Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402

EA-12-049

February 28, 2013

10 CFR 2.202

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

Browns Ferry Nuclear Plant, Units 1, 2, and 3
Facility Operating License Nos. DPR-33, DPR-52, and DPR-68
NRC Docket Nos. 50-259, 50-260, and 50-296

Subject: **Tennessee Valley Authority (TVA) - Overall Integrated Plan in Response to 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) for Browns Ferry Nuclear Plant**

References:

1. NRC Order Number EA-12-049, "Issuance of Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," dated March 12, 2012 (ML12054A735)

2. NRC Interim Staff Guidance JLD-ISG-2012-01, "Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," Revision 0, dated August 29, 2012 (ML12229A174)

3. NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," Revision 0, dated August 2012 (ML12242A378)

4. Letter from TVA to NRC, "Tennessee Valley Authority - Initial Status Report in Response to March 12, 2012, Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design- Basis External Events (Order Number EA-12-049)," dated October 29, 2012 (ML12307A104)

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On March 12, 2012, the Nuclear Regulatory Commission (NRC) issued an immediately effective order (Order Number EA-12-049) entitled "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies For Beyond-Design-Basis External Events" to "All Power Reactor Licensees and Holders of Construction Permits in Active or Deferred Status" (Reference 1). The Order indicated that, as a result of the NRC's evaluation of the lessons learned from the March 2011 accident at Fukushima Dai-ichi, the NRC determined that certain actions are required by nuclear power plant licensees and construction permit holders. Specifically, the NRC required additional defense-in-depth measures to address uncertainties associated with protection from beyond-design-basis events. With respect to this Order, the NRC determined that all power reactor licensees and construction permit holders must "develop, implement, and maintain guidance and strategies to maintain or restore core cooling, containment, and SFP [spent fuel pool] cooling capabilities following a beyond-design-basis external event." Specific requirements are outlined in Attachment 2 to the Order.

The Order requires submission of an overall integrated plan, including a description of how compliance with the requirements described in Attachment 2 of the Order will be achieved. The Order requires the plan to be submitted to the NRC for review by February 28, 2013. In addition, the Order requires submission of an initial status report 60 days following issuance of the final interim staff guidance and at six month intervals following submittal of the overall integrated plan, which delineates progress in implementing the requirements of the Order. The interim staff guidance containing specific details on implementation of the requirements of the order was scheduled to be issued in August 2012. Finally, the order requires full implementation of its requirements no later than two refueling cycles after submittal of the overall integrated plan, or December 31, 2016, whichever comes first, or prior to issuance of an operating license for units under construction.

The NRC issued Interim Staff Guidance on August 29, 2012 (Reference 2) which endorses industry guidance document NEI 12-06, Revision 0 (Reference 3) with clarifications and exceptions identified in Reference 2. Reference 3, Section 13.1 contains the specific reporting requirements for the overall integrated plan.

By letter dated October 29, 2012 (Reference 4), TVA submitted an initial status report regarding the progress in establishing mitigation strategies for beyond-design-basis external events, as required by the Reference 1 Order.

The purpose of this letter is to provide the overall integrated plan pursuant to Section IV, Condition C.1.a, of Reference 1. This letter confirms TVA has received the Reference 2 interim staff guidance and has an overall integrated plan developed in accordance with the provided guidance for the Browns Ferry Nuclear Plant (BFN) to define and deploy strategies that will enhance the ability to cope with conditions resulting from beyond-design-basis external events.

The information in the enclosure to this letter provides the BFN overall integrated plan for mitigation strategies using the guidance contained in Reference 3. The integrated plan is based on conceptual design information. Final design details and associated procedure guidance, status of open items identified in the Enclosure, as well as any revisions to the information contained in the Enclosure, will be provided in the 6-month integrated plan updates required by Reference 1.

The Enclosure describes the plans that TVA will use to meet the regulatory requirements outlined in Attachment 2 of Reference 1, but does not identify any additional actions to be taken by TVA. Therefore, this letter contains no regulatory commitments.

If you have any questions regarding this report, please contact Kevin Casey at (423) 751-8523.

I declare under penalty of perjury that the foregoing is true and correct.
Executed on the 28th day of February 2013.

Respectfully,

J. W. Shea
Vice President, Nuclear Licensing

Enclosure:

Browns Ferry Nuclear Plant, Mitigation Strategies for Beyond-Design-Basis External Events Overall Integrated Plan

cc (Enclosure):

NRR Director - NRC Headquarters
NRO Director - NRC Headquarters
NRC Regional Administrator - Region II
NRR Project Manager - Browns Ferry Nuclear Plant
NRC Senior Resident Inspector - Browns Ferry Nuclear Plant

ENCLOSURE

BROWNS FERRY NUCLEAR PLANT

MITIGATION STRATEGIES FOR BEYOND-DESIGN-BASIS EXTERNAL EVENTS OVERALL INTEGRATED PLAN

General Integrated Plan Elements (PWR & BWR)

(Section 1) Determine Applicable Extreme External Hazard **Ref: NEI 12-06, section 4.0 -9.0** **JLD-ISG-2012-01, section 1.0**	*Input the hazards applicable to the site; seismic, external flood, high winds, snow, ice, cold, high temps.* *Describe how NEI 12-06 sections 5 – 9 were applied and the basis for why the plant screened out for certain hazards.*

The Browns Ferry Nuclear Plant (BFNP) has been evaluated using the Nuclear Energy Institute (NEI) Flexible and Diverse Coping Mitigation Strategies (FLEX) guidance and the following applicable hazards have been identified:

- seismic events,
- external flooding,
- storms with high winds and tornadoes,
- snow, ice, extreme cold and
- extreme heat.

Browns Ferry Nuclear Plant has determined the functional threats from each of these hazards and identified FLEX equipment that may be affected. The FLEX equipment and FLEX strategies consider the impacts of the applicable external hazards and will address protection and deployment of FLEX equipment, procedural interfaces, and utilization of on-site and off-site resources.

<u>Seismic Hazard Assessment</u>

Per NEI 12-06, seismic hazards must be considered for all nuclear sites. As a result, the credited FLEX equipment will be assessed based on current BFNP seismic licensing basis to ensure that the equipment remains accessible and available after a Beyond-Design-Basis External Event (BDBEE) and that the FLEX equipment does not become a target or source of a seismic interaction from other systems, structures, or components (Open Item, OI 9). Per the BFNP Units 1, 2, and 3 Updated Final Safety Analysis Reports (UFSAR) section 2.5 (Ref. 1d) for a Design Basis Earthquake (DBE) / Safe Shutdown Earthquake (SSE) the maximum rock acceleration requirements are 0.2g horizontal and 0.133g vertical. For an Operating Basis Earthquake (OBE), the maximum horizontal and vertical ground accelerations are 0.1g and 0.067g. The FLEX strategies developed for BFNP will include documentation ensuring that any storage locations and deployment routes meet the FLEX seismic criteria (Open Item, OI 14).

<u>Liquefaction</u>

The liquefaction potential of all FLEX deployment routes will be addressed in a future assessment (Open Item, OI 2).

(Section 1) Determine Applicable Extreme External Hazard

Ref: NEI 12-06, section 4.0 -9.0
JLD-ISG-2012-01, section 1.0

External Flooding Hazard Assessment

Browns Ferry Nuclear Plant is susceptible to flooding via two sources:

- local intense precipitation and
- river flooding.

The Probable Maximum Flood (PMF) will reach a maximum still-water elevation of 572.5', per UFSAR section 2.4A (Ref. 1c). A maximum flood elevation of 578' at BFNP results from a combination of the PMF and wind wave run-up on a vertical wall per UFSAR (Ref. 1c). Browns Ferry Nuclear Plant structures, located in the flood plain which house equipment important to safety are designed to remain watertight by utilizing both permanently installed and temporary barriers. The FLEX strategies developed for BFNP will include documentation ensuring that any storage locations, deployment routes, and connection points meet the FLEX flooding criteria or are at an elevation not susceptible to flooding (except for those strategy elements not credited for flooding). In addition, BFNP is also developing procedures and strategies for delivery of offsite FLEX equipment during Phase 3 which considers regional impacts from flooding (Open Item, OI 14).

Storms with High Winds and Tornadoes Hazards Assessment

NEI 12-06 Figures 7-1 and 7-2 were used for this assessment.

Browns Ferry Nuclear Plant is susceptible to hurricanes, as the plant is within the contour lines shown in NEI 12-06 Figure 7-1 (Ref. 3a).

It was determined that BFNP site has the potential to experience damaging winds caused by tornado exceeding 130 mph. Figure 7-2 of NEI 12-06 indicates a maximum wind speed of 200 mph for Region 1 plants, including BFNP. Therefore, high-wind hazards are applicable to BFNP. It should be noted that BFNP was designed to 300 mph wind loads.

In summary, based on available local data and NEI 12-06 Figures 7-1 and 7-2 (Ref. 3a & 3b) BFNP is susceptible to severe storms with high winds so the hazard is considered to be credible.

Snow, Ice, and Extreme Cold Hazards Assessment

Per NEI 12-06 (Ref. 3) all sites should consider the temperature ranges and weather conditions for their site in storing and deploying their FLEX equipment. Equipment procured should be suitable for use in the anticipated range of conditions for the site, consistent with normal design practices.

(Section 1) Determine Applicable Extreme External Hazard

Ref: NEI 12-06, section 4.0 -9.0
JLD-ISG-2012-01, section 1.0

Applicability of snow and extreme cold

As depicted in NEI 12-06 Figure 8-1 (Ref. 3c) for plants located below the 35th parallel, snow and extreme cold events are unlikely to present a significant problem for deployment of FLEX. Browns Ferry Nuclear Plant is below the 35th parallel; however, based on historical data collected from both NEI 12-06 Figure 8-1 (Ref. 3c) and the BFNP UFSAR, snowfalls in excess of 6 inches have occurred in the past. Browns Ferry Nuclear Plant UFSAR section 2.3.5.3 (Ref. 1b) references snowfall reports of 17.1, 10.1, and 10.0 inches near BFNP. Per UFSAR section 2.3.5.1 (Ref. 1a), in a typical year, Decatur, Alabama (located approximately 10 miles southeast of BFNP) has approximately 57 days per year with minimum temperatures equal to or less than 32°F with an extreme daily temperature record of -12°F. Therefore, the FLEX strategies will consider the challenges caused by extreme snowfall and extremely cold temperatures.

Applicability of ice storms

Browns Ferry Nuclear Plant is located in either ice severity level 4 or 5 region, defined by NEI 12-06 Figure 8-2 (Ref. 3d). Browns Ferry Nuclear Plant FLEX strategies will consider impedances caused by ice storms.

In summary, based on the available local data and NEI 12-06, Figures 8-1 and 8-2 (Ref. 3c & 3d) BFNP does experience significant amounts of snow, ice, and extreme cold temperatures; therefore, the hazards are considered to be credible.

Extreme Heat

Per NEI 12-06 (Ref. 3) all sites must address high temperatures. Virtually every state in the lower 48 contiguous United States has experienced temperatures in excess of 110°F. Many states have experienced temperatures in excess of 120°F. Per the UFSAR section 2.3.5.1, in a typical year, Decatur, Alabama (located approximately 10 miles southeast of BFNP) has approximately 70 days per year with maximum temperatures equal to or greater than 90°F, with an extreme daily temperature record of 108°F.

Selection of BFNP FLEX equipment will consider the site maximum expected temperatures in their specification, storage, and deployment requirements, including adequate ventilation or supplementary cooling, as required.

(Section 1) Determine Applicable Extreme External Hazard

Ref: NEI 12-06, section 4.0 -9.0
JLD-ISG-2012-01, section 1.0

References:

1. Browns Ferry Nuclear Plant (BFNP) Updated Final Safety Analysis Report (UFSAR)
    a. Section 2.3.5.1
    b. Section 2.3.5.3
    c. Section 2.4
    d. Section 2.5
2. Draft Interim Staff Guidance JLD-ISG-2012-01, Compliance with Order EA-12-049, “Order Modifying Licenses with Regard to Requirements for Mitigating Strategies for Beyond-Design-Basis External Events”; Docket ID NRC-2012-0068
3. NEI 12-06, “Diverse and Flexible Coping Strategies (FLEX) Implementation Guide”
    a. Figure 7-1
    b. Figure 7-2
    c. Figure 8-1
    d. Figure 8-2

Notes:

None

(Section 2) Key Site assumptions to implement NEI 12-06 strategies. **Ref: NEI 12-06, section 3.2.1**	*Provide key assumptions associated with implementation of FLEX Strategies:* • *Flood and seismic re-evaluations pursuant to the 10 CFR 50.54(f) letter of March 12, 2012 are not completed and therefore, not assumed in this submittal. As the re-evaluations are completed, appropriate issues will be entered into the corrective action system and addressed on a schedule commensurate with other licensing bases changes.* • *Exceptions for the site security plan or other (license/site specific) requirements of 10CFR may be required.* • *Deployment resources are assumed to begin arriving at hour 6 and fully staffed by 24 hours.* • *Certain Technical Specifications cannot be complied with during FLEX implementation.*

Key assumptions associated with implementation of Flexible and Diverse Coping Mitigation Strategies (FLEX) Strategies for Browns Ferry Nuclear Plant (BFNP) are described below:

Flood and seismic re-evaluations pursuant to the 10 CFR 50.54(f) letter of March 12, 2012 (Ref. 1) are not completed and therefore, not assumed in this submittal. As the re-evaluations are completed, appropriate issues will be entered into the corrective action program and addressed (Open Item, OI 1).

- The following conditions exist for the baseline case:
  - Seismically designed DC battery banks are available;
  - Seismically designed AC and DC distribution panels are available;
  - Plant initial response is the same as for Station Blackout (SBO);
  - Best estimate analysis and decay heat is used to establish requirements for operator time and action;
  - System, Structure, or Component (SSC) failures that are random or due to causes beyond those stipulated in the Order are not assumed.
- Margin will be added to design FLEX components and hard connection points to address future requirements as re-evaluation warrants. Portable FLEX components will be procured commercially.
- The design hardened connections shall be protected against external events or are established at multiple and diverse locations.
- Deployment strategies and deployment routes are assessed for impact due to identified hazards (Open Item, OI 14).
- Phase 2 FLEX components are stored at the site and available after the event they are designed to mitigate.

(Section 2) Key Site assumptions to implement NEI 12-06 strategies.

Ref: NEI 12-06, section 3.2.1

- Additional staff resources are expected to begin arriving at 6 hours and the site will be fully staffed 24 hours after the event. (Ref. 2)
- Exceptions for the site security plan or other (license/site specific) requirements may be identified during the design process. These exceptions will be processed when they are identified.
- FLEX assumes that:
  (1) On-site staff are at site administrative minimum shift staffing levels (minimum staffing may include additional staffing that is procedurally brought on-site in advance of a predicted external event, e.g., hurricane or flood);
  (2) There are no independent, concurrent events, e.g., no active security threat;
  (3) All personnel on-site are available to support site response (including Security, etc.).

  The normal emergency response capabilities are augmented by NEI 12-01 (Ref. 4). Staffing will continue to be developed further as the design phase for FLEX progresses. (Open Item, OI 15)
- Though specific strategies are being 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 will be incorporated into the unit Operating Procedures in accordance with established procedure change processes, and their impact to the design basis capabilities of the unit evaluated under 10 CFR 50.59. (Open Item, OI 17) 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. Per Final Response to Task Interface Agreement (TIA) 2004-04 (Ref. 3) the result of the beyond-design-basis event may place the plant in a condition where it cannot comply with certain Technical Specifications, and as such, may warrant invocation of 10 CFR 50.54(x) and/or 10 CFR 73.55(p).

[redacted]

(Section 2) Key Site assumptions to implement NEI 12-06 strategies.

Ref: NEI 12-06, section 3.2.1

References:

1. 10 CFR 50.54(f)
2. BWR Owners' Group – "Emergency Procedure and Severe Accident Guidelines", Revision 3 (February 2013)
3. Final Response to Task Interface Agreement (TIA) 2004-04, "Acceptability of Proceduralized Departures from Technical Specifications (TSs) Requirements at the Surry Power Station, (TAC Nos. MC4331 and MC4332)," dated September 12, 2006 (Accession No. ML060590273)
4. NEI 12-01, "Guideline for Assessing Beyond-Design-Basis Accident Response Staffing and Communications Capabilities"
5. NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide"

Notes:

None

Section 3) Extent to which the guidance, JLD-ISG-2012-01 and NEI 12-06, are being followed. **Identify any deviations to JLD-ISG-2012-01 and NEI 12-06.** **Ref: JLD-ISG-2012-01** **NEI 12-06, section 13.1**	*Include a description of any alternatives to the guidance, and provide a milestone schedule of planned action.*

Browns Ferry Nuclear Plant has no known deviations to the guidelines in JLD-ISG-2012-01 (Ref. 1) and NEI 12-06 (Ref. 2). If deviations are identified, then the deviations will be communicated in a future "6 month update" following identification.

<u>References</u>:

1. Draft Interim Staff Guidance JLD-ISG-2012-01, Compliance with Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigating Strategies for Beyond-Design-Basis External Events"; Docket ID NRC-2012-0068
2. NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide"

<u>Notes:</u>

<u>None</u>

(Section 4) Provide a sequence of events and identify any time constraint required for success including the technical basis for the time constraint. **Ref: NEI 12-06, section 3.2.1.7** **JLD-ISG-2012-01, section 2.1**	*Strategies that have a time constraint to be successful should be identified with a technical basis and a justification provided that the time can reasonably be met (for example, a walkthrough of deployment).* *Describe in detail in this section the technical basis for the time constraint identified on the sequence of events timeline Attachment 1A* *See attached sequence of events timeline (Attachment 1A).* *Technical Basis Support information, see attached NSSS Significant Reference Analysis Deviation Table (Attachment 1B)*

<u>Discussion of time constraints identified in Attachment 1A table.</u>

Items 1-3: For floods, plant shutdown begins when river level reaches 558' per Abnormal Operating Instruction, 0-AOI-100-3 (Ref 1b). This is more than 4 days before flood waters would reach plant grade level (565', based on UFSAR Section 2.4 Ref. 3a). Deployment of Flexible and Diverse Coping Mitigation Strategies (FLEX) Pumping Systems must be complete before flood waters reach the transport path, which shall be at plant grade or higher. FLEX Pumping System deployment has been estimated by walkthrough to take 8 hours (to be confirmed during the design/staffing evaluation process). A Beyond-Design-Basis Flood (BDBF) would not exceed the maximum flood height for which Emergency Core Cooling System (ECCS) equipment is qualified for at least another 36 hours based on the Updated Final Safety Analysis Report (UFSAR) estimate above (Ref. 3a). Start-up of the 4 kV and 480 V FLEX Diesel Generators (DG) (225 kVA and 3 MWe) can be performed after the normal emergency diesel generators are lost.

Item 4: BDBF begins when Design Basis Flood (DBF) peak level is exceeded. (Peak elevation and timing based on UFSAR Section 2.4, Figure 16 (Ref. 3ai)).

Item 5: All 3 units are assumed to be in power operation unless previously shutdown by a procedure driven by the postulated event. For floods, FLEX deployment would have already been complete and the units would be at or near cold shutdown.

Item 6: Normal plant response to loss of offsite power.

Item 7: Normal plant response to loss of offsite and onsite AC power (Station Blackout, SBO)

Item 8: Dispatch personnel to deploy the Diesel Driven FLEX Pumping Systems, FPS1,FPS2, FPS3, FPS4 and commence laying hose, as required. (Note: these pumps will have already been deployed for a DBF (see Item 2). Plant Staff will begin establishing the FLEX pumps as soon as notified that the station is in an SBO (*before* the rest of the FLEX procedures are entered). New procedure guidance is to be developed as part of the FLEX Support Guidelines (FSGs).

(Section 4) Provide a sequence of events and identify any time constraint required for success including the technical basis for the time constraint.

Ref: **NEI 12-06, section 3.2.1.7**
JLD-ISG-2012-01, section 2.1

Table top evaluation and demonstration with one pump assembly (without augmented suction lift pumps) was performed by site personnel to obtain an 8 hour estimate for deploying all the FLEX pumps and hoses. A formal validation of the timeline will be performed once the procedure guidance is developed and related staffing study is completed (Open Item, OI 16).

Item 9: Reactor Pressure Vessel (RPV) controlled depressurization will be governed by new BWROG Emergency Procedure Guideline (EPG) guidance (Ref. 5 and 7). Based on the modeling in the evaluation, plant systems were demonstrated to support requirements for core cooling, and containment integrity. Since Operators will still be in the design basis SBO procedures, the SBO procedures must also stipulate this depressurization until the conditions for exiting the design basis SBO procedures are met. Main Steam Relief Valve (MSRV) control is maintained from the control room with sufficient DC power and pneumatic pressure to operate the MSRVs throughout Phase 1 and Phase 2 (if required). According to GEH studies (Ref. 7), the MSRV pilot solenoid coil electrical resistance will increase due to a higher containment temperature with a longer duration event than an existing SBO coping time. Browns Ferry Nuclear Plant will evaluate MSRV qualification against the predicted containment response with FLEX implementation to ensure there will be sufficient DC bus voltage during the Extended Loss of AC Power (ELAP) event (Open Item, OI 4). If required, there will be a modification to increase voltage as necessary to achieve the necessary coil current, or modifications will be made to reduce the coil resistance under higher temperature conditions. Because the MSRV control system will be exhausting control gas to the containment and containment pressure will be higher, BFNP is evaluating methods to establish any required increases in pneumatic supply pressure and modifications that may be required to ensure a supply of control gas for the MSRVs over the longer ELAP interval.

Item 10: 1 hour, **Entry into ELAP** - *Time critical at a time greater than 1 hour.*
A period of one hour is selected conservatively to ensure that ELAP entry conditions can be verified by control room staff and it is validated that Emergency Diesel Generators (EDGs) are not available. One hour is a reasonable assumption for Operators to perform initial evaluation of the EDGs. Entry into ELAP provides guidance to Operators to perform ELAP actions. A formal validation of the timeline will be performed once the procedure guidance is developed and related staffing study is completed (Open Item, OI 15, 16).

(Section 4) Provide a sequence of events and identify any time constraint required for success including the technical basis for the time constraint.

Ref: **NEI 12-06, section 3.2.1.7**
JLD-ISG-2012-01, section 2.1

Item 11: 1 hour, **Mission to start 480 V FLEX Diesel Generators**, FDMG1,FDMG2, FDMG3 - *Complete by 2 hours after event (1 hour after notification to start).*
480 V FLEX DGs will be mounted in an accessible area on the diesel building roof. They are directly accessible from the control bay without going out of doors, except at the roof level. The units will be designed so that starting and aligning them will be simple. A formal validation of the timeline will be performed once the procedure guidance is developed and related staffing study is completed (Open Item, OI 15, 16).

Item 12: **Dispatch Operations (OPS) personnel to perform electrical lineups for 4 kV FLEX Diesel Generators**. *This item must be complete at T+8 hours.*
If the event is a flood, procedures will require OPS to man the FLEX bunker building. The 4 kV FLEX DGs can be started locally. They are lined up at the 4 kV Shutdown Boards which are immediately accessible from the control room.
A formal validation of the timeline will be performed once the procedure guidance is developed and related staffing study is completed (Open Item, OI 15, 16).

Item 13: Conditional - **ONLY IF** one or more 480 V FLEX Diesel Generators did NOT start and load, **Commence a shallow DC load shed only for those 480 V FLEX Diesel Generators that did NOT start.** *(Note: Load shed not applicable to flood because the 4 kV FLEX DGs would already be available as an alternative to the 480 V FLEX DGs.)*

An extreme tornado could exceed the protection limits for more than one 480V FLEX DG. (A beyond-design-basis tornado for BFNP would exceed 300MPH; protection for the FLEX DGs shall bear 230 MPH based on NRC region 1 tornado, missiles, and velocities defined in NRC Regulatory Guide 1.76 Revision 1). The 480 V FLEX DGs shall be protected from other beyond-design-basis events listed in Section 1. New procedure guidance is to be developed as part of the FSGs. Initial load shedding must be complete by T+4 to extend battery capability to 12 hours (Ref. 2).

A table top evaluation was performed by site personnel to obtain a one hour estimate, leaving a margin of one hour (before T+4). A formal validation of the timeline will be performed once the procedure guidance is developed and related staffing study is completed (Open Item, OI 15, 16). The breakers to be operated are in the control bay in normally accessible areas and will be marked for ready identification during ELAP conditions.

(Section 4) Provide a sequence of events and identify any time constraint required for success including the technical basis for the time constraint.

Ref: **NEI 12-06, section 3.2.1.7**
JLD-ISG-2012-01, section 2.1

The locations to implement shallow load shed are in the following rooms:

- Control Bay - Battery Board Rm 1 - El 593' (8 breakers),
- Control Bay - Battery Board Rm 2 - El 593' (8 breakers),
- Control Bay - Battery Board Rm 3 - El 593' (8 breakers),
- Control Bay - 250 V DC Reactor MOV Board 1A - El 621' (3 Breakers),
- Control Bay - 250 V DC Reactor MOV Board 2A - El 621' (3 Breakers),
- Control Bay - 250 V DC Reactor MOV Board 3A - El 621' (3 Breakers),
- Control Bay - 250 V DC Reactor MOV Board 1B - El 593' (3 Breakers) and
- Control Bay - 250 V DC Reactor MOV Board 2B - El 593' (3 Breakers).

Item 14: At T+>2 hours - At the expected cooldown rate the Unit is being maintained at 150 psig (depressurization starts at T+30 min. by a rate of 100°F/hr).

Item 15: At T+3 hours - **lay out and secure hoses on the Spent Fuel Pool (SFP) deck to provide supplemental SFP water in the event SFP addition is later required** from the Emergency Equipment Cooling Water (EECW) system *(FLEX Pumping System (FPS1) will be available at 8 hours).*

A tabletop demonstrates this activity can be conducted in one hour and conditions on the refueling deck will not have deteriorated such that crew access is excessively restricted.. Formal validation of the timeline will be performed once the procedure guidance is developed and related staffing study is completed. This action may not be needed for many hours based on SFP inventory and conditions. TVA-Q-25075A, *Station Blackout Coping* (Ref. 14) and TVA may establish alternative completion limits based on actual spent fuel conditions.

Item 16: If DC load shedding was performed because one or more of the 480 V FLEX DGs did not perform, then this load shedding must be complete by 4 hours to extend battery life to 12 hours (Ref. 2).

Item 17: Verify all three 4 kV FLEX DGs FDMG1, FDMG2, FDMG3, are started and ready for service. This will energize one division of safety related (4 kV) electrical distribution on each unit. Restore control bay and plant lighting.

Item 18: Except for tornado events, the 4 kV FLEX DGs FDMG1, FDMG2, FDMG3, are N+1 for failure of one of the 480 V FLEX DG. For extreme tornado events, the 480 V FLEX DGs are assumed to be potentially lost and the 4 kV FLEX DGs can be primary for charging the batteries. Either of the 4 kV FLEX DGs, FMDG1 or FMDG2, can be aligned to feed the battery chargers credited for Batteries 1 or 2 In a tornado event involving loss of 480 V FLEX DG (FLDG3) the primary supply for Battery 3 is 4 kV FLEX DG, FMDG3.

(Section 4) Provide a sequence of events and identify any time constraint required for success including the technical basis for the time constraint.

Ref: **NEI 12-06, section 3.2.1.7**
JLD-ISG-2012-01, section 2.1

N+1 for loss of the primary 4 kV FLEX DG, FMDG3, is to align Battery Charger 2B (which can charge any of the unit batteries) to Battery 3. Battery Charger 2B can be supplied by 480V Shutdown Board 2B. 480V Shutdown Board 2B is not normally energized for FLEX strategies; however, it can be supplied from either 4 kV FLEX DGs, FMDG1 or FMDG2. A table top evaluation was performed by site personnel to obtain a two hour estimate. Since this activity begins at T+8 hours, and Battery 3 will last 12 hours without charging, the maximum allowable time for this activity is 4 hours. A formal validation of the timeline will be performed once the design is finalized, procedure guidance is developed, and the related staffing study is complete.

Item 19: A tabletop and pump demonstration indicates this can be complete in 8 hours, beginning with the SBO. Crews have done an exercise to install and pump with the low pressure FLEX pumps; however, the augmented suction lift for extreme low lake level has not yet been practiced. Formal validation of the timeline will be performed once procedural guidance is developed and the related staffing study is complete.

Item 20: With access to the Ultimate Heat Sink (UHS) established via FLEX low pressure diesel driven pumps and with 4 kV power supplied by 4 kV FLEX DGs, a shutdown process begins. Core Spray (CS) is provided for vessel makeup. Containment pressure estimates in Emergency Operating Instructions (EOI) Program Manuals (Ref. 4) are consistent with current emergency procedure guidance (Ref. 6a and 6b), providing for adequate NPSH for vessel injection and for Residual Heat Removal (RHR). Residual Heat Removal (RHR) will be used for torus cooling, shutdown cooling and later for makeup to the SFP, if required (from RHR to SFP cooling supply, after the torus is cooler than the SFP) based on new FLEX guidelines to be developed. Browns Ferry Nuclear Plant (BFNP) Updated Final Safety Analysis Report (UFSAR) Figure 14.6-11 (Ref. 3bi) shows containment response to placing RHR containment cooling in service after a loss of coolant accident.

The response of containment to the above FLEX strategy would be different than the response shown in Figure 14.11 (Ref. 3bi) in that after 8 hours, the core decay heat would be much lower and also the FLEX UHS side flow rate in the RHR heat exchanger is planned to be less. The FLEX strategy uses 1 heat exchanger, with the 5000 gpm FLEX pump flow shared among 2 units (less than 2500 gpm each after flow losses). The accident case in Figure 14.6-11 (Ref. 3bi) is based on an RHRSW flow of 4000 gpm per heat exchanger, with a minimum of 2 heat exchangers in service. In the accident case, changing from 4 heat exchangers (Figure 14.6-11 - curve B) (Ref. 3bi) to 2 heat exchangers (Figure 14.6-11 - curve C) (Ref. 3bi) results in a more gradual containment cooldown.

(Section 4) Provide a sequence of events and identify any time constraint required for success including the technical basis for the time constraint.

Ref: **NEI 12-06, section 3.2.1.7**
JLD-ISG-2012-01, section 2.1

The containment cooling rate with FLEX could be even more gradual; however, preliminary MAAP analyses (Reference 8) indicate even with only 1500 gpm RHRSW flow, containment temperatures will decline. TVA will conduct additional analyses to confirm the effectiveness of the RHR heat exchanger lineup under FLEX conditions.

Item 21: GEH Evaluation of FLEX Implementation Guidelines (Ref. 7) provides guidance for controlling the plant during an ELAP while maintaining core cooling, containment integrity, and spent fuel cooling relying on the FLEX Pumping Systems, FPS1, FPS2, FPS3, FPS4, but not the 4 kV auxiliary power system in the short term. Reference 7 describes the BFNP adaptation of that guidance.

Item 22: Water is added to the SFP from the river using FLEX Pumping System, FPS1. This is done if necessary to maintain the fuel in the pool submerged sufficiently to prevent damage and to provide adequate shielding. The SFP need not be maintained at normal water level and additional FLEX guidance will be developed using the systems from Order EA 12-051 (Ref. 11) (Open Item, OI 12). If the evaporation rate from the SFP is very high, it will be because the unit has just returned to service from a refueling outage. Residual heat from the reactor unit will be relatively low and the torus will not be too hot to use for makeup to the SFP via RHR assist. If the 4 kV FLEX DGs are available, SFP cooling will be restored using Reactor Building Closed Cooling Water (RBCCW) supplied via EECW from FLEX Pumping System, FPS1. This should reduce the evaporation rate so that addition to the SFP can be performed using demineralized water in Phase 3. If river water must be added to the SFP, it can be supplied via FPS1 through either the connection to the condensate storage and supply system or through the EECW supply line for emergency SFP makeup.

Item 23: The Torus venting process, if needed, results in a loss of torus inventory (approximately 225 gpm at 8 hours) Emergency Operating Instructions (EOI) Program Manuals (Ref. 4). Eventually this inventory loss will have to be made up to maintain suppression pool level parameters within limits. If makeup is required before Phase 3, it can be supplied by the connections from FPS1.

Item 24: If the 4 kV FLEX DGs are available, SFP cooling will be restored using RBCCW. The EECW for RBCCW will be supplied from FPS1. This should reduce the evaporation rate so that addition to the SFP can be performed using demineralized water in Phase 3.

Item 25: The industry will establish two Regional Response Centers (RRC) to support utilities during beyond-design-basis events. Fuel support for FLEX equipment will be provided after the first 24 hours in accordance with the TVA playbook (the Regional Response Center's plan for coordinating with each utility). TVA will have enough diesel fuel onsite for the first 24 hours (Open Item, OI 3).

(Section 4) Provide a sequence of events and identify any time constraint required for success including the technical basis for the time constraint.

Ref: **NEI 12-06, section 3.2.1.7**
JLD-ISG-2012-01, section 2.1

Item 26: Sargent and Lundy Study: Loss of HVAC During ELAP (Ref. 12) specifies manual actions to ensure acceptable hydrogen limits in the battery rooms. A formal validation of the timeline will be performed once the procedure guidance is developed and related staffing study is complete (Open Item, OI 15, 16).

Item 27: Sargent and Lundy Study: Loss of HVAC During ELAP (Ref. 12) specifies manual actions needed to ensure acceptable room temperatures. A formal validation of the timeline will be performed once the procedure guidance is developed and related staffing study is complete (Open Item, OI 15, 16).

Technical Basis Support information

1. On behalf of the Boiling Water Reactor Owners Group (BWROG), GEH Evaluation of FLEX Implementation Guidelines, NEDC-33771P, Revision 0 (Ref. 7) to supplement the guidance in NEI 12-06 (Ref. 9) by providing additional Boiling Water Reactor (BWR)-specific information regarding the individual plant response to the ELAP and Loss of Ultimate Heat Sink (LUHS) events. The document includes identification of the generic event scenario and expected plant response, the associated analytical bases and recommended actions for performance of a site-specific gap analysis.

   GEH Evaluation (Ref. 7) utilized the NRC accepted SUPERHEX (SHEX) computer code methodology for BWR's long term containment analysis for the ELAP analysis. As part of this document, a generic BWR 4/Mark I containment NSSS evaluation was performed. TVA utilized this generic evaluation as appropriate to develop coping strategies.

2. Environmental conditions within the station areas were evaluated utilizing Thermal Model Generator Methods (TMG).

3. Per the guidance in 10 CFR 50.63 and Regulatory Guide 1.155 BFNP is an alternate AC, four hour coping plant for Station Blackout (SBO) considerations. Applicable portions of supporting analysis have been used in ELAP evaluations as starting points for the evaluations performed to meet the guidance from NEI 12-06 (Ref. 9).

(Section 4) Provide a sequence of events and identify any time constraint required for success including the technical basis for the time constraint.

Ref: **NEI 12-06, section 3.2.1.7**
JLD-ISG-2012-01, section 2.1

References:

1. Abnormal Operating Instructions (AOIs)
   a. 0-AOI-100-3, Flood Above Elevation 558'
2. AREVA Engineering Information Record Document No.: 51-9198045-000, "Browns Ferry Post Fukushima FLEX Response Evaluation"
3. Browns Ferry Nuclear Plant (BFNP) Updated Final Safety Analysis Report (UFSAR) Revision 31, 11/12
   a. Section 2.4A
      i. Figure 16
   b. 14.6
      i. Figure 11
4. BFNP Emergency Operating Instruction (EOI) Program Manuals
5. BWR Owners' Group – "Emergency Procedure and Severe Accident Guidelines", Revision 3 (February 2013)
6. Emergency Operating Instructions (EOIs)
   a. EOI-1 (Units 1, 2, and 3)
   b. EOI-2 (Units 1, 2, and 3)
   c. EOI-3 (Units 1, 2, and 3)
7. "GEH Evaluation of FLEX Implementation Guidelines", NEDC-33771P, Revision 0
8. MAAP Analysis (William Z. Mims, Jr., Doulos Consulting Services BFN FLEX - BFN-SBO-CASE-0003B-01-014-RHRHX 02222013
9. NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide"
10. NUMARC 87-00, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors", Revision 1
11. "Order to Enhance Spent Fuel Pool Instrumentation", EA-12-051
12. Sargent and Lundy Study: "Loss of HVAC During ELAP", Project 12938-012
13. Surveillance Instructions
    a. 1-SR-3.4.9.1(1) Reactor Heatup and Cooldown Rate Monitoring
14. (TVA -Q-25075A, *Station Blackout Coping* (R14 930512 510))

Notes:

None

(Section 5) Identify how strategies will be deployed in all modes. Ref: NEI 12-06, section 13.1.6	*Describe how the strategies will be deployed in all modes.*

Deployment routes shown in Figure 4 of Attachment 4 will be utilized to transport FLEX equipment to the deployment areas. The identified paths and deployment areas will be accessible during all modes of operation (however, deployment location for some equipment will be different for flood conditions and the identified paths may be inundated after deployment, in case of a beyond-design-basis flood). This deployment strategy will be included within an administrative program in order to keep pathways clear or to clear the pathways (Open Items, OI 2 and OI 14).

References:

1. Attachment 4
   a. Figure 4
2. NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide"

Notes:

None

(Section 6) Provide a milestone schedule. This schedule should include:
• **Modifications timeline**
  ○ **Phase 1 Modifications**
  ○ **Phase 2 Modifications**
  ○ **Phase 3 Modifications**
• **Procedure guidance development complete**
  ○ **Strategies**
  ○ **Maintenance**
• **Storage plan (reasonable protection)**
• **Staffing analysis completion**
• **FLEX equipment acquisition timeline**
• **Training completion for the strategies**
• **Regional Response Centers operational**
 	
Ref: NEI 12-06, section 13.1
	The dates specifically required by the order are obligated or committed dates. Other dates are planned dates subject to change. Updates will be provided in the periodic (six month) status reports.
	See attached milestone schedule Attachment 2

See attached milestone schedule in Attachment 2.

References:

1. Attachment 2
2. NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide"

Notes:

None

(Section 7) Identify how the programmatic controls will be met.	
(Section 7) Identify how the programmatic controls will be met. **Ref: NEI 12-06 section 11** **JLD-ISG-2012-01 section 6.0**	*Provide a description of the programmatic controls equipment protection, storage and deployment and equipment quality. See section 11 in NEI 12-06. Storage of equipment, 11.3, will be documented in later sections of this template and need not be included in this section.* *See section 6.0 of JLD-ISG-2012-01.*

Browns Ferry Nuclear Plant will implement an administrative program for implementation and maintenance of the BFNP FLEX strategies in accordance with NEI 12-06 guidance.

- *Equipment quality:* The equipment for ELAP will be dedicated to FLEX and will have unique identification numbers. Installed structures, systems and components pursuant to 10 CFR 50.63(a) (Ref. 1) will continue to meet the augmented quality guidelines of Regulatory Guide 1.155, Station Blackout (Ref. 4).
- *Equipment protection:* BFNP will construct structures to provide protection of the FLEX equipment to meet the requirements identified in NEI 12-06 section 11 (Ref. 3a). The schedule to construct the structures is still to be determined.
- *Storage and deployment:* BFNP will develop procedures and programs to address storage structure requirements and deployment/haul path requirements relative to the hazards applicable to BFNP.
- *Maintenance and Testing:* BFNP will utilize the standard EPRI industry PM process for establishing the maintenance and testing actions for FLEX components. The administrative program will include maintenance guidance, testing procedures and frequencies established based on type of equipment and considerations made within the EPRI guidelines.
- *Design Control:* BFNP will follow the current programmatic control structure for existing processes such as design and procedure configuration.

References:

1. 10 CFR 50.63(a)
2. Draft Interim Staff Guidance JLD-ISG-2012-01, Compliance with Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigating Strategies for Beyond-Design-Basis External Events"; Docket ID NRC-2012-0068
3. NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide"
   a. Section 11
4. Regulatory Guide 1.155, Station Blackout

Notes:

None

(Section 8) Describe training plan	List training plans for affected organizations or describe the plan for training development

New training of general station staff and EP will be performed prior to the first BFNP unit design implementation outage. These programs and controls will be implemented in accordance with the Systematic Approach to Training (Open Item, OI 18).

References:

None

Notes:

None

(Section 9) Describe Regional Response Center plan	*Discussion in this section may include the following information and will be further developed as the Regional Response Center development is completed.* • *Site-specific RRC plan* • *Identification of the primary and secondary RRC sites* • *Identification of any alternate equipment sites (i.e., another nearby site with compatible equipment that can be deployed)* • *Describe how delivery to the site is acceptable* • *Describe how all requirements in NEI 12-06 are identified*

The nuclear industry will establish two Regional Response Centers (RRCs) to support utilities during beyond-design-basis events. Each RRC will hold five sets of equipment, four of which will be able to be fully deployed when requested; the fifth set will have equipment in a maintenance cycle. Equipment will be moved from an RRC to a local Assembly Area, established by the Strategic Alliance for FLEX Emergency Response (SAFER) team and TVA. Communications will be established between BFNP and the SAFER team and required equipment moved to the site as needed. First arriving equipment, as established during development of BFNP's playbook, will be delivered to the site within 24 hours from the initial request.

TVA will establish a contract with the SAFER team in accordance with the requirements of Section 12 of Reference 2 (Open Item, OI 19).

References:

None

Notes:

None

Maintain Core Cooling

(Section 10) Determine Baseline coping capability with installed coping[1] modifications not including FLEX modifications, utilizing methods described in Table 3-1 of NEI 12-06:

- **RCIC/HPCI/IC**
- **Depressurize RPV for injection with portable injection source**
- **Sustained water source**

BWR Installed Equipment Phase 1:

Provide a general description of the coping strategies using installed equipment including modifications that are proposed to maintain core cooling. Identify methods (RCIC/HPCI/IC) and strategy (ies) utilized to achieve this coping time.

<u>Power Operation, Startup, and Hot Shutdown</u>

At the initiation of the Beyond-Design-Basis External Event (BDBEE), Main Steam Isolation Valves (MSIVs) automatically close, feedwater is lost, and Safety Relief Valves (SRVs) automatically cycle to control pressure, causing reactor water level to decrease. When reactor water level reaches -45 inches, Reactor Core Isolation Cooling (RCIC), 1-OI-71 (Ref. 6a) and High Pressure Coolant Injection (HPCI), 1-OI-73 (Ref. 6b), automatically start with normal suction from the Condensate Storage Tanks (CST) and inject to the RPV. This HPCI/RCIC injection recovers the reactor level to the normal band. Condensate Storage Tanks (CSTs) at BFNP are not qualified for all the hazards listed in Section 1 and therefore, are not credited for Phase 1 coping, but they would be used if available. When HPCI is secured, operator guidance will be changed to specify transferring HPCI suction to the suppression pool. This must be done in the first hour to extend battery life to 12 hours, Browns Ferry Post Fukushima FLEX Response Evaluation (Ref. 2). The SRVs control reactor pressure, 0-AOI-57-1A (Ref. 1a). If a CST is NOT lost, it will be used for injection and the heatup curve of the suppression pool will be less severe. If CST suction is available, this ultimately results in an increase in water mass in the suppression pool. Reactor Core Isolation Cooling (RCIC) will be used for vessel level control and Main Steam Relief Valves (MSRVs) will be used for pressure control. After 30 minutes, a cooldown is initiated near the maximum allowable rate (100°F/hour), per GEH Evaluation of FLEX Implementation Guidelines (Ref. 5).

After confirmation the Emergency Diesel Generators (EDGs) cannot be restarted, but no later than one hour, the crew enters the FLEX guidelines.

RCIC trip and isolation signals will be overridden in accordance with FLEX procedural guidance for ELAP. The automatic depressurization system will be prevented from automatically initiating while low pressure makeup is not available (with keylock switches). The primary method of reactor pressure control is operation of the MSRVs. Operator control of reactor pressure using MSRVs requires DC control power and pneumatic pressure (supplied by station batteries and the drywell pneumatics system, respectively).

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[1] Coping modifications consist of modifications installed to increase initial coping time, i.e., generators to preserve vital instruments or increase operating time on battery powered equipment.

Maintain Core Cooling

(Section 10) BWR Installed Equipment Phase 1:

For Phase 1, power for the MSRVs is supplied by the station batteries. At event initiation the nitrogen storage tank, with a backup supply from the Containment Atmosphere Dilution system, automatically supplies pneumatic pressure for MSRV operation. However, these nitrogen tanks are not designed to withstand all BDBEE and a modification will be performed to provide a backup nitrogen control station within the Reactor Buildings for BFNP-1, 2 and 3. In addition, each Automatic Depressurization System (ADS) MSRV is provided an accumulator which contains enough pneumatic pressure to operate each valve through five open/close cycles, per the Updated Final Safety Analysis Report (UFSAR) (Ref. 3a). Mechanical SRV operation will also control reactor pressure.

RCIC exhaust and MSRV cycling will increase torus and drywell temperatures and pressures. Plant stability can be maintained during the first 8 hours of the beyond-design-basis event by following the guidance in GEH Evaluation of FLEX Implementation Guidelines (Ref. 5).

1. Containment design limits will not be exceeded for temperatures or pressures (Ref. 5).
2. Suppression pool temperature increases will not result in RCIC failure from lube oil heating or from loss of Net Positive Suction Head (NPSH) (considering the projected torus pressure) Browns Ferry Post Fukushima FLEX Response Evaluation (Ref. 2) and GEH Evaluation of FLEX Implementation Guidelines (Ref. 5). Browns Ferry Nuclear Plant will take actions as necessary to assure RCIC can operate at elevated temperatures (Open Item, OI 7).
3. Battery supplies will be sufficient for RCIC, Main Steam Relief Valves (MSRVs), Hardened Containment Vent System (HCVS) and for indication, considering load shed manual actions, Browns Ferry Post Fukushima FLEX Response Evaluation (Ref. 2).
4. MSRV solenoid voltage will be sufficient for higher drywell temperatures. (This is currently being evaluated to determine if a modification is necessary).
5. MSRV operating gas will be sufficient for higher drywell pressures.

In accordance with Emergency Procedure Guidelines (EPGs) and per Boiling Water Reactors Owner's Group (BWROG) guidance, Emergency Operating Procedures (EOPs) have been revised to allow termination of RPV emergency depressurization to a controlled pressure reduction rate at a pressure that will allow continued RCIC operation, because steam driven RCIC is the sole means of core cooling.

The Operators will use CST suction initially if it is available, and while this improves NPSH for RCIC and decreases the containment temperature trends, it can challenge Heat Capacity Temperature Limit (HCTL) (for Torus/Suppression Pool), Pressure Suppression Pressure (PSP) (a function of Primary Containment Water Level) or MSRV tailpipe limits because of the increasing water level in the torus. Without venting, the drywell design temperature limit of 281°F will be reached in approximately 8.3 hours if suction is from the suppression pool, GEH Evaluation of FLEX Implementation Guidelines (Ref. 5) and the temperature limit will be reached at approximately 8.8 hours if suction is from the CST. Emergency Operating Instructions (EOIs)/Flex Suppoert Guidelines (FSGs) will be revised to direct Operators to terminate RPV emergency depressurization to prevent loss of RCIC.

Maintain Core Cooling

(Section 10) BWR Installed Equipment Phase 1:

By the end of 8 hours, the RCIC makeup rate required is approximately 240 gpm. If the CST is being used (and it is not credited), suction will be transferred either when suppression pool water level gets to the limit that would transfer HPCI or when CST supply is low. Once suction is transferred to the suppression pool (which may be at the beginning of the event if the CST is lost due to the beyond-design-basis initiating event) essentially all of the mass added via RCIC injection into the reactor vessel is returned to the suppression pool by the MSRVs.

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 vessel will heatup. When temperature reaches 212°F, (Hot Shutdown) the vessel will begin to pressurize. During the pressure rise RCIC can be returned to service with suction from the CST to provide injection flow. When pressure rises to the SRV setpoints then pressure will be controlled by SRVs. The primary and alternate strategies for Cold Shutdown are the same as those for Power Operation, Startup, and Hot Shutdown as discussed above for core cooling. The drywell airlock may be open, but the amount of steaming will have limited impact on the Reactor Building until Phase 2 manpower is available to shut the airlock before Phase 2 actions are required in the Reactor Building airlock area.

During Refueling, there are many variables that impact the ability to cool the core. In the event of an ELAP during Refueling, there are no installed plant systems available to cool the core; thus, transition to Phase 2 will occur immediately. Phase 2 is discussed in Section 11.

Details:

(Section 10a) Provide a brief description of Procedures / Strategies / Guidelines	*Confirm that procedure/guidance exists or will be developed to support implementation*

Browns Ferry Nuclear Plant will utilize the industry developed guidance from the Owners Groups, EPRI and NEI Task team to develop site specific procedures or guidelines to address the criteria in NEI 12-06 (Ref. 6). These procedures and/or guidelines will support the existing symptom based command and control strategies in the current EOIs (Open Item, OI 17).

Maintain Core Cooling

(Section 10b) Identify modifications	*List modifications*

- Change power supply of containment instrumentation (drywell atmospheric temperature and suppression pool level) from the AC instrument bus to station battery to provide continuous power to critical instruments so that critical containment parameters can be monitored throughout the event. (Open Item, OI 9)
- Install a protected nitrogen control station to provide backup pneumatic supply to the MSRVs. (Open Item, OI 4)
- Perform modifications, as necessary, to ensure that the RCIC inventory control function is seismically robust. (Open Item, OI 8)
- Label non-critical DC loads to allow Operators to more readily identify the loads that will be shed during the Phase 1 load shedding activity. (Open Item, OI 9)

(Section 10c) Key Reactor Parameters	*List instrumentation credited for this coping evaluation.*

PX-071-0001A RCIC FLOW INSTRUMENTATION POWER SUPPLY
FT-071-0001A RCIC TURB STM SPLY FLOW TRANSMITTER
FM-071-0001A RCIC STM SIGNAL FLOW MODIFIER
FI-71-1A RCIC STEAM FLOW
LS-064-0054A SUPPR CHAMBER WTR LVL SW
TM-64-52 DRYWELL TEMPERATURE MONITOR
LT-064-0066 SUPPR CHBR NR WTR LVL
LI-64-66 SUPPR POOL WATER LEVEL
LT-003-0060 REACTOR WATER LEVEL B NORM RANGE
PDT-064-0137 DW TO TORUS DIFF PRESS XMTR (Indic., Alarm, Interlock)
PDS-064-0137A DRYWELL TO SUPPR CHAMBER DIFF PRESS
1-PT-064-0135 DW PRESS XMTR (Indic., Alarm, Interlock)
1-PS-064-0135 DRYWELL PRESS
1-PI-64-135 DRYWELL PRESSURE

Valve positions and controls:

- *1-FSV-064-0020; FCV-64-20 Suppression Chamber Vacuum Relief Valve*
- *1-FSV-064-0021; 1-FCV-64-21 Suppression Chamber Vacuum Relief Valve*

Maintain Core Cooling	
(Section 10c) Key Reactor Parameters	*List instrumentation credited for this coping evaluation.*

Condensate Storage Tank Level (for RCIC)

- *Battery voltage*
- *4160/480 VAC voltage*
- *Battery Amperes*
- *Reliable Hardened Vent System (RHVS) Radiation Monitor*
- *RHVS valve position indication*
- *RHVS power status*
- *Nitrogen system supply status*
- *RHVS effluent temperature*

1. References:
2. Abnormal Operating Instructions (AOIs)
   a. 0-AOI-57-1A, Loss of Offsite Power (161 and 500 KV)/Station Blackout
3. AREVA Engineering Information Record Document No.: 51-9198045-000, "Browns Ferry Post Fukushima FLEX Response Evaluation"
4. Browns Ferry Nuclear Plant (BFNP) Updated Final Safety Analysis Report (UFSAR)
   a. Section 4.4-4
5. EOI Program Manuals (i.e., NPSH Limit Worksheets)
6. "GEH Evaluation of FLEX Implementation Guidelines", NEDC-33771P, Revision 0
7. NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide"
8. Plant Operating Instructions
   a. 1-OI-71, RCIC System
   b. 1-OI-73, HPCI System

Notes:

The duration of each station battery was calculated to last no less than 12 hours following a load shed at 4 hours.

Maintain Core Cooling
(Section 11) BWR Portable Equipment Phase 2:

Provide a general description of the coping strategies using on-site portable equipment including modifications that are proposed to maintain core cooling. Identify methods (RCIC/HPCI/IC) and strategy (ies) utilized to achieve this coping time.

During Phase 1, plant personnel deploy FLEX equipment. For flood events, the equipment is staged many hours before the peak flood waters exceed the design basis (see Attachment 1A). For other events, equipment is placed in service beginning with the SBO condition – in some cases, before an ELAP is declared (see timeline, Attachment 1A).

The following is a list of equipment is planned to be onsite, protected (within the limitations described) and ready for use at or before the beginning of Phase 2.

1) Three 480 V FLEX Diesel Generators (DGs) are permanently staged on the roof area of the adjacent Diesel Buildings. They are protected for all of the extreme natural events in Section 1 except for extreme tornados. These will be available before Phase 2 to supply battery chargers, Integrated Computer System (ICS) inverters, and other loads.
   a) The Unit 1 Distribution Panel will be able to supply power to 250 V DC Unit Battery Charger #1, Unit 1 ICS Inverter, 480 V Shutdown Board 1A and three additional 100 amp spare disconnects.
   b) The Unit 2 Distribution Panel will be able to supply power to 250 V DC Unit Battery Charger #2, Unit 2 ICS Inverter, 480 V Shutdown Board 2A and three additional 100 amp spare disconnects.
   c) The Unit 3 Distribution Panel will be able to supply power to 250 V DC Unit Battery Charger #3, Unit 3 ICS Inverter, 480 V Shutdown Board 3A and three additional 100 amp spare disconnects.
2) Three 4 kV FLEX DGs are permanently staged in a protected bunker structure. At the beginning of Phase 2 they will be available to support the primary loads listed below.
   a) 4 kV FLEX DGs can be aligned to battery chargers and are the backup supply in case of failure or tornado hazard loss of one or more of the 480 V FLEX DGs. If any 4 kV FLEX DG is lost, a power supply for a battery charger can be aligned.
   b) FMDG - 1 is aligned to:
      i) RHR 2B from Shutdown Board C (RHR Service Water (RHRSW) header B) and
      ii) CS 2A from Shutdown Board A.
   c) FMDG - 2 is aligned to:
      i) RHR 1D from Shutdown Board D (RHRSW header D) and
      ii) CS 1C from Shutdown Board B.
   d) FMDG-3 is aligned to:
      i) RHR 3B from Shutdown Board 3EC (RHRSW header B) and
      ii) CS 3A from Shutdown Board 3EA.
   e) Manual breaker operations may be necessary due to discharge of Shutdown Board control power batteries, 0-AOI-57-1A (Ref. 1a).

Maintain Core Cooling
(Section 11) BWR Portable Equipment Phase 2:

3) Low Pressure Pumping units are available at the beginning of Phase 2
   a) Each FLEX Pumping System (FPS1, FPS2, FPS3, and FPS4) consists of a portable diesel pump rated at 5000 gpm at 150 psi discharge head. Suction lift capability is rated at 6 feet. The diesel driver is rated at 600 HP. In the case of extreme low lake level, each Flex Pumping System is deployed with suction lift augmentation. Suction lift augmentation is provided for each of the main pumps (FLPP1, FLPP2, FLPP3, and FLPP4) by a FLEX floating booster pump (FLBP) set aligned to the suction of the main pump. FLEX floating booster pump sets (FLBP1, FLBP2, FLBP3 and FLBP4) include two pumps in parallel, 2500 gpm each with a 343 HP diesel hydraulic drive system. The pump systems include trailers, lift units, and hoses. TVA is designing deployment locations for the pumps, including ramps, winches or other transfer assemblies as necessary to deploy all pumps and hoses within the 8 hour Phase 1 coping interval. The staff begins deployment of these pumps as soon as SBO occurs rather than waiting to exhaust all attempts to restore the emergency electric supply system.
   b) FLEX Pumping Systems are assigned as follows.
      i) FPS1 can be connected to one or more of the following:
         (1) Three Containment Integrated Leak Rate Test (CILRT) penetrations through Reactor Building wall, elevation 565' (4" pipe) - inside 1A, 2A, 3A RHRSW pipe tunnel, (From inside the Reactor Building, connections can be made to condensate and then to the vessel through RHR fill line, or to SFP makeup (normal), or to the torus),
         (2) The EECW South header - hookup outside pipe tunnel (3B & D Service Water (SW) tunnel) (The EDGs will be isolated by manual action if needed to ensure adequate cooling to operating SSCs). The S header can be used for SFP makeup,and
         (3) The EECW N Header - same as described in 3.b.i.2 above.
      ii) FPS2 is aligned to B RHRSW at one, or more, of the following locations;
         (1) At the intake structure,
         (2) In the tunnel at RHRSW piping and/or
         (3) By drilling a new 16" penetration through Reactor Building wall and connecting to the Heat Exchanger (HTX).

         Note: The B RHRSW can provide standby coolant to any unit, if needed.
      iii) (FPS3) – could be connected to D RHRSW at one, or more, of the following locations:
         (1) At the intake structure,
         (2) In the tunnel at RHRSW piping and/or
         (3) By drilling a new 16" penetration through Reactor Building wall and connecting to the HTX.

         Note : The D RHRSW can provide standby coolant to any unit, if needed.
      iv) (FPS4) - (N+1), is a spare.

4) Augmented operating gas will be staged for the Main Steam Relief Valves (MSRVs).

Primary Phase 2 strategy for a unit that is not in cold shutdown.

During Phase 2, as in Phase 1, reactor core cooling is initially maintained using RCIC in automatic mode (i.e., with Operators controlling the RCIC flow controller) with suction from the suppression pool or the CST (if available). The CST is not credited as being able to sustain all events in Section 1; however, it would be used if available, because it provides additional margin before containment temperature is challenged, and it reduces the temperature of the RCIC bearing cooler. This plan addresses CST use because if the CST survives, its use requires consideration of the need for mass removal from the CST.

At Phase 2, RHR cooling will be initiated supported by the 4 kV FLEX DGs and FLEX Pumping Systems (FPS1, FPS2, and FPS3) as described above. Based on the 1979 ANS 5.1 Bounding Decay Heat Fraction cited in GEH Evaluation of FLEX Implementation Guidelines (Ref. 5), and the heat transfer to the RHR heat exchangers at FLEX system flow rates shared among units, preliminary estimates indicate suppression pool and containment temperatures/pressures will reduce at a stable rate slower than a normal cooldown. Core Spray (CS), with suction from the suppression pool (or CST if it is available) can also be used for vessel injection. Reactor Core Isolation Cooling (RCIC) will ultimately be secured with vessel makeup taken over by CS.

Suppression pool water level will increase if there is addition from the CST (if it is not offset by venting). Addition of water from the CST will be terminated if necessary to prevent challenging the containment control limits and to maintain availability of the Hardened Containment Vent System (HCVS). The battery chargers will be available from either the 480 V FLEX DGs, or the 4 kV FLEX DGs through the Shutdown Boards. Suppression pool water level can be reduced by operation of HPCI (after battery chargers are available) or CS in modified CST test mode (suction from torus, discharge to the CST). Containment pressure could also potentially be used as a driving force to reject water from the torus back to the CST without pumping power (RHR drain pump system); however, this alternative is still under consideration.

Containment coolers will also be placed in service powered by the 4 kV FLEX DGs and supported by FLEX Pumping System (FPS1, or spare FPS4 if available).

During Phase 2, reactor pressure is controlled by manual operation of MSRVs as described in Phase 1. As backup to the nitrogen tank and the MSRV accumulators, a pre-staged emergency N2 control station will be utilized, as necessary. This N2 control station will be added by plant modification.

Maintain Core Cooling

(Section 11) BWR Portable Equipment Phase 2:

Alternate Phase 2 strategy for a unit that is not in cold shutdown.

RCIC will continue to supply makeup to the reactor vessel as in Phase 1; however, if one of the 4 kV FLEX DGs is unavailable, one unit will have to be shut down by alternate means.

At Phase 2 (8 hours – see section 10 and Table 1A), the HCVS will be opened to cool the containment; otherwise the drywell temperature limit would be reached per GEH Evaluation of FLEX Implementation Guidelines (Ref. 5). Hardened Containment Vent System (HCVS) operation will be controlled to ensure overpressure for RCIC NPSH. The mass loss through the HCVS (225 gpm estimated in Ref. 5) will eventually have to be made up. If Phase 3 is not available yet, the torus level will be restored as needed using FLEX Pumping System, FPS1 (water from the Tennessee River). Suppression pool and containment temperatures/pressures will eventually be reduced and RCIC operation can continue for vessel injection as long as the steam supply is adequate. If Phase 3 has not been entered when RCIC goes offline, FLEX Pumping System, FPS1 can be used to provide vessel makeup after pressure is lowered (normally; however, if the decay heat is no longer sufficient to maintain a continuous RCIC steam supply, RCIC would be operated intermittently until a low pressure makeup from a demineralized water source could be placed in service either in Phase 2 or 3). Alternatively, FLEX Pumping Systems (FPS2 or FPS3) can provide river water injection to the vessel via the standby coolant crosstie from RHRSW. Vessel makeup (T+8 hours and later) requirements will be less than 250 gpm (Ref. 5); therefore, use of either FPS1 or FPS2/FPS3 supplies will not significantly impact the other units that will be using the primary strategy.

Primary strategy for a unit that is less than RCIC supply pressure at the time of the external event:

If the plant operates in Mode 3 when the SBO occurs, there is more time available to align and start the FLEX Pumping Systems than is the case for Mode 4 operation, Technical Justification to Support Risk Informed Modification to Selected Required Action End States for BWR Plants (Ref. 4). The reason more time is available in Mode 3, which increases the probability of success, is availability of RCIC. The strategy is to transition from Mode 4 to Mode 3 with minimal inventory loss. When RCIC is started, the makeup rate is greater than the mass loss from the core. With no inventory loss other than normal system leakage (TS limit), there is sufficient water to prevent uncovering the core before the FLEX Pumping Systems can be utilized in Phase 2.

Maintain Core Cooling

(Section 11) BWR Portable Equipment Phase 2:

Primary strategy for a unit that is in Cold Shutdown and Refueling:

During Refueling, many variables exist which impact the ability to cool the core. In the event of an ELAP during Refueling, there are no installed plant systems available to cool the core; thus, transition to Phase 2 will occur immediately. To accommodate the activities of vessel disassembly and refueling, water levels in the reactor vessel and the reactor cavity are often changed. The most limiting condition is the case in which the reactor head is removed and water level in the vessel is at or below the reactor vessel flange. If an ELAP/LUHS (Extended Loss of AC Power /Loss of Ultimate Heat Sink) occurs during this condition then boiling in the core may occur quite rapidly (dependent on the time after shutdown).

Pre-staging of FLEX pumps cannot be credited per the guideline of NEI 12-06 (Ref. 6) since an event could disable any pre-staged pump. Deploying and implementation of FLEX equipment to supply injection flow must commence immediately from the time of the event and must be rapid enough to prevent fuel uncovery. Note that the rate of heat addition in cold shutdown is low and the required vessel makeup rate is very low; therefore, there should be sufficient time to establish vessel injection. During an outage period, there are more personnel on site to provide the necessary resources. Guidance will be provided to ensure that sufficient area is available for deployment and that haul paths remain accessible without interference from outage equipment during refueling outages. Outage risk management procedures will be updated to include FLEX equipment as part of outage risk management.

Details:

(Section 11a) Provide a brief description of Procedures / Strategies / Guidelines	*Confirm that procedure/guidance exists or will be developed to support implementation*

Browns Ferry Nuclear Plant will utilize the industry developed guidance from the Owners Groups, EPRI and NEI Task team to develop site specific procedures or guidelines to address the criteria in NEI 12-06 (Ref. 6). These procedures and/or guidelines will support the existing symptom based command and control strategies in the current EOIs (Open Item, OI 17).

[redacted]

Maintain Core Cooling	
(Section 11) BWR Portable Equipment Phase 2:	
(Section 11b) Identify modifications	*List modifications all connections will be accessible*

- Construct a Flexible Equipment Storage Building (FESB), located above the Probable Maximum Flood (PMF) level, which is adequately protected from the hazards listed in Section 1. This storage facility will be used to store support equipment and items, including the four FLEX Pumping Systems and the three 4 kV FLEX DGs. (Open Items, OI 9 and OI 10)
- Install one 4 kV FLEX DG in the protected storage facility with prewired cable; routed and connectable to 4 kV Shutdown Boards "A" and "C".
- Install one 4 kV FLEX DG in the protected storage facility with prewired cable; routed and connectable to 4 kV Shutdown Boards "B" and "D".
- Install one 4 kV FLEX DG in the protected storage facility with prewired cable; routed and connectable to 4 kV Shutdown Boards "3EA" and "3EC".
- Install one 480 V FLEX DG, located above the PMF level, that is adequately protected from the hazards listed in Section 1 and in a storage enclosure designed equivalent to the requirements of NEI 12-06 (Ref. 6a). This 480 V FLEX DG will be prewired with a connection point to 1A 480 V Shutdown Board (normal feed to 250 V safety related Battery Charger 1). Also, it will be prewired with quick disconnects directly to 250 V safety related Battery Charger 1.
- Install one 480 V FLEX DG, located above the PMF level, that is adequately protected from the hazards listed in Section 1 and in a storage enclosure designed equivalent to the requirements of NEI 12-06 (Ref. 6a). This 480 V FLEX DG will be prewired with a connection point to 2A 480 V Shutdown Board (normal feed to 250 V safety related Battery Charger 2). Also, it will be prewired with quick disconnects directly to 250 V safety related Battery Charger 2.
- Install one 480 V FLEX DG, located above the PMF level, that is adequately protected from the hazards listed in Section 1 and in a storage enclosure designed equivalent to the requirements of NEI 12-06 (Ref. 6a). This 480 V FLEX DG will be prewired with a connection point to 3A 480 V Shutdown Board (normal feed to 250 V safety related Battery Charger 3). Also, it will be prewired with quick disconnects directly to 250 V safety related Battery Charger 3.
- Install connection points on the "B" and "D" RHRSW piping at the Intake Structure or RHRSW Tunnel for the FLEX pump discharge hose connections.
- Install connection point(s) on the common EECW header piping at the Intake Structure or RHRSW Tunnel for the FLEX pump discharge hose connections (Open Item, OI 11).

(Section 11b) Identify modifications	*List modifications all connections will be accessible*

- Modify 4 inch Reactor Building penetrations, currently used to provide air for the CILRT to be accessible outside the RHRSW Tunnels and above the PMF level. The extended penetration will be modified to allow a FLEX pump discharge hose connection. (Open Item, OI 9)
- Install new connections at the CSTs for direct connection to the FLEX pumps. (Open Item, OI 9)
- Install new hose connection point on the 4 inch Control Rod Drive (CRD) return header to the reactor feedwater system. (Open Item, OI 9)
- Modify HCVS system to permit venting more than one unit at the same time, if necessary (this should not be necessary, based on DG availability). (Open Items, OI 9 and OI 11)

(Section 11c) Key Reactor Parameters	*List instrumentation credited or recovered for this coping evaluation.*

Same as instruments listed in above section, Maintain Core Cooling Phase 1

(Section 11d) Storage / Protection of Equipment :

Describe storage / protection plan or schedule to determine storage requirements

Seismic	*List how equipment is protected or scheduled to protect*

Portable equipment and connection materials required to implement this FLEX strategy will be maintained in the FESB, which is designed to meet or exceed BFNP design basis Safe Shutdown Earthquake (SSE) protection requirements.

Flooding Note: if stored below current flood level, then ensure procedures exist to move equipment prior to exceeding flood level	*List how equipment is protected or scheduled to protect*

Portable equipment required to implement this FLEX strategy will be maintained in the FESB, which is sited in a suitable location that is above the PMF level and as such is not susceptible to flooding from any source. FLEX equipment deployment paths maintain a minimum elevation of 565' for which the plant will have over 4 days to deploy FLEX equipment based on plant response to a flooding event in 0-AOI-100-3 (Ref. 1b). See Updated Final Safety Analysis Report (UFSAR) Section 2.4A, Figure 16 (Ref. 3a)

Severe Storms with High Winds	*List how equipment is protected or scheduled to protect*

Portable equipment required to implement this FLEX strategy will be maintained in the FESB, which is designed to meet or exceed the licensing basis high wind hazard for BFNP.

(Section 11d) Storage / Protection of Equipment : Describe storage / protection plan or schedule to determine storage requirements	
Snow, Ice, and Extreme Cold	*List how equipment is protected or scheduled to protect*
The FESB will be evaluated for snow, ice, and extreme cold temperature effects. Heating will be provided as required to assure no adverse effects on the FLEX equipment. The FESB will have a stand-alone HVAC system.	
High Temperatures	*List how equipment is protected or scheduled to protect*
The FESB will be evaluated for high temperature effects and ventilation will be provided as required to assure no adverse effects on the FLEX equipment. The FESB will have a stand-alone HVAC system.	

(Section 11e) Deployment Conceptual Modification (Attachment 3 contains Conceptual Sketches)		
Strategy	**Modifications**	**Protection of connections**
Identify strategy including how the equipment will be deployed to the point of use.	*Identify modifications*	*Identify how the connection is protected*
• Three FLEX Pumping Systems will be deployed to supply river water into existing systems. o FLEX Pumping System (FPS1) will be deployed to supply water into the South EECW header via installed connections near the intake pumping station. o FLEX Pumping System (FPS2) will be deployed to supply water into the RHRSW "B" header via installed connections near the intake pumping station or via a 16" flanged connection in RHRSW Tunnel 3B.	• Install hose connections sized for FPS1 on the RHRSW "B" header inside the intake pumping station. • Install hose connections sized for FPS3 on the RHRSW "D" header inside the intake pumping station. • Install hose connections sized for FPS1 on the EECW header that will be connected to a 16" flange physically located in RHRSW Tunnel 3B. • Install hose connection to CSTs 1 & 3.	The connections are being installed on piping that are in a seismically designed structure and are not impacted by outside hazards. The CSTs are not designed to be available for the ELAP, but may be used to mitigate events if able to maintain pressure and position retention.

(Section 11e) Deployment Conceptual Modification (Attachment 3 contains Conceptual Sketches)		
Strategy	**Modifications**	**Protection of connections**
Identify strategy including how the equipment will be deployed to the point of use.	*Identify modifications*	*Identify how the connection is protected*
○ FLEX Pumping System (FPS3) will be deployed to supply water into the RHRSW "D" header via installed connections near the intake pumping station.		

<u>References</u>:

1. Abnormal Operating Instructions (AOIs)
   a. 0-AOI-57-1A, section 4.2
   b. 0-AOI-100-3, Flood Above Elevation 558'
2. Attachment 1A Timeline, Attachment 1A
3. Browns Ferry Nuclear Plant (BFNP) Updated Final Safety Analysis Report (UFSAR)
   a. Section 2.4A
4. BWROG Report, NEDC-32988-A, Rev 2, "Technical Justification to Support Risk Informed Modification to Selected Required Action End States for BWR Plants," Section I (NRC's SE) and Section II (Responses to NRC's RAI), ML030170060
5. "GEH Evaluation of FLEX Implementation Guidelines", NEDC-33771P, Revision 0
6. NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide"
   a. Section 7.3.1.1.b

<u>Notes:</u>

None

Maintain Core Cooling

(Section 12) BWR Portable Equipment Phase 3:

Provide a general description of the coping strategies using Phase 3 equipment including modifications that are proposed to maintain core cooling. Identify methods (RCIC/HPCI/IC) and strategy (ies) utilized to achieve this coping time.

Primary (and Alternate) Strategy

For Phase 3, the core cooling maintenance strategy is initially dependent on the strategy being implemented in Phase 2 (primary or alternate); however, the end state strategy is the same.

1. For those (2 or 3) units applying the primary strategy using the 4 kV FLEX Diesel Generators (DGs), Residual Heat Removal (RHR) and Core Spray (CS) (see Section 11 "Primary Phase 2 strategy for a unit that is not in cold shutdown"): Phase 3 will provide additional support to continue and reinforce the Phase 2 strategy. Phase 3 will provide additional diesel fuel and supplies and redundancy for the FLEX equipment being used. Additionally, Phase 3 will provide for demineralized water to makeup to the torus, Spent Fuel Pool (SFP), and Reactor Pressure Vessel (RPV) as necessary.

2. If any of the 4 kV FLEX DGs did not operate in Phase 2, the affected unit will be in the Phase 2 'alternate strategy' at the beginning of Phase 3, utilizing venting for containment cooling, and injection of river water for reactor and/or SFP makeup using the FLEX Pumping Systems (see Section 11, "Alternate Phase 2 strategy for a unit that is not in cold shutdown"). The Phase 3 strategy is to provide diesel power from the Regional Response Center (RRC) to convert this unit to the primary strategy discussed in 1) above.

Details:

(Section 12a) Provide a brief description of Procedures / Strategies / Guidelines	*Confirm that procedure/guidance exists or will be developed to support implementation*

Browns Ferry Nuclear Plant will utilize the industry developed guidance from the Owners Groups, EPRI and NEI Task team to develop site specific procedures or guidelines to address the criteria in NEI 12-06 (Ref. 1). These procedures and/or guidelines will support the existing symptom based command and control strategies in the current EOIs (Open Item, OI 17).

[redacted]

Maintain Core Cooling	
(Section 12b) Identify modifications	*List modifications*

- The RRC pumps, if needed (to replace the FLEX Pumping Systems in service), will utilize the same piping connections developed for Phase 2.
- Modifications will allow for the connection of RRC DGs to replace any FLEX DG that has failed.

(Section 12c) Key Reactor Parameters	*List instrumentation credited or recovered for this coping evaluation.*

Same as instruments listed in Section10c, augmented by the instruments associated with monitoring the DGs and Pumping Systems provided by the RRC.

(Section 12d) Deployment Conceptual Modification
(Attachment 3 contains Conceptual Sketches)

Strategy	**Modifications**	**Protection of connections**
Identify strategy including how the equipment will be deployed to the point of use.	*Identify modifications*	*Identify how the connection is protected*
Phase 3 equipment will be provided by the RRC, which is to be located in Memphis, TN. Equipment transported to the site will be either immediately staged at the point of use location (pumps and generators) or temporarily stored at the lay down area shown on Figure 4 until moved to the point of use area. Deployment paths identified on Figure 4 will be used to move equipment as necessary.	No modifications identified for Phase 3 deployment issues	• The FLEX/RRC pump make-up connections are the same as described for Phase 2 and shall be protected against the specific hazards used in the strategy (i.e., some high point connections may be isolated and not used for tornadoes, but implemented for floods). • The 480 VAC FLEX connection panels are located in a structure and level protected for all hazards. The RRC 480 VAC DGs can be connected even if the 480 V FLEX Diesel Generators were lost in a tornado event. • All other equipment will be portable.

[redacted]

Maintain Core Cooling

References:

1. NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide"

Notes:

None

Maintain Containment
(Section 13) Determine Baseline coping capability with installed coping[2] modifications not including FLEX modifications, utilizing methods described in Table 3-1 of NEI 12-06: • **Containment Venting or Alternate Heat Removal** • **Hydrogen Igniters (Mark III containments only)**
BWR Installed Equipment Phase 1:
Provide a general description of the coping strategies using installed equipment including modifications that are proposed to maintain containment integrity. Identify methods (containment vent or alternative / Hydrogen Igniters) and strategy (ies) utilized to achieve this coping time. During Phase 1, the primary strategy is to control reactor parameters so as not to challenge containment limits within the first 8 hours of the event to give time to deploy cooling pumps for Phase 2. Reactor pressure is lowered at near the maximum cooldown rate to ensure that if there were an unplanned rapid depressurization during this interval, the heat rejected from the reactor system to the containment would not exceed the ability of the Hardened Containment Vent System (HCVS) to mitigate. Venting is not expected to be required during the first 8 hours of the event based on following the operational strategies in GEH Evaluation of FLEX Implementation Guidelines (Ref. 1). Procedures would caution that venting during the first 8 hours, if required, must be minimized to avoid an adverse impact on Reactor Core Isolation Cooling (RCIC) Net Positive Suction Head (NPSH) (if RCIC must be aligned to the suppression pool rather than the Condensate Storage Tank (CST)). RCIC is the only credited vessel makeup during Phase 1. Containment parameters will be monitored during Phase 1, initially powered by batteries, until additional air cooled diesel backed power systems are started and aligned to power the battery chargers. The containment vent system is not credited for Phase 1; however, modifications to the containment vent system are planned in response to NRC Order EA-12-050 (Ref. 2). (Open Item, OI 11)

[2] Coping modifications consist of modifications installed to increase initial coping time, i.e., generators to preserve vital instruments or increase operating time on battery powered equipment.

Maintain Containment	
Details:	
(Section 13a) Provide a brief description of Procedures / Strategies / Guidelines	*Confirm that procedure/guidance exists or will be developed to support implementation*
Browns Ferry Nuclear Plant will utilize the industry developed guidance from the Owners Groups, EPRI and NEI Task team to develop site specific procedures or guidelines to address the criteria in NEI 12-06 (Ref. 3). These procedures and/or guidelines will support the existing symptom based command and control strategies in the current EOIs (Open Item, OI 17).	
(Section 13b) Identify modifications	*List modifications*
Hardened Containment Vent System (HCVS) (i.e., Reliable Hardened Vent) is currently installed but will be enhanced in accordance with NRC Order EA-12-050 (Ref. 2) (Open Item, OI 11).	
(Section 13c) Key Containment Parameters	*List instrumentation credited for this coping evaluation.*

Containment Essential Instrumentation	**Safety Function**
Drywell & Torus Pressure • PDT-064-0137 DW TO TORUS DIFF PRESS XMTR (Indic., Alarm, Interlock) • PDS-064-0137A DRYWELL TO SUPPR CHAMBER DIFF PRESS • PT-064-0135 DW PRESS XMTR (Indic., Alarm, Interlock) • PS-064-0135 DRYWELL PRESS • PI-64-135 DRYWELL PRESSURE	Containment integrity

[redacted]	
Maintain Containment	
Containment Essential Instrumentation	**Safety Function**
Drywell & Torus Temperature • TM-64-52 DRYWELL TEMPERATURE MONITOR	Containment integrity
Torus Water Level • LS-064-0054A SUPPR CHAMBER WTR LVL SW • LT-064-0066 SUPPR CHBR NR WTR LVL • LI-64-66 SUPPR POOL WATER LEVEL	Containment integrity
Suppression Chamber to Reactor Building Vacuum Relief Valve Position and Controls: • FSV-064-0020; FCV-64-20 Suppression Chamber Vacuum Relief Valve and • FSV-064-0021; FCV-64-21 Suppression Chamber Vacuum Relief Valve	Containment integrity
Containment Inerting Instr power • PX-076-0016 CONTAINMENT INERTING INSTR POWER SUPPLY	
Containment Hardened Vent Rad Monitor (Component No. TBD) (Open Item, OI 11)	RHVS effluent radioactivity
RHV system valve position indication (Component No. TBD) (Open Item, OI 11)	RHVS operability
RHV system pressure indication (Component No. TBD) (Open Item, OI 11)	RHVS operability
RHV system power status (Component No. TBD) (Open Item, OI 11)	RHVS operability
Nitrogen system supply status (Component No. TBD) (Open Item, OI 11)	RHVS operability
RHV effluent temperature (Component No. TBD) (Open Item, OI 11)	RHVS operability

[redacted]

Maintain Containment

References:

1. "GEH Evaluation of FLEX Implementation Guidelines", NEDC-33771P, Revision 0
2. "Issuance of Order to Modify Licenses with Regard to Reliable Hardened Containment Vents", EA-12-050
3. NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide"

Notes:

None

Maintain Containment

(Section 14) BWR Portable Equipment Phase 2:

Provide a general description of the coping strategies using on-site portable equipment including modifications that are proposed to maintain containment integrity. Identify methods (containment vent or alternative / Hydrogen Igniters) and strategy (ies) utilized to achieve this coping time.

During Phase 1, plant personnel establish and align FLEX equipment. For flood events, the equipment is staged many hours before the peak flood waters exceed the design basis (see Attachment 1A). For other events, equipment is placed in service beginning with the Station Blackout (SBO) condition – in some cases, before an Extended Loss of AC Power (ELAP) is declared (see timeline, Attachment 1A).

The following is a list of equipment planned to be onsite, protected (within the limitations described) and ready for use at or before the beginning of Phase 2.

1) Three 480 V FLEX DGs are permanently staged on the roof area of the adjacent Diesel Buildings. They are protected for all of the extreme natural events in Section 1 except for extreme tornados. These will be available before Phase 2 to supply battery chargers, ICS inverters, and other loads.
   a) The Unit 1 Distribution Panel will be able to supply power to 250 V DC Unit Battery Charger #1, Unit 1 ICS Inverter, 480 V Shutdown Board 1A and three additional 100 amp spare disconnects.
   b) The Unit 2 Distribution Panel will be able to supply power to 250 V DC Unit Battery Charger #2, Unit 2 ICS Inverter, 480 V Shutdown Board 2A and three additional 100 amp spare disconnects.
   c) The Unit 3 Distribution Panel will be able to supply power to 250 V DC Unit Battery Charger #3, Unit 3 ICS Inverter, 480 V Shutdown Board 3A and three additional 100 amp spare disconnects.
2) Three 4 kV FLEX DGs are permanently staged in a protected bunker structure. At the beginning of Phase 2 they will be available to support the primary loads listed below;
   a) The 4 kV FLEX DGs (FMDG1, FMDG2, FMDG3) can be aligned to battery chargers and are the backup supply in case of failure or tornado hazard loss of one or more of the three 480 V FLEX DGs. If any one of the three 4 kV FLEX DGs is lost, a power supply for a battery charger can be aligned from an adjacent unit.
      i) FMDG1 is aligned to:
         RHR 2B from Shutdown Board C (RHRSW header B).
      ii) FMDG2 is aligned to:
         RHR 1D from Shutdown Board D (RHRSW header D).
      iii) FMDG3 is aligned to:
         RHR 3B from Shutdown Board 3EC (RHRSW header B).
   b) Manual breaker operations may be necessary due to discharge of Shutdown Board control power batteries, 0-AOI-57-1A (Ref. 1a).
   c) N+1 for the 4 kV FLEX DGs is the alternate strategy.

Maintain Containment

(Section 14) BWR Portable Equipment Phase 2:

3) Four low pressure FLEX Pumping Systems are available at the beginning of Phase 2.
   a) Each FLEX Pumping System (FPS1, FPS2, FPS3, and FPS4) consists of a portable diesel driven pump rated at 5000 gpm at 150 psi discharge head. Suction lift capability is rated at 6 feet. The diesel driver is rated at 600 HP. In the case of extreme low lake level, each FLEX Pumping System is deployed with suction lift augmentation. Suction lift augmentation is provided for each of the main pumps (FPS1, FPS2, FPS3, and FPS4) by FLEX floating booster pump (FLBP) sets aligned to the suction of the main pumps. The FLEX floating booster pump sets include two pumps in parallel, 2500 gpm each with a 343HP diesel hydraulic drive system. The FLEX Pumping Systems include trailers, lift units, and hoses. TVA is designing deployment locations for the pumps, including ramps, winches or other transfer assemblies as necessary to deploy all pumps and hoses within the 8 hour Phase 1 coping interval. The staff begins deployment of the FLEX Pumping Systems as soon as SBO occurs rather than waiting to exhaust all attempts to restore the emergency electric supply system.
   b) The FLEX Pumping Systems are assigned as follows.
      i) FPS1 can be connected to one or more of the following:
         (1) Three CILRT penetrations through Reactor Building wall, elevation 565' (4" pipe) - inside 1A, 2A, 3A RHRSW pipe tunnel, (From inside the Reactor Building, connections can be made to condensate storage and supply and then to the vessel through RHR fill line, or to SFP makeup (normal), or to the torus.
         (2) The EECW South header - hookup outside pipe tunnel (3B & D Service Water (SW) tunnel) (The EDGs will be isolated by manual action if needed to ensure adequate cooling to operating SSCs). The S header can be used for SFP makeup, and
         (3) The EECW N Header - same as described in 3.b.i.2 above.
      ii) FPS2 could be connected to B RHRSW at one, or more, of the following locations:
         (1) At the intake structure,
         (2) In the tunnel at RHRSW piping and/or
         (3) By drilling a new 16" penetration through Reactor Building wall and connecting to the Heat Exchanger (HTX).

         Note: The B RHRSW can provide standby coolant to any unit, if needed.
      iii) FPS3 – could be connected to D RHRSW at one, or more, of the following locations:
         (1) At the intake structure,
         (2) In the tunnel at RHRSW piping and/or
         (3) By drilling a new 16" penetration through Reactor Building wall and connecting to the HTX.

         Note: The D RHRSW can provide standby coolant to any unit, if needed.
      iv) FPS4 - (N+1), is a spare.

Maintain Containment

(Section 14) BWR Portable Equipment Phase 2:

Based on Table 4.5.2-2 of GEH Evaluation of FLEX Implementation Guidelines (Ref. 4), Summary of Analysis Results for No Containment Venting (RCIC Suction from suppression pool) with heat input from Main Steam Relief Valves (MSRVs) and from RCIC during Phase 1, the primary containment temperature limit can be approached at around 8.3 hours. During Phase 2, FLEX deployment provides several alternatives for managing the heat load on containment.

1) One method is to remove heat from the reactor system (reducing containment heat addition rate):

  a) Use the RHR shutdown cooling system, with:

    i) River water supplied to the RHRSW B and D headers by FLEX Pumping Systems, FPS2 and FPS3,

    ii) RHR seal and room cooling provided by the EECW connection from FLEX Pumping System, FPS1 and

    iii) RHR pump motive power from one of the 4 kV FLEX DGs (by unit).

  b) Heat can be removed by running HPCI in CST to CST mode (Remove work from reactor steam heat) (If the CST is available).

    i) High Pressure Coolant Injection (HPCI) battery power is provided by chargers that are diesel backed (as noted above) in Phase 2. HPCI is not run until chargers are online.

2) Another method is to remove heat directly from containment:

  a) Using the RHR containment cooling system with:

    i) River water supplied to the RHRSW B and D headers by FLEX Pumping Systems, FPS2 and FPS3,

    ii) Residual Heat Removal (RHR) seal and room cooling provided by the EECW connection from FLEX Pumping System, FPS1, and

    iii) Residual Heat Removal (RHR) pump motive power from one of the 4 kV FLEX DGs (by unit);

  b) The containment cooling system can be used with:

    i) EECW supply for RBCCW system from FLEX Pumping System, FPS1, and

    ii) Motive supply for fans, valves, controllers, and pumps from FLEX DGs (4 kV DGs and in some cases 480 V DGs)

  c) Venting the containment is another method with

    i) Power for the containment vent system in accordance with NRC Order EA-12-050 (Ref. 5), and

Maintain Containment

(Section 14) BWR Portable Equipment Phase 2:

ii) Makeup to the suppression pool, if required during Phase 2, provided by FLEX Pumping System, FPS1.

d) Spraying the drywell (and/or the wet well) may be required. This is done by:

i) containment spray from RHRSW to RHR standby coolant crosstie, with

ii) Residual Heat Removal Service Water (RHRSW) charging from FLEX Pumping Systems, FPS2 or FPS3, depending on unit.

iii) Water removal from the torus, if required, driven through RHR drain pump system using containment pressure if pump not available. May also use a special HPCI lineup – Torus to CST, if available.

The N+1 strategy for loss of a single 4 kV FLEX DGs uses the containment vent system alternative (potentially combined with HPCI in CST to CST mode). FLEX deployment will allow the operators to choose the best combination of choices above. All units share FLEX Pumping Systems, FPS1, FPS2, and FPS3; therefore, the choices will be coordinated. The primary strategy, if all FLEX DGs are functioning, is to use RHR and containment coolers for containment heat load control.

RCIC may still be in service for all or part of Phase 2.

Emergency procedures currently require transfer of RCIC suction supply from CST if needed to prevent adding too much inventory to the suppression pool. The CST is not credited as being able to sustain all the events listed in Section 1; however, it would be used if available, because it provides additional margin before containment temperature is challenged, and it reduces the temperature of the RCIC bearing cooler. This plan addresses CST use because if the CST survives, its use requires consideration of the need for mass removal from the suppression pool.

Details:

(Section 14a) Provide a brief description of Procedures / Strategies / Guidelines	*Confirm that procedure/guidance exists or will be developed to support implementation*

Browns Ferry Nuclear Plant will utilize the industry developed guidance from the Owners Groups, EPRI and NEI Task team to develop site specific procedures or guidelines to address the criteria in NEI 12-06 (Ref. 6). These procedures and/or guidelines will support the existing symptom based command and control strategies in the current EOIs (Open Item, OI 17).

Maintain Containment	
(Section 14) BWR Portable Equipment Phase 2:	
(Section 14b) Identify modifications	*List modifications*

- Construct a Flexible Equipment Storage Building (FESB), located above the Probable Maximum Flood (PMF) level, which is adequately protected from the hazards listed in Section 1. This storage facility will be used to store support equipment and items, including the four FLEX Pumping Systems and the three 4 kV FLEX DGs. (Open Items, OI 9 and OI 10)
- Install one 4 kV FLEX DG in the protected storage facility with prewired cable; routed and connectable to 4 kV Shutdown Boards "A" and "C". (Open Item, OI 9)
- Install one 4 kV FLEX DG in the protected storage facility with prewired cable; routed and connectable to 4 kV Shutdown Boards "B" and "D". (Open Item, OI 9)
- Install one 4 kV FLEX DG in the protected storage facility with prewired cable; routed and connectable to 4 kV Shutdown Boards "3EA" and "3EC". (Open Item, OI 9)
- Install one 480 V FLEX DG, located above the PMF level, that is adequately protected from the hazards listed in Section 1 and in a storage enclosure designed equivalent to the requirements of NEI 12-06 (Ref. 6a). This 480 V FLEX DG will be prewired with a connection point to the 1A 480 V Shutdown Board (normal feed to 250 V safety related Battery Charger 1). Also, it will be prewired with quick disconnects directly to 250 V safety related Battery Charger 1.
- Install one 480 V FLEX DG, located above the PMF level, that is adequately protected from the hazards listed in Section 1 and in a storage enclosure designed equivalent to the requirements of NEI 12-06 (Ref. 6a). This 480 V FLEX DG will be prewired with a connection point to the 2A 480 V Shutdown Board (normal feed to 250 V safety related Battery Charger 2). Also, it will be prewired with quick disconnects directly to 250 V safety related Battery Charger 2.
- Install one 480 V FLEX DG, located above the PMF level, that is adequately protected from the hazards listed in Section 1 and in a storage enclosure designed equivalent to the requirements of NEI 12-06 (Ref. 6a). This 480 V FLEX DG will be prewired with a connection point to the 3A 480 V Shutdown Board (normal feed to 250 V safety related Battery Charger 3). Also, it will be prewired with quick disconnects directly to 250 V safety related Battery Charger 3.
- Install connection points on the "B" and "D" RHRSW piping at the Intake Structure or RHRSW Tunnel for the FLEX pump discharge hose connections. (Open Item, OI 9)
- Install connection Point(s) on either of the common EECW header piping at the Intake Structure or RHRSW Tunnel for the FLEX pump discharge hose connections. (Open Item, OI 9).

Maintain Containment

(Section 14) BWR Portable Equipment Phase 2:

- Modify 4 inch Reactor Building penetrations, currently used to provide air for the Containment Integrated Leak Rate Test (CILRT), to be accessible outside the RHRSW Tunnels and above the PMF level. The extended penetration will be modified to allow a FLEX pump discharge hose connection.
- Install new connections at the CSTs for direct connection to the FLEX pumps (protected connection in case the CST is lost – this allows for Torus makeup).
- Install a Hardened Containment Vent System (HCVS) as required by NRC Order EA-12-050 (Ref. 5).

(Section 14c) Key Containment Parameters	*List instrumentation credited or recovered for this coping evaluation.*

See instrumentation listed in Phase 1 section.

(Section 14d) Storage / Protection of Equipment :

Describe storage / protection plan or schedule to determine storage requirements

Seismic	*List how equipment is protected or scheduled to protect*

Portable equipment, maintained in the FESB, and connection points required to implement this FLEX strategy will be designed to meet or exceed BFNP design basis Safe Shutdown Earthquake (SSE) protection requirements.

Flooding Note: if stored below current flood level, then ensure procedures exist to move equipment prior to exceeding flood level.	*List how equipment is protected or scheduled to protect*

Portable equipment required to implement this FLEX strategy will be maintained in the FESB, which is sited in a suitable location that is above the Probable Maximum Flood (PMF) level and, as such, is not susceptible to flooding from any source. FLEX equipment deployment paths shall maintain a minimum elevation of 565', Mean Sea Level (MSL). Plant shutdown is required when flood levels reach 558' MSL in accordance with 0-AOI-100-3 (Ref. 1b). Updated Final Safety Analysis Report (UFSAR). Based on UFSAR Chapter 2.4A Figure 16 (Ref. 2ai) shows the plant has approximately 4 days from the time river level reaches 558' MSL to the time the water level would reach 565' MSL.

Maintain Containment

(Section 14) BWR Portable Equipment Phase 2:

Severe Storms with High Winds	*List how equipment is protected or scheduled to protect*

Portable equipment required to implement this FLEX strategy will be maintained in the FESB, which is designed to meet or exceed the licensing basis high wind hazard for BFNP.

Snow, Ice, and Extreme Cold	*List how equipment is protected or scheduled to protect*

The FESB will be evaluated for snow, ice, and extreme cold temperature effects and heating will be provided as required to assure no adverse effects on the FLEX equipment. The FESB will have a stand-alone HVAC system.

High Temperatures	*List how equipment is protected or scheduled to protect*

The FESB will be evaluated for high temperature effects and ventilation will be provided as required to assure no adverse effects on the FLEX equipment. The FESB will have a stand-alone HVAC system.

(Section 14e) Deployment Conceptual Design
(Attachment 3 contains Conceptual Sketches)

Strategy	**Modifications**	**Protection of connections**
Identify strategy including how the equipment will be deployed to the point of use.	*Identify modifications*	*Identify how the connection is protected*
Hardened Containment Vent System (HCVS) is designed as permanently installed equipment. No deployment strategy is required. FLEX Pumping Systems will be deployed as shown in Figures 3a and 3b. FLEX DGs (both 4 kV and 480 V) are permanently mounted in protected locations or enclosures.	The Hardened Containment Vent System (HCVS) is currently installed but will be enhanced in accordance with Ref. 2 and guidance given in Ref. 1. (Open Item, OI 11)	Hardened Containment Vent System (HCVS) is designed as permanently installed equipment. No connection points are required. Pump connection points are protected from the hazards for which they are used. 480 V FLEX DGs shall be protected from all events except tornados. DG panels shall be protected from all events listed in Section 1.

Maintain Containment
(Section 14) BWR Portable Equipment Phase 2:

References:

1. Abnormal Operating Instructions (AOIs)
   a. 0-AOI-57-1A, Loss of Offsite Power (161 and 500 KV)/Station Blackout
   b. 0-AOI-100-3, Flood Above Elevation 558'
2. Browns Ferry Nuclear Plant (BFNP) Updated Final Safety Analysis Report (UFSAR)
   a. Section 2.4A,
      i. Figure 16
3. Draft Interim Staff Guidance JLD-ISG-2012-01, Compliance with Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigating Strategies for Beyond-Design-Basis External Events"; Docket ID NRC-2012-0068
4. GEH Evaluation of FLEX Implementation Guidelines, NEDC-33771P, Revision 0
5. "Issuance of Order to Modify Licenses with Regard to Reliable Hardened Containment Vents" , EA-12-050
6. NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide"
   a. Section 7.3.1.1.b

Notes:

None

Maintain Containment

(Section 15) BWR Portable Equipment Phase 3:

Provide a general description of the coping strategies using Phase 3 equipment including modifications that are proposed to maintain containment integrity. Identify methods (containment vent or alternative / Hydrogen Igniters) and strategy (ies) utilized to achieve this coping time.

Primary (and Alternate) Strategy

For Phase 3, the containment cooling maintenance strategy is initially dependent on the strategy being implemented in Phase 2 (primary or alternate); however, the end state strategy is the same.

1) For those (2 or 3) units applying the primary strategy using the 4 kV FLEX DGs, with RHR containment cooling and drywell coolers, Phase 3 will provide additional support to continue and reinforce the Phase 2 strategy. Phase 3 will provide additional diesel fuel and supplies and redundancy for the FLEX equipment being used. Additionally, Phase 3 will provide for demineralized water to makeup to the torus as needed (as an alternative to river water makeup using FLEX Pumping System, FPS1 (described in the Phase 2 strategy).
2) If any of the 4 kV FLEX DGs did not operate in Phase 2, the affected unit will be in the Phase 2 'alternate strategy' at the beginning of Phase 3, utilizing venting for containment cooling, and injection of river water for drywell spray using the FLEX Pumping Systems. The Phase 3 strategy is to provide diesel power from the Regional Response Center (RRC) to convert this unit to the primary strategy discussed in 1) above.

Details:

(Section 15a) Provide a brief description of Procedures / Strategies / Guidelines	*Confirm that procedure/guidance exists or will be developed to support implementation*

Same as Section 14a.

(Section 15b) Identify modifications	*List modifications*

Same as Section 14b, except that additional connection points will be provided to replace any FLEX DGs that have failed. (Open Item, OI 9)

Maintain Containment

(Section 15) BWR Portable Equipment Phase 3:

(Section 15c) Key Containment Parameters	*List instrumentation credited or recovered for this coping evaluation.*
Same as Section 14c.	

(Section 15d) Deployment Conceptual Design
(Attachment 3 contains Conceptual Sketches)

Strategy	Modifications	Protection of connections
Identify strategy including how the equipment will be deployed to the point of use.	*Identify modifications*	*Identify how the connection is protected*
Same as Section 14d.	Same as Section 14d.	Same as Section 14d.

References:

None

Notes:

None

Maintain Spent Fuel Pool Cooling

(Section 16) Determine Baseline coping capability with installed coping[3] modifications not including FLEX modifications, utilizing methods described in Table 3-1 of NEI 12-06:

- **Makeup with Portable Injection Source**

BWR Installed Equipment Phase 1:

Provide a general description of the coping strategies using installed equipment including modifications that are proposed to maintain spent fuel pool cooling. Identify methods (makeup with portable injection source) and strategy (ies) utilized to achieve this coping time.

The normal Spent Fuel Pool (SFP) water inventory provides sufficient SFP cooling to prevent fuel damage for the entire coping period until Phase 2 (8 hours). RTM-96 Response Technical Manual, Volume 1 (Ref. 2), was used with a full core recently discharged plus 20 years of accumulated discharges, after 5 days shutdown.

- The time for the SFP to boil is 3.1 hours.
- The required makeup to offset boil off is 81 gallons per minute.
- The SFP must be virtually drained for substantial damage to occur. Pools are considered coolable as long as 20% of the fuel is covered.
- Cladding failure with release of the fission products in the fuel pin gap is possible within 2 hours to several days after the pool is drained.
- The boil dry time is estimated at 49.3 hours.

TVA will develop procedures (as shown on timeline, Attachment 1A) to deploy and secure makeup hoses at the SFP before boiling would occur. This could be required as early as 3.1 hours to avoid having to access the SFP deck while boiling is in progress; however, TVA may allow for a longer time period if actual SFP loads are lower (as would normally be expected). At eight hours into the event, more than 40 hours remain before the fuel becomes inadequately cooled.

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[3] Coping modifications consist of modifications installed to increase initial coping time, i.e., generators to preserve vital instruments or increase operating time on battery powered equipment.

Maintain Spent Fuel Pool Cooling

Details:

(Section 16a) Provide a brief description of Procedures / Strategies / Guidelines	*Confirm that procedure/guidance exists or will be developed to support implementation*

Browns Ferry Nuclear Plant will utilize the industry developed guidance from the Owners Groups, EPRI and NEI Task team to develop site specific procedures or guidelines to address the criteria in NEI 12-06 (Ref. 1). These procedures and/or guidelines will support the existing symptom based command and control strategies in the current EOIs (Open Item, OI 17).

(Section 16b) Identify modifications	*List modifications*

Modifications to install SFP level instrumentation per NRC Order EA-12-051 (Ref. 3). (Open Item, OI 12)

(Section 16c) Key SFP Parameters	*List instrumentation credited or recovered for this coping evaluation.*

Per NRC Order EA-12-051.

<u>References</u>:

1. NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide"
2. NUREG/BR-0150 Vol. 1, Rev. 4, "RTM-96 Response Technical Manual", Volume 1, ML003747073
   a. Table D-1. "Heatup and boil-dry times for a typical spent fuel pool"
3. "Order to Enhance Spent Fuel Pool Instrumentation", EA-12-051

<u>Notes:</u>

None

Maintain Spent Fuel Pool Cooling

(Section 17) BWR Portable Equipment Phase 2:

Provide a general description of the coping strategies using on-site portable equipment including modifications that are proposed to maintain spent fuel pool cooling. Identify methods (makeup with portable injection source) and strategy (ies) utilized to achieve this coping time.

The normal Spent Fuel Pool (SFP) water inventory provides sufficient SFP cooling to prevent fuel damage for the entire Phase 1 coping period until Phase 2 (8 hours); however, Plant Staff will have deployed hoses at the refuel floor, if necessary (see Section 16), to avoid having to access the refuel deck while the SFP is boiling.

During Phase 1, plant personnel will deploy Phase 2 equipment. For flood events, the equipment is staged many hours before the peak flood waters exceed the design basis (see Attachment 1A). For other events, equipment is placed in service beginning with the SBO condition – in some cases, before an ELAP is declared (see timeline, Attachment 1A).

1) Three 480 V FLEX DGs are permanently staged on the roof area of the adjacent Diesel Buildings. They are protected for all of the extreme natural events in Section 1 except for extreme tornados. These will be available before Phase 2 to supply battery chargers, ICS inverters, and other loads.
   a) The Unit 1 Distribution Panel will be able to supply power to 250 V DC Unit Battery Charger #1, Unit 1 ICS Inverter, 480 V Shutdown Board 1A and three additional 100 amp spare disconnects.
   b) The Unit 2 Distribution Panel will be able to supply power to 250 V DC Unit Battery Charger #2, Unit 2 ICS Inverter, 480 V Shutdown Board 2A and three additional 100 amp spare disconnects.
   c) The Unit 3 Distribution Panel will be able to supply power to 250 V DC Unit Battery Charger #3, Unit 3 ICS Inverter, 480 V Shutdown Board 1A and three additional 100 amp spare disconnects.
2) Three 4 kV FLEX DGs are permanently staged in a protected bunker structure. At the beginning of Phase 2 they will be available to support the primary loads listed below.
   a) 4 kV FLEX DGs can be aligned to battery chargers and are the backup supply in case of failure or tornado hazard loss of one or more of the three 480 V FLEX DGs. If any 4 kV FLEX DG is lost, a power supply for a battery charger can be aligned.
      i. FMDG1 is aligned to:
         RHR 2B from Shutdown Board C (RHRSW header B).
      ii. FMDG2 is aligned to:
         RHR 1D from Shutdown Board D (RHRSW header D).
      iii. FMDG3 is aligned to:
         RHR 3B from Shutdown Board 3EC (RHRSW header B).
   b) Manual breaker operations may be necessary due to discharge of Shutdown Board control power batteries 0-AOI-57-1A (Ref. 1a).
   c) N+1 for the 4 kV FLEX DGs is an alternate strategy.

Maintain Spent Fuel Pool Cooling

(Section 17) BWR Portable Equipment Phase 2:

3) FLEX Pumping Systems are available at the beginning of Phase 2:
   a) Each of the FLEX Pumping Systems (FPS1, FPS2, FPS3, and FPS4) consists of a portable diesel pump rated at 5000 gpm at 150 psi discharge head. Suction lift capability is rated at 6 feet. The diesel driver is rated at 600HP. In the case of extreme low lake level, each FLEX Pumping System is deployed with suction lift augmentation. Suction lift augmentation is provided for each of the main pumps (FLPP1, FLPP2, FLPP3, and FLPP4) by FLEX floating booster pump sets (FLBP1, FLBP2, FLBP3 and FLBP4) aligned to the suction of the main pumps. The FLEX floating booster pump sets include two pumps in parallel, 2500 gpm each with a 343 HP diesel hydraulic drive system. The pump systems include trailers, lift units, and hoses. TVA is designing deployment locations for the pumps including ramps, winches or other transfer assemblies as necessary to deploy all pumps and hoses within the 8 hour Phase 1 coping interval. The staff begins deployment of these pumps as soon as SBO occurs rather than waiting to exhaust all attempts to restore the emergency electric supply system.
   b) FLEX Pumping Systems are assigned as follows.
      i) FPS1 can be connected to one or more of the following:
         (1) Three CILRT penetrations through Reactor Building wall, elevation 565' (4" pipe) - inside 1A, 2A, 3A RHRSW pipe tunnel, (From inside the Reactor Building, connections can be made to condensate storage and supply and then to the vessel through RHR fill line, or to SFP makeup (normal), or to the torus),
         (2) The EECW South header - hookup outside pipe tunnel (3B & D Service Water (SW) tunnel), (the EDGs will be isolated by manual action if needed to ensure adequate cooling to operating SSCs). The S header can be used for SFP makeup.
         (3) The EECW N Header - same as described in 3.b.i.2 above.
      ii) FPS2 is aligned to B RHRSW at one, or more, of the following locations:
         (1) At the intake structure,
         (2) In the tunnel at RHRSW piping and/or
         (3) By drilling a new 16" penetration through Reactor Building and connecting to the Heat Exchanger (HTX).

         Note: The B RHRSW can provide standby coolant to any unit, if needed.
      iii) FPS3 – could be connected to D RHRSW at one, or more, of the following locations:
         (1) At the intake structure,
         (2) In the tunnel at RHRSW piping and/or
         (3) By drilling a new 16" penetration through Reactor Building wall and connecting to the Heat Exchanger (HTX).

         Note: The D RHRSW can provide standby coolant to any unit, if needed.
      iv) FPS4 - (N+1), spare

Maintain Spent Fuel Pool Cooling

(Section 17) BWR Portable Equipment Phase 2:

SFP level instrumentation will be provided in accordance with NRC Order EA-12-051 (Ref. 4) (Open Item, OI 12)

Primary Strategy when SFP heat load is high (early in cycle after an offload).

If SFP heat load is high, the demand for reactor and containment cooling is a lot lower. An RHR pump, powered by a 4 kV FLEX DG can be aligned to SFP cooling assist mode to provide SFP cooling. Residual Heat Removal (RHR) can also provide makeup to the SFP (torus temperatures would be maintained below boiling since unit heat load will be low). Residual Heat Removal (RHR) room and seal coolers will be supported by FLEX Pumping System, FPS1 (via EECW system piping). FLEX Pumping Systems FPS2 or FPS3 will provide river cooling supply to the RHR heat exchangers.

The Fuel Pool Cooling and Cleanup (FPCCU) system will be operated with power from 4 kV FLEX DGs. FLEX Pumping System, FPS1, provides cooling water for the Reactor Building Closed Cooling Water System (RBCCW) Heat Exchanger (HTX) which, in turn, supplies cooling to the FPCCU HTXs.

Alternate Strategy (N + 1) when SFP heat load is high (early in cycle after an offload).

If an RHR pump is not available (assuming a 4 kV FLEX DG is unavailable), the fuel pool makeup requirements will be met by connecting the EECW makeup line to the SFP through the hoses previously aligned on the refuel deck. The EECW system will be charged using FLEX Pumping System, FPS1. A second alternative (N + 2) is to inject flow from FLEX Pumping System, FPS2 or FPS3 (depending on unit) via the RHR standby coolant alignment to RHR SFP makeup.

Strategies when SFP heat load is low (late in core life)

When SFP heat load is low, SFP cooling is not needed until after Phase 3 begins. If SFP makeup or cooling is needed before Phase 3, these same strategies would be implemented, only later.

Schedule:

(Section 17a) Provide a brief description of Procedures / Strategies / Guidelines	*Confirm that procedure/guidance exists or will be developed to support implementation*

Browns Ferry Nuclear Plant will utilize the industry developed guidance from the Owners Groups, EPRI and NEI Task team to develop site specific procedures or guidelines to address the criteria in NEI 12-06 (Ref. 3). These procedures and/or guidelines will support the existing symptom based command and control strategies in the current EOIs (Open Item, OI 17).

Maintain Spent Fuel Pool Cooling

(Section 17) BWR Portable Equipment Phase 2:

(Section 17b) Identify modifications	*List modifications*

- Modification to install SFP level instrumentation per NRC Order EA-12-051 (Ref. 4). (Open Item, OI 12)
- Hardened bunker to store equipment (i.e., FLEX pumps, hoses, DGs, transport equipment, ramps to river, diesel fuel transfer pump systems) as described above.

(Section 17c) Key SFP Parameters	*List instrumentation credited or recovered for this coping evaluation.*

NRC Order EA-12-051 (Ref. 4)

Instrumentation required for RHR system alignment and FPCCU system instruments required to operate system will be provided with diesel backed power. (Open Item, OI 12)

(Section 17d) Storage / Protection of Equipment :

Describe storage / protection plan or schedule to determine storage requirements

Seismic	*List how equipment is protected or scheduled to protect*

The permanent piping system used to provide water from the intake structure to the plant is the RHRSW piping which is seismically qualified. FLEX pumps will be stored in storage structures designed and constructed to meet the requirements of NEI 12-06 (Ref. 3).

Portable equipment, maintained in the FESB, and connection points required to implement this FLEX strategy will be designed to meet or exceed BFNP design basis Safe Shutdown Earthquake (SSE) protection requirements.

Flooding Note: if stored below current flood level, then ensure procedures exist to move equipment prior to exceeding flood level.	*List how equipment is protected or scheduled to protect*

Portable equipment required to implement this FLEX strategy will be maintained in the FESB, which is sited in a suitable location that is above the Probable Maximum Flood (PMF) level and, as such, is not susceptible to flooding from any source. FLEX equipment deployment paths shall maintain a minimum elevation of 565', Mean Sea Level (MSL). Plant shutdown is required when flood levels reach 558' MSL in accordance with 0-AOI-100-3 (Ref. 1b). Updated Final Safety Analysis Report (UFSAR) Chapter 2.4A Figure 16 (Ref. 2ai) shows the plant has approximately 4 days from the time river level reaches 558' MSL to the time the water level would reach 565' MSL.

Maintain Spent Fuel Pool Cooling	
(Section 17) BWR Portable Equipment Phase 2:	
Severe Storms with High Winds	*List how equipment is protected or scheduled to protect*
The piping used to provide makeup flow to the SFP is contained within buildings that are protected from storms and high winds. Portable equipment required to implement this FLEX strategy will be maintained in the FESB, which is designed to meet or exceed the licensing basis high wind hazard for BFNP.	
Snow, Ice, and Extreme Cold	*List how equipment is protected or scheduled to protect*
The piping used to provide makeup flow to the SFP is contained within buildings that are protected from snow, ice, and extreme cold. The FESB will be evaluated for snow, ice, and extreme cold temperature effects and heating will be provided as required to assure no adverse effects on the FLEX equipment. The FESB will have a stand-alone HVAC system.	
High Temperatures	*List how equipment is protected or scheduled to protect*
The piping used to provide makeup flow to the SFP is contained within buildings that are protected from high temperatures. The FESB will be evaluated for high temperature effects and ventilation will be provided as required to assure no adverse effects on the FLEX equipment. The FESB will have a stand-alone HVAC system.	

[redacted]		
Maintain Spent Fuel Pool Cooling		
(Section 17e) Deployment Conceptual Design **(Attachment 3 contains Conceptual Sketches)**		
Strategy	**Modifications**	**Protection of connections**
Identify strategy including how the equipment will be deployed to the point of use.	*Identify modifications*	*Identify how the connection is protected*
FLEX Pumping Systems shall be deployed to supply water to the Emergency Equipment Cooling Water (EECW). • One arrangement would have a FLEX Pumping System connected to the EECW South header in the RHRSW Tunnel 3B. • A second arrangement would have a FLEX Pumping System supply water through the Containment Integrated Leak Rate Test (CILRT) connection in the RHRSW Tunnel 1A, running hoses in the Reactor Building to the Condensate Storage and Supply connections: which then, could be valved-in to supply water to the SPF.	• The arrangement through the RHRSW tunnel is described in Section 10E. • The second arrangement through the ILRT penetration requires no modifications.	Both connection points are located in protected structures.

Maintain Spent Fuel Pool Cooling

References:

1. Abnormal Operating Instructions (AOIs)
    a. 0-AOI-57-1A, section 4.2
    b. 0-AOI-100-3, Flood Above Elevation 558'
2. Browns Ferry Nuclear Plant (BFNP) Updated Final Safety Analysis Report (UFSAR)
    a. Section 2.4A
        i. Figure 16
3. NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide"
4. "Order to Enhance Spent Fuel Pool Instrumentation", EA-12-051

Notes:

None

Maintain Spent Fuel Pool Cooling

(Section 18) BWR Portable Equipment Phase 3:

Provide a general description of the coping strategies using Phase 3 equipment including modifications that are proposed to maintain spent fuel pool cooling. Identify methods (makeup with portable injection source) and strategy (ies) utilized to achieve this coping time.

The industry will establish two Regional Response Centers (RRC) to support utilities during beyond-design-basis events. Each RRC will hold five sets of equipment, four of which will be able to be fully deployed when requested, the fifth set will have equipment in a maintenance cycle. Equipment will be moved from an RRC to a local Assembly Area, established by the SAFER team and the utility. Communications will be established between the affected nuclear site and the SAFER team and required equipment will be moved to the site as needed. First arriving equipment, as established during development of the BFNP playbook (the Regional Response Center's plan for coordinating with each utility), will be delivered to the site within 24 hours from the initial request. The Browns Ferry Nuclear Plant Playbook will establish appropriate requirements for additional fuel and consumables to support the in-process Phase 2 strategies and will provide additional backup for extended operation of the Phase 2 strategies. In addition, the Phase 3 BFNP Playbook will include provisions for recovery facilities (i.e., demineralized water supply). TVA is working with the Nuclear Industry to develop standard requirements for RRC response. More details regarding the BFNP Phase 3 Playbook and the Regional Response Centers will be provided in later updates (Open Item, OI 19).

The following Phase 2 equipment will continue to be used in Phase 3 if it is still required for spent fuel cooling.

1) Three 480 V FLEX DGs are permanently staged on the roof area of the adjacent Diesel Buildings. They are protected for all of the extreme natural events in Section 1 except for extreme tornados. These will be available before Phase 2 to supply battery chargers, ICS inverters, and other loads.
   a) The Unit 1 Distribution Panel will be able to supply power to 250 V DC Unit Battery Charger #1, Unit 1 ICS Inverter, 480 V Shutdown Board 1A and three additional 100 amp spare disconnects.
   b) The Unit 2 Distribution Panel will be able to supply power to 250 V DC Unit Battery Charger #2, Unit 2 ICS Inverter, 480 V Shutdown Board 2A and three additional 100 amp spare disconnects.
   c) The Unit 3 Distribution Panel will be able to supply power to 250 V DC Unit Battery Charger #3, Unit 3 ICS Inverter, 480 V Shutdown Board 3A and three additional 100 amp spare disconnects.

Maintain Spent Fuel Pool Cooling

(Section 18) BWR Portable Equipment Phase 3:

2) Three 4 kV FLEX DGs are permanently staged in a protected bunker structure. At the beginning of Phase 2 they will be available to support the primary loads listed below.
   a) 4 kV FLEX DGs (FMDG1, FMDG2, FMDG3) can be aligned to battery chargers and are the backup supply in case of failure or tornado hazard loss of one or more of the three 480 V FLEX DGs. If any 4 kV FLEX DG is lost, a power supply for a battery charger can be aligned.
      i) FMDG1 is aligned to Residual Heat Removal (RHR) 2B from Shutdown Board C (RHRSW header B).
      ii) FMDG2 is aligned to Residual Heat Removal (RHR) 1D from Shutdown Board D (RHRSW header D).
      iii) FMDG3 is aligned to Residual Heat Removal (RHR) 3B from Shutdown Board 3EC (RHRSW header B).
   b) Manual breaker operations may be necessary due to discharge of Shutdown Board control power batteries, 0-AOI-57-1A (Ref. 1a).
   c) N+1 for the 4 kV FLEX DGs is an alternate strategy.
3) FLEX Pumping Systems:
   a) Each FLEX Pumping Systems (FPS1, FPS2, FPS3, and FPS4) consist of a portable diesel pump rated at 5000 gpm at 150 psi discharge head. Suction lift capability is rated at 6 feet. The diesel driver is rated at 600HP. In the case of extreme low lake level, each FLEX Pumping System is deployed with suction lift augmentation. Suction lift augmentation is provided for each of the main pumps (FPS1, FPS2, FPS3, and FPS4) by FLEX floating booster pump (FLBP) sets aligned to the suction of the main pumps. The FLBP sets include two pumps in parallel, 2500 gpm each with a 343 HP diesel hydraulic drive system. The FLEX Pumping Systems include trailers, lift units, and hoses. TVA is designing deployment locations for the pumps, including ramps, winches or other transfer assemblies as necessary to deploy all pumps and hoses within the 8 hour Phase 1 coping interval. The staff begins deployment of these pumps as soon as SBO occurs rather than waiting to exhaust all attempts to restore the emergency electric supply system.
   b) FLEX Pumping System assignments:
      i) FPS1 – can be connected to one or more of the following:
         (1) Three CILRT penetrations through Reactor Building wall, elevation 565' (4" pipe) - inside 1A, 2A, 3A RHRSW pipe tunnel. (From inside the Reactor Building, connections can be made to condensate and then to the vessel through RHR fill line, or to SFP makeup (normal), or to the torus),
         (2) The EECW South header - hookup outside pipe tunnel (3B & D Service Water (SW) tunnel) (The EDGs will be isolated by manual action if needed to ensure adequate cooling to operating SSCs). The S header can be used for SFP makeup, and
         (3) The EECW N Header - same as described in 3.b.i.2 above.

Maintain Spent Fuel Pool Cooling

(Section 18) BWR Portable Equipment Phase 3:

ii) FPS2 is aligned to B RHRSW at one, or more, of the following locations:
   (1) At the intake structure,
   (2) In the tunnel at RHRSW piping and/or
   (3) By drilling a new 16" penetration through Reactor Building and connecting to the Heat Exchanger (HTX).
   Note: The B RHRSW can provide standby coolant to any unit, if needed.

iii) FPS3 – could be connected to D RHRSW at one, or more, of the following locations:
   (1) At the intake structure,
   (2) In the tunnel at RHRSW piping and/or
   (3) By drilling a new 16" penetration through Reactor Building wall and connecting to the HTX.
   Note: The D RHRSW can provide standby coolant to any unit, if needed.

iv) FPS4 - (N+1), spare

SFP level instrumentation will be provided in accordance with NRC Order EA-12-051 (Ref. 3) (Open Item, OI 12)

Primary Strategy when SFP heat load is high (early in cycle after an offload).

If SFP heat load is high, the demand for reactor and containment cooling is significantly lower. An RHR pump, powered by a 4 kV FLEX DG (or a FLEX DG provided by the RRC) can be aligned to SFP cooling assist mode to provide SFP cooling. Residual Heat Removal (RHR) can also provide makeup to the SFP (torus temperatures would be maintained below boiling since unit heat load will be low). Residual Heat Removal (RHR) room and seal coolers will be supported by FLEX Pumping System, FPS1 (via EECW system piping). FLEX Pumping Systems, FPS2 or FPS3 will provide river cooling supply to the RHR heat exchangers.

The Fuel Pool Cooling and Cleanup (FPCCU) system will be operated with power from 4 kV FLEX DGs. FLEX Pumping System, FPS1 provides cooling water for the Reactor Building Closed Cooling Water System (RBCCW) Heat Exchanger (HTX) which, in turn, supplies cooling to the FPCCU HTXs.

Other strategies may be developed based on equipment supplied from the RRC (i.e., makeup pumps, demineralized water system, portable heat exchangers, and restoration of Auxiliary Decay Heat Removal System (ADHR)). If developed, these will be provided in later updates.

Maintain Spent Fuel Pool Cooling

(Section 18) BWR Portable Equipment Phase 3:

Schedule:

(Section 18a) Provide a brief description of Procedures / Strategies / Guidelines	*Confirm that procedure/guidance exists or will be developed to support implementation*

Browns Ferry Nuclear Plant will utilize the industry developed guidance from the Owners Groups, EPRI and NEI Task team to develop site specific procedures or guidelines to address the criteria in NEI 12-06 (Ref. 2). These procedures and/or guidelines will support the existing symptom based command and control strategies in the current EOIs (Open Item, OI 17).

(Section 18b) Identify modifications	*List modifications*

Modification to install SFP level instrumentation per NRC Order EA-12-051 (Ref. 3).

(Section 18c) Key SFP Parameter	*List instrumentation credited or recovered for this coping evaluation.*

SFP Level per Order EA-12-051 (Ref. 3).

(Section 18d) Deployment Conceptual Design
(Attachment 3 contains Conceptual Sketches)

Strategy	**Modifications**	**Protection of connections**
Identify strategy including how the equipment will be deployed to the point of use.	*Identify modifications*	*Identify how the connection is protected*
See Phase 2 discussion, Section 17	See Phase 2 discussion, Section 17	See Phase 2 discussion, Section 17

Maintain Spent Fuel Pool Cooling

(Section 18) BWR Portable Equipment Phase 3:

References:

1. Abnormal Operating Instructions (AOIs)
   a. 0-AOI-57-1A, section 4.2
2. NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide"
3. "Order to Enhance Spent Fuel Pool Instrumentation", EA-12-051

Notes:

None

Safety Functions Support

(Section 19) Determine Baseline coping capability with installed coping[4] modifications not including FLEX modifications.

BWR Installed Equipment Phase 1

Provide a general description of the coping strategies using installed equipment including station modifications that are proposed to maintain and/or support safety functions. Identify methods and strategy (ies) utilized to achieve coping times.

Main Control Room Habitability

Under ELAP conditions with no mitigating actions taken, initial analysis projects the control room to approach 110°F (the assumed maximum temperature for efficient human performance) in a time of approximately 19 hours (U1/U2) and 24 hours (U3). Phase 1 FLEX strategy is to block open the entrance door to the Main Control Room (MCR) when the MCR temperature reaches 94°F (U1/U2) and 93°F (U3) (the assumed outside temperature at the time of event occurrence). This will establish a flow path for air to flow from the control building (and outside) to the MCR. The preliminary assessment indicates that by employing this strategy the MCR temperature will rise to approximately 101°F (U1/U2) and 99 °F (U3) at the 8 hour point by which time Phase 2 actions can be implemented, NEI 12-06 (Ref. 2). See Phase 2 discussion below.

RCIC Room Habitability

Under the Station Blackout (SBO) case the temperature remains below 127°F for the entire transient of 8 hours. To determine the temperature impact to the pump rooms over an extended period, the curves in the above assessment were extrapolated to 72 hours. The extrapolation indicated that temperature in the pump rooms will rise to a maximum of approximately 151°F in approximately 72 hours.

At 8 hours, 4 kV FLEX DGs are in service allowing RCIC to be shutdown GEH Evaluation of FLEX Implementation Guidelines (Ref. 1)

For the purposes of NEI 12-06 (Ref. 2), it is not anticipated that continuous habitability would be required in the pump rooms. If personnel entry is required into the pump room, then personal protective measures such as ice vests will be taken in accordance with Site Administrative and Safety Procedures and Processes.

Other areas/rooms listed in *Loss of HVAC During ELAP* (Ref. 3) at BFNP were evaluated. The rooms selected contain equipment necessary and/or desired for coping with emergency plant functions during an ELAP condition. These areas are not anticipated to require continuous habitability and personal protective measures will be implemented in accordance with Site Administrative and Safety Procedures and Processes.

[4] Coping modifications consist of modifications installed to increase initial coping time, i.e., generators to preserve vital instruments or increase operating time on battery powered equipment.

Safety Functions Support

Details:

(Section 19a) Provide a brief description of Procedures / Strategies / Guidelines	*Confirm that procedure/guidance exists or will be developed to support implementation*

Browns Ferry Nuclear Plant will utilize the industry developed guidance from the Owners Groups, EPRI and NEI Task team to develop site specific procedures or guidelines to address the criteria in NEI 12-06 (Ref. 2). These procedures and/or guidelines will support the existing symptom based command and control strategies in the current EOIs (Open Item, OI 17).

(Section 19b) Identify modifications	*List modifications*

No modifications are required to support implementation of portable equipment Phase 1. Modifications that are required will be described upon future design reviews that are controlled by the utility Standard Programs and Processes (SPPs).

(Section 19c) Key Parameter	*List instrumentation credited for this coping evaluation phase.*

Battery operated portable temperature instruments are available from the BFNP tool room. These are used during normal plant operation to monitor local conditions during HVAC /chiller maintenance outages and would be available, if needed to monitor temperature in critical areas of the plant, including the MCR. A set of required portable temperature instrumentation will be identified as required FLEX equipment and will be maintained accordingly.

<u>References</u>:

1. "GEH Evaluation of FLEX Implementation Guidelines", NEDC-33771P, Revision 0
2. NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide"
3. Sargent and Lundy Study: "Loss of HVAC During ELAP", Project 12938-012

<u>Notes:</u>

None

Safety Functions Support

(Section 20) BWR Portable Equipment Phase 2

Provide a general description of the coping strategies using on-site portable equipment including station modifications that are proposed to maintain and/or support safety functions. Identify methods and strategy (ies) utilized to achieve coping times.

Main Control Room Habitability

Primary Strategy

The primary strategy for maintaining the environment of the Main Control Room (MCR) during Phase 2 will be the employment of portable fans.

- One fan blowing air at the outdoor temperature into the U1/U2 MCR 617.0-C12.
- One fan blowing air at the outdoor temperature into the U3 MCR 617.0-C19.

Temporary duct could be run from outside, through the Turbine Building, through the Corridor, and into the MCR. Power for the fans will be determined at a later date.

For the MCR areas, a breach of the Main Control Room Habitability Zone (MCRHZ) boundary and addition of temporary fans can be utilized to reduce temperatures in the MCR areas. Installation of supply and discharge flexible ductwork on the fans and locating the fans accordingly can reduce noise in the MCR areas.

RCIC Room Habitability

Primary Strategy

The primary strategy for maintaining the environment of the RCIC room will use the same strategy as in Phase 1, section 19. Based on extrapolation of the heat up curves, temperature in the RCIC room will rise to approximately 151°F in approximately 72 hours.

At 8 hours, 4 kV FLEX DGs are in service allowing RCIC to be shutdown, at which time the RCIC room will be at approximately 126°F Browns Ferry Post Fukushima FLEX Response Evaluation (Ref. 2); thus, RCIC room temperature is maintained well below equipment design limits during RCIC operations in Phase 1, Phase 2, and Phase 3.

It is not anticipated that habitability of the RCIC room will be required; however, if personnel habitability becomes necessary then personal protective measures will be implemented in accordance with Site Administrative and Safety Procedures and Processes.

Safety Functions Support

(Section 20) BWR Portable Equipment Phase 2

RHR / CS Room Habitability

Under the Station Blackout (SBO) case the temperature remains below 120°F for the entire transient of 8 hours. To determine the temperature impact to the pump rooms over an extended period, the curves in the above calculation were extrapolated to 72 hours. The extrapolation indicated that temperature in the pump rooms will rise to a maximum of approximately 145°F in approximately 72 hours.

At 7 hours, the 4kV FLEX DGs are in service allowing RCIC to be shutdown Browns Ferry Post Fukushima FLEX Response Evaluation (Ref. 2).

At 8 hours after the Event initiation it is assumed that the FLEX Pumping Systems are deployed for service with hoses aligned.

- "B" and "D" RHRSW headers are charged from FLEX Pumping Systems, FPS2 and FPS3.
- EECW headers charged from FLEX Pumping System, FPS1.
- Water is available on elevation 565' of each Reactor via lines from FLEX Pumping System, FPS1.
- One spare FLEX Pumping System, FPS4, is also potentially available.

If all three 4 kV FLEX DGs are functioning; the actions are to:

- Start a Core Spray (CS) pump,
- Once low pressure injection is available, secure RCIC,
- Utilize Main Steam Relief Valves (MSRVs) (or HPCI) and depressurize the RPV sufficiently to inject CS for RPV level control with suction from the torus, and
- Initiate an RHR pump aligned for shutdown cooling (or torus cooling) and cool down to cold conditions.

For the purposes of NEI 12-06, it is not anticipated that continuous habitability would be required in the pump rooms. If personnel entry is required into the pump room, then personal protective measures such as ice vests will be taken in accordance with Site Administrative and Safety Procedures and Processes.

Engineered Safety Feature (ESF) Switchgear Rooms

For Phase 2, the rooms containing the 480 VAC ESF switchgear will be begin to heat up as the switchgear is energized by the 4 kV FLEX DGs; therefore, they were evaluated for limiting temperatures for equipment survivability. The calculations performed in *Loss of HVAC During ELAP* (Ref. 7) indicate that switchgear rooms rise to 90°F at the end of a four hour coping period. Under ELAP conditions, the units' switchgear are de-energized at the onset of the ELAP and remain de-energized until Phase 2 when portions of the switchgear are reenergized by the 4 kV FLEX DGs. The rooms will begin to heat up in Phase 2, following the energization of some 480 VAC switchgear by the 4 kV FLEX DGs and therefore, a coping period for the

Safety Functions Support

(Section 20) BWR Portable Equipment Phase 2

duration of Phase 2 must be considered.

An acceptable strategy for heat removal from the switchgear rooms is the establishment of a method to exhaust the heat to the outside by means of portable exhaust fans. Note that the 4160 VAC switchgear is not energized during the Phase 1 coping period.

<u>Battery Room Ventilation</u>

During battery charging operations in Phase 2 and 3, ventilation is required in the main battery rooms due to hydrogen generation. The battery rooms were evaluated for heat loads and it was determined that the resultant temperature rise is negligible, *Loss of HVAC During ELAP* (Ref. 1). The calculation of battery room hydrogen generation determined that hydrogen levels will not reach two percent until 29.9 hours assuming charging starts at time 0 and Battery room initial temperature is at 110°F with equalizing voltage at 2.33 volts *Loss of HVAC During ELAP*
(Ref. 1).

A shallow load shed can be performed that extends the Unit Battery life to no less than 12 hours with minimal load shedding. When the identified loads are shed from Unit Batteries 1, 2, and 3 it is expected that BFNP will achieve a 12 hour Unit Battery discharge duration Browns Ferry Post Fukushima FLEX Response Evaluation (Ref. 2). The batteries will be placed on charge in Phase 2 before the discharge duration runs out. (Open Item, OI 6)

Hydrogen generation does not occur unless the batteries are on charge. Phase 2 strategies can provide power both for charging and to supply power for room ventilation

There are two strategies for venting the battery rooms. The primary strategy is to repower the existing emergency exhaust fans which are connected to the Emergency Power bus. This will occur after the 4 kV FLEX DG has been connected to power the 480 V bus. The alternate strategy is to prop open doors and set up portable fans.

<u>Spent Fuel Pool Area</u>

The Spent Fuel Pool (SFP) area for BFNP is a common area for all three units. Normal HVAC is supplied from fans located on grade level on the south side of the Reactor Building. The Reactor Building Heating and Ventilating System (HVAC) is shut down and isolated when that zone of secondary containment is isolated and connected to the SGTS. For steam line failures in the Reactor Building, Updated Final Safety Analysis Report (UFSAR) Section 5-5.3 (Ref. 3b) but outside the drywell and outside the main steam valve room, the pressure would be relieved to the refueling room by the hatches and hatchways. The pressure within secondary containment would then be relieved to the large blowout panels in the insulated metal siding. Therefore, there would be no manual actions required to relieve pressure during an ELAP.

Safety Functions Support	
(Section 20) BWR Portable Equipment Phase 2	
Ventilation of the refuel floor, elevation 664.0', during an ELAP can be established by opening doors to the vent tower and vent tower roof of units 1 and 3. The equipment hatches for each unit will always have a minimum opening area and allow air from the lower floors to rise and be released through the open doors to the vent tower, Updated Final Safety Analysis Report (UFSAR) Section 5-5.3 (Ref. 3a). <u>Spent Fuel Pool Gate Seals</u> Removable gates are provided at the transfer canal of the SFP to facilitate movement of fuel during refueling operations. The gates have non-inflatable (rubber) seals, as described in Reactor Assembly (Unit 1/3) (Ref. 4) and Reactor Vessel Disassembly and Reassembly (Ref. 5). Therefore, the SFP gate seals are not a consideration during an ELAP.	
Details:	
(Section 20a) Provide a brief description of Procedures / Strategies / Guidelines	*Confirm that procedure/guidance exists or will be developed to support implementation*
Browns Ferry Nuclear Plant will utilize the industry developed guidance from the Owners Groups, EPRI and NEI Task team to develop site specific procedures or guidelines to address the criteria in NEI 12-06. These procedures and/or guidelines will support the existing symptom based command and control strategies in the current EOIs (Open Item, OI 17).	
(Section 20b) Identify modifications	*List modifications*
No modifications are required to support implementation of Phase 2 portable equipment. Modifications that are required will be described based upon future design reviews that are controlled by the utility Standard Programs and Processes (SPPs).	
(Section 20c) Key Parameter	*List instrumentation credited for this coping evaluation phase.*
None	

Safety Functions Support	
(Section 20) BWR Portable Equipment Phase 2	
(Section 20d) Storage / Protection of Equipment : **Describe storage / protection plan or schedule to determine storage requirements**	
Seismic	*List how equipment is protected or scheduled to protect*
Portable equipment, maintained in the FESB, and connection points required to implement this FLEX strategy will be designed to meet or exceed BFNP design basis Safe Shutdown Earthquake (SSE) protection requirements	
Flooding Note: if stored below current flood level, then ensure procedures exist to move equipment prior to exceeding flood level.	*List how equipment is protected or scheduled to protect*
Portable equipment required to implement this FLEX strategy will be maintained in the FESB, which is sited in a suitable location that is above the Probable Maximum Flood (PMF) level and, as such, is not susceptible to flooding from any source. FLEX equipment deployment paths maintain a minimum elevation of 565', Mean Sea Level (MSL). Plant shutdown is required when river level reaches 558' MSL in accordance with 0-AOI-100-3 (Ref. 1a). Updated Final Safety Analysis Report (UFSAR) Section 2.4A Figure 16 (Ref. 3ai) shows that more than 4 days will elapse in a rising flood sequence between river elevation 558' MSL and 565' MSL.	
Severe Storms with High Winds	*List how equipment is protected or scheduled to protect*
Portable equipment required to implement this FLEX strategy will be maintained in the FESB, which is designed to meet or exceed the licensing basis high wind hazard for BFNP.	
Snow, Ice, and Extreme Cold	*List how equipment is protected or scheduled to protect*
The FESB will be evaluated for snow, ice, and extreme cold temperature effects and heating will be provided as required to assure no adverse effects on the FLEX equipment. The FESB will have a stand-alone HVAC system.	
High Temperatures	*List how equipment is protected or scheduled to protect*
The FESB will be evaluated for high temperature effects and ventilation will be provided as required to assure no adverse effects on the FLEX equipment. The FESB will have a stand-alone HVAC system.	

Safety Functions Support

(Section 20) BWR Portable Equipment Phase 2

(Section 20e) Deployment Conceptual Design

(Attachment 3 contains Conceptual Sketches)

Strategy	**Modifications**	**Protection of connections**
Identify strategy including how the equipment will be deployed to the point of use.	*Identify modifications*	*Identify how the connection is protected*
Phase 2 of the FLEX strategy, Section 11E, will allow the Emergency Equipment Cooling Water (EECW) system to receive an adequate supply of water to provide cooling for the RHR room coolers, Core Spray (CS) room coolers, RHR pump seal heat exchangers, Unit 3 Control Bay Chillers and the Unit 3 Electric Board room chillers. An electrical load study will be performed to ascertain the ability of the common Unit 1 & 2 chillers to be placed into service that would provide chilled water for the Unit 1 & 2 Control Bay and the Unit 1 & 2 Electric Board rooms (Open Item, OI 5).	No modifications are required for this deployment.	There are no connection points associated with this section.

Safety Functions Support

(Section 20) BWR Portable Equipment Phase 2

(Section 20e) Deployment Conceptual Design
(Attachment 3 contains Conceptual Sketches)

Strategy	**Modifications**	**Protection of connections**
Identify strategy including how the equipment will be deployed to the point of use.	*Identify modifications*	*Identify how the connection is protected*
Otherwise the Emergency Condensing unit would be placed into service and only the control bay air handling units would be operable to cool the safety related areas in the Control Bay.		

References:

1. Abnormal Operating Instructions (AOIs)
   a. 0-AOI-100-3, Flood Above Elevation 558'
2. AREVA Engineering Information Record Document No.: 51-9198045-000, "Browns Ferry Post Fukushima FLEX Response Evaluation"
3. Browns Ferry Nuclear Plant (BFNP) Updated Final Safety Analysis Report (UFSAR)
   a. Section 2.4A
      i. Figure 16
   b. Section 5-5.3, 0-47E200-2 & 3-47E200-11
4. GEK-779 Volume II, GEK-9646A, "Reactor Assembly (Unit 1/3)", GEK-9646B (U2)
5. MSI-0-001-VSL001, "Reactor Vessel Disassembly and Reassembly", section 7.16
6. NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide"
7. Sargent and Lundy Study: "Loss of HVAC During ELAP", Project 12938-012

Notes:

None

Safety Functions Support

(Section 21) BWR Portable Equipment Phase 3

Provide a general description of the coping strategies using Phase 3 equipment including modifications that are proposed to maintain and/or support safety functions. Identify methods and strategy (ies) utilized to achieve coping times.

Main Control Room Habitability

The primary and secondary strategies for cooling the MCR are the same in Phase 3 as for Phase 2.

Other Support Requirements

Other areas of support required in Phase 3 are the same as described in the Phase 2 section of Safety Functions Support section.

References:

1. "FLEX Implementation HVAC Analysis Impact Study", Project No. 12938-012 (Corporate)
2. "Browns Ferry Post Fukushima FLEX Response Evaluation", 91-9198045-000

Details:

(Section 21a) Provide a brief description of Procedures / Strategies / Guidelines	*Confirm that procedure/guidance exists or will be developed to support implementation*

See Phase 2 discussion, section 20

(Section 21b) Identify modifications	*List modifications*

See Phase 2 discussion, section 20

(Section 21c) Key Containment Parameters	*List instrumentation credited or recovered for this coping evaluation.*

See Phase 2 discussion, section 20

Safety Functions Support		
(Section 21) BWR Portable Equipment Phase 3		
(Section 21d) Deployment Conceptual Design **(Attachment 3 contains Conceptual Sketches)**		
Strategy	**Modifications**	**Protection of connections**
Identify strategy including how the equipment will be deployed to the point of use.	*Identify modifications*	*Identify how the connection is protected*
See Phase 2, Safety Functions Support	See Phase 2, Safety Functions Support	See Phase 2, Safety Functions Support

References:

1. AREVA Engineering Information Record Document No.: 51-9198045-000, “Browns Ferry Post Fukushima FLEX Response Evaluation”
2. Sargent and Lundy Study: “Loss of HVAC During ELAP”, Project 12938-012

Notes:

None

(Section 22) BWR Portable Equipment Phase 2							
Use and (potential / flexibility) diverse uses						*Performance Criteria (Open Item, OI 13)*	*Maintenance*
List portable equipment [1]	Core	Containment	SFP	Instrumentation	Accessibility		Maintenance / PM requirements
Four FLEX Low Pressure Pumps, FLPP	**X**	**X**	**X**			5000 gpm 150 psig	Will follow EPRI template requirements
Four Floating Booster Pumps, FLBP						5,000 gpm 50 ft	Will follow EPRI template requirements
Three 4 kV FLEX Diesel Generators	**X**	**X**	**X**	**X**	**X**	4100 V 3 MWe	Will follow EPRI template requirements
Three 480 V FLEX Diesel Generators	**X**	**X**		**X**		480 V 225 kVA	Will follow EPRI template requirements
Hoses, adapters and connectors	**X**	**X**	**X**		**X**	As required to implement strategies	Will follow EPRI template requirements
Two Diesel Transfer Pumps	**X**	**X**	**X**			200 gpm	Will follow EPRI template requirements
Two sets of Cables for connecting portable generators	**X**			**X**	**X**	N/A	Will follow EPRI template requirements
Six Portable ventilation fans	**X**	**X**	**X**	**X**		120V TBD, cfm as specified in design studies	Will follow EPRI template requirements

(Section 23) BWR Portable Equipment Phase 3							
Use and (potential / flexibility) diverse uses						*Performance Criteria (Open Item, OI 13)*	*Notes*
List portable equipment	Core	Containment	SFP	Instrumentation	Accessibility		
Low Pressure FLEX Pumps	X	X	X			5000 gpm 150 psig	Will follow EPRI template requirements
Floating Booster Pumps	X	X	X			5,000 gpm 50 ft Lift	Will follow EPRI template requirements
Medium Voltage Diesel Generators	X	X	X	X	X	4100 V MW TBD	Will follow EPRI template requirements
Low Voltage Diesel Generators	X	X		X		480 V MW TBD	Will follow EPRI template requirements
Hoses, adapters and connectors	X	X	X		X	As required to implement strategies	Will follow EPRI template requirements
Diesel Transfer Pumps	X	X	X			200 gpm	Will follow EPRI template requirements
Portable ventilation fans	X			X		5,000 cfm	Will follow EPRI template requirements
480 V Air Compressors	X					200 cfm 100 psig	Will follow EPRI template requirements
Mobile Water Purification Unit	X	X	X			Capacity TBD	Will follow EPRI template requirements

(Section 24) Phase 3 Response Equipment/Commodities

Item	Notes
Radiation Protection Equipment • Survey instruments • Dosimetry • Off-site monitoring/sampling • Radiological counting equipment • Radiation protection supplies • Equipment decontamination supplies • Respiratory protection	
Commodities • Food • Meals Ready to Eat (MRE) • Microwavable Meals • Potable water • Sanitation	
Fuel Requirements • Diesel Fuel • Diesel Fuel Bladders	
Heavy Equipment • Transportation equipment • 4 wheel drive tow vehicle • Debris clearing equipment	
Communications Equipment • Satellite Phones • Portable Radios	
Portable Interior Lighting • Flashlights • Headlamps • Batteries	
Portable Exterior Lighting • Light units with diesel generator	
Personnel equipment • Tools • Gloves, etc.	

LIST OF ATTACHMENTS
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Attachment 1A, Sequence of Events Timeline

Action item	Elapsed Time	Action	Time Constraint Y/N [5]	Remarks / Applicability
1	T- ~198 hours	For floods, plant shutdown begins when river level reaches 558' per procedure AOI-100-3. FLEX deployment begins.	N	Plant meets required shutdown criteria approximately 190+ hours before design basis peak flood level is reached (for FLEX, this is assumed to be exceeded).
2	T -190 hours	For Floods, FLEX deployment is complete.	Y	Time critical at T-72 hours, the point at which the deployment route is covered.
3	T-72 hours	Flood waters reach plant grade level, FLEX Pumping System deployment must be complete. (Estimated complete at T-190 hours). OPS personnel have manned the FLEX bunker and lined up FLEX Diesel Generators (DGs).	Y	Based on design basis flood.
4	T-0	For floods, flood waters exceed design basis	N	This is the point at which a design basis peak flood level would be reached.
5	0	All offsite power, and normal access to heat sink is lost - **Phase 1 Commences**	NA	All 3 units are assumed to be in power operation unless previously shutdown by procedure driven by the postulated event.
6	T< 5 secs	MSIVs isolate (for events where plant is initially in Mode 1).	N	Response to loss of offsite power.

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

Action item	Elapsed Time	Action	Time Constraint Y/N [6]	Remarks / Applicability
7	T+30 secs	High Pressure Coolant Injection (HPCI) and RCIC achieve full flow. After HPCI and RCIC recover RPV level, HPCI will be secured and RCIC will be the primary system for RPV level control. When HPCI is secured, Operators will be directed (a change to the SBO procedure to shift HPCI suction to the suppression pool from the MCR.	N	Design basis - Event initiated based on preliminary estimates (and assumed for these valves are not operated after the first hour to maintain battery life for 12 hours (Open Item, OI 6).
8	T+0 hours	Dispatch Fire Protection personnel to deploy the FLEX Pumping Systems and commence laying hose, as required. (Note: the FLEX Pumping Systems will have already been deployed for a design basis flood (see Item 2.) Direction to deploy the FLEX Pumping Systems will be in the SBO procedures before the ELAP procedures are entered.	N	FLEX Pumping Systems should be available for service by T+8 hours.
9	T + 30 minutes	RPV depressurization starts at 30 minutes by a rate of 100°F/hr.	Y	Planned changes to EPG guidance.
10	T+1 hour	SBO procedure is exited and FLEX Support Guidelines (FSGs) are entered. Cooldown is continued to a final pressure of 150 psig. (Cooldown will be complete for flood events)	Y	New EPG guidance for core makeup when RCIC is the only source. (TVA will determine if and when manual actions are required to support continued use of Main Steam Relief Valves (MSRVs.))

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

Attachment 1A, Sequence of Events Timeline

Action item	Elapsed Time	Action	Time Constraint Y/N [7]	Remarks / Applicability
11	T+1 hour	Dispatch OPS personnel to start the 480 V FLEX Diesel Generators (DG). A 480 V FLEX DG will energize one division of 480 V distribution panels. Verify Battery chargers are in service.	Y	NEI 12-06 section 3.2.1.7 applicable. New procedure guidance to be developed as part of the FLEX Support Guidelines. Time critical at T+2 hours.
12	T+1 hours	Dispatch OPS personnel to perform electrical lineups for 4 kV FLEX Diesel Generators (DGs). (This will already have been done for floods – see Item 3, Section 4.)	Y	New procedure guidance to be developed as part of the FLEX Support Guidelines Time critical after T+7 hours.
13	T+2-3 hours	ONLY IF one or more 480 V FLEX Diesel Generators (DGs) did NOT start and load, commence a shallow DC load shed only for those 480 V FLEX DGs that did not start. (Not applicable to flood.)	Y	New procedure guidance to be developed as part of the FLEX Support Guidelines. Time critical after T+3 hours to complete by T+4
14	T+>2 hours	Unit is being maintained at 150 psig (having started a cooldown depressurization at item 9).	N	New procedure guidance based on analysis not to emergency depressurize when RCIC is the only vessel makeup

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

Action item	Elapsed Time	Action	Time Constraint Y/N [8]	Remarks / Applicability
15	T+3 hours	Lay-out and secure hoses on the SFP deck to provide supplemental SFP water addition without entering the area. This time can be increased based on actual SFP loading and procedures that will be implemented to maintain staff awareness if actions are needed within the first 24 hours. The SFP will not boil in the first 8 hours unless the unit has been shutdown less than 5 days (for a 1/3 core offload) and there is generally enough additional staff immediately after an outage to perform this action without the core team being used for other FLEX actions during the first 8 hours.	Y	Time criticalness depends on the time since last core offload and additions/deletions of SFP inventory.
16	T + 4 hours	If DC load shedding was performed because one or more of the 480 V FLEX DGs did not start and load, then this load shedding must be complete.	N	NEI 12-06 section 3.2.1.7 applicable.
17	T+7 hours	Verify 4 kV FLEX DGs are started and ready for service. • One division of safety related electrical distribution is energized o 4 kV FLEX DG will energize one division of 4 kV distribution. • Verify DC battery chargers are energized • Restore control bay and plant lighting	Y	NEI 12-06 section 3.2.1.7 applicable. New procedure guidance to be developed as part of the FLEX Support Guidelines
18	T+8 hours	If any 4 kV FLEX DG did not start and load, AND a 480 V FLEX DG is not supplying a battery, then dispatch team to align battery chargers from an adjacent unit. (Note: N+1 4 kV supply for battery charging is considered an adjacent unit for a tornado event that exceeds the protection basis for the 480 V FLEX DGs.)	Y	Time critical before 12 hours based on battery discharge.

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

Action item	Elapsed Time	Action	Time Constraint Y/N [9]	Remarks / Applicability
19	T+8 hours	FLEX Pumping Systems are deployed for service with hoses aligned. • "B" and "D" RHRSW headers are charged (FLEX Pumping Systems, FPS2 and FPS3) • EECW headers charged (FLEX Pumping System, FPS1) • Water is available on elevation 565' of each Reactor via lines from FLEX Pumping System, FPS1 • One spare FLEX Pumping System, FPS4 is also potentially available (not credited).	Y	NEI 12-06 section 3.2.1.7 applicable. New procedure guidance to be developed as part of the FLEX Support Guidelines (FSGs).

20	T+8 hours	Transition to Phase 2 of FLEX implementation.
		If all three 4 kV FLEX Diesel Generators are functioning:
		• Start a Core Spray Pump
		• Once low pressure injection is available, secure RCIC
		• Utilize MSRV's (or HPCI) and depressurize the RPV sufficiently to inject Core Spray for RPV level control with suction from the torus.
		• Initiate an RHR pump aligned for shutdown cooling (or torus cooling) and cool down to cold conditions.
		  o FLEX Pumping Systems, FPS2 and FPS3 (~10000 gpm) will supply RHRSW among three units.
		  o FLEX Pumping System, FPS1 will supply EECW to necessary loads, including RHR and CS room coolers and RHR seal coolers.
			Y	NEI 12-06 section 3.2.1.7 applicable.
				
				New procedure guidance to be developed as part of the FLEX Support Guidelines

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

Action item	Elapsed Time	Action	Time Constraint Y/N [10]	Remarks / Applicability
21	T+8 hours	The following is the N+1 strategy for loss of one 4 kV FLEX Diesel Generator. If any 4 kV FLEX Diesel Generator does NOT function, for the unit assigned to that FLEX DG: • The drywell and torus will be cooled using an alternate FLEX strategy – venting. • The hardened containment vent system (HCVS) is opened to maintain drywell and torus temperature and pressure below design limits. Containment pressure is maintained at above the pressure needed to maintain RCIC NPSH. • Vessel pressure continues to be maintained at 150 psig and RCIC continues to inject for as long as 24 hours. o Analysis indicates torus level will decline at approximately ½ foot per hour, depending on residual heat and venting rates needed to maintain containment limits.	Y	NEI 12-06 section 3.2.1.7 applicable. New procedure guidance to be developed as part of the FLEX Support Guidelines NEI 12-06 section 3.2.1.7 applicable.
22	T+>8 hours	Add water to the SFP from the river using FLEX Pumping System, FPS1. This will be done if it is not possible to establish makeup from the torus.	Y	Time critical at water level based on guidance to be developed. Hoses will be secured and anchored at 4 hours (or later, depending on pre-established guidance) so that additions can be made to the SFP from a lower floor with minimum risk to workers.

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

Action item	Elapsed Time	Action	Time Constraint Y/N [11]	Remarks / Applicability
23	T+12 hours	If torus water level is reaching lower allowable limit, then add water from the river to the torus using FLEX Pumping Systems, FPS1 (or FPS4, spare). (This should not be necessary unless extensive venting is required to maintain containment within limits.)	Y	
24	T+12 hours	Longer term coping: • Restore normal control bay air conditioning or take other actions • Restore an RBCCW pump and heat exchanger • Restore a SFP cooling pump and heat exchanger	N	
25	T+12 - 72 hours	Sustain coping by maintaining diesel equipment fueled and in service	Y	NEI 12-06 section 3.2.1.7 applicable.
26	T + 24 hours	Manual actions to prevent excessive hydrogen accumulation in battery rooms if ventilation is not restored.		The calculation of battery room hydrogen generation determined that hydrogen levels will not reach 2% until 29.9 hours (Open Item, OI 6).
27	T+24 hours	Manual actions to restore ventilation (if normal ventilation is not restored) by opening doors, portable fans, etc (Open Item, OI 13).		

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

Attachment 1B
NSSS Significant Reference Analysis Deviation Table
NEDC 33771P, GEH Evaluation of FLEX Implementation Guidelines

Item	Parameter of interest	NEDC value (NEDC 33771P Revision 0, December 2012)	NEDC page	Plant applied value	Gap and discussion
	Suppression Pool Temperature	86 °F	17	95 °F	1
	Vent size	12"	D9, D8, 43, 44,	14"	2

Gaps and Discussion:

1. The thermal hydraulic analysis for the BFNP suppression pool shall be based on an initial temperature of 95°F (BFN TS limit).
2. The existing BFNP HCVS system is a 14" nominal pipe diameter. The existing configuration has a documented analysis based on vent size. Any changes to the vent configuration as detailed in accordance with EA-12-50 will be conservative compared to the NEDC 33771P. The proposed configuration will have a throttling valve installed to allow operations to control containment pressure to limit the rise of the Wetwell temperature. A proposed modification to connect the Drywell vent to the HCVS discharge path will also allow a controlled vent pressure to be within OPS control (Open Item, OI 11).

Attachment 2
Milestones

Browns Ferry Milestone Schedule

The following milestone schedule is provided: The dates are planning dates subject to change as design and implementation details are developed. Any changes to the following target dates will be reflected in the subsequent 6 month status reports

Activity	Original Target Date	(Will be updated every 6 months)
Submit Overall Integrated Implementation Plan	**2/28/2013**	
6 Month Status Updates		
Update 1	**Aug-13**	
Update 2	**Feb-14**	
Update 3	**Aug-14**	
Update 4	**Feb-15**	
Update 5	**Aug-15**	
Update 6	**Feb-16**	
Update 7	**Aug-16**	
FLEX Strategy Evaluation	**June-13**	
Perform Staffing Analysis	**Oct-14**	
Modifications		
Modifications Evaluation	**Jun-13**	
Engineering and Implementation		
Unit 1 N-1 Walkdown note 24 mouths before outage	**Oct-14**	
Unit 2 N-1 Walkdown 24 months before outage	**Mar-13**	
Unit 3 N-1 Walkdown note 24 months before outage	**Feb-14**	
Design Engineering		
Unit 1 Implementation Outage	**Nov-16***	
Unit 2 Implementation Outage	**Apr-15***	
Unit 3 Implementation Outage	**Apr-16***	
ON-SITE FLEX EQUIPMENT		
Procure	**Oct-13**	
Purchase	**Jun-14**	

Attachment 2
Milestones

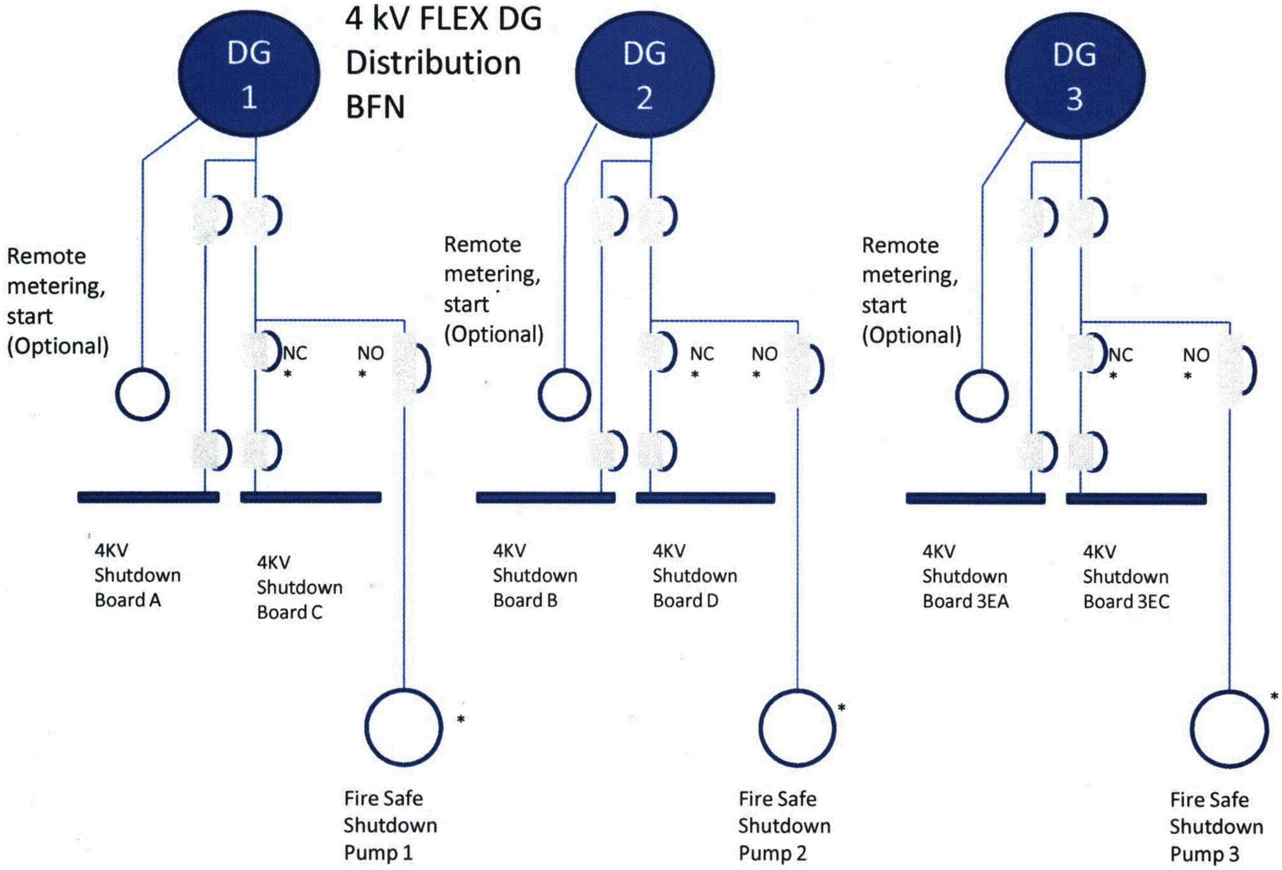
Browns Ferry Milestone Schedule		
The following milestone schedule is provided: The dates are planning dates subject to change as design and implementation details are developed. Any changes to the following target dates will be reflected in the subsequent 6 month status reports		
Activity	**Original Target Date**	**Status (Will be updated every 6 months)**
OFF-SITE FLEX EQUIPMENT		
Develop Strategies with RRC	**Dec-13**	
Install Off-site Delivery Station (if necessary)	***N/A***	
PROCEDURES		
BWROG issues FSG guidelines	**Jan-14**	
Create Browns Ferry FSG	**Mar-14**	
Create Maintenance Procedures	**Jun-14**	
TRAINING (Open Item, OI 18)		
Develop Training Plan	**Jan-14**	
Implement Training	**Mar-14**	
Submit Completion Report	**Dec-16**	

*(Full compliance after second listed refueling outage)

Index

Attachment 3
Conceptual Sketches

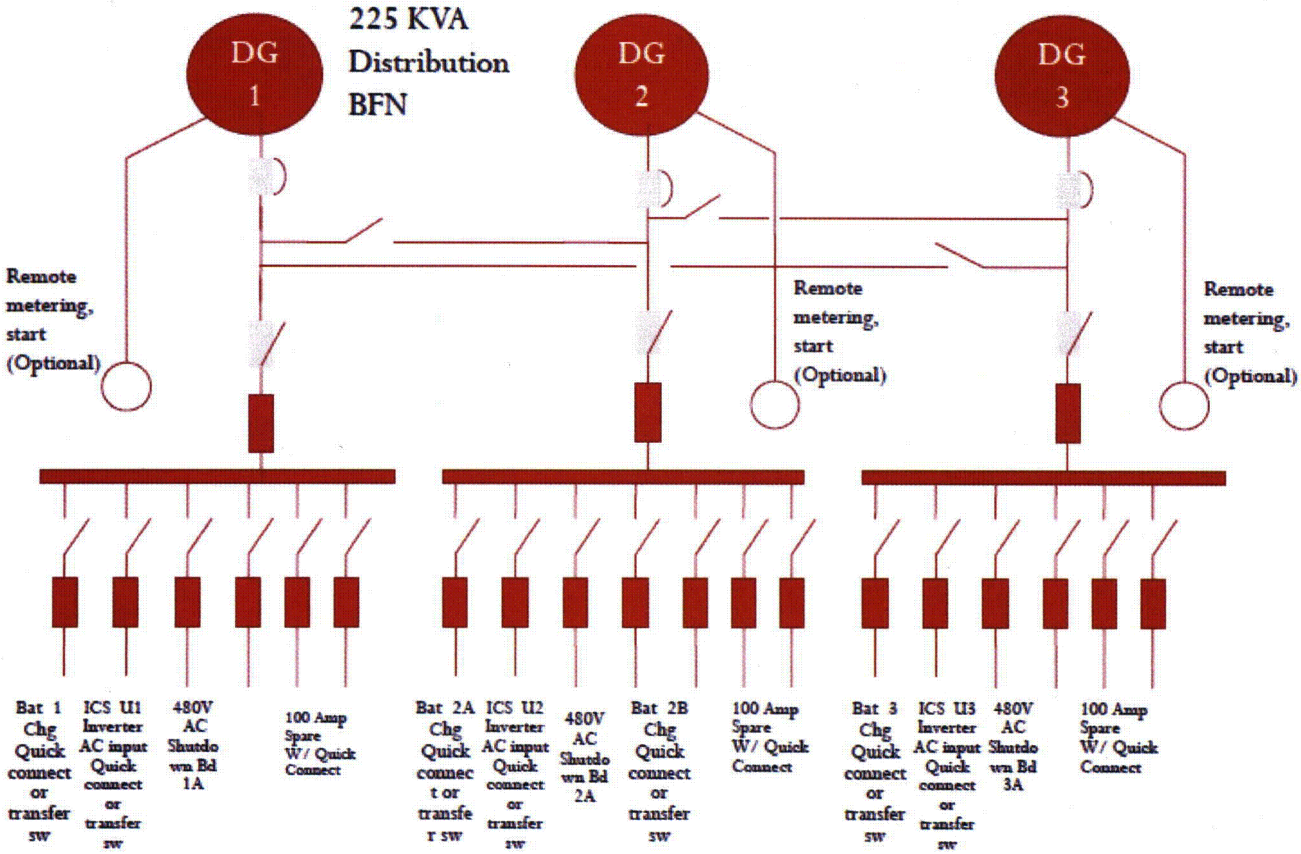
Figure 1 - Electrical Diagram for FLEX Strategies



* NFPA-805 Features - Fire Safe Shutdown pump breaker shall be normally open. Manual or remote breaker closure features and cable runs to pump will be engineered by NFPA-805 project. NFPA-805 breakers will be charged to NFPA-805 project.

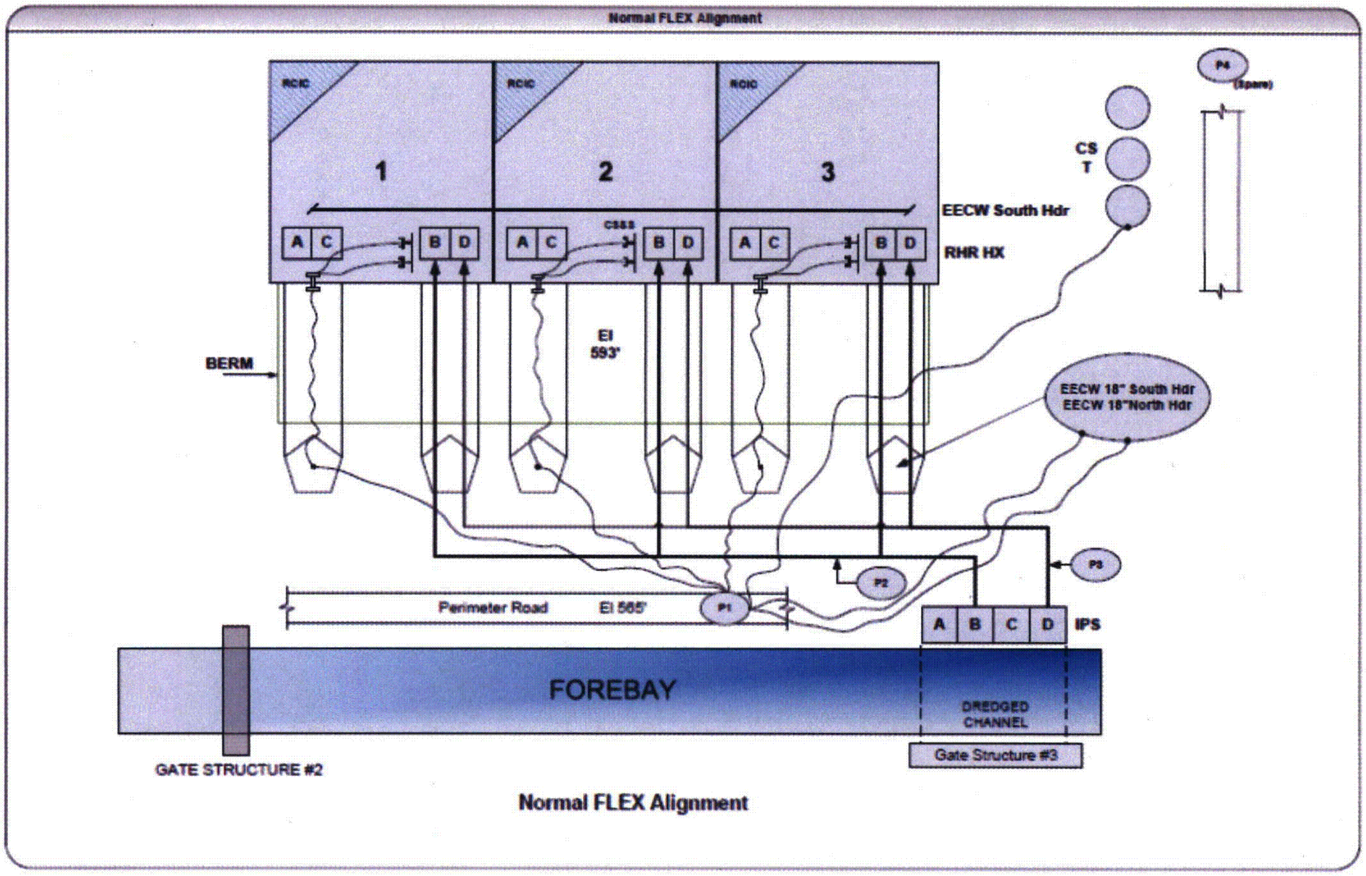
Attachment 3
Conceptual Sketches

Figure 2 - Electrical Diagram for FLEX Strategies



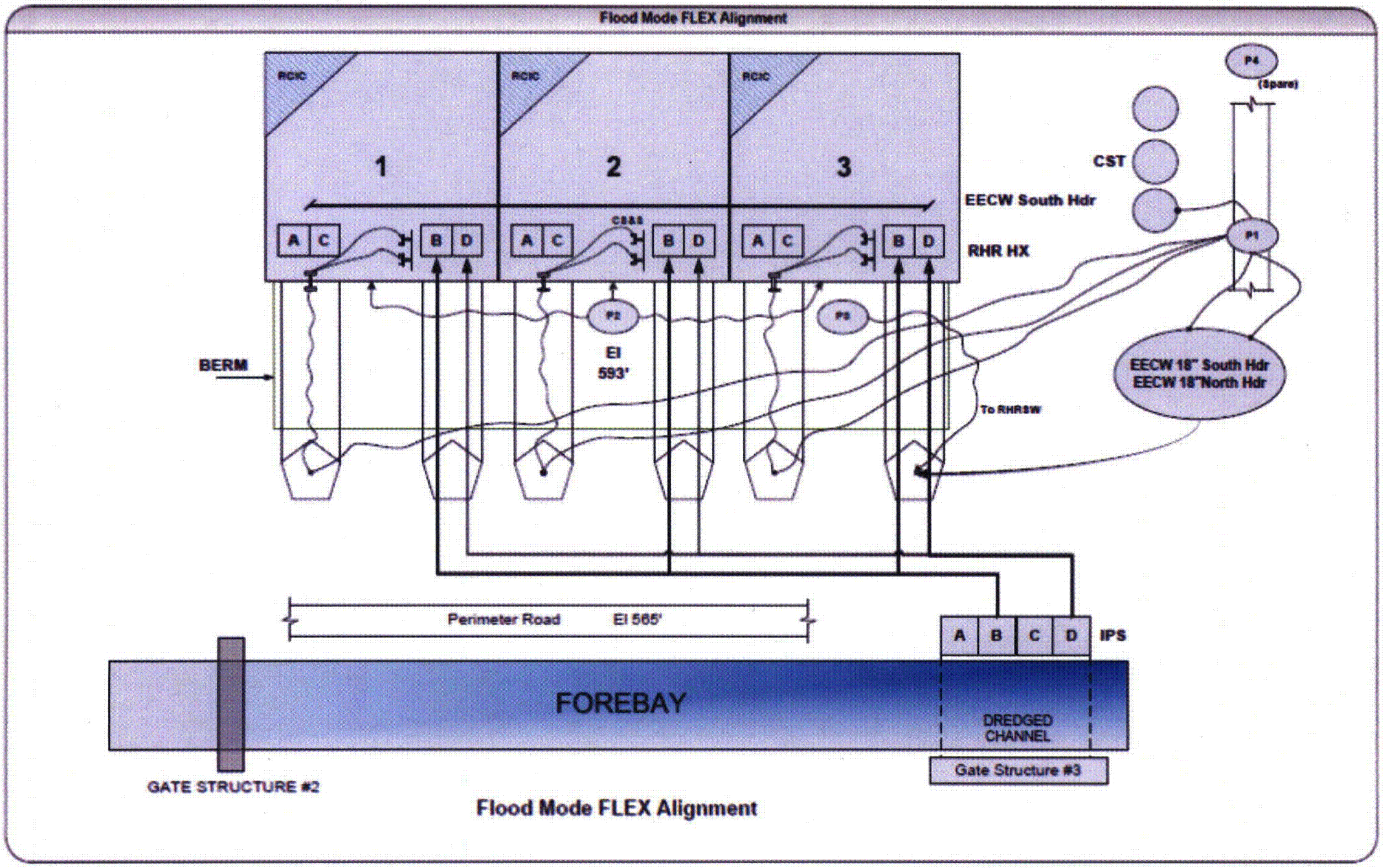
Attachment 3
Conceptual Sketches

Figure 3A–Flow Diagram for Normal FLEX Alignment for Browns Ferry



Attachment 3
Conceptual Sketches

Figure 3B–Flow Diagram for Browns Ferry Flood Mode FLEX Alignment



Attachment 3
Conceptual Sketches

Figure 3C: FLEX Pumping System connection depiction, Flood Mode

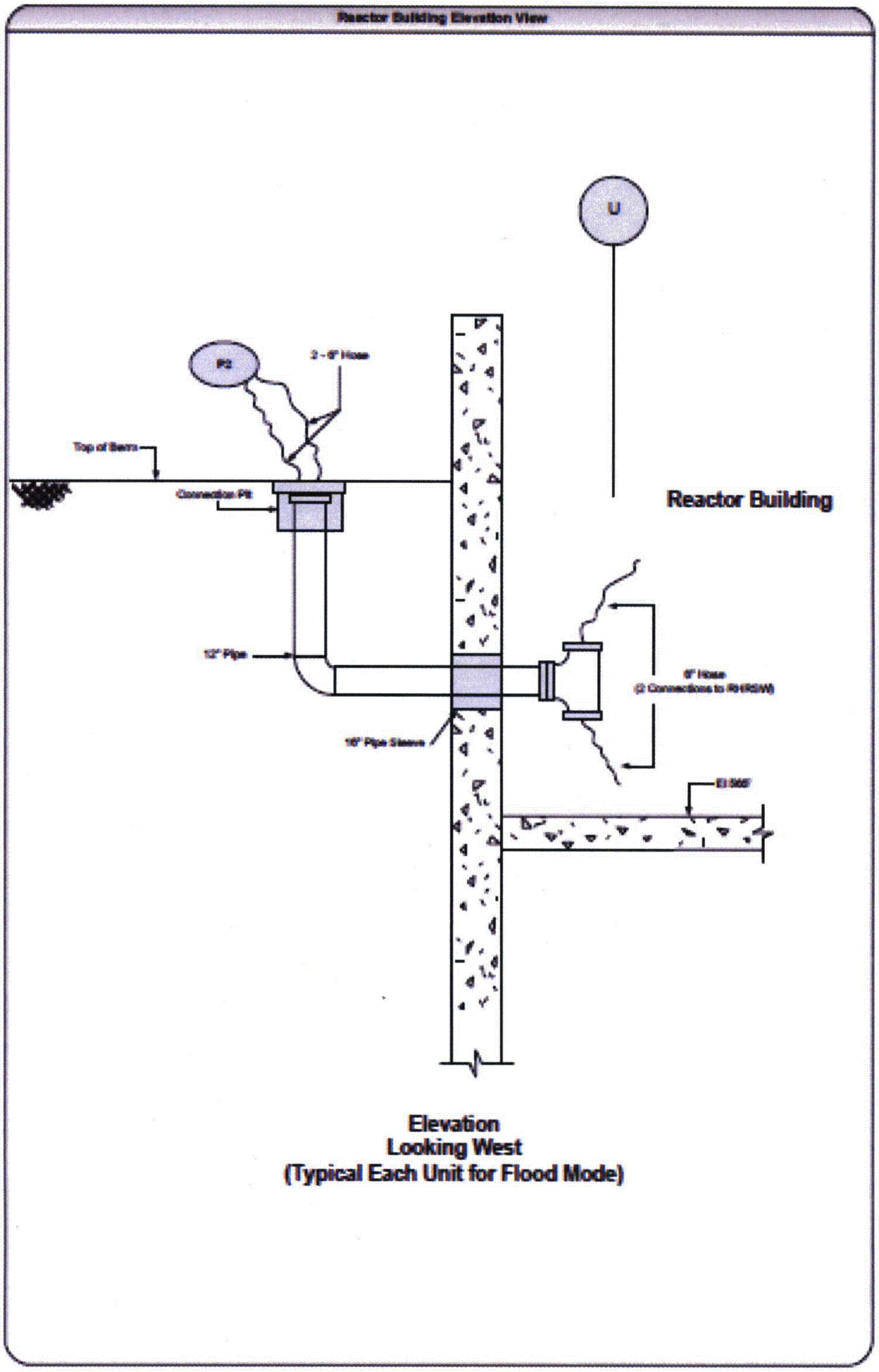
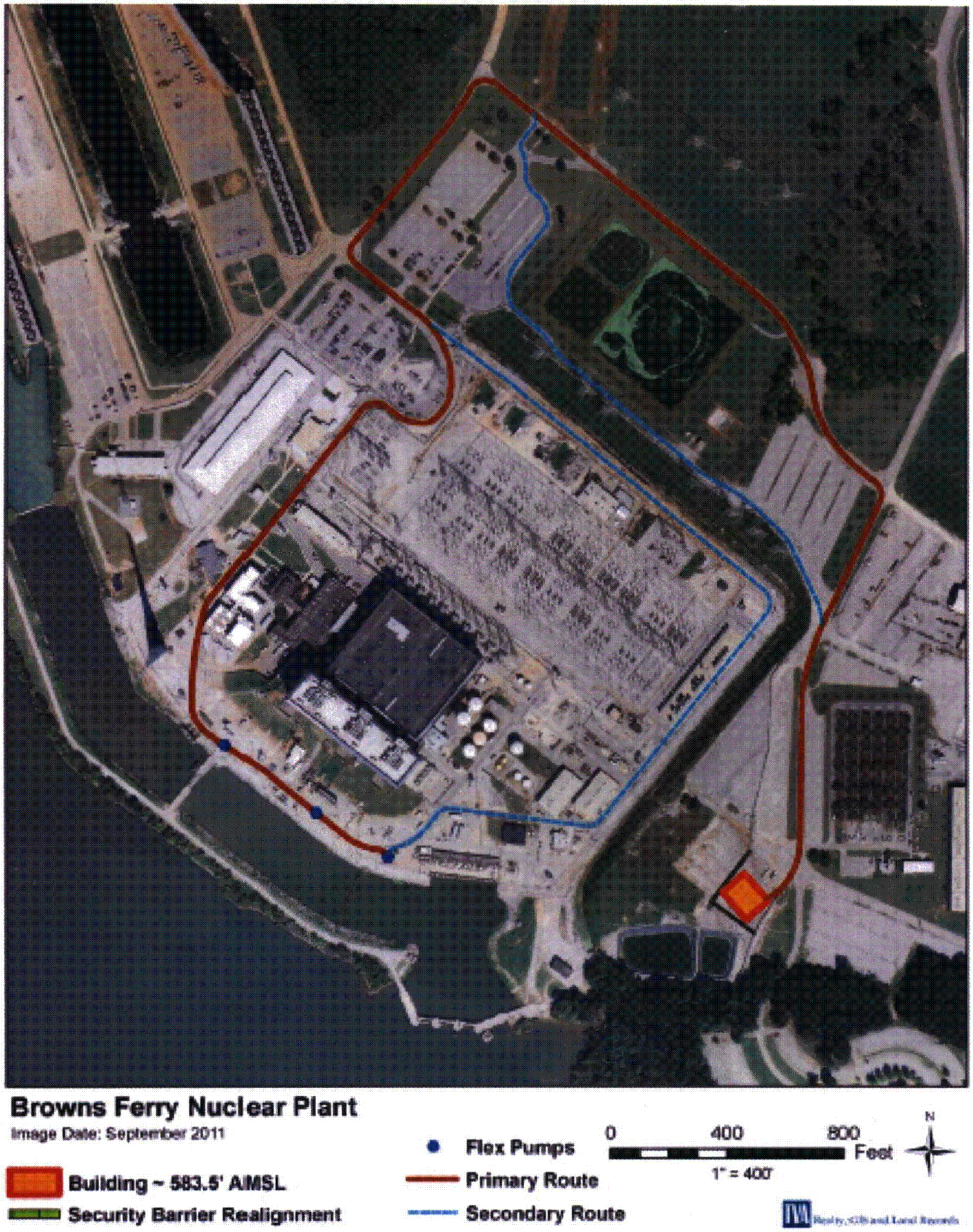


Figure 4: Location of Hardened FLEX Storage Building and Haul Route for FLEX Pumps
(Open Item, OI 2)



Attachment 4
List of Acronyms and Equipment Designators

AOI	Abnormal Operating Instruction
AOV	Air Operated Valve
ADS	Automatic Depressurization System
BDBEE	Beyond-Design-Basis External Events
BDBF	Beyond-Design-Basis Flood
BWR	Boiling Water Reactor
BWROG	BWR Owners Group
CILRT	Containment Integrated Leak Rate Test
CIV	Containment Isolation Valve
CRD	Control Rod Drive
CS	Core Spray
CST	Condensate Storage Tank
DBE	Design Basis Earthquake / Design Baseline Evaluation
DBF	Design Basis Flood
DG	Diesel Generator
ECCS	Emergency Core Cooling System
EDG	Emergency Diesel Generator
EECW	Emergency Equipment Cooling Water
ELAP	Extended Loss of AC Power
EOI	Emergency Operating Instruction
EOP	Emergency Operating Procedure
EPG	BWROG Emergency Procedure Guideline
FESB	Flexible Equipment Storage Building
FLEX	Flexible and Diverse Coping Mitigation Strategies
FPCCU	Fuel Pool Cooling and Cleanup System
FSAR	Final Safety Analysis Report
FSG	Flex Support Guidelines
GEH	GE Hitachi
HCTL	Heat Capacity Temperature Limit (for Torus/Suppression Pool)
HCVS	Hardened Containment Vent System
HPCI	High Pressure Coolant Injection
HTX	Heat Exchanger
HVAC	Heating Ventilation Air Conditioning
ICS	Integrated Computer System
ILRT	Integrated Leak Rate Test
kVA	KiloVolt-Ampere
LUHS	Loss of Ultimate Heat Sink
MAAP	Modular Accident Analysis Program
MCR	Main Control Room
MCRHZ	Main Control Room Habitability Zone
MELB	Moderate Energy Line Break
MRE	Meals Ready to Eat
MSL	Mean Sea Level

Attachment 4
List of Acronyms and Equipment Designators

MSRV	Main Steam Relief Valve
NEI	Nuclear Energy Institute
NPSH	Net Positive Suction Head
OBE	Operating Basis Earthquake
OPS	Operations Department
PMF	Probable Maximum Flood
PCP-lim	Primary Containment Pressure Limit
PSP	Pressure Suppression Pressure (function of Primary Containment Water Level)
PWR	Pressurized Water Reactor
RBCCW	Reactor Building Closed Cooling Water
RCIC	Reactor Core Isolation Cooling
RHR	Residual Heat Removal
RHRSW	RHR Service Water
RHVS	Reliable Hardened Vent System
RPV	Reactor Pressure Vessel
RRC	Regional Response Center
RWCU	Reactor Water Clean Up
SAFER	Strategic Alliance for FLEX Emergency Response
SBO	Station Blackout
SFP	Spent Fuel Pool
SGTS	Standby Gas Treatment System
SHEX	SUPERHEX computer code
SOV	Solenoid Operated Valve
SRV	Safety Relief Valve
SSC	System, Structure, or Component
SSE	Safe Shutdown Earthquake
UFSAR	Updated Final Safety Analysis Report
UHS	Ultimate Heat Sink

Equipment Designators

Diesel Generators

FMDG – FLEX Medium Voltage (FMDG1/2/3)	4 kV FLEX 3 MWe air cooled Diesel Generators (DG)
FLDG – FLEX Low Voltage (FLDG1/2/3)	480 V FLEX 225 kVA air cooled Diesel Generators (DG)

Pumps, if written in strategy as deployed/used

FPS – FLEX Pumping System (FPS1/2/3/4)	FLEX low pressure diesel driven pumps *(Pumping system may comprise both based on the event)*

Pumps, if written for the specific pump, alone

FLPP	FLEX low pressure pump
FLBP	FLEX floating booster pump

Attachment 5
List of Open Items

1. Flood and seismic re-evaluations pursuant to the 10 CFR 50.54(f) letter of March 12, 2012 are not completed and therefore not assumed in this submittal. As the re-evaluations are completed, appropriate issues will be entered into the corrective action system and addressed

2. Liquefaction of haul route for FLEX will be analyzed.

3. TVA will confirm that they have enough fuel onsite for the first 24 hours. A diesel fuel storage and refueling plan also has to be developed.

4. BFNP will evaluate MSRV qualification against the predicted containment response with FLEX implementation to ensure there will be sufficient DC bus voltage and pneumatic pressure to operate the MSRVs throughout Phase 1 and Phase 2.

5. An electrical load study will be performed to ascertain the ability of the common Unit 1 & 2 chillers to be placed into service powered by the FLEX DGs that would provide chilled water for the Unit 1 & 2 Control Bay and the Unit 1 & 2 Electric Board rooms.

6. Validate the preliminary Battery studies that were performed to ensure appropriate battery life will be available with regards to the overall FLEX strategies.

7. BFNP will take actions as necessary to assure RCIC can operate at elevated temperatures.

8. Perform modifications, as necessary, to ensure that RCIC is seismically robust.

9. Develop and perform the design modifications identified in the FLEX strategy document to permit the timely and safe connection of the FLEX and RRC equipment during the adverse conditions encountered during these beyond-design-basis events.

10. Design and construct a Flexible Equipment Storage Building, located above the probable maximum flood level, which is adequately protected from the hazards listed in Section 1. This storage facility will be used to store support equipment and items, including the four FLEX Pumping Systems and the three 4 kV FLEX DGs.

11. Design and install the modifications required by Order EA-12-050 for the Hardened Containment Vent System (HCVS). This will include modifying the HCVS system to permit controlled venting more than one unit at the same time, if necessary.

12. Design and install the modifications required by Order EA-12-051 for enhancing the SFP.

13. Determine the design specifications for FLEX equipment yet to be ordered, such as the Six Portable ventilation fans, the Mobile Water Purification Unit, debris removal equipment for the FLEX Equipment Haul path and piping for the FLEX low pressure pumps.

14. Deployment strategies and deployment routes will be assessed for impact due to identified hazards and guidance developed/provided to ensure that 1) sufficient area is available for

deployment, 2) haul paths remain accessible without interference from outage equipment during refueling outages and 3) deployment locations for the pumps, including ramps, winches or other transfer assemblies, as appropriate to deploy all pumps and hoses within the 8 hour Phase 1 coping interval.

15. Detailed staffing studies based on the procedures/guidance developed.

16. Validation of the time lines for the various strategies.

17. Browns Ferry Nuclear Plant (BFNP) will utilize the industry developed guidance from the Owners Groups, EPRI and NEI Task team to develop site specific procedures or guidelines to address the criteria in NEI 12-06. These procedures and/or guidelines will support the existing symptom based command and control strategies in the current EOIs.

18. New training of general station staff and EP will be performed prior to the first BFNP unit design implementation outage. These programs and controls will be implemented in accordance with the Systematic Approach to Training.

19. TVA will establish a contract with the Strategic Alliance for FLEX Emergency Response (SAFER) team. A local assembly area must also be established by SAFER and TVA for equipment moved from the Regional Response Center (RRC) to BFNP.