

No plant modifications have been installed to support mitigating strategies for Phase 3. The connection of the majority of Phase 3 equipment can be made to connection points established for Phase 2 equipment and strategies. The remaining Phase 3 non-redundant equipment will be deployed as needed utilizing field established connections, without the reliance on plug and play type modifications. Other Phase 3 equipment that is not a backup or redundant to Phase 2 can be applied towards recovery efforts.

3.3.4 Systems, Structures, Components

3.3.4.1 Reactor Core Isolation Cooling

The Reactor Core Isolation Cooling System is designed to assure that sufficient reactor water inventory is maintained in the reactor vessel thus assuring continuity of core cooling. Reactor vessel water is maintained or supplemented by the RCIC during the following conditions:

(1) When the reactor vessel is isolated and yet maintained in the hot standby condition;

(2) When the reactor vessel is isolated and accompanied by a loss of normal coolant flow from the reactor feedwater system;

(3) When a complete plant shutdown under conditions of loss of normal feedwater system is started but before the reactor is depressurized to a level where the reactor shutdown cooling mode of the RHR system can be placed into operation.

When actuated, the RCIC system pumps water from either the RCIC storage tank or the suppression pool to the reactor vessel. Once the FLEX suppression pool cooling strategy has been lined up, the RCIC pump can take suction from the RHR heat exchanger using previously abandoned piping intended for the Steam Condensing Mode of RHR. This strategy is described further in the Containment Integrity Phase 2 discussion (Section 3.4.2).

The RCIC system includes one turbine-driven pump, one gland seal system DC powered air compressor, automatic valves, control devices for this equipment, and sensors and logic circuitry.

The RCIC logic is powered by the 125 VDC Division 1 system, except the inboard isolation valves logic which is powered by the 125 VDC Division 2 system. Motive power for inboard isolation valves is by Division 2 standby AC power, while outboard isolation valves are driven by Division 1 standby AC power. The AC driven containment isolation valves are normally open and are expected to remain open following the onset of the ELAP/LUHS. The remaining valves are driven by the Division 1 DC system.

The RCIC pump takes suction directly from the suppression pool. To prevent foreign objects in the suppression pool from entering the RCIC flow path, a strainer is located on the RCIC and ECCS pump suction lines in the suppression pool. The design of the strainer precludes the entrance of foreign materials greater than 3/32 inch diameter into the RCIC flow path (Reference 27).

3.3.4.2 Batteries

The safety related 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 required for monitoring RPV level and RCIC operation. Within 60 minutes of ELAP/LUHS event onset, load shedding of non-essential equipment provides an estimated total service time of approximately 6 hours of operation.

3.3.5 Key Reactor Parameters

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

- Wide Range RPV Level: Division 1 ATMs 1B21-N691A and 1B21-N691E
- RPV Pressure: Division 1 ATMs 1B21-N697A, 1B21-N697E, 1B21-N678A (wide range)

The above instrumentation is available prior to and after DC load shedding of the DC busses during SBO/ELAP response procedure implementation for up to 6 hours. Availability after 6 hours is dependent on actions to restore AC power to the Division 1 Battery Charger (Primary) or the safety-related swing battery charger (Alternate).

In the unlikely event that battery chargers or alternate methods of repowering NSPS is damaged and non-functional rendering key parameter instrumentation unavailable, alternate methods for obtaining the critical parameters locally is provided in FLEX Support Guide 4303.01P015 Alternate Methods For Obtaining Essential Parameter Values (Reference 66).

3.3.6 Thermal Hydraulic Analysis

MAAP4 computer code was used to simulate the Extended Loss of AC Power (ELAP) event for Clinton and is an acceptable method for establishing a timeline which meets the intent of NRC Order EA-12-049 (Reference 1). The graph in Figure 7 below uses data from the MAAP case of record (Case 18) (Reference 18) and illustrates that RPV level remains above top-of-active-fuel (TAF) using RCIC for RPV makeup during the first eight hours of the event, and that RPV level is stabilized with RPV pressure in the 150 – 250 psig pressure band.

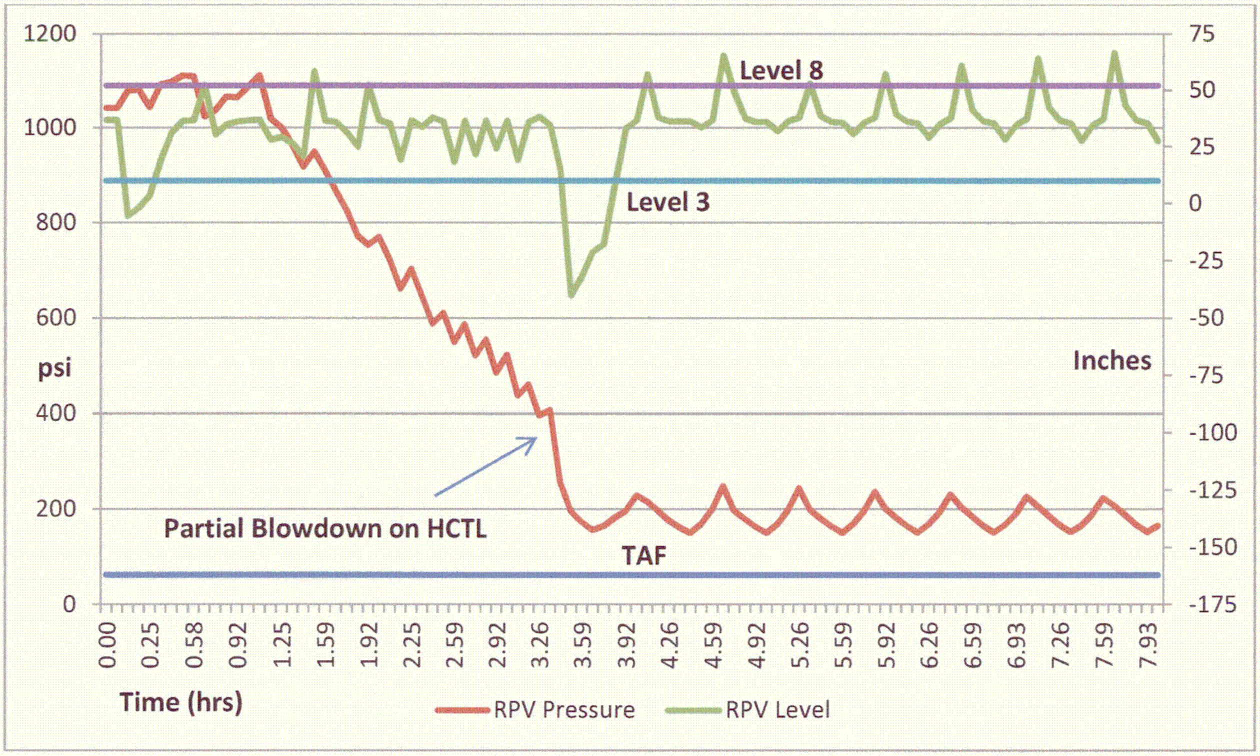

Figure 7 RPV Level and Pressure – First 8 Hours

3.3.7 Reactor Coolant System Leakage

A reactor coolant system leakage rate of 100 gpm was assumed in the ELAP MAAP analysis. This leakage rate is consistent with the analysis documented in Calc EPU-T0903 Rev 0 (Reference 28). The leakage rate includes 30 gpm for primary system leakage and 36 gpm for reactor recirculation pump leakage. This is consistent with existing Clinton SBO licensing bases and conservative relative to NUMARC 87-00 Rev 1 requirements (Reference 29).

3.4 Containment Integrity

During an ELAP suppression pool temperature rises as the SRVs relieve RPV pressure to the suppression pool and operators conduct a forced cooldown with SRVs. RCIC will be used for RPV level control and the turbine exhaust also adds heat to the pool. As suppression pool temperature rises, wetwell temperature and containment pressure rise in kind. A strategy to transfer heat from the suppression pool to the UHS prevents the heat addition from challenging containment design pressure and controls containment and suppression pool temperature at values that do not challenge primary containment integrity.

Additionally, NEI 12-06 specifies in Table C-2 a performance attribute for plants with a Mark III type containment the ability to re-power hydrogen igniters. The Hydrogen Igniter System (HIS) is designed to ignite hydrogen in the unlikely occurrence of a degraded core event which results in the generation of excessive quantities of hydrogen from a large metal-water reaction in the reactor pressure vessel. The HIS is designed to burn hydrogen at low concentrations, thereby maintaining the concentration of hydrogen below that, if ignited, could lead to containment overpressurization failure.

3.4.1 Phase 1

During Phase 1, containment integrity is maintained by normal design features of the containment, such as the containment isolation valves. In accordance with NEI 12-06, the containment isolation actions delineated in the SBO procedure are sufficient.

RPV pressure will be gradually reduced with SRVs to approximately 150 psig while the suppression pool has sufficient heat capacity to absorb a portion of the sensible heat in the reactor. RPV pressure will be controlled between 150 – 250 psig. Decay heat will continue to heatup the suppression pool during the initial phase through RCIC exhaust and SRV operation. The water in the upper containment pool is dumped to the suppression pool once a FLEX generator has been lined up to the 480 VAC distribution system and power is available to the upper pool dump valves. This is a Phase 2 action relying on FLEX equipment, expected to occur at $t_0 + 6$ hours.

Suppression Pool Level and Containment Pressure instruments remain available during Phase 1 since they are powered from Division 1 NSPS. Suppression Pool Temperature is manually obtained using procedure 4200.01C003 Monitoring Cnmt Temperatures During a SBO (Reference 30).

Containment heat removal and hydrogen igniter operation are not possible during Phase 1 since they both rely on the availability of 480 VAC power. This requirement is met in Phase 2.

3.4.2 Phase 2

During Phase 2, the installed 480 VAC FLEX generator will be lined up to the Division 1, or alternatively Division 2 AC distribution to repower 1SM001A and 1SM002A, or alternatively 1SM001B and 1SM002B Supp Pool Dump Valves. The added inventory from the upper pools will extend the time before suppression pool cooling is required to avoid significant containment pressurization. To accomplish suppression pool cooling a 480 VAC Suppression Pool Cleanup and Transfer (SF) pump supplied by the FLEX generator is lined up to circulate suppression pool water through the shell side of an RHR heat exchanger using modified RHR Steam Condensing Mode Piping. Water from the Diesel Generator Building FLEX Manifold supplies the heat exchanger tube side that is normally supplied from the Shutdown Service Water (SX) system. The Division 1 and Division 2 SX system supply headers were modified to allow a limited restoration of either of the SX subsystems from the Diesel Generator Building FLEX Manifold.

For diversity, either RHR heat exchanger can be used for the suppression pool cooling strategy. The one chosen will depend on the SX division supplied from the Diesel Generator Building FLEX Manifold and the electrical division aligned to the FLEX generator. This strategy will provide an unlimited coping period for the containment.

Suppression pool water addition is required to maintain RCIC pump NPSH and provide additional pressure suppression volume. The suppression pool level band specified in EOP-6 Primary Containment Control (Reference 32) allows the operators to maintain level in the range established when upper containment pool water was added to the suppression pool. The Diesel Generator Building FLEX Manifold can supply the LPCS injection header or alternatively the RHR-C injection header, and water can be added as needed to the suppression pool using 1E21-F012 LPCS Test Return To Sup Pool Valve or 1E12-F021 RHR C Test Valve To Suppr Pool. These two valves are located outside the primary containment and can be operated manually with the handwheel or electrically via the FLEX generator.

The installed FLEX generator can also repower the Division 1, or alternatively the Division 2, hydrogen igniter distribution panel from Aux Building MCC 1A1, or alternatively Aux Building MCC 1B1, to allow igniter operation as prescribed by EOP-6 Primary Containment Control.

3.4.3 Phase 3

The Phase 3 strategy is to use the Phase 2 connections, both mechanical and electrical, but supply water using Phase 3 portable pumps and AC power using Phase 3 portable generators if necessary. The Phase 3 equipment will act as backup or redundant equipment to the Phase 2 portable equipment and is deployed from an off-site facility and delivered to Clinton Power Station. The off-site facility supplying this equipment is the National SAFER Response Center (NSRC) through executed contractual agreements with Pooled Equipment Inventory Company (PEICo). The NSRC will support initial portable FLEX equipment delivery to the site within 24 hours of a request for deployment per the Clinton SAFER Response Plan (Reference 26). The Clinton SAFER Response Plan defines the actions necessary to deliver pre-specified equipment to Clinton Power Station. Designated local staging areas have been selected to support deliveries of requested SAFER equipment from the NSRC to Clinton Power Station. Resources will be available, and sufficient, at the times required for Phase 3 implementation.

No plant modifications have been installed to support mitigating strategies for Phase 3. The connection of the majority of Phase 3 equipment can be made to connection points established for Phase 2 equipment and strategies. The remaining Phase 3 non-redundant equipment will be deployed as needed utilizing field established connections, without the reliance on plug and play type modifications. Other Phase 3 equipment that is not a backup or redundant to Phase 2 can be applied towards recovery efforts.

3.4.4 Systems, Structures, and Components

3.4.4.1 Containment Cooling System

The containment heat removal system, consisting of the containment spray system and suppression pool cooling system, is an integral part of the RHR system. The system includes a heat exchanger to prevent excessive containment temperatures and pressures thus maintaining containment integrity following a LOCA. To fulfill this purpose, the containment cooling system meets the following safety design bases:

- The system limits the long-term bulk temperature of the suppression pool to 185°F without spray operation when considering the energy additions to the containment following a LOCA.
- The single failure criteria apply to the system.
- The system is designed to safety grade requirements including the capability to perform its function following a loss-of-coolant accident.
- The system is operable during those environmental conditions imposed by the LOCA.
- The containment heat removal system is designed to Seismic Category I requirements. System components, as appropriate, are designed to meet ASME Code Section III, Class 2 requirements.
- The ECCS/RCIC suction strainer is sized to prevent passage of particles over 3/32 inch in diameter which could cause malfunction of the containment heat removal system equipment or plug the containment spray nozzles.

The RHR heat exchangers are vertically mounted shell-and-U-tube with SX passing through the tubes. The heat exchangers are located in separate rooms in the Auxiliary Building on elevations 707 ft, 6 in. up to approximately 781 ft, 0 in. The heat exchangers support the Shutdown Cooling, Suppression Pool Cooling, and Containment Spray modes of RHR.

3.4.4.2 Suppression Pool Cleanup and Transfer System (SF)

The primary purpose of the SF system is to remove radioactive contaminants, including iodine, from the containment suppression pool water and to maintain the suppression pool water quality to meet plant operation requirements.

There are two modes of operation for the suppression pool cleanup system, and they are defined by the flow path of the water to be cleaned. Since leakage through the safety/relief valves during normal operation causes radioactive iodine to accumulate in the suppression pool, the system is operated to minimize personnel exposure during containment access. This may be done continuously or on an "as required" basis to maintain airborne radioiodine in the containment below the Derived Air Concentration (DAC). A non-safety related plate heat exchanger, cooled by the WO system, may be placed in service in parallel with the deminerializers to cool the suppression pool.

During normal operation, either of the two suppression pool cleanup transfer pumps takes suction from the suppression pool, transferring pool water through the SF system piping and then to the inlet of the fuel pool cooling and cleanup filter-demineralizers. The fuel pool cooling and cleanup filter-demineralizers remove iodine and other impurities from the water. The processed water is then returned to the suppression pool.

The design-basis transient for the SF system is an MSIV isolation event at power. Following a SRV blowdown, both transfer pumps may be operated to process suppression pool water through the fuel pool cooling and cleanup filter-demineralizers.

Four filter-demineralizers are installed, one of which will normally be in use in the Fuel Pool Cooling and Cleanup (FC) system. Therefore, three filter-demineralizers are available for suppression pool cleanup. This condition allows suppression pool water to be processed at a maximum flow rate of 3000 gpm.

When the maximum suppression pool cleanup flow rate is desired or when the fuel pool cleanup system is unavailable for suppression pool cleanup, the condensate cleanup system may be used. Both transfer pumps operate to process 3500 gpm through one condensate demineralizer vessel and back to the suppression pool. Connections are made to only one condensate polisher to reduce the possibility of mixing suppression pool water with the condensate feedwater.

The SF system may be used to transfer water from the suppression pool to the upper containment pool in Mode 5. Water is transferred through the SF system piping to the "J" Condensate Polisher. After passing through the polisher, it can be valved into the condensate system to be transferred to the upper containment pool via the condensate feedwater systems and reactor vessel rather than returning to the suppression pool.

The piping used to interconnect SF with the "J" polisher was modified to enable the SF pumps to supply the RHR heat exchangers. The original plant design provided a means of supplying RCIC steam to the inlet of either RHR heat exchanger. A six inch tie-in point was added to the "J" polisher supply line, and to the RHR-A heat exchanger inlet piping, allowing either heat exchanger to be used for a FLEX Suppression Pool Cooling system. The SF pumps and piping were bolstered to meet seismic criteria and a manual valve was added to isolate the non-seismic downstream piping leading to the Turbine Building.

3.4.4.3 Hydrogen Ignition System (HIS)

Hydrogen generation due to a degraded core is possible only following extensive core uncovery. It requires the simultaneous occurrence of either a LOCA or a transient event, and the failure of emergency coolant supply to the core. For this situation hydrogen mitigation is accomplished by the Hydrogen Ignition System (HIS). This system is not an Engineered Safety Feature (ESF) system since the conditions requiring operation of this system are beyond the scope of a design basis accident.

Effective February 25, 1985, the NRC amended the hydrogen control requirements of 10 CFR 50.44 for all boiling water reactor facilities with Mark III type containments for which construction permits were issued prior to March 28, 1979. The revised rule requires the installation of a hydrogen control system capable of accommodating an amount of hydrogen equivalent to that generated from the reaction of 75% of the fuel cladding (surrounding the active fuel region) with water, without loss of containment integrity. The HIS is designed to accomplish this goal.

CPS participated in a hydrogen control owners group effort to develop and implement a hydrogen control program for Mark III containments. This group conducted analytical and testing activities to support the hydrogen control program development.

As a result of participation in this group, CPS now has an operational hydrogen control system based on the igniter systems developed and employed at the Grand Gulf, Sequoyah, McGuire, and D. C. Cook Nuclear Stations.

The HIS is designed to prevent the accumulation of hydrogen in concentrations that, if ignited, could lead to containment overpressurization failure. The operation of the RHR containment sprays during HIS operation will be based solely on containment temperature. The HIS is not required for events which result in the generation of hydrogen less than or equal to the amounts and release rates considered in the design of the Combustible Gas Control System as described in USAR Subsection 6.2.5.1 (Reference 67). It is intended, though, that the HIS be manually actuated for all event sequences which possess the potential to generate excessive amounts of hydrogen which can be communicated into the containment or drywell.

The HIS is designed to ignite hydrogen in the unlikely occurrence of a degraded core event which results in the generation of excessive quantities of hydrogen from a large metal-water reaction in the reactor pressure vessel. The HIS is designed to burn hydrogen at low concentrations, thereby maintaining the concentration of hydrogen below that, if ignited, could lead to containment overpressurization failure. The potential for significant pocketing of hydrogen will be precluded by:

- Utilization of distributed ignition sources; and
- Mixing caused by turbulence resulting from localized burns and the churning effect of the containment sprays.

The HIS is designed with suitable redundancy such that no single active component failure, including failure of power supplies, will prevent functioning of the system. The HIS is comprised of 115 igniter assemblies which are powered from two Class 1E power distribution panels. Each panel supplies a division of the igniter assemblies. The HIS is designed to operate for a minimum of 168 hours following initiation in an accident condition.

The igniter assemblies are fed by 120VAC, 60Hz power from two divisional Class 1E distribution panels. These distribution panels receive their power from Class 1E transformers rated 480V/120-208V, 60Hz, 3-phase with grounded neutral. Each transformer is fed from divisional Class 1E, 480V, MCC feeder breakers, which can be powered from one of the station standby diesel generators. These panels are re-powered by the FLEX electrical strategy.

Of the 115 igniter assemblies installed, 56 are powered from the Division 1 power panel and 59 from the Division 2 power panel. Furthermore, for each division, the igniter assemblies are connected through six circuits with each circuit comprised of two series connected breakers (for backup protection of electrical penetration) tied to a contactor. Five to twelve igniter assemblies are connected to each of these circuits. A control switch, one for each divisional group of igniter assemblies, is located in the control room to provide remote operation of the HIS. Power from each of the contactor circuits is brought into the containment through electrical penetrations to junction boxes where power is distributed to individual igniter assemblies.

3.4.5 Key Containment Parameters

The following instrumentation is available prior to and after DC load shedding of the DC busses during SBO/ELAP response procedure implementation for up to 6 hours. Availability after 6 hours is dependent on actions to restore AC power the Division 1 Battery Charger (Primary) or the safety-related swing battery charger (Alternate).

- Suppression Pool Temperature - Manually obtained using procedure 4200.01C003 Monitoring CNMT Temperatures During a SBO (Reference 30),
- Suppression Pool Level - 1E51-N636A and 1E51-N636E,
- Containment Pressure - 1E12-N662A and 1E12-N662C.

In the unlikely event that battery chargers or alternate methods of repowering NSPS is damaged and non-functional rendering key parameter instrumentation unavailable, alternate methods for obtaining the critical parameters locally is provided in FLEX Support Guide 4303.01P015 Alternate Methods For Obtaining Essential Parameter Values (Reference 66).

3.4.6 Thermal-Hydraulic Analyses

The MAAP4 computer code was used to simulate the Extended Loss of AC Power (ELAP) event for Clinton and is an acceptable method for establishing a timeline which meets the intent of NRC Order EA-12-049 (Reference 1). Several Clinton Modular Accident Analysis Program (MAAP) cases were run to analyze methods of containment heat removal, including containment venting, suppression pool feed and bleed, and suppression pool cooling using a FLEX strategy. The MAAP cases indicate an alternate suppression pool cooling method provides the fewest operational challenges while providing margin to the primary containment design pressure limit. UHS temperature was designated at 91.4°F in the suppression pool cooling cases.

The following time constraints were used as MAAP input parameters, or were identified in the FLEX suppression pool cooling MAAP Case 18 results:

- RPV pressure is reduced to a pressure band of 150-250 psig at a rate of 50°F/hr starting at t_0 + 1 hr.
- Suppression Pool Heat Capacity Temperature Limit (HCTL) is reached in t_0 + 3.4 hours. A partial Emergency Depressurization is performed per CPS 4402.01, EOP-6 PRIMARY CONTAINMENT CONTROL (Reference 32).
- Suppression Pool Makeup (SPMU) from the upper containment pool is designated to occur at t_0 + 5.5 hours when FLEX AC power is expected to be available to the SPMU valves in the containment.
- The suppression pool cooling lineup is designated to occur at t_0 + 8 hrs to provide the maximum time for establishing a suppression pool cooling lineup using a FLEX strategy, while maintaining acceptable containment parameter values. The service water tube side flow from the FLEX pump was designated at 2000 gpm, and the shell side suppression pool flow was designated at 1500 gpm. The peak suppression pool temperature in this case is 209°F, well below the acceptable suction temperature established in Exelon Position Paper EXC-WP-10 RCIC Operation at Elevated Temperatures Rev. 1 [Reference 33]. Peak containment pressure is 24.9 psia, compared to containment design pressure of 29.7 psia.
- Suppression pool makeup from the FLEX pump was designated to maintain level between the values of 23 ft. and 23 ft 9 in. The first injection of makeup occurs at t_0 + 6 hours.

The MAAP Case 18 results are summarized below and shown graphically in Figure 8 MAAP Containment Results.

Peak SP Temp (°F)	209
Peak Wetwell Airspace Temp (°F)	186
Peak Wetwell Airspace Press (psia)	24.9
SP Level (ft)	Min=19.4, Max=23.9
Peak Drywell Airspace Temp (°F)	254
Peak Drywell Airspace Press (psia)	29.2
Min RCIC NPSHA (ft)	38.7

3.4.7 Impact of Elevated Containment Temperatures

The Clinton MAAP scenario results indicate that at t_0 + 72 hours conditions in the drywell (i.e., pressures and temperatures) have either stabilized or are in a downward trend. Continued operation of suppression pool cooling (via the RHR heat exchanger and FLEX pump) after 72 hours combined with the relatively low decay heat in the reactor will prevent further rises in drywell pressures and temperatures. NUREG-2122 Glossary of Risk-Related Terms in Support of Risk-Informed Decisionmaking [Reference 34] defines a safe stable state as:

- Condition of the reactor in which the necessary safety functions are achieved.
- In a PRA, safe stable states are represented by success paths in modeling of accident sequences. A safe stable state implies that the plant conditions are controllable within the success criteria for maintenance of safety functions.
- The ASME/ANS PRA Standard (Reference 72) defines the term safe stable state as "*a plant condition, following an initiating event, in which reactor coolant system conditions are controllable at or near desired values.*"

Based on this description of a safe stable end state and the scenario conditions stated above, Cases 11-18 demonstrate a safe stable end state at t_{0+}72 hours.

3.4.7.1 Equipment Environmental Concerns

EC 401985 EQ Review of FLEX Components in the Containment and Drywell (Reference 35) was developed to show that the electrical equipment in containment will function in the high temperature environment for as long as it is needed to provide the FLEX function. Of special concern are the actuators for the SRVs and the RPV level instruments. The evaluation includes a discussion of the containment EQ profile and the expected containment conditions during an ELAP event for an indefinite duration.

For the purpose of evaluation, a review of equipment subjected to FLEX post BDBEE ambient conditions in the drywell and containment (i.e. wetwell) was performed to assess the functionality of the selected instruments/devices under elevated temperatures and pressures for an extended duration. The selected devices are those that FLEX strategies depend on to be functional after a BDBEE. These FLEX ambient conditions are, in some aspects, somewhat more severe than the Design Basis Accident (DBA) conditions that the equipment was originally qualified for. The current qualification of the equipment, under normal and DBA conditions, is analyzed and supported in a number of equipment specific EQ reports. For purposes of this evaluation, these EQ reports were reviewed to determine the actual testing/analyses performed on the equipment adequately establishes the capabilities of the equipment to perform under a somewhat more severe FLEX conditions. The specific equipment items of concern to FLEX strategies were reviewed, also, additional equipment in the circuit path out to the containment penetrations were also reviewed, as their functionality supports the specific equipment of interest.

- Main Steam Safety Relief Valve (SRV) solenoids located in the drywell
- Safety Relief Valves located in the drywell
- Rosemount Transmitters located in the located in the containment (i.e. wetwell area)
- Weed temperature instruments located in the containment
- Hydrogen Igniters located in the containment and drywell

As the function of these devices depend on other supporting items in the circuit path, the following additional items were also evaluated:

- Conax electric conductor seal assemblies (ECSAs)
- Raychem cable splice kits
- Conax containment penetrations
- Okonite low voltage power cables
- Okonite instrument cables

The review of the EQ reports showed that the equipment meets the required DBA conditions, but also have shown capabilities, either through testing or analysis, that exceed those conditions and can be expected to perform their required functions under post beyond design basis conditions for an extended period of time.

3.4.7.2 Suppression Pool Temperature Concerns

The MAAP analysis discussed above indicate a peak suppression pool water temperature that exceeds the 185°F design temperature. EC 401925 Suppression Pool Liner Evaluation for Elevated Suppression Pool Temperatures during an Extended Loss of AC Power (Reference 36) was developed to confirm the elevated suppression pool temperature does not compromise primary containment integrity. The primary concern is the impact on the Suppression Pool liner at this elevated temperature (potential for buckling and excessive stress and strain). Other components in the Suppression Pool that would be impacted by the BDBEE maximum temperature are the SRV quenchers, the ECCS suction strainer, and ECCS suction piping from the strainer.

Suppression Pool Liner

The Suppression Pool liner consists of SA240, Type 304 stainless steel plates, ¼" thick, welded together and anchored to the concrete containment. The liner provides leak tight integrity for potentially contaminated water and is not used as a strength element for the containment structure. Liner stresses and strains have been evaluated at 185°F and are acceptable.

The Containment Fuel Pool (828' Containment Building) and the Spent Fuel Pool (755' Fuel Building) are other pools at Clinton that are also designed to provide leak tight integrity for potentially contaminated water. The design of these pools is the same as the Suppression Pool and use the same material (SA240, Type 304 stainless steel plates, ¼" thick, welded together).

As a part of a Spent Fuel Pool re-rack project in 2004, a liner buckling analysis for the Spent Fuel Pool Liner was performed (Reference 36). This analysis developed a finite element model using the ANSYS computer code. An extremely conservative water temperature of 252°F was used as an input for the thermal load. Another conservative assumption used in this analysis was that the hydrostatic pressure used for the Spent Fuel Pool was based on half of the actual Spent Fuel Pool depth (normal Spent Fuel Pool depth is 42', so hydrostatic pressure used was based on a depth of 21'). From this analysis, the Spent Fuel Pool liner plate does not buckle due to differential thermal expansion and the maximum calculated stress and strain in the liner plate are within allowable limits, even with these conservative assumptions.

Since the Spent Fuel Pool and the Suppression Pool are designed in the same manner, the analysis for the Spent Fuel Pool noted above can also be applied to the Suppression Pool. The Suppression Pool depth during the BDBEE will be ≈23'. This is comparable to the depth used for the Spent Fuel Pool analysis. The maximum temperature reached during the BDBEE is 210°F which is less than the 252°F used in the Spent Fuel Pool analysis. Thus it can be concluded that the Suppression Pool liner plate will not buckle and the stress and strain will be within allowable limits at the maximum temperature of 210°F following a BDBEE.

SRV quenchers

The SRV quenchers are submerged in the suppression pool to condense steam released from the reactor vessel via the SRVs. The piping and quenchers are designed for high pressure/high temperature steam conditions and thus are not impacted by the suppression pool temperature at 210°F.

A local suppression pool temperature limit for SRV discharge is not required to be evaluated since the SRV quencher is an X-quencher device and the ECCS suction strainer is located below the quencher elevation based on NRC SE evaluation for GE Topical Reports NEDO-30832, Elimination of Limit on BWR Suppression Pool Temperature for SRV Discharge with Quenchers (Reference 59), and NEDO-31695, BWR Suppression Pool Temperature Technical Specification Limits, dated August 29, 1994 (Reference 60).

ECCS Suction Strainer

The ECCS suction strainer consists of segments that are bolted together to form a 360° ring in the suppression pool. It is made of Type 304 stainless steel and sits on the suppression pool floor. Radial supports are provided to accommodate loads and thermal expansion. To ensure system function, the strainer is designed with sufficient strainer surface to provide for very low fluid approach velocities (≈0.02 fps). This will minimize head loss due to any postulated debris loading conditions.

The strainer is designed for 200°F per Design Specification K-2888B, Specification for ECCS Suction Strainer (Reference 61). The radial restraints tend to prevent outward expansion of the strainer ring, thereby producing stress in the strainer structure as it thermally expands when the suppression pool temperature is increased to 200°F. To alleviate these stresses, the strainer segments are connected together with flexible connections using Belleville springs that accommodate the thermal growth of the strainer. Based on review of the strainer structural analysis, the resulting loads on the strainer segments due to an additional 10°F for suppression pool temperature would not have an adverse impact.

RCIC Suction Piping

The RCIC suction piping design temperature is 170°F. EC Evaluation 401924 (Reference 62) evaluated the impact on this suction piping for 210° F water. This evaluation concluded that the RCIC suction piping and supports can withstand the additional thermal loading due to 210°F suppression pool temperature.

Suppression Pool Temperature Monitoring

RTDs in the suppression pool are used to monitor temperature. These temperature elements were qualified to the more severe drywell temperature profiles under normal and design basis accident conditions. Thus these elements will not be adversely affected by the elevated suppression pool temperature per EC Evaluation 401985 (Reference 35).

Other

Peak containment pressure of 9.9 psig in an ELAP event does not exceed the design pressure of 15 psig. Peak containment airspace temperature of 186°F in an ELAP event exceeds the design temperature of 185°F. Exceeding the containment airspace design temperature by one degree would have an insignificant impact on containment in an ELAP event. Peak drywell temperature of 254°F and pressure of 14.2 psig in an ELAP event do not exceed drywell design temperature of 330°F and pressure of 30 psig.

Conclusion

Even with an elevated temperature of 210°F following a BDBEE, the Suppression Pool liner will not buckle and the stress and strain will be within allowable limits based on review of comparable pool designs and the Spent Fuel Pool liner analysis. The other components in the Suppression Pool are not adversely impacted by the elevated temperature.

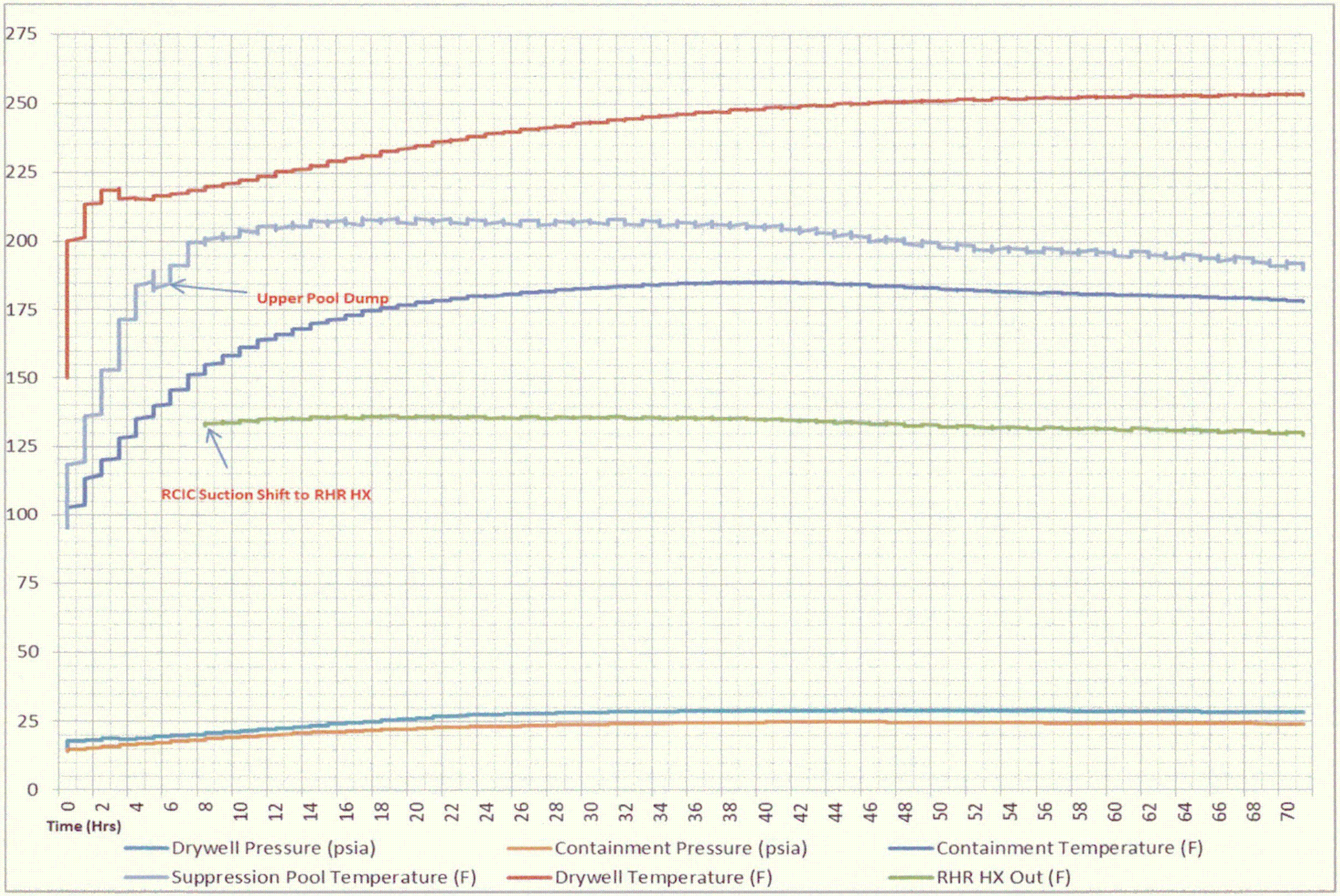

Figure 8 MAAP Containment Results

3.5 Spent Fuel Pool Cooling/Inventory

The Clinton Spent Fuel Pool (SFP) is a wet spent-fuel storage facility located on the in the Fuel Building inside the Secondary Containment. It provides specially designed underwater storage space for the reactor spent fuel assemblies which require shielding and cooling during storage and handling. Normal makeup water source to the SFP is from Cycled Condensate (CY) via the FC System. The basic FLEX strategy for maintaining SFP cooling is to monitor SFP level and provide makeup water to the SFP sufficient to maintain substantial radiation shielding for a person standing on the SFP operating deck and cooling for the spent fuel.

3.5.1 Phase 1 Strategy

There are no phase 1 actions required. The FLEX strategy during Phase 1 of an ELAP/LUHS event for SFP cooling is to utilize the SFP water level instrumentation installed in response to NRC Order EA-12-051 to monitor the SFP water level. Within the first 16 hours, stage a FLEX portable diesel driven pump for the addition of makeup water to the SFP as it is needed in order to restore and maintain the normal level in Phase 2.

3.5.2 Phase 2 Strategy

After the SFP reaches the boiling point a source of makeup water will need to be provided to ensure the fuel in the SFP remains cool and radiological conditions on the fuel handling floor do not degrade. The seismically qualified emergency SFP makeup supply from the SX system will be used to supply >86 gpm to the SFP. Motor operated valve 1SX016A and 1SX016B SSW to Fuel Pool Make-Up Vlv can be operated manually with the handwheel, or with AC power supplied from the FLEX Diesel Generator. The valve used will depend on which SX division the Diesel Generator Building FLEX Manifold is supplying.

Alternatively, a hose can be connected to the Diesel Generator Building FLEX Manifold and routed to the Fuel Building Fuel Handling Floor and restrained at the SFP handrail. If required, this hose can supply two monitor nozzles staged on the Fuel Handling Floor to provide the SFP with 250 gpm of spray. Two oscillating monitor nozzles are used to provide spray flow from opposite sides of the Spent Fuel Pool.

3.5.3 Phase 3 Strategy

Phase 3 Strategy is to continue with the Phase 2 methodologies using a FLEX Pump. Additional High Capacity Pumps will be available from the NSRC as a backup to the on-site FLEX Pumps.

3.5.4 Structures, Systems, and Components

The Fuel Pool Cooling and Cleanup (FC) System is designed to remove decay heat generated by the Spent Fuel Pool (SFP) assemblies from the spent fuel pool water. The FC System is also designed to clarify and purify the spent fuel pool, fuel transfer pool, and cask storage pool.

The SFP is designed for the underwater storage of spent fuel assemblies and control rods after their removal from the reactor. Maintaining an adequate water level in the SFP ensures the integrity of the spent fuel racks and decreases the radiation dose rate in the area around the pool.

3.5.5 Key SFP Parameters

The key parameter for the SFP Make-up strategy is the SFP water level. The SFP water level is monitored by the instrumentation that has been installed in response to Order EA-12-051, Reliable Spent Fuel Pool level Instrumentation (Reference 4) and complies with the industry guidance provided by the Nuclear Energy Institute guidance document NEI 12-02 (Reference 5). Prior to installing this system, SFP monitoring system was composed of level switches that provide a signal to an alarm in the MCR when the water level in the SFP reaches either the low- or low-low-level setpoint. The original instrumentation system did not meet the requirements set forth under NRC Order EA-12-051.

The modification installed two new Westinghouse Guided Wave Radar (GWR) wide-range level instrumentation systems for primary and backup indication of the SFP level. The system is composed of GWR level sensors, level transmitters and local electronics boxes that contain the level indication for the SFP. To ensure adequate channel separation, the level sensor for the primary channel is mounted in the northwest corner of the pool and the level sensor for the backup channel is mounted near the southeast side of the pool. The two sensors are separated by a distance of approximately 43½' which is a longer distance than the shorter dimension of the spent fuel pool specified by the NEI 12-02 guidance. The indication for the primary channel is located in the Auxiliary Building while the indication for the backup channel is located in the Control Building.

The normal power feed to the primary and backup channels will be provided from 120/208 VAC lighting panels 1LL24EB (RLC 124) and 1LL49EB (RLC 149) respectively. Upon a loss of power a battery and UPS will supply power for up to 72 hours. A male 120 VAC receptacle on the bottom of 1PL115JA and 1PL115JB provides a means of supplying the system from an external electrical source, such as a FLEX generator via a portable power cart.

The Spent Fuel Pool levels of interest are listed below. These are not setpoints, but instead are meant to correlate the indicated water levels to the amount of coverage of fuel assemblies in the pool.

- Level 1 - This is the level that is adequate to support operation of the normal fuel pool cooling system. At Clinton, this corresponds to water level at elevation 754' (approximately 27' 4 ¼" above the top of the fuel rack).
- Level 2 – This is the level that is adequate to provide substantial radiation shielding for a person standing on the spent fuel pool operating deck. Designation of this level should not be interpreted to imply that actions to initiate water make-up should be delayed until SFP water levels have reached or are lower than this point. At Clinton, this corresponds to water level at elevation 737.31' (approximately 10.56' above the top of the fuel rack).
- Level 3 – This is the level where fuel remains covered and actions to implement make-up water addition should no longer be deferred. Designation of this level should not be interpreted to imply that actions to initiate water make-up should be delayed until this level is reached. At Clinton, this corresponds to water level at elevation 727.31' (elevation 726'-7-3/4" is at the top of the fuel rack).

At the bottom of the probe is a 4" long weight, the tip of which is positioned 5" above the fuel rack. Therefore, a deadband of 9" exists above the top of the fuel rack, which the probe does not measure.

3.5.6 Thermal-Hydraulic Analyses

Below is a description of the SFP and the decay heat loading for the pool, effects from loss of cooling are also included which indicate no operator action is required for 38.65 hours (time to boil off to the top of fuel racks) after loss of cooling using the Maximum Abnormal Heat Load (MAHL).

The CPS spent fuel pool has a capacity of 3796 fuel storage cells. On an as-needed basis the cask storage pool may be utilized for storage of up to 2 racks with 264 cells capacity which increases the pool total storage capacity to 4060 fuel assemblies. CPS is licensed to store 3,796 fuel assemblies in the spent fuel pool and an additional 363 in the fuel cask storage pool, as needed.

CPS UFSAR section 9.1.3.3.1 (Reference 37) discusses the peak fuel pool temperature for two decay heat load cases with the Fuel Pool Cooling and Cleanup System (FC) in service and also with a sudden loss of the FC system. The basis for the UFSAR discussion is contained in Calculation 01FC43 (Reference 73).

Case 1 Maximum Normal Heat Load (MNHL) - This normal batch discharge case conservatively assumes more fuel cells are occupied than available. The MNHL case assumes that the spent fuel pool and cask storage pool has a combined total of 4159 cells to store spent fuel bundles and 4056 cells have already been filled with spent fuel bundles from 13 previous 18 month long operating cycles. The normal batch discharge of 312 bundles with an average exposure of 43.0 GWd/MT is initiated 24 hours after reactor shutdown from a 24 month long operating cycle. So the spent fuel storage is conservatively overfilled after this batch discharge. The MNHL is calculated to be 27.7 million Btu/hr.

Case 2 Maximum Abnormal Heat Load (MAHL) - This full-core discharge case is an extension from the MNHL case after 24 months of full power operation from the last outage. This case assumes that a full-core discharge of 624 fuel bundles with an average exposure of 43.0 GWd/MT is initiated 24 hours after shutdown. The previous batch of 312 fuel bundles discharged in the spent fuel storage pool mentioned in Case 1 has just decayed for 24 months. So the spent fuel storage is conservatively overfilled after this full-core discharge. The MAHL is calculated to be 40.0 million Btu/hr.

The analysis of Case 1 shows that the spent fuel pool and cask storage pool bulk temperature will peak at 125.8°F if the batch discharge of 312 bundles is initiated 24 hours after reactor shutdown with one train of FC in operation. The highest evaporation heat loss rate reaches 0.4 million Btu/hr. Additionally for Case 1, it is arbitrarily assumed that all pool cooling is lost when spent fuel pool temperature is at its peak. It would take 5.3 hours for the pool temperature to reach boiling, and the peak boil-off rate at about 60 gpm, which is less than the Seismic Category I spent fuel pool emergency water makeup system capability of 100 gpm. Calculation 01FC43 shows that for Case 1 the time to reach the top of the fuel racks with no makeup is 55.81 hours.

The analysis of Case 2 shows that the spent fuel pool and cask storage pool bulk temperature reaches a maximum of 134.9°F with only one train of FC operating (both trains available) if a full core discharge 624 bundles (after 24 months of full power operation) is initiated 24 hours after reactor shutdown. The worst evaporation heat loss rate is about 0.6 million Btu/hr. Additionally for Case 2, it is also arbitrarily assumed that all pool cooling is lost when spent fuel pool temperature is at its peak. The pool temperature rises to boiling in 3.2 hours. The peak boil-off rate is about 86 gpm, which is less than the Seismic Category I spent fuel pool emergency water makeup system capability of 100 gpm. Calculation 01FC43 shows that for Case 2 the time to reach the top of the fuel racks with no makeup is 38.65 hours.

3.5.7 Impact of Elevated Fuel Handling Floor Temperature

Calculation VF-54 (Reference 38) was developed to determine the bulk Spent Fuel Pool (SFP) area conditions following a BDBEE in order to determine the time after the occurrence of the BDBEE at which the SFP area exceeds 110°F, the dry bulb temperature limit for human habitability according to NUMARC 87-00, Rev. 1 (Reference 29).

Several cases were analyzed:

- Case 1, the BDBEE occurs during normal operation.
- Case 2, the BDBEE occurs when the SFP reaches its maximum bulk temperature during a Normal Core discharge.
- Case 3, the BDBEE occurs when the SFP reaches its maximum bulk temperature during a Full Core discharge.
- Case 4 is the same as Case 1; however, the elevation 737' railroad bay door below the SFP area is opened to the outside environment, and a fan is powered in order to draw air from the environment up to the SFP area via the floor opening in the SFP area. The capacity of the fan is chosen such that the SFP area will be maintained below the acceptance criteria of 110°F. This is a sensitivity study only and does reflect precise phenomena that would occur due to vertical air flow through the floor opening. The purpose of this sensitivity study is to determine the magnitude of air flow required to maintain the SFP area in a habitable condition.

Since Case 1 and Case 4 assume non-outage conditions, shift staffing considerations require that operator actions needed to achieve the core cooling, containment integrity, and spent fuel pool cooling objectives consider the impact of an elevated temperature in deployment areas and connection points (Figure 9). During outage conditions (Cases 2 and 3) the added around-the-clock staffing will allow the shorter timelines to be met.

Case 1 indicates that habitable conditions on the Fuel Handling Floor are compromised at t_0 + 11 hours when boiling in the SFP begins. This impacts the safety function strategies as follows:

1) Core Cooling – the RPV makeup from the UHS strategy uses a hose connection to the LPCS injection header located on the Fuel Handling Floor of the Fuel Building. FLEX Support Guide 4306.01P004 FLEX Low Pressure RPV Makeup (Reference 68) that implements this backup strategy alerts the operators to complete the hose deployment and pressurize the LPCS injection header prior to t_0 + 11 hours.
2) Containment Integrity – similar to the core cooling function, the Suppression Pool makeup from the UHS strategy uses a hose connection to the LPCS injection header located on the Fuel Handling Floor of the Fuel Building. FLEX Support Guide 4306.01P006 FLEX Suppression Pool Makeup (Reference 69) that implements this strategy also alerts the operators to complete the hose deployment and pressurize the LPCS injection header prior to t_0 + 11 hours.
3) Spent Fuel Pool Cooling – the SFP spray strategy uses hose connections to monitor nozzles staged on the Fuel Handling Floor of the Fuel Building. FLEX Support Guide 4306.01P007 FLEX Spent Fuel Pool Makeup (Reference 70) alerts the operators to complete the hose deployment prior to t_0 + 11 hours. It is recognized that if SFP spray was required due to a BDB seismic event, the spray strategy would be implemented on a more urgent basis.

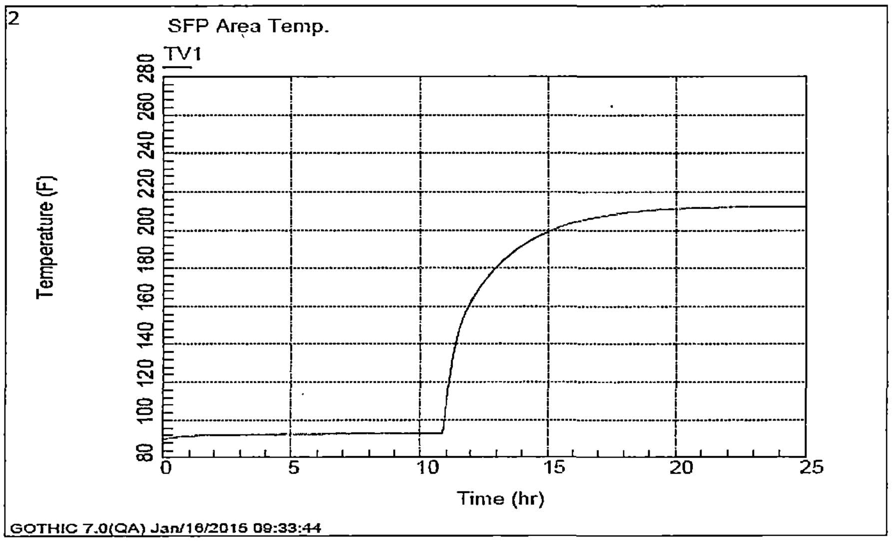

Figure 9 Fuel Handling Floor Temperature Following a BDBEE

The FLEX Support Guides mentioned above also alert the operators to 1) not fully block open the airlock doors when routing the hose into the Fuel Building, 2) protect the hose with foam pipe insulation staged in the Control Building 781' Lagging Storage Area, and 3) use sections of the insulation to fill in the door opening to keep the heat from the SFP from migrating into the Auxiliary Building.

4 Support Strategies

4.1 Refueling FLEX Equipment

The FLEX strategies for safety functions and/or maintenance of safety functions involves several elements including the supply of fuel to necessary diesel powered generators, pumps, hauling vehicles, etc. The general coping strategy for supplying fuel oil to diesel driven portable equipment is:

1) maintain the FLEX equipment fuel tanks at least 80% full,
2) maintain a 500 gallon reserve in a trailer mounted fuel tank,
3) replenish supplies with fuel stored in an installed Emergency Diesel Generator Fuel Oil Storage Tank (FOST).

Fuel is obtained from the FOST by re-powering the installed Diesel Generator Fuel Oil Transfer Pump and pumping a continuous supply of fuel oil the associated Diesel Generator Day Tank. A pre-staged portable 120 VAC fuel transfer pump can take suction from the Day Tank by removing a flange on the top of the Day Tank and routing a pre-staged suction hose into the Day Tank. The discharge of the portable fuel transfer pump is routed outside to the south side of the Diesel Generator Building through an engineered port in the Diesel Generator Building outside wall. A pre-staged tee is connected to the hose outside (Figure 10).

The installed Diesel Generator Fuel Oil Transfer Pump is supplied from a MCC that is repowered by the FLEX Generator. The portable 120 VAC fuel transfer pump is powered from a power cart described in section 3.1.4.

The remainder of the refueling strategy is described below.

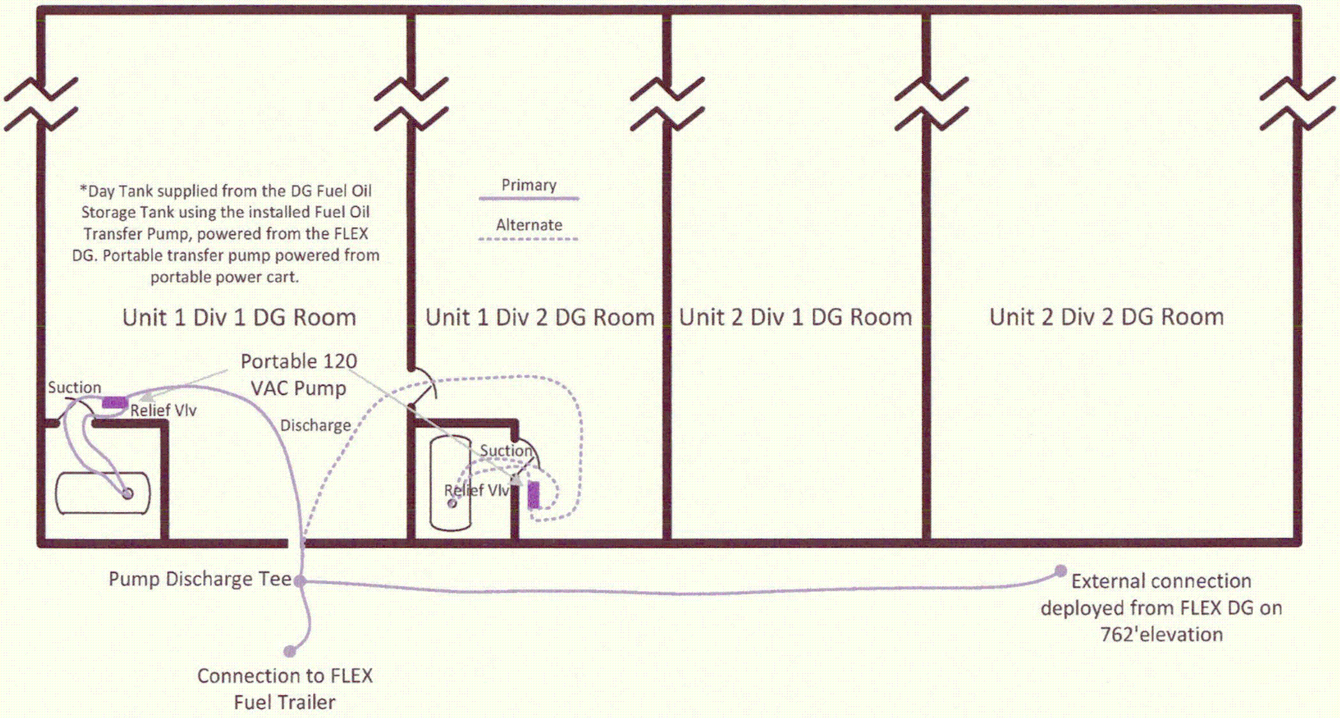

Figure 10 Fuel Oil Strategy

4.1.1.1 FLEX Pump Refueling Strategy

The Hale diesel-driven pump used to supply makeup and cooling water to the plant is stored in its final deployment location, inside the FLEX Storage Building. The pump trailer has an installed 400 gallon fuel tank. A trailer mounted 500 gallon fuel tank with a 12 VDC fuel transfer pump is also stored inside the FLEX Storage Building. The Hale pump will run on its stored fuel and then be refueled from the fuel trailer. Once the fuel trailer contents have been pumped to the Hale pump, the fuel trailer will be deployed to the south side of the Diesel Generator Building and filled from the hose exiting the building using a hose attached to the tee mentioned above. The fuel trailer would then be returned to the FLEX Storage Building to refuel the Hale pump.

4.1.1.2 FLEX Generator Refueling Strategy

The FLEX Generator is refueled by deploying a pre-staged fuel hose from the FLEX Generator Room on the 762' elevation of the Diesel Generator Building to outside grade level. The hose is attached to the tee mentioned above, and refueling of the generator can occur as needed through the remainder of the BDBEE.

In the event the installed FLEX Generator was unavailable and N+1 FLEX Generator was deployed instead to the south side of the Diesel Generator Building, the pre-staged fuel hose would be lowered to the ground from the 762' elevation and used to refuel the N+1 generator as needed.

4.1.1.3 Fuel Consumption

The fuel oil level equivalent to a 7 day supply at the maximum post-LOCA load demand for the Division 1 Diesel Generator is 51,000 gallons (primary strategy), for the Division 2 Diesel Generator is 45,000 gallons (alternate strategy). The quantity of fuel oil required in either the primary or alternate strategy can be served by the respective fuel oil storage tank for well over 30 days. The Emergency Response Organization would be able to transfer fuel oil, if needed, from the opposite division, and another 29,500 gallons of fuel oil in the Division 3 storage tank could be used as well. It is expected that the emergency response organization can ensure delivery of replenishment fuel as required within the times identified above.

Equipment	Fuel Tank Capacity	Full Load Consumption Rate	Total Run Time	Run Time to 20% of FO Tank Capacity
FLEX Pump	400 gal	25.4 gal/hr	15.7 hrs	12.5 hrs
FLEX Generator	500 gal	34.4 gal/hr	14.5 hrs	11.6 hrs

The portable fuel transfer pump is capable of 10 gpm (600 GPH) flow. It would take one hour (conservatively) to refill the fuel trailer from the Diesel Generator Day Tank. The fuel trailer DC pump can deliver 25 gpm (1500 GPH). It would take one-half hour (conservatively) to refill the FLEX pump assuming it was nearly empty. The FLEX pump can run fully loaded with an 80% full tank for 12.5 hours. Given that the FLEX Generator can be refueled without the use of the fuel trailer, these delivery rates are well above the full load usage rate of all FLEX Phase 2 portable equipment.

The FLEX haul vehicle, three 5.5 KW generators used for communications equipment and the 6.5 KW generator used for FLEX Storage Building backup power represent a negligible added fuel usage on the FLEX refueling strategy.

4.2 ADS Air Supply

SRVs are each provided with an air accumulator located in the drywell capable of providing for a total of thirty-seven (37) lifts without backup. Additionally, nine (9) of the SRVs are capable of being supplied with actuating air from backup air bottles located in the Auxiliary Building, providing enough air for an additional two-hundred (200) lifts (100 per division) (Reference 28). Since the cooldown begins at t_0 + 1 hour, lining up the ADS backup air bottles at t_0 + 2 hours will be needed to ensure a pneumatic supply is maintained for controlling RPV pressure in the specified band. Since the total number of SRV lifts required to cooldown the RPV and remain depressurized is indeterminate, a FLEX capability to supply air to ADS backup air bottles at t_0 + 24 hours ensures a long term supply of SRV actuating air.

The FLEX ADS air strategy uses a pre-staged hose and hose adapter to connect the installed Division 1, or alternatively the Division 2 Diesel Generator Starting Air Compressors to the ADS Backup Air Bottle charging line. The strategy is implemented by removing a spoolpiece downstream of the DG air receiver and installing in its place the hose fitting. A modification on the ADS air charging line provides a connection point for the air hose (Figure 11).

The starting air compressors are supplied from DG MCC 1A (Division 1) or alternatively DG MCC 1B (Division 2) which are re-powered by the FLEX Generator.

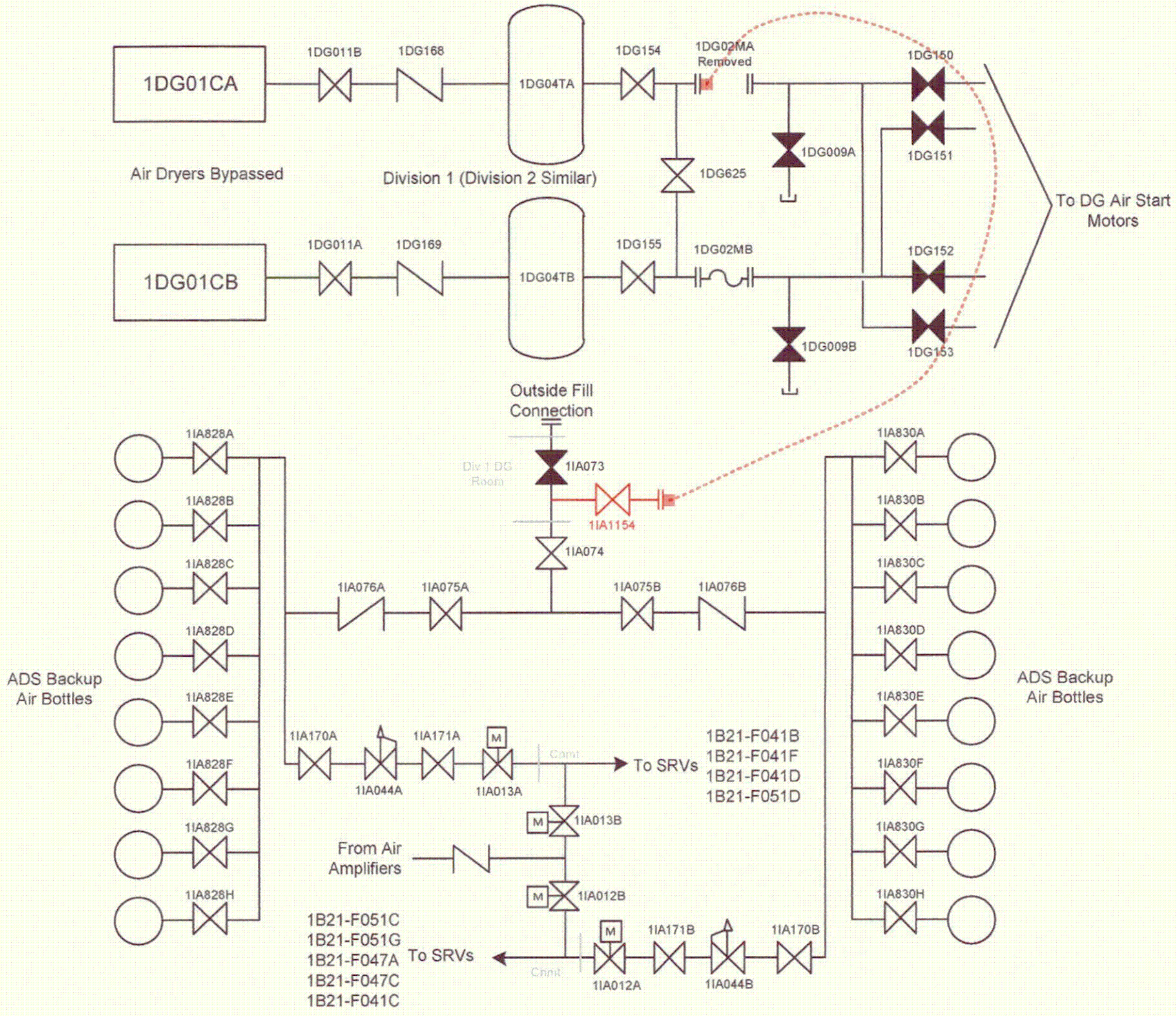

Figure 11 ADS Air Supply Strategy

4.3 Ventilation

4.3.1.1 RCIC Room

The Transient Analysis of RCIC Pump Room for Extended Loss of AC Power (Reference 39) is a GOTHIC analysis that provided recommendations for maintaining the room below the equipment qualification limit of 145°F. Those recommendations are incorporated in a FLEX Support Guide to ensure RCIC will remain operational for as long as required. The recommendations included opening the RCIC room door within six (6) hours and supplying air from a portable fan within thirty (30) hours. FLEX Support Guide 4306.01P010 FLEX Ventilation (Reference 40) includes steps to perform these actions. Additionally, in the primary FLEX strategy the RCIC Room Cooler is repowered and SX is supplied to the room cooler.

The portable fan can be powered from a power cart described in section 3.1.4.

4.3.1.2 NSPS Inverter Rooms

Calculation VX-050, Inverter Room Heatup and Battery Room H2 Generation Following a BDBEE (Reference 13), determined that propping open the NSPS Inverter room doors and using a portable fan to blow cooler air into the room would result in a steady state temperature of 106°F. The maximum temperature expected in this room for a DBA event is 122°F (Reference 41, Reference 42). Therefore equipment in the NSPS Inverter rooms is bounded by current EQ designs.

The portable fan can be powered from a power cart described in section 3.1.4.

4.3.1.3 Battery Rooms

Calculation VX-050 (Reference 13) modeled the primary strategy (Division 1) using some conservative assumptions (exhaust fan and battery charger repowered after 8 hours instead of 5.5 hours). The 1A1 Battery room has a final temperature of 112°F at the end of the 100 hour run. The 1B1 Battery room has a final temperature of 125.5°F at the end of the 100 hour run. The 1B1 Battery is not credited in the primary strategy.

The alternate strategy (Division 2) was modeled in the same calculation using the same assumptions (exhaust fan and battery charger repowered after 8 hours instead of 5.5 hours). In the alternate strategy the swing charger is supplying the Division 1 DC bus. The 1A1 Battery room has a final temperature of 117°F at the end of the run. The 1B1 Battery room has a final temperature of 115.5°F.

Calculation VX-050 (Reference 13) determined that propping open the battery room doors would be sufficient to keep the H2 concentration less than 2%. In addition to propping open the battery room doors a portable fan is staged to help maintain the room temperature.

The portable fan can be powered from a power cart described in section 3.1.4.

4.3.1.4 Fuel Handling Floor

Calculation VF-054 (Reference 38) analyzed the habitability conditions on the Fuel Handling Floor following a BDBEE and identified the timeline for completing required FLEX strategy actions in the affected area for core cooling, containment integrity, and spent fuel pool cooling. This is discussed in section 3.5.7.

In order to lengthen the time the Fuel Handling Floor is habitable, FLEX Support Guide 4306.01P010 FLEX Ventilation (Reference 40) provides steps to run the Standby Gas Treatment System (VG) to provide an exhaust path for the heated air and steam rising from the Spent Fuel Pool.

4.3.1.5 Switchgear Rooms

FLEX Support Guide 4306.01P010 FLEX Ventilation (Reference 40) provides steps to create cross-ventilation by opening doors to adjacent areas and running a pre-staged portable fan to circulate air. The portable fan can be powered from a power cart described in section 3.1.4.

4.3.1.6 Main Control Room

Calculation 3C10-0390-001, Main Control Room Temperature Transient Following Station Blackout (Reference 43), determined the Main Control Room (MCR) temperature transient when all MCR cooling is lost due to an SBO. The MCR temperature reaches a peak value of 119°F at a time of 30 minutes after the SBO. A portable exhaust fan is then turned on and MCR temperature reduces to ≈110°F and stays at ≈110°F for the duration of the SBO.

Calculation IP-M-0409 (Reference 44), Main Control Room Temperature Rise During Station Blackout (SBO) Based on Temperature Survey, determined the MCR temperature for SBO conditions based on actual temperature data obtained when both trains of the control room HVAC were off and with no exhaust fan assumed to operate. This calculation determined that MCR temperature would be 107°F at the end of an SBO.

Based on the above, it is reasonable to assume that using the exhaust fan during an ELAP will keep MCR temperature <110°F. Deployment of the exhaust fan is covered by plant procedure CPS 4200.01, Loss of AC Power (Reference 45) for a Station Blackout, or FLEX Support Guide 4306.01P010 FLEX Ventilation (Reference 40) if the event is determined to be an extended loss of AC power. The FLEX strategy modified the SBO strategy by substituting an AC fan for the gasoline fan used in the SBO strategy. The AC fan can be powered from the same portable generator staged in the MCR area for the satellite phones, or from a power cart described in section 3.1.4.

Main Control Room habitability conditions will be supported by implementing the existing SBO strategy for cooling the room. A toolbox approach, e.g., rotation of personnel, will be employed if further mitigating actions are required.

4.3.1.7 LPCS Pump Room

The SF pumps are in the LPCS pump room, Auxiliary Building el. 707'. For a BDBEE, the only heat load in this room would be from a running SF pump and the suppression pool water at 210°F. This room is ≈20' W X ≈85' L X ≈20' H therefore the general area heat-up should not be too extreme. The pumps are designed to pump with 250°F water. In addition, room access doors can be propped open to provide some area cooling.

FLEX Support Guide 4306.01P010 FLEX Ventilation (Reference 40) provides steps to run the Standby Gas Treatment System (VG) to provide an exhaust path for the heated air inside the room.

4.4 Lighting

4.4.1.1 Phase 1

A lighting review evaluated the lighting available to make required piping and electrical connections, perform instrumentation monitoring and the associated travel paths to/from the various areas. Battery powered (Appendix "R") emergency lights, backed up by LED hard hat lamps and battery operated LED Pelican lights, provide adequate lighting for all primary connection points in the BDB Strategies. The Appendix "R" emergency lights are designed and periodically tested to ensure the battery pack will provide a minimum of 8 hours of lighting with no external AC power sources.

4.4.1.2 Phase 2 and 3

Once the FLEX Generator has repowered portions of the vital 480 VAC system, Standby Lighting Cabinets (SLC) in Division 1 or Division 2 will light large areas of the plant. The primary (Division 1) electrical strategy will energize a SLC that lights the Control and Diesel Generator Buildings, and the alternate (Division 2) electrical strategy will energize a SLC that lights the Auxiliary Building. LED tripod lights are staged in the FLEX DG room to provide additional lighting during Phase 2 and 3.

The Hale pump battery operated "Scene lights" provide sufficient lighting in the FLEX Storage Building to support the UHS water strategy.

4.5 Water Removal

NEI 12-06 section 5.3.3.2 states "consideration should be given to the impacts from large internal flooding sources that are not seismically robust and do not require ac power (e.g., gravity drainage from lake or cooling basins for non-safety-related cooling water systems)". There is the potential that RCIC pump seal leakage could require water removal from the RCIC pump room. Additionally, the Control Building basement could accumulate seismically induced leakage from fluid systems within the Control Building, including Plant Service Water (WS), Plant Chilled Water (WO), Component Cooling Water (CC), and Cycled and Makeup Condensate (CY/MC).

Clinton has developed a water removal strategy for Auxiliary Building (RCIC room) and Control Building basements that transfers accumulated water to the unused Unit 2 Diesel Generator Fuel Oil Storage Tank rooms where the potentially contaminated water can be sequestered and prevented from flowing back to Clinton Lake. These large empty rooms serve as a seismically robust storage area for water pumped from the Auxiliary and Control Buildings. The listed equipment below is stored in FLEX tool boxes in the Auxiliary and Control Buildings:

- 120 VAC submersible pumps with 1½ inch discharge ports capable of 90 gpm,
- 100 foot lengths of 1½ inch fire hose capable of reaching from the RCIC room and Control Building basement to any of the Unit 2 FOST rooms,
- Extension cords capable of reaching the power cart described in section 3.1.4 on Control Building 737' elevation from the RCIC pump room and Control Building basement.

The equipment discussed above is staged in FLEX tool boxes in the Auxiliary Building basement and Control Building basement.

4.6 Communications

Exelon employs a defense in depth approach to ensure a reliable communication system is available for the MCR and TSC. If during a BDBEE the telephone systems become non-functional, operators and Emergency Response Organization (ERO) personnel shall employ a diverse communications strategy:

4.6.1.1 Fixed Satellite Telephone Systems:

For the MCR a fixed satellite system is available with three (3) satellite phones. The MCR system has an uninterruptable back-up power supply and the capability to connect to an AC source supplied by the FLEX generator or a portable generator.

4.6.1.2 Handheld Iridium Satellite Phones

If the MCR satellite phone system becomes nonfunctional, MCR staff will have access to two (2) Iridium satellite phones available to meet the immediate communications requirements. These Iridium satellite phones are portable and must have a clear view of the southwest sky. The Iridium satellite phones along with spare batteries and battery chargers will be stored in the MCR area. A portable generator is staged in the same area for the purpose of charging batteries.

4.6.1.3 Portable Satellite Systems

For the MCR, a portable back-up satellite dish and communication case is available in the event that the permanently mounted satellite system fails after a BDBEE. The portable communication case and satellite dish can be deployed and tied into the hardwired system since the majority of the components, other than the non-seismically mounted satellite dish, are in safety-related or seismically rated structures.

TSC/OSC staff has access to a portable satellite communication case and satellite dish. These portable satellite communication systems are mounted on trailers and stored in the FLEX Storage Building.

4.6.1.4 Radios

Radio communications capability during a BDBEE exists via portable radio to radio talk around frequency. This feature allows station emergency workers to utilize existing station radios generally without the aid of a repeater or antenna system. This capability may be limited to line of sight communication. A total of twenty two (22) radios and a total of three (3) batteries per radio are stored in the MCR area. A portable generator is staged in the same area for the purpose of charging batteries.

4.6.1.5 Sound Powered Phone System

The function of the Sound Powered Telephone Subsystem is to provide an independent, reliable communications system for plant personnel. In a BDBEE the system allows the Control Room staff to provide direction to plant operators performing actions required during an ELAP when normal communications equipment is not functional.

The system consists of an independent network of telephone jacks installed in the vicinity of panels, racks and other selected locations vital to operation throughout the plant. Headsets are plugged into the jacks to permit communications between remote locations. Sound Powered Phone (SPP) headsets generate the required audio signal with no battery or external AC power to operate.

Clinton has twelve (12) additional sound-powered telephones with 100 foot cables stored in the Diesel Generator Building 762' elevation, central to the FLEX mitigating strategy locations. Twelve (12) drop stations have been identified that are in or near the locations where operator actions are required. A patch panel in the Main Control Room allows the drop stations to be interconnected in a network using a patch cord staged in the Main Control Room.

4.6.1.6 Bullhorns

The primary system to notify plant personnel is the Public Address system. NEI 12-01 states, if portions of the Public Address system are not powered from a battery-backed source, then reasonable alternate methods should exist to provide emergency notification to the plant staff in the areas that would not receive an announcement. To substitute for the non-credited Public Address system, bullhorns are stored in the MCR area.

4.7 Heat Tracing

The equipment used to support the FLEX strategies is stored either inside the plant or in the FLEX Storage Building which is protected from snow, ice, and extreme cold in accordance with NEI 12-06, and is temperature controlled. FLEX connection points are located inside qualified structures which are temperature controlled; therefore heat tracing is not used or required. Equipment/tools that support making the connections are stored inside in the vicinity of the connection points.

4.8 Foul Weather Gear

The Clinton FLEX water and electrical strategies do not require outdoor deployment of pumps, generators, hoses, or cables. An operator and security officer need to travel on foot to the FLEX Storage Building a short distance away from the power block. Once inside the FLEX Storage Building, the tasks associated with the water strategy are performed indoors. The primary (N) FLEX Generator is installed in the robust Diesel Generator Building, as are the interconnecting cables. Foul weather gear for extended periods of outdoor work is not required at Clinton.

5 Hazard Determination

5.1 Seismic

Per the Updated Final Safety Analysis Report (UFSAR) Section 3.7.1.1, the seismic criteria for CPS include two design basis earthquake spectra: Operating Basis Earthquake (OBE) and the Safe Shutdown Earthquake (SSE).

UFSAR section 2.5.4.8 was reviewed to perform a limited evaluation of the liquefaction potential outside the power block area for a safe shutdown earthquake (SSE) event.

There are no liquefaction susceptible soils within the area of the principal structures for a SSE event with a maximum horizontal acceleration equal to 0.25g. Therefore, the likelihood of liquefaction at the site for a SSE event with a maximum horizontal acceleration equal to 0.25g is low.

Thus the Clinton site screens in for an assessment for seismic hazard except for soil liquefaction.

For Diverse and Flexible Coping Strategies (FLEX), 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.).

5.2 External Flooding

The cooling lake is designed to withstand the effects of a probable maximum storm occurring over the entire drainage basin upstream of the dam site. Results of the hydrologic analyses discussed in UFSAR sections 2.4.3 and 2.4.8 show that a probable maximum flood (PMF) runoff into the lake routed through the spillways will raise the lake water level to elevation 708.8 feet at the dam site. The backwater effect along the North Fork finger will raise the PMF water level at the station site to elevation 708.9 feet.

Superimposing the wind wave effect due to a sustained 40 mph wind acting on the PMF water level will result in wave runup elevations of 711.9 feet and 713.8 feet for significant waves and maximum (1%) waves, respectively, at the station site. The station's Seismic Category I structures with grade elevation of 736 feet will not be affected by the PMF design conditions. The circulating water screen house is designed to withstand the effects of PMF.

The following protection measures are adopted for Seismic Category I systems and components located in the circulating water screen house and located below the PMF level.

- Water stops are provided in all construction joints up to the maximum flood level.
- Water seal rings are provided for all penetrations in exterior walls below the maximum flood level.
- Watertight doors designed to withstand the hydrostatic head of the maximum flood level are provided for all doorways located on both the entrance walls and the internal walls of the Shutdown Service Water (SX) pump rooms which are below the maximum flood level.
- Hatches are provided on the roof of the SX pump structure (elevation 730 feet) for access during PMF.

In accordance with NEI 12-06 section 6.2.1,Susceptibility to External Flooding, CPS screens in for an assessment for external flood hazard since the site is "kept dry" by the measures listed above that protect safety related components in the circulating water screen house below the PMF.

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.

Flood Hazard Reevaluation

Since the original submittal of the Integrated Plan, Clinton Power Station has completed and submitted the Flood Hazard Reevaluation Report (FHRR) (Reference 52) requested by the 10 CFR 50.54(f) letter dated March 12, 2012. The reevaluation represents the most current flooding analysis for Clinton Power Station Unit 1. The reevaluation results were mostly bounded by the original Clinton Power Station UFSAR/USAR site flooding vulnerabilities and characteristics, in that the non-events such as seiche and dam failures continued to be non-events.

5.3 Severe Storms with High Wind

Clinton site is located at 40° 10' 19.5" north latitude and 88° 50' 3" west longitude. NEI 12-06 Figure 7-2, Recommended Tornado Design Wind Speeds for the 10-6/year Probability Level indicates Clinton is in Region 1- 200 mph. Thus the Clinton site screens in for an assessment for high winds and tornados, including missiles produced by these events.

5.4 Ice, Snow and Extreme Cold

The guidelines provided in NEI 12-06 section 8.2.1 generally include the need to consider extreme snowfall at plant sites above the 35th parallel, which includes the Clinton site, located at 40° 10' 19.5" North and 88° 50' 3" West.

The Clinton site is located within the region characterized by EPRI as ice severity level 5 (NEI 12-06, Figure 8-2, Maximum Ice Storm Severity Maps). Consequently, the Clinton site is subject to severe icing conditions that could also cause catastrophic destruction to electrical transmission lines.

Thus the Clinton site screens in for an assessment for snow, ice, and extreme cold hazard.

5.5 High Temperatures

NEI 12-06 section 9.2 requires all sites to consider the impact of extreme high temperatures. Central Illinois summers are warm and humid, with periods of extremely hot weather over 100°F. UFSAR Section 2.3.2 discusses the local meteorology for CPS.

Thus the Clinton site screens in for an assessment for extreme high temperature hazard.

6 Storage Building/Haul Routes

6.1 Protection of FLEX Equipment/Storage Building

Clinton has constructed a single hardened FLEX storage structure of approximately 3000 square feet that will meet the requirements for the external events identified in NEI

12-06, such as earthquakes, storms (high winds, and tornadoes), extreme snow, ice, extreme heat, and cold temperature conditions. The FLEX Storage Building (FSB) is located below the Probable Maximum Flood (PMF) level of 708'-11" elevation per DC-SD-01-CP, Section 2.1.5 (Reference 71), but the site is not susceptible to rapidly developing flooding events such as dam failures, seiches and tsunamis. Therefore a flooding event at Clinton provides adequate warning time to deploy equipment in response to a flood per NEI 12-06. The FSB location on the Circulating Water Screen House (CWSH) provides nearby roadway access for deployment of the FLEX equipment in response to a BDBEE.

The FSB is located inside the Protected Area (PA) fence on the south east portion of the CWSH at elevation 699'-0", over the existing Unit 2 Shutdown Service Water (SX) Pump Room foundations. The FSB consists of a safety related, cast-in-place floor slab and non-safety related precast wall and roof panels. The FSB walls and roof are non-safety related, but must be seismically robust per the guidance of NEI 12-06, and are designed according to Seismic Category I requirements. New structures located outside the CWSH and FSB, including the vehicle door missile barriers and vehicle deployment ramp, are non-safety related, but must be seismically robust per the guidance of NEI 12-06, and are therefore designed according to Seismic Category I requirements.

Large FLEX portable equipment such as FLEX Pumps, gantry crane, portable FLEX Generator, portable Fuel trailer, tractor with front loader, and satellite communications trailers are secured with tie-down straps to floor anchors integrated into the floor slab inside the FSB to protect them during a seismic event.

6.2 Haul Routes

Clinton has limited the need for debris removal in the first several hours of the BDB event through these design considerations:

- Access to the Ultimate Heat sink (UHS) for the FLEX pump is inside the FSB, using the floor openings originally designed for the Unit 2 SX pumps. Relocation of the FLEX pump is only required in the event of a BDB flood, and in that case debris removal along the deployment path will not be required.
- Refueling of the primary (N) FLEX generator installed inside the Diesel Generator Building does not require the use of the portable fuel trailer. Instead the fuel is pumped directly to the FLEX diesel generator from the installed divisional Diesel Generator Day Tanks.
- Debris removal along the haul path is needed only when the FLEX pump inside

the FSB needs refueling and the fuel stored in the fuel trailer has been used. At that time the fuel trailer will be towed to the area outside the Diesel Generator Building and refilled from the divisional Diesel Generator Day Tank.

Should a BDB event occur while the N generator is unavailable, then debris removal is a consideration. The N+1 generator is staged in the FSB hitched to the hauling/debris removal vehicle and ready to deploy to the area south of the Diesel Generator Building where it can support the FLEX electrical strategy.

Debris removal equipment is stored inside the FSB in order to be reasonably protected from the applicable external events such that the equipment is likely to remain functional and deployable to clear obstructions from the pathway between the equipment's storage location and its deployment location. Deployments of the FLEX and debris removal equipment from the FSB are not dependent on electrical power.

Figure 12 below shows the haul paths from the A1 staging area (FLEX Storage Building) to the A2 staging area (South of the Diesel Generator Building). These haul paths have been reviewed for potential soil liquefaction and have been determined to be stable following a seismic event.

The deployment of onsite FLEX equipment to implement coping strategies beyond the initial plant capabilities (Phase 1) requires that pathways between the FSB and the staging/deployment locations be clear of debris resulting from seismic, high wind (tornado), or excessive snow/ice. Clearing of FLEX deployment pathways has been incorporated into the Clinton snow removal plan. Additional equipment that may be needed include a bolt cutter and proximity voltage detector in the event that downed power lines are encountered.

A New Holland 115 hp tractor with a front end loader is stored in the FSB for equipment hauling and debris removal.

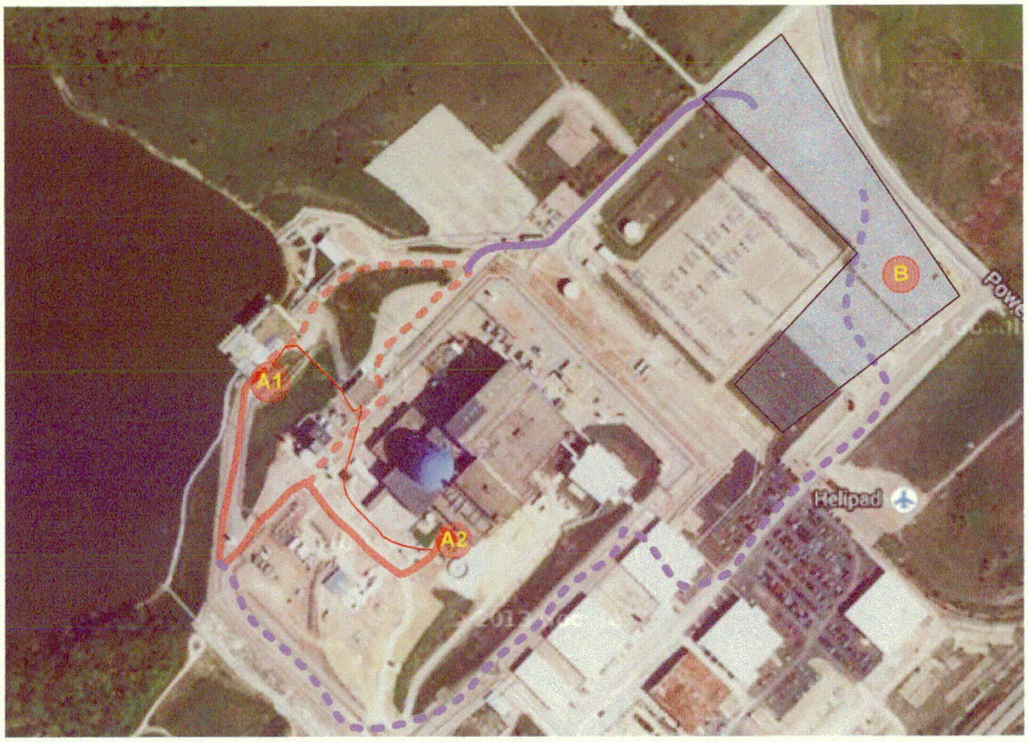

Figure 12 BDB Storage Building Location and Haul Route

- **A1 Staging Area** (A1)

  Storage building housing the FLEX pumps, portable generator, fuel trailer and debris removal vehicle. Operators need to travel on foot to this location to gain access to the building to lineup the FLEX pump.

- **A2 Staging Area** (A2)

  External water and electrical connection used for NSRC redundant equipment, and is the location of the source of fuel oil to refill the FLEX pumps.

- **Pedestrian Travel Route** ———

  Personnel travelling on foot to the A1 Staging Area. The primary or alternate vehicle routes can be used as well.

- **Phase 2 Primary Vehicle Travel Route** ▬▬

  The primary travel route between A1 and A2 Staging Area.

- **Phase 2 Alternate Vehicle Travel Route** ▬ ▬ ▬

  The alternate travel route between A1 and A2 Staging Area.

- **B Staging Area** (B)

  The laydown area for Phase 3 equipment arriving from the NSRC or other locations.

- **Phase 3 Primary Vehicle Travel Route** ▬▬

  The primary travel route from the B staging area to the A1 and A2 Staging Areas.

- **Phase 3 Alternate Vehicle Travel Route** ▬ ▬ ▬

  The alternate travel route from the B staging area to the A1 and A2 Staging Areas.

6.3 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 required as part of the immediate activities during Phase 1.

Doors and gates serve a variety of barrier functions on the site. One primary function is security and is discussed below. However, other barrier functions include fire, flood, radiation, ventilation, tornado, and HELB. As barriers, these doors and gates are typically administratively controlled to maintain their function as barriers during normal operations. Following an a BDB external event and subsequent ELAP/LUHS event, FLEX coping strategies require the routing of hoses and cables through various barriers in order to connect FLEX equipment to station fluid and electrical systems. For this reason doors will be opened and remain open. This relaxation of 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. Operators responding to the BDBEE possess keys for defeating security doors. Electrically operated gates on the site access roads and on the footpath leading to the FLEX Storage Building can be manually opened by a Security Officer.

7 Deployment of Strategies

7.1 Electrical Strategy

The strategy uses an installed FLEX diesel generator to energize the FLEX electrical riser, and from there energize portions of the existing 480 VAC distribution system necessary to implement the core cooling, containment integrity, and SFP cooling strategies. There is a primary strategy that utilizes Division 1 electrical busses and an alternate strategy that utilizes Division 2 and some non-divisional busses (Figure 1).

The strategy is implemented by deploying nine (9) 4/0 cables (three per phase), located on reels inside fixed storage cabinets between the FLEX Generator in the Diesel Generator Building and electrical panel 1FX01E in the adjacent Control Building on the same elevation. There are three reel cabinets in the Diesel Generator Building that contain the cables that connect to the generator. These cables are routed through a rollup door that separates the two buildings. Three reel cabinets in the Control Building contain the cables that connect to 1FX01E and to the cables routed from the generator.

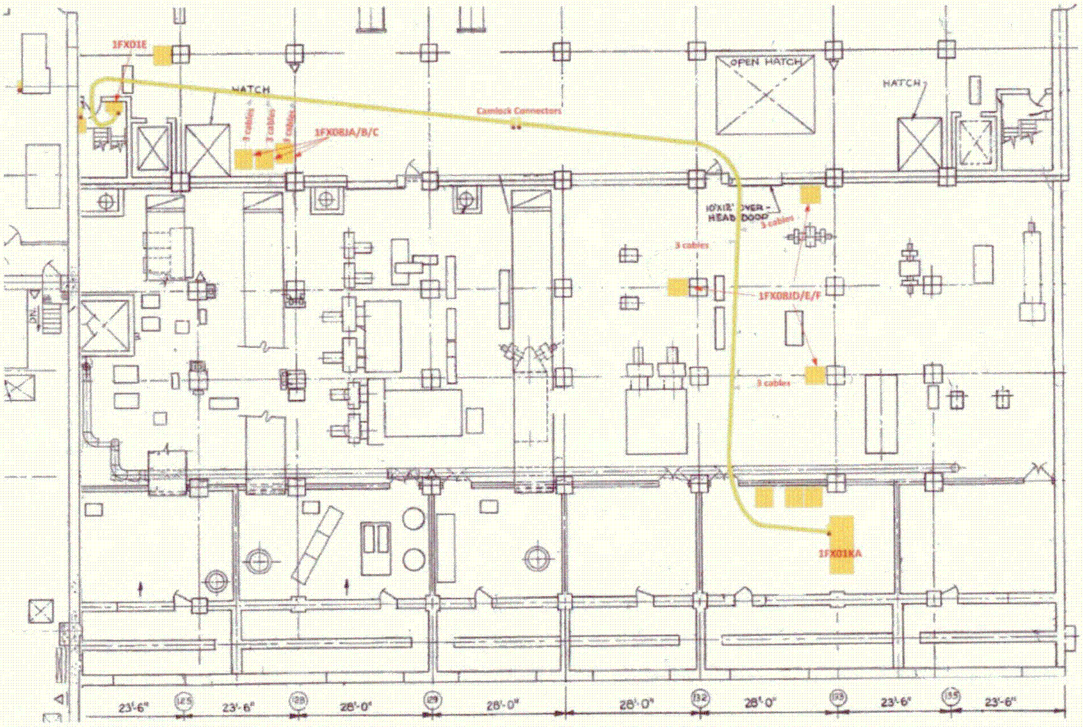

Figure 13 FLEX Generator Electrical Deployment

The FLEX Generator requires a ventilation flow path to bring in outside air for cooling and combustion. Doors are blocked open to allow air to flow in through louvers in the adjacent unused Unit 2 Division 3 Diesel Generator Vent Fan room, then into the room housing the FLEX Generator. A fan in the generator exhaust air ducting forces the air outside through the louvers in the room housing the generator.

A decision by the MCR to use either the primary or alternate strategy for core cooling, containment integrity and SFP cooling determines which electrical strategy to use. Once the cable deployment for one of these strategies is completed, the FLEX Generator is started and load applied to the generator.

7.1.1.1 <u>Primary Strategy</u>

The primary electrical strategy requires cables to be deployed in three locations:

1) From the riser connection box on Control Building 781' elevation to the FLEX connection on Unit Substation 1A. This connection supplies power to the Division 1 safety-related MCCs that supply the installed Division 1 Battery Charger, motor operated valves and fans used in the safety function and support strategies. The Division 1 Hydrogen Igniter Distribution Panel is re-powered through this connection.

   The cable reel cabinet is located on Auxiliary Building 781' elevation East side near the target Unit Substation.

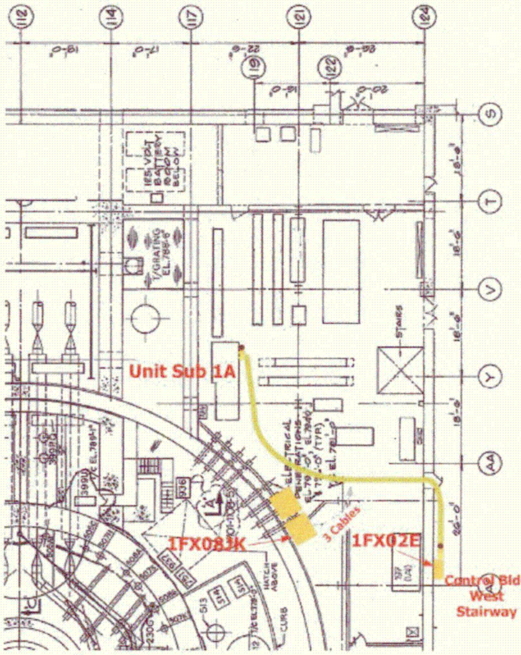

Figure 14 Unit Sub 1A Electrical Deployment

2) From the riser connection box on Control Building 825' elevation to the FLEX connection on Unit Substation A. This connection supplies power to the alternate supply for the Division 1 NSPS Inverter, Division 1 Standby Gas Treatment System components, and AC powered instrumentation for suppression pool, drywell, and containment temperature monitoring.

   The cable reels are located on Control Building 825' elevation near the target Unit Substation.

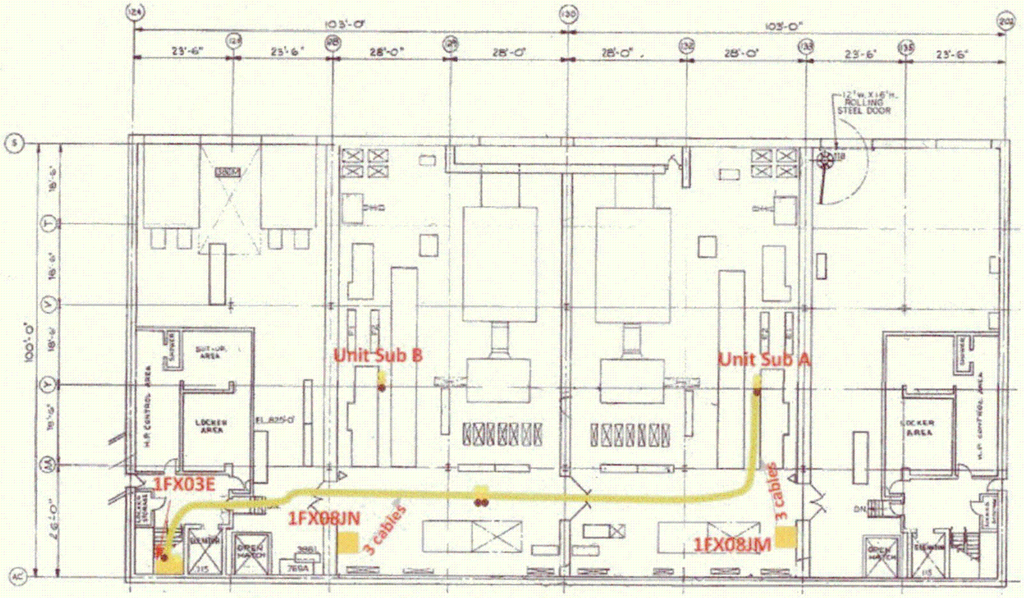

Figure 15 Unit Sub A Electrical Deployment

3) From the riser connection box on Control Building 702' elevation to the FLEX connection on Unit Substation 1F or 1G. This connection supplies power to the Suppression Pool Cleanup and transfer Pump A or B.

   The cable reel cabinet is located on Control Building 702' elevation near the target Unit Substation.

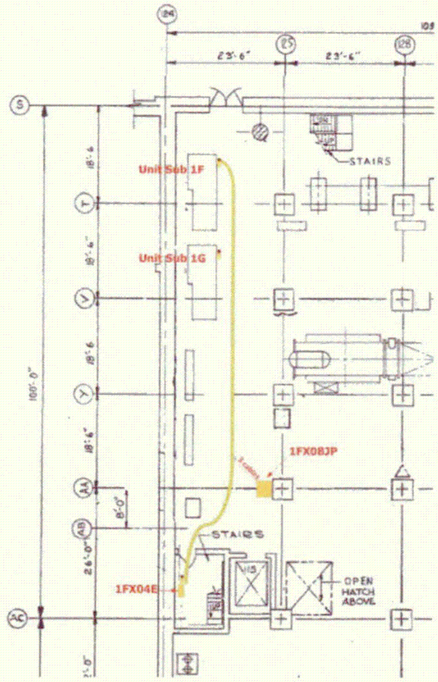

Figure 16 Unit Sub 1F/1G Electrical Deployment

7.1.1.2 Alternate Strategy

The alternate electrical strategy requires cables to be deployed in five locations:

1) From the riser connection box on Control Building 781' elevation to the FLEX connection box in the cable spreading room on Auxiliary Building 781' elevation East side. This connection box is hard-wired over the steam tunnel to a connection box in the Division 2 Switchgear Room on Auxiliary Building 781' elevation West side.

   The cable reel cabinets are located on Auxiliary Building 781'elevation East side near the target connection boxes.

2) From the connection box in the Division 2 Switchgear Room to the FLEX connection on Unit Substation 1B. This connection supplies power to the Division 2 safety-related MCCs that supply the installed Division 2 Battery Charger, motor operated valves and fans used in the safety function and support strategies. The Division 2 Hydrogen Igniter Distribution Panel is re-powered through this connection.

   The cable reel cabinets are located on Auxiliary Building 781' elevation East side near the target Unit Substation.

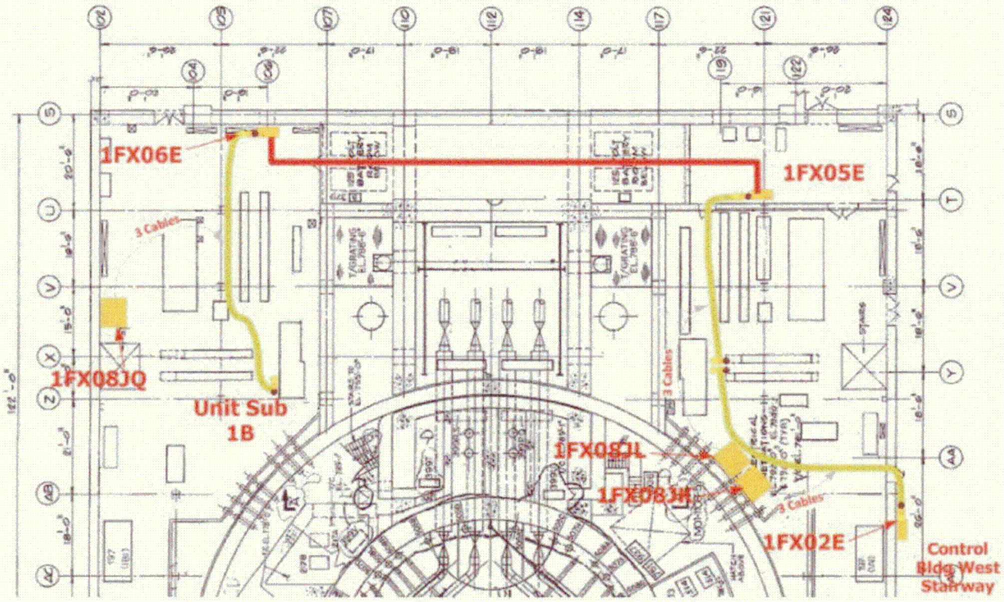

Figure 17 Unit Sub 1B Electrical Deployment

3) From the riser connection box on Control Building 762' elevation to the FLEX connection on Unit Substation 1L. This Unit Substation has an installed cross-tie to Unit Substation 1M, which supplies the MCC that powers the safety-related Swing Battery Charger. The Swing Charger is used to supply the Division 1 DC MCC to maintain power to RCIC system valves and controls.

   The cable reel cabinets are located on Control Building 762' elevation near the target Unit Substation.

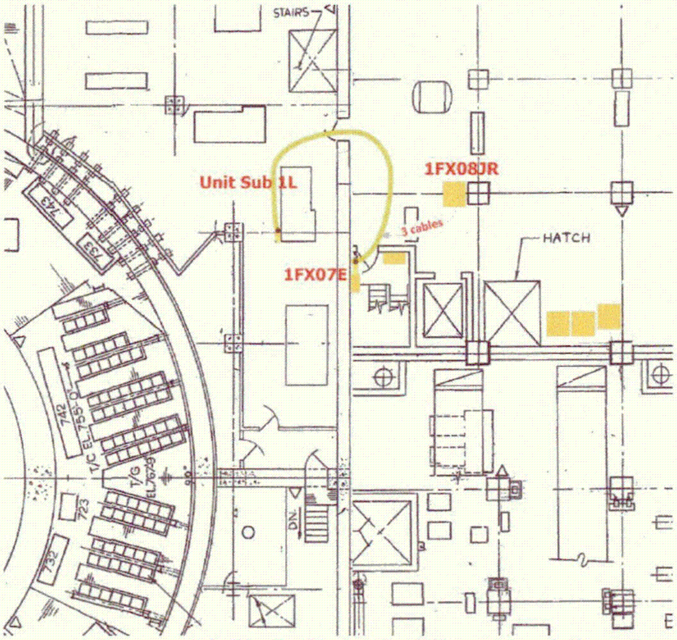

Figure 18 Unit Sub 1L Electrical Deployment

4) From the riser connection box on Control Building 825' elevation to the FLEX connection on Unit Substation B. This connection supplies power to the alternate supply for the Division 2 NSPS Inverter, Division 2 Standby Gas Treatment System components, and AC powered instrumentation for suppression pool, drywell, and containment temperature monitoring.

   The cable reel is located on Control Building 825' elevation near the target Unit Substation

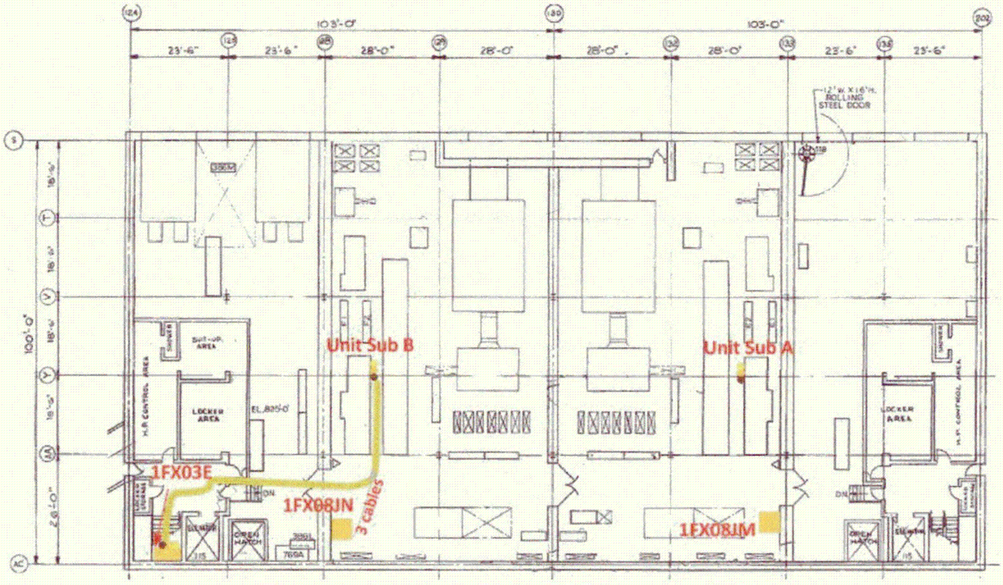

Figure 19 Unit Sub B Electrical Deployment

5) From the riser connection box on Control Building 702' elevation to the FLEX connection on Unit Substation 1F or 1G. This connection supplies power to the Suppression Pool Cleanup and transfer Pump A or B.

   The cable reel cabinet is located on Control Building 702' elevation near the target Unit Substation.

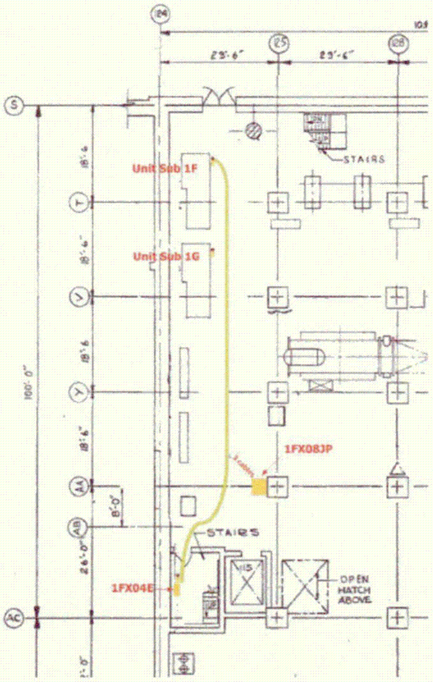

Figure 20 Unit Sub 1F/1G Electrical Deployment

7.2 UHS Water Supply Strategy

The UHS is a submerged pond and intake flume of about 590 acre-feet capacity that underlies Clinton Lake. The Unit 2 Shutdown Service Water (SX) Pump room foundation on the unfinished side of the Circulating Water Screenhouse was used as the foundation for the FLEX Storage Building, and the unused SX pump bays inside the FLEX Storage Building were used to provide access to the UHS for the FLEX Pump stored inside the building. An unused Unit 2 SX 30" supply line that runs from the Screehouse to the plant was modified to allow the FLEX pump to discharge to the supply line. Access to the UHS for the FLEX pump suction and access the SX supply line are accomplished without the need to deploy the pump to a different location.

To begin supplying UHS water to the plant following a BDBEE an operator and security officer traverse to the FLEX Storage Building, passing through Gate 6W on the way with assistance from the security officer. The security officer will unlock the UHS hatch covers and following steps are taken by the operator:

1) Turns on the Hale pump scene lights.
2) Moves the generator out to the building approach to make room for the pump discharge hoses.
3) Starts the portable generator and shifts building AC power to the generator.
4) Starts the building exhaust fans.
5) Opens the UHS access hatch using the installed winch.
6) Lifts the submersible pumps attached to the chainfall a few inches and moves the portable gantry crane over the UHS access hatch.
7) Lowers the submersible pumps into the UHS.
8) Connects the discharge hoses to the FLEX Pump and manifold.
9) Starts the Hale pump using the hardcard and begins filling the 30" SX supply line.

An operator begins venting the piping at the permanent, seismically installed manifold in the Diesel Generator Building 762' elevation using a hose that was deployed in parallel with the steps above. Communication by radio in talk-around mode has been demonstrated between these two locations.

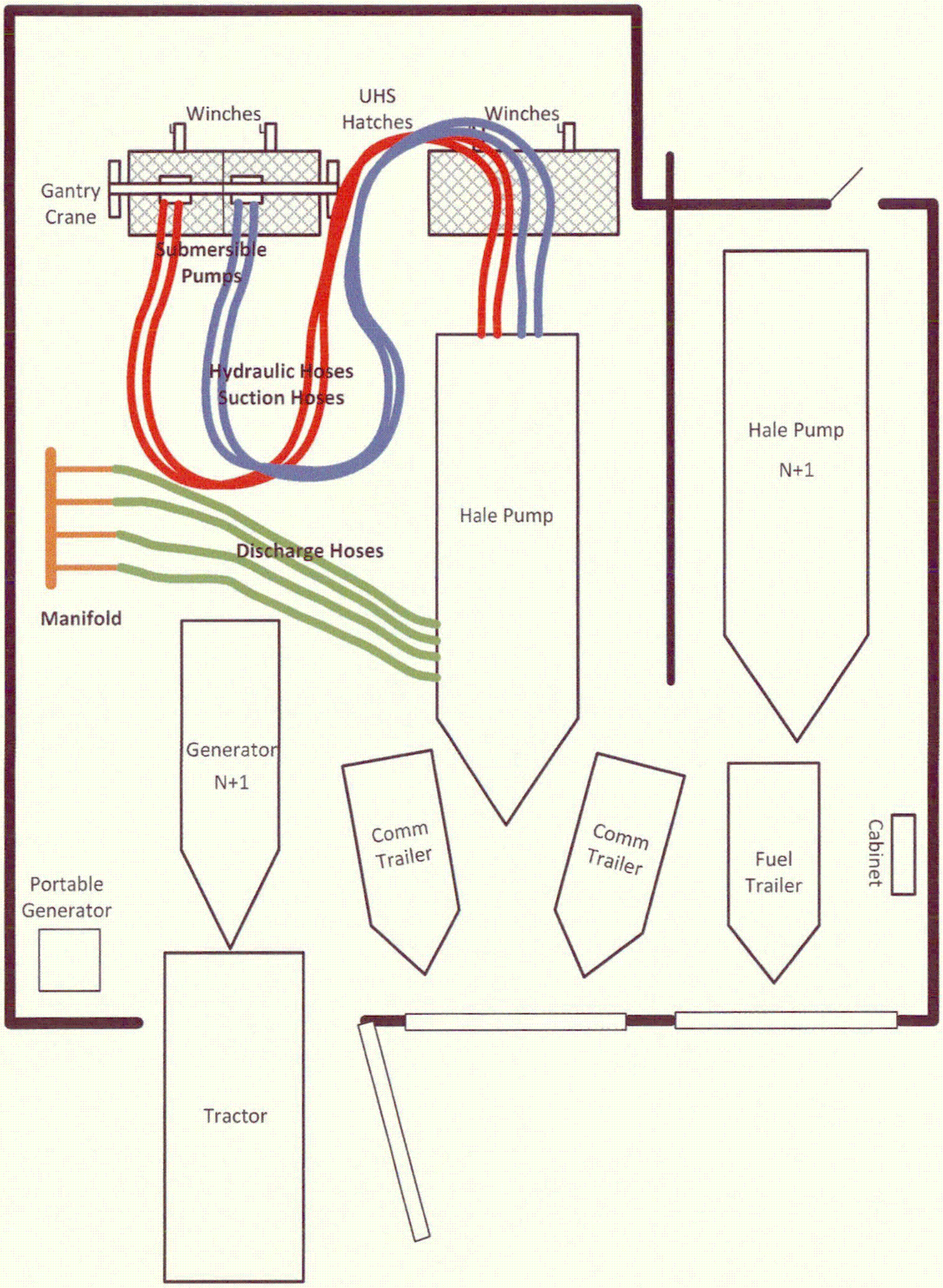

Figure 21 FLEX Pump Deployment Strategy

7.3 RPV Make-up Strategy

The Clinton strategy for RPV makeup utilizes RCIC to the maximum extent. Actions are taken to control suction water temperature by shifting suction to the cooler RHR heat exchanger outlet water once suppression pool cooling is in service. When RCIC is no longer available the SF pump can supply suppression pool water to the RPV using the LPCI injection line. The discussion below describes a method for supplying UHS water to the RPV in the event that becomes necessary.

Section 7.2 described how the FLEX Pump supplies UHS water to the Diesel Generator Building FLEX Manifold. In parallel with the steps that filled the SX supply line and pressurized the FLEX manifold, operators and available auxiliary staff deployed 6” hose, pre-staged on wheeled carts in 100’ lengths, between a 6” Storz connection on the Diesel Generator Building FLEX Manifold and the LPCS injection header. A modification installed on the LPCS header provides a 3” connection into LPCS from the hose using a pre-staged 3” NPT to 6” Storz adapter.

For diversity, an identical modification was installed on the RHR-C injection header, located nearly 180° offset and one floor below the LPCS connection. Additional hose reels are pre-staged on the floor below in case the RHR-C connection is used instead of LPCS.

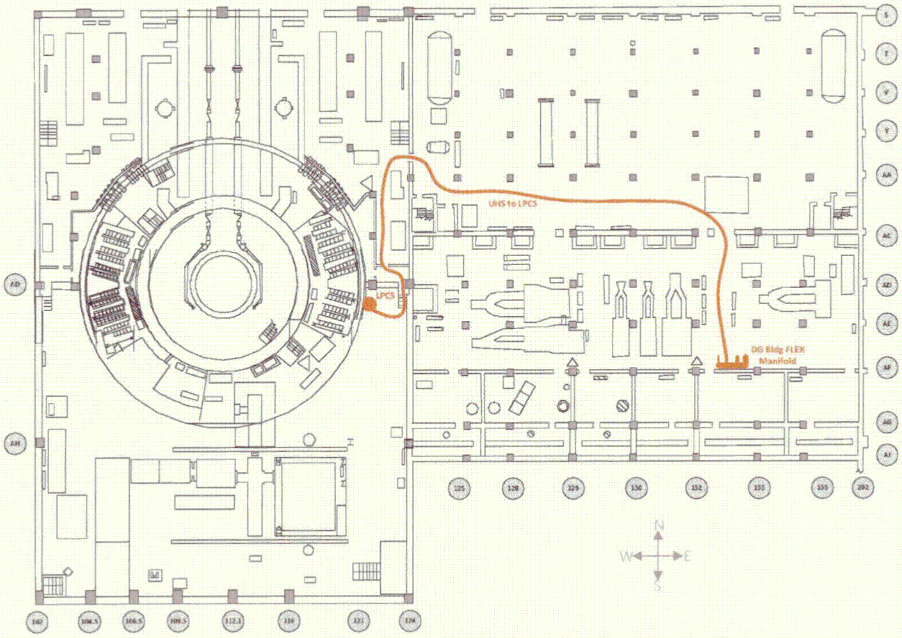

Figure 22 LPCS RPV Makeup Strategy

7.4 Shutdown Service Water System Restoration Strategy

Shutdown Service Water (SX) is partially restored from the FLEX pump to support the suppression pool cooling strategy and the SFP makeup strategy. Most other SX loads are isolated to ensure adequate flow is available for those strategies. The RCIC room cooler (Division 1 only) and the NSPS Inverter room cooler is left in service.

Section 7.2 described how the FLEX Pump supplies UHS water to the Diesel Generator Building FLEX Manifold. In parallel with the steps that filled the SX supply line and pressurized the FLEX manifold, operators and available auxiliary staff deployed a 100' length of 8" hose on a pre-staged wheeled cart between an 8" Storz connection on the Diesel Generator Building FLEX Manifold and the Division 1 SX supply header for the primary strategy. A modification installed on the SX header provides an 8" connection into SX from the hose using a pre-staged 8" NPT to 8" Storz adapter.

An identical modification was installed on the Division 2 SX supply header for the alternate strategy. An additional 50' length of 8" hose is pre-staged to reach the Division 2 SX connection.

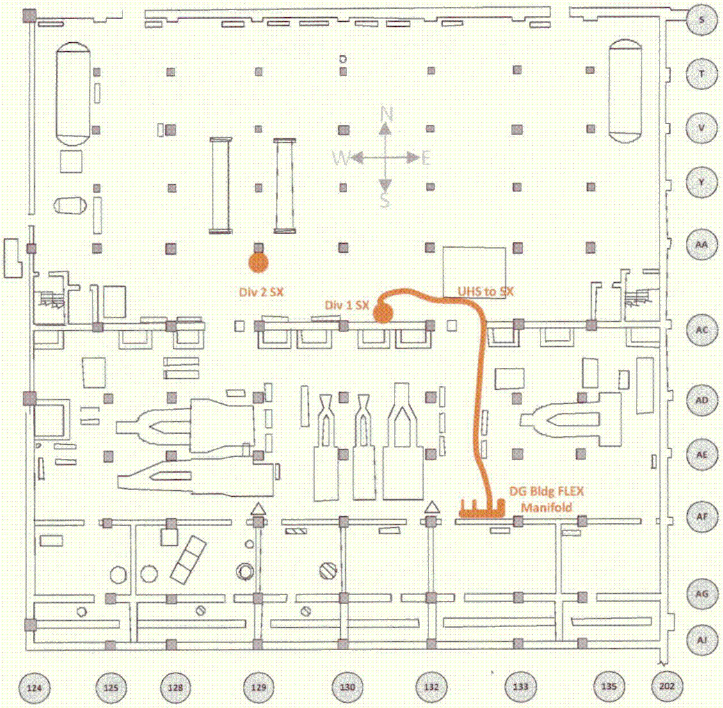

Figure 23 SX Supply Strategy

7.5 Suppression Pool Cooling Strategy

The suppression pool cooling strategy requires 1500 gpm of flow through the shell side of the RHR heat exchanger in the division where SX was partially restored. The tube side of the heat exchanger requires 2000 gpm of SX flow from the FLEX pump. Section 7.4 described the deployment of the SX strategy. The shell side flow requires the deployment of 6" high-temperature hose between a connection on the Suppression Pool Cleanup and Transfer (SF) system on Auxiliary Building 737' elevation and a modification to RHR in the RHR-A heat exchanger room mezzanine in the Auxiliary Building 789' elevation. The modification to RHR provides a flowpath to either RHR-A or RHR-B heat exchanger.

The 6" high-temperature hose is deployed as follows:

1) Because of the congested piping configuration on the RHR-A heat exchanger mezzanine, the first 50' section of 6" high-temperature hose is pre-deployed, meaning the hose is connected to the RHR system and routed to the 762' elevation below.
2) The second length of 6" high-temperature hose is pre-staged on a wheeled cart in the Diesel Generator Building 762' elevation where it can be rolled to the heat exchanger room door and spooled into the heat exchanger room. This length of hose is connected to the pre-deployed hose from the mezzanine using a Victaulic coupling and passed to the 737' elevation through an engineered opening in the deck grating and routed into the heat exchanger room airlock on the 737' elevation.
3) The third length of 6" high-temperature hose is pre-staged on a wheeled cart in the Auxiliary Building 737' elevation near the SF connection. A 90° Victaulic elbow is connected to the hose in the airlock, and this hose is connected between the elbow and the Victaulic coupling on the SF connection.

The SF pipe that was modified with a 6" connection point has an air-operated valve (1SF011) that fails shut on a loss of power or loss of air. A portable nitrogen bottle, regulator, and tubing are pre-staged in the Division 1 Diesel Generator room to allow the valve to be opened.

7.6 Spent Fuel Pool Make-up Strategy

Section 7.2 described how the FLEX Pump supplies UHS water the Diesel Generator Building FLEX Manifold. In parallel with the steps that filled the SX supply line and pressurized the FLEX manifold, operators and available auxiliary staff deployed 3" hose, pre-staged on wheeled carts in 100' lengths, between a 3" Storz connection on the Diesel Generator Building FLEX Manifold and a 3" wye staged in a B.5.b cage on the Fuel Handling Floor. Blitzfire oscillating nozzles and 3" hoses staged in B.5.b cages on the Fuel Handling Floor allow the FLEX pump to spray the SFP from two directions.

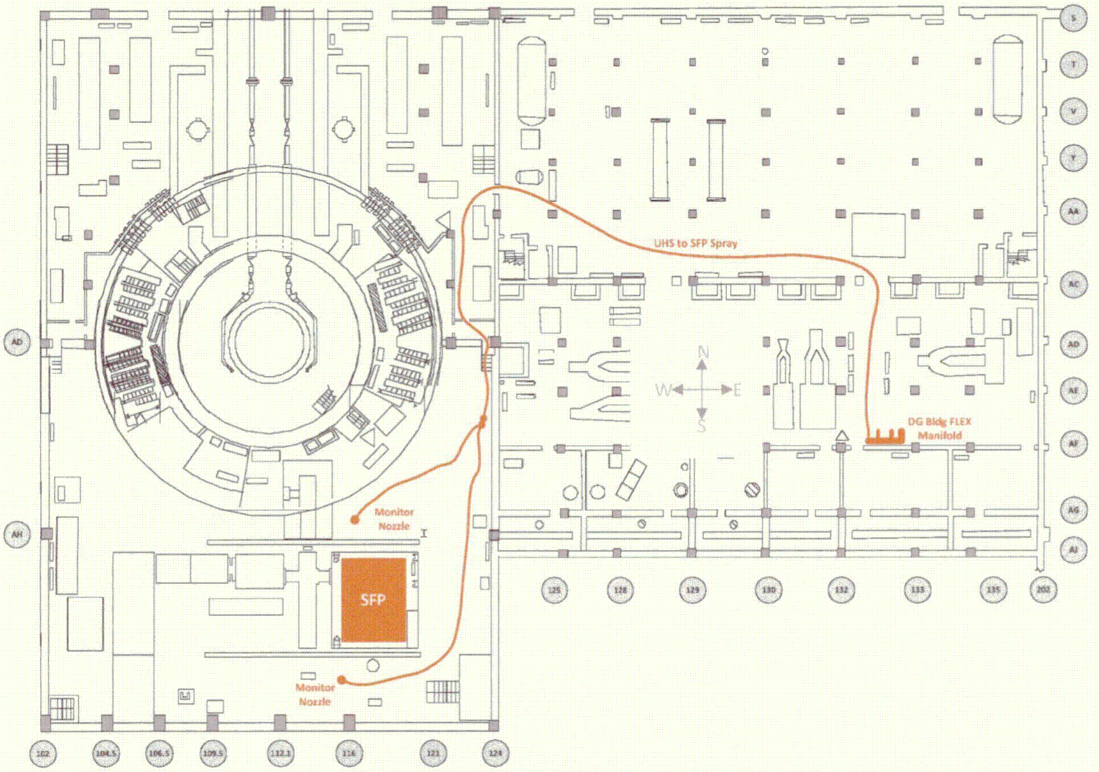

Figure 24 SFP Makeup/Spray Strategy

8 Offsite Resources

8.1 National SAFER Response Center

The industry has established two (2) National SAFER Response Centers (NSRCs) to support utilities during BDB events. Clinton has established contracts and issued purchase orders to Pooled Inventory Management for participation in the establishment and support of two (2) National SAFER Response Centers (NSRC) through the Strategic Alliance for FLEX Emergency Response (SAFER). 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, on-site BDB/FLEX equipment hoses and cable end fittings are standardized with the equipment supplied from the NSRC. In the event of a BDB external event and subsequent ELAP/LUHS condition, equipment will be moved from an NSRC to a local assembly area established by the Strategic Alliance for FLEX Emergency Response (SAFER) team. For Clinton the local assembly area is the Decatur Illinois Airport. From there, equipment can be taken to the Clinton site and staged at Staging Area 'B' by helicopter if ground transportation is unavailable or inhibited. Communications will be established between the Clinton 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 at which equipment is delivered is identified in the Clinton SAFER Response Plan documented in procedure CC-CL-118-1001 (Reference 26).

8.2 Equipment List

The equipment stored and maintained at the NSRC for transportation to the Clinton Staging Area 'B' to support the response to a BDB external event is listed in Table 4. Table 4 identifies the equipment that is specifically credited in the FLEX strategies for Clinton but also lists the equipment that will be available for backup/replacement should on-site equipment break down. Since all the equipment will be located at the Clinton Staging Area 'B', the time needed for the replacement of a failed component will be minimal.

9 Water Sources

Clinton use the suppression pool as the primary water source for RPV makeup and the UHS as the primary source for containment cooling and SFP makeup throughout the ELAP/LUHS event.

9.1 Suppression Pool

The suppression pool offers a relatively clean source of makeup water to the RPV; first from RCIC and later from the SF pump operating in a suppression pool cooling mode. At the beginning of the event, the suppression pool is near reactor quality water. The elevated suppression pool level band and reactor coolant leakage into the drywell require water addition from the UHS to maintain suppression pool level. This will degrade suppression pool water quality, but it will remain a favorable water source.

The Clinton core cooling strategy uses RCIC to the maximum extent for RPV injection. The temperature of the water supplied to the pump is maintained in a range that does not challenge its long-term availability. Once a FLEX pump is available at t_0 + 6 hours, raw water from the UHS is used to makeup to the suppression pool to compensate for

RCS leakage into the drywell. A calculation from MAAP case 18 indicates that 187,031 gallons of lake water are added to the 1,174,149 gallons of relatively clean suppression pool water during the first 72 hours of the event.

The RCIC pump takes suction from the suppression pool through the common ECCS suction strainer that was designed to conform to Regulatory Guide 1.82 Rev 2, Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident (Reference 53). The ECCS suction strainer will prevent solids >3/32" from entering the RCIC system and being injected into the RPV.

When RCIC is no longer available, the primary RPV makeup source continues to be the suppression pool. The Suppression Pool Cleanup and Transfer (SF) pump that is used for suppression pool cooling with an RHR heat exchanger can inject water in the RPV using the associated LPCI injection valve. The SF pumps have suction strainers which limit solids >1/8" from being injected into the RPV.

It is also noted that the clean but non-credited RCIC Storage Tank is referenced in the FLEX Support Guide 4306.01P005 FLEX RCIC Operation (Reference 54) as a water source for RPV makeup.

9.2 Ultimate Heat Sink

The normal surface elevation of Clinton Lake is 690'. The UHS has a design water surface elevation of 675 feet, a surface area of 158 acres, a volume of 1054 acre-feet and a depth of 6.5 feet of water below the design water surface elevation. The FLEX pump takes suction on the UHS using two hydraulically driven submersible pumps suspended from a chainfall attached to a gantry crane inside the FLEX Storage Building. To limit the intake of silt and debris, the chainfall has sufficient length to submerge the pumps below the UHS design water surface elevation, but not enough length to place the pumps on the floor of the UHS.

The submersible pumps are fitted with a strainer box that precludes objects larger than 7/16" from entering the pump. This box is fixed on to the submersible and in such a way that the pump can be lifted with the chainfall and the strainer cleaned by hand if cleaning becomes necessary.

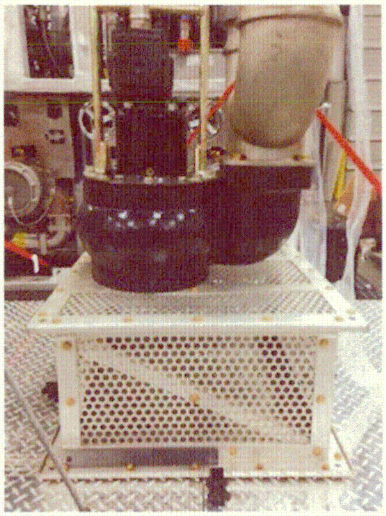

Figure 25 Submersible Pump Basket Strainer

The two submersible pumps provide the suction for the 3000 gpm diesel driven FLEX pump. The FLEX pump supplies the Diesel Generator Building FLEX Manifold via an unused underground Unit 2 SX pump 30" supply line. The manifold supplies the Unit 1 SX system which provides cooling to the RHR heat exchanger and a water supply for SFP emergency makeup. The manifold also supplies makeup water for the suppression pool and a "last resort" water supply for RPV makeup. The effect of material that could pass through the FLEX pump on systems supplied by the Diesel Generator Building FLEX Manifold is discussed below:

1) The RHR heat exchanger tubes have a 1/2" inside diameter and should not be adversely affected by the smaller material that could pass through the FLEX pump.

2) The fuel in the SFP is expected to remain submerged with only enough water added from the UHS to makeup for boil-off. Cooling of fuel in the SFP should not be affected by the material that could pass through the FLEX pump.

3) Makeup to the RPV with RCIC supplied from the suppression pool first passes through the common ECCS suction strainer, preventing solids >3/32" from entering the RCIC system and being injected into the RPV. Additionally, as discussed in section 9.1 above, the suppression pool water is less than 16% "contaminated" with lake water after 72 hours.

4) Makeup to the RPV with SF through the LPCI injection line and supplied from the suppression pool first passes through a pump suction strainer, preventing solids >1/8" from being injected into the RPV. Additionally, as discussed in section 9.1 above, the suppression pool water is less than 16% "contaminated" with lake water after 72 hours.

5) With respect to RPV makeup directly from the UHS, the LPCS and RHR-C connection points supply water to the RPV inside the shroud region. Adequate cooling is assured when the inside shroud region remains flooded because coolant can enter the fuel through the top of the fuel channels and maintain low fuel temperatures. This is based on BWROG report, BWROG-TP-15-007 (Reference 55). This report states "BWR fuel can be adequately cooled when the core inlet is postulated to be fully blocked from debris injected with the make-up coolant. The fuel is effectively cooled when the inside shroud is flooded, and this is accomplished by either injecting makeup coolant inside the shroud or by maintaining the water level above the steam separator return elevation if injecting make-up in the downcomer." This report also references an analysis performed for Byron and Braidwood for steam generator fouling. In the worst case, the evaluations determined that a deposition of ~6 cubic feet of debris occurs in a 72 hour period in a steam generator. The resulting heat transfer degradation from the effective reduction in U-tube surface area from deposited solids and the buildup of scale caused by the boil off of raw water was calculated to be 5.8% of rated heat transfer capability. This level of degradation is well below the threshold at which heat transfer capability is effectively lost for the decay heat load that exists at the point in time post shutdown that the heat transfer degradation occurs. Applying these results to a BWR reactor vessel which has a greater volume and more heat transfer surface area associated with the fuel cladding would imply that the results would be on a similar order of magnitude in that significant degradation in heat transfer capability is not anticipated. This will ensure cooling for at least 72 hours after commencing injection from the UHS. During this time, Clinton will develop recovery methods that will utilize a clean source of water. The recovery methods could include transition back to the suppression pool, arranging for clean water sources or other methods to filter water prior to injecting into the core.

10 Shutdown and Refueling Analysis

Clinton Power Station will abide by the Nuclear Energy Institute position paper entitled "Shutdown/Refueling Modes" (Reference 21) addressing mitigating strategies in shutdown and refueling modes. This position paper is dated September 18, 2013 and has been endorsed by the NRC staff (Reference 22). These mitigating strategies are defined below.

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

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

    - Outage conditions are highly diverse and will be a significant challenge to developing modifications, procedures and supporting analysis that will be valid under all shutdown/refueling conditions.

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

    - Resource availability is much greater and more diverse during outages, particularly during high risk evolutions such as shutdown and refueling mode operations and reduced inventory conditions (e.g., RPV water level below the vessel flange with irradiated fuel seated in the reactor vessel (BWR), mid-loop operation with fuel seated in the reactor vessel or reactor vessel head installed with Reactor Coolant System loops isolated (PWR)). This includes command and control structures to support event mitigation and recovery.

    - Shutdown Safety Management Program procedures require availability of a greater number of systems than required by plant Technical Specifications to ensure capability of key safety functions. Contingency plans are developed as required when the defense in depth is reduced below a specified minimum value. A defense in depth strategy is recognized by previous NRC and industry initiatives to improve shutdown safety.

2. No modifications, analyses, nor engineering evaluations need to be performed to support shutdown/refueling FLEX strategy implementation. This approach is fully consistent with the NEI position paper on shutdown/refueling modes and the NRC endorsement letter of the NEI position paper.

11 Sequence of Events

The Table 1 below presents a Sequence of Events (SOE) Timeline for an ELAP/LUHS event at Clinton. Validation of each of the FLEX time constraint actions has been completed in accordance the FLEX Validation Process document issued by NEI and includes consideration for staffing.

Table 1 Sequence of Events Timeline

Action item	Elapsed Time	Action	Time Constraint Y/N	Remarks / Applicability
	0	Event starts, Scram, Recirc Pumps Trip	NA	
1	Level 2 +30 sec	RCIC has started and begins to inject	NA	
2	10 min	Control level and pressure per procedures	Y	
3	29 min	Bypass RCIC leak detection isolation logic	Y	
4	1 hr	Defeat Low RCIC Steam Supply Pressure Isolation per CPS 4410.01C001, Defeating RCIC Interlocks	N	
5	1 hr	Initiate CPS 4200.01C003, Monitoring CNMT Temperatures During A SBO	N	
6	1 hr	Complete CPS 4200.01C002, DC Load Shedding During A SBO	Y	
7	1 hr	Initiate Beyond Design Basis FLEX Strategies	Y	
8	1 hr	Begin RPV depressurization to 150 psig with SRVs at 50°F/hr. Control RPV pressure between 150 and 250 psig.	N	

9	1 hr	Commence Lining Up FLEX generator	N	
10	1 hr	Commence UHS Pump Deployment	N	
11	2 hr	Place ADS Backup Air Bottles in service per CPS 3101.01, Main Steam (MS, IS & ADS).	Y	
12	5.5 hr	Energize MCC 1A3	N	
13	5.5 hr	Open the SPMU valves	Y	
14	5.5 hr	Energize MCC 1A1	N	
15	5.5 hr	Startup Div 1 Battery Charger and supply DC MCC 1A	Y	
16	5.5 hr	Energize Hydrogen Igniter Distribution Panel (MCC 1A1)	N	
17	5.5 hr	Energize DG MCC 1A and Standby Lighting Cabinet 1LL70EA	N	
18	6 hr	FLEX pump available for RPV makeup	Y	
19	6 hr	Open RCIC room doors	Y	
20	8 hr	Place FLEX suppression pool cooling strategy in service	Y	
21	8 hr	Makeup to Suppression Pool as needed	Y	
22	11 hr	Setup hoses and nozzles for the Spent Fuel Pool Spray strategy	Y	Based on SFP Area Conditions Following BDBEE calculation VF-54.
23	11 hr	Commence FLEX generator and pump refueling operations	Y	Based on actual consumption rate and 80% usage
24	12 hr	Initiate supplemental MCR ventilation per CPS 4200.01C001, MCR Cooling During A SBO	N	
25	12 hr	Commence Spent Fuel Pool makeup (>86 gpm) as needed	Y	
26	12 hr	Establish Fuel Bldg steam vent path	N	
27	24 hr	Commence recharging the ADS backup air bottles with a DG Starting Air Compressor	Y	
28	24 hr	First piece of RRC equipment arrives at the staging area	N	
29	30 hr	Establish RCIC Pump Room compensatory action (portable fan)	Y	

30	24-72 hr	Continue to maintain critical functions of core cooling (via RCIC), containment (via alternate suppression pool cooling) and SFP cooling (FLEX pump injection to SFP). Utilize initial RRC equipment in spare capacity.	N	

12 Programmatic Elements

12.1 Overall Program Document

Clinton procedure CC-CL-118 (Reference 46) provides a description of the Diverse and Flexible Coping Strategies (FLEX) Program for Clinton. This procedure implements Exelon fleet program document CC-AA-118 which contains governing criteria and detailed requirements. The key elements of the program include:

- Summary of the Clinton FLEX strategies
- Maintenance of the FSGs including any impacts on the interfacing procedures (EOPs, OPs, ONs, etc.)
- Maintenance and testing of FLEX equipment (i.e., SFP level instrumentation, emergency communications equipment, portable FLEX equipment, FLEX support equipment, and FLEX support vehicles)
- Portable equipment deployment routes, staging areas, and connections to existing mechanical and electrical systems
- Validation of time critical operator actions
- The FLEX Storage Building and the Regional Response Center
- Supporting evaluations, calculations, and FLEX drawings
- Tracking of commitments and FLEX equipment unavailability
- Staffing and Training
- Configuration Management
- Program Maintenance

The instructions required to implement the various elements of the FLEX Program at Clinton and thereby ensure readiness of in the event of a BDBEE are contained in

Exelon fleet program document CC-AA-118, Diverse and Flexible Coping Strategies (FLEX) and Spent Fuel Pool Instrumentation Program Document.

Design control procedure CC-AA-102, Design Input and Configuration Impact Screening (Reference 47) has been revised to ensure that changes to the plant design, physical plant layout, roads, buildings, and miscellaneous structures will not adversely impact the approved FLEX strategies.

Design control procedure CC-AA-309-101, Engineering Technical Evaluations (Reference 75) has been revised to ensure technical evaluations are performed when new information is received that potenetially challenges the conservatism of current external event design assumptions.

Future changes to the FLEX strategies may be made without prior NRC approval provided 1) the revised FLEX strategies meet the requirements of NEI 12-06 or a previously approved alternate approach, and 2) an engineering basis is documented that ensures that the change in FLEX strategies continues to ensure the key safety functions (core and SFP cooling, containment integrity) are met.

12.2 Procedural Guidance

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

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

Procedural interfaces have been incorporated into CPS 4306.01 Extended Loss of AC Power / Loss of Ultimate Heat Sink (Reference 31) to the extent necessary to include appropriate reference to FSGs and provide command and control for the ELAP.

Changes to FSGs are controlled by Exelon fleet procedure AD-AA-101, Processing of Procedures and T&RMs (Reference 48). FSG changes will be reviewed and validated by the involved groups to the extent necessary to ensure the strategy remains feasible. Validation for existing FSGs has been accomplished in accordance with the guidelines provided in NEI APC14-17, FLEX Validation Process, issued July 18, 2014 (Reference 49).

12.3 Staffing

Using the methodology of NEI 12-01, Guideline for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities (Reference 7), an assessment of the capability of Clinton on-shift staff and augmented Emergency Response Organization (ERO) to respond to a BDBEE was performed (Reference 50).

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

1) an extended loss of AC power (ELAP)
2) an extended loss of access to ultimate heat sink (UHS)
3) impact on units (the unit is in operation at the time of the event)
4) impeded access to the unit by off-site responders as follows:
    - 0 to 6 Hours Post Event – No site access.
    - 6 to 24 Hours Post Event – Limited site access. Individuals may access the site by walking, personal vehicle or via alternate transportation capabilities (e.g., private resource providers or public sector support).
    - 24+ Hours Post Event – Improved site access. Site access is restored to a near-normal status and/or augmented transportation resources are available to deliver equipment, supplies and large numbers of personnel.

Clinton Operations personnel conducted a table-top review of the on-shift response to the postulated BDBEE and extended loss of AC power for the Initial and Transition Phases using the FLEX mitigating strategies. Resources needed to perform initial event response actions were identified from the Emergency Operating Procedures (EOPs) and CPS 4306.01 Extended Loss of AC Power/Loss of Ultimate Heat Sink (Reference 31). Particular attention was given to the sequence and timing of each procedural step, its duration, and the on-shift individual performing the step to account for both the task and time motion analyses of NEI 10-05, Assessment of On-Shift Emergency Response Organization Staffing and Capabilities.

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

The Phase 2 Staffing Assessment also identified the staffing necessary to support the Expanded Response Capability for the BDBEE as defined for the Phase 2 staffing assessment. This staffing will be provided by the current Clinton site resources, supplemented by Exelon fleet resources, as necessary.

12.4 Training

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

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

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

Where appropriate, integrated FLEX drills will be conducted periodically; with all time-sensitive actions evaluated over a period of not more than eight years. It is not required to connect/operate temporary/permanently installed equipment during these drills.

13 FLEX Equipment

13.1 Equipment List

The equipment stored and maintained at the Clinton FLEX Storage Building and various pre-staged locations at Clinton necessary for the implementation of the FLEX strategies in response to a BDB external event are listed in Table 3. Table 3 identifies the quantity, applicable strategy, and capacity/rating for the major BDB/FLEX equipment components only, as well as, various clarifying notes. Details regarding fittings, tools, hose lengths, consumable supplies, etc., are not in Table 3 but are detailed in CPS 3822.04C007 FLEX Equipment Checklist (Reference 56).

13.2 Equipment Maintenance and Testing

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

EPRI has completed and has issued "Preventive Maintenance Basis for FLEX Equipment – Project Overview Report" (Reference 51). Preventative Maintenance Templates for the major FLEX equipment including the portable diesel pumps and generators have also been issued.

The PM Templates include activities such as:

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

The EPRI PM Templates for FLEX equipment conform to the guidance of NEI 12-06 providing assurance that stored or pre-staged FLEX equipment are being properly maintained and tested. EPRI Templates are used for equipment where applicable. However, in those cases where EPRI templates were not available, Preventative Maintenance (PM) actions were developed based on manufacturer provided information/recommendations and Exelon fleet procedure ER-AA-200, Preventive Maintenance Program. Refer to Table 2 for an overview. Detailed information on FLEX and FLEX support equipment PM's is contained in FLEX program document CC-CL-118 (Reference 46).

Table 2 Clinton FLEX Equipment Test and Maintenance Overview

Equipment	Quantity	Weekly	Quarterly	6 Month	Annual	3 Year	Notes
Diesel Pump FP3000DJ-TCL	2	Walk down		Functional Test and Inspection			Performance Test, Inspection & PM (Wet Run) once per cycle
Diesel Generator (Cummins 500 kW)	2	Walk down		Functional Test and Inspection (Unloaded Run)	Performance Test, Inspection and PM (30% Loaded Run)	Performance Test, Inspection and PM (100% Loaded Run)	
Cables	Stored in Plant (see 3822.04C007 for location)				Visual Inspection & assessment		Replace every 10 years or test and justify extension/life
Hoses (for both pumps and permanent connections hoses)	Stored in Plant and FLEX Building(see 3822.04C007 for location)				Visual Inspection & assessment	Hydrostatic test of all hoses	Replace every 10 years
Communications (hand-held radios, Sound powered phones, 120VAC generators)	12 - SPP 3 - 120VAC generators 22 - radios			Functional test & inspection (Radios), Functional test including associated FLEX circuits (sound powered phones)		Inspection (small 120VAC generators)	

13.3 Equipment Unavailability

The unavailability of FLEX equipment and applicable connections that directly perform a FLEX mitigation strategy for core, containment, and SFP is controlled and managed per CC-CL-118 such that risk to mitigating strategy capability is minimized. The guidance in this procedure 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.

FLEX support equipment is defined as equipment not required to directly support maintenance of the key safety functions. There are no requirements specified in NEI 12-06 for unavailability time for any of the FLEX support equipment. This equipment is important to the successful Implementation of the Clinton FLEX strategy and Exelon requires establishment of an unavailability time (Reference 58).

- One or more pieces of FLEX support equipment available but not in its evaluated configuration for protection restore protection within 90 days.
- One or more pieces of FLEX support equipment is unavailable, restore the equipment to available within 45 days AND implement compensatory measures for the lost function within 72 hours.

When FLEX equipment deficiencies are identified the following action will be taken:

1. Identified equipment deficiencies shall be entered into the corrective action program.
2. Equipment deficiencies that would prevent FLEX equipment from performing the intended function shall be worked under the station priority list in accordance with the work management process.
3. Equipment that cannot perform its intended functions shall be declared unavailable. Unavailability **shall** be tracked per CC-CL-118, utilizing the electronic Shift Operations Management System (eSOMS).

Table 3 Portable Equipment Stored On-Site

Use and (Potential / Flexibility) Diverse Uses						
List Portable Equipment	**Core**	**Containment**	**SFP**	**Instrumentation**	**Accessibility**	***Performance Criteria***
FLEX diesel-driven pump (2) and assoc. hoses and fittings	X	X	X			3000 gpm @ 150 psig, Supports core, containment and SFP cooling
FLEX generators (2) and associated cables, connectors	X	X	X	X		500 kW, 480 VAC, Supports core, containment and SFP cooling, instrumentation and controls
Tow vehicle (1)	X	X	X		X	Support large FLEX equipment deployment and debris removal
Fuel trailer (1) with 500 gal. tank and pump	X	X	X	X	X	Support adding fuel to diesel engine driven FLEX equipment
Portable fuel transfer pumps (2)[1]	X	X	X	X	X	Support adding fuel to diesel engine driven FLEX equipment

Table 3 Portable Equipment Stored On-Site (cont.)

	Use and (Potential / Flexibility) Diverse Uses					
List Portable Equipment	***Core***	***Containment***	***SFP***	***Instrumentation***	***Accessibility***	***Performance Criteria***
Communications equipment[1] (SPP, spare radio batteries and chargers, handheld satellite phones)	X	X	X	X	X	Support on-site and off-site communications
Communications small portable generator. (3)[1]	X	X	X	X	X	5.5 kW, 120 VAC, Support communication equipment
Misc. debris removal equipment[1] (large bolt cutters, proximity voltage detector)					X	Support FLEX deployment
Misc. Support Equipment[1] (hand tools, flashlights & batteries, lanterns, extension cords, spill kits, rope)					X	Support FLEX deployment
NOTE 1: Support equipment. Not required to meet N+1.						

Table 4 BWR Portable Equipment from NSRC

Use and (Potential / Flexibility) Diverse Uses									Performance Criteria		Notes
List Portable Equipment	Quantity Req'd /Unit	Quantity Provided / Unit	Power	Core Cooling	Cont. Cooling/ Integrity	Access	Instrumentation.	SFP Cooling			
Medium Voltage Generators	0	2	Jet Turb.	X	X		X		4.16 kV	1 MW	(1)
Low Voltage Generators	1	1	Jet Turb	X	X		X		480VAC	1100 KW	(1)
High Pressure Injection Pump	0	1	Diesel						2000psi	60 GPM	(1)
S/G RPV Makeup Pump	1	1	Diesel	X	X				500 psi	500 GPM	(1)
Low Pressure / Medium Flow Pump	1	1	Diesel	X	X				300 psi	2500 GPM	(1)
Low Pressure / High Flow Pump	0	1	Diesel	X	X			X	150 psi	5000 GPM	(1)

Table 4 BWR Portable Equipment from NSRC (cont.)

Use and (Potential / Flexibility) Diverse Uses									Performance Criteria		Notes
List Portable Equipment	**Quantity Req'd /Unit**	**Quantity Provided / Unit**	**Power**	**Core Cooling**	**Cont. Cooling/ Integrity**	**Access**	**Instrumentation.**	**SFP Cooling**			
Lighting Towers	3	3	Diesel			X			440,000 Lu		(1)
Diesel Fuel Transfer	1	1	AC/DC	X	X	X	X	X	500 gallon air-lift container		(1)
Diesel Fuel Transfer Tank	1	1							264 gallon tank, with mounted AC/DC pumps		(1)
Portable Fuel Transfer Pump	1	1							60 gpm after filtration		(1)
Electrical Distribution System	1	1							4160 V	250 MVA, 1200 A	(1)
Suction Booster Lift Pump	2	2	Diesel	X	X			X	26 Feet Lift	5000 GPM	(2)

Note 1 NSRC Generic Equipment – Not required for Phase 2 FLEX Strategy – Provided as Defense-in-Depth.

Note 2 NSRC Non-Generic Equipment needed to support use of NSRC Generic Pumps due to suction lift requirements using Clinton Lake as source of make-up water. – Not required for Phase 2 FLEX Strategy – Provided as Defense-in-Depth

14 References

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22) NRC Endorsement of NEI Shutdown and Refueling paper: ADAMS Accession No. ML13267A382
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27) USAR 6.2.2.2
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29) NUMARC 87-00 Rev 1, Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors
30) CPS 4200.01C003 Monitoring Cnmt Temperatures During a SBO
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32) CPS 4402.01, Rev 030, EOP-6 Primary Containment Control
33) EXC-WP-10_ RCIC Operation at Elevated Temperatures_Rev. 1
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35) EC 401985 EQ Review Of FLEX Components in the Containment and Drywell
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