| | |
|---|---|
| **From:** | RILEY, Jim |
| **To:** | Marshall, Michael; Shams, Mohamed |
| **Cc:** | BAUER, Scott; Bill Webster (william.webster@dom.com); bolognar@firstenergycorp.com; Bunt, Randy; Christopher P Burks (Generation - 6); Dave Schupp; Dean Hubbard (dmhubbard@duke-energy.com); Dean Price (Generation - 6); Don Bentley (DBENTLE@entergy.com); Gambrell, David; GASPER, JOSEPH K; Geiger, Charlotte; George Attarian; Giddens, John; Greg Halnon; joe.bellini@aterrasolutions.com; Lingle, Ronnie; Lyter, Jay W:(GenCo-Nuc); Michael Henig (Generation - 6); Miller, Andrew; Nick Pappas (nicholas.pappas@aps.com); Powell, Michael; Ray Schneider (schneire@westinghouse.com); RILEY, Jim; Ruf, Gary (Gary.Ruf@pseg.com); Spink, Thomas E <tespink@tva.gov> (tespink@tva.gov) |
| **Subject:** | [External_Sender] MSA Example |
| **Date:** | Wednesday, December 09, 2015 3:17:01 PM |
| **Attachments:** | Plant G44 MSA submittal - rev 1 - 12-8-15.docx<br>MSA Draft Scope and Template - rev 0a 11-16-15.docx |

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Mo, Mike;

Attached is an example MSA for a generic G.4.4 plant (THMS). We are continuing to work on examples for G.4.1, G.4.2, and G.4.3 plants and will send you those examples when they are completed.

Please send us your comments on this example and on the MSA template which we sent to you earlier (attached again for convenience).

Thanks,

*Jim Riley*

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**2016 Mitigating Strategies Assessments for Flooding**
**Documentation Requirements**
**(DRAFT)**

**Acronyms:**

- MSFHI – Mitigating Strategies Flood Hazard Information (from the FHRR and MSFHI letter)
- FHRR – Flood Hazard Reevaluation Report
- DB – Design Basis
- AMS – Alternative Hazard Mitigating Strategies
- THMS – Targeted Hazard Mitigating Strategies

1. Documentation

1.1. NEI 12-06, Rev. 1a, Section G.2 – Characterization of the MSFHI

Document the characterization of the MSFHI. This can be done by summarizing and/or referencing the FHRR submittal and associated RAI/Audit responses.

1.2. NEI 12-06, Rev. 1a, Section G.3 – Comparison of the MSFHI and FLEX DB Flood

Document the nature of any element not bounded for all applicable flood-causing mechanisms. The following table format can be used for each applicable flood mechanism. Identify if individual controlling flood-causing mechanisms or a bounding set of parameters are utilized. The table can be used to define individual controlling mechanisms or bounding parameters. If one set of bounding parameters are utilized, note the associated mechanism for each parameter. This information should have already been developed with the FHRR submittal, and associated RAI responses, and can be referenced in lieu of presenting again with the table below.

*Table 1 – Flood Causing Mechanism A or Bounding Set of Parameters*

| | Flood Scenario Parameter | FLEX Design Basis Flood Hazard | MSFHI | Bounded (B) or Not Bounded (NB) |
|---|---|---|---|---|
| Flood Level and Associated Effects | 1. Max Stillwater Elevation (ft. MSL) | | | |
| | 2. Max Wave Run-up Elevation (ft. MSL) | | | |
| | 3. Max Hydrodynamic/Debris Loading (psf) | | | |
| | 4. Effects of Sediment Deposition/Erosion | | | |
| | 5. Concurrent Site Conditions | | | |
| | 6. Effects on Groundwater | | | |
| Flood Event Duration | 7. Warning Time (hours) | | | |
| | 8. Period of Site Preparation (hours) | | | |
| | 9. Period of Inundation (hours) | | | |
| | 10. Period of Recession (hours) | | | |
| Other | 11. Plant Mode of Operations | | | |

| | | | | |
|---|---|---|---|---|
| | 12. Other Factors | | | |

Additional notes, 'N/A' justifications (why a particular parameter is judged not to affect the site), and explanations regarding the bounded/non-bounded determination.

1. None
2. None
3. None
4. [Discuss velocity and scour results and provide comparisons with CDB, permissible velocities, presence of scour resistant material, etc.]
5. [Discuss conditions that could exist concurrent with this flood-causing mechanism or combined-effect flood (e.g. high winds, ice formation, etc.)]
6. [Discuss if and how this flood-causing mechanism or combined-effect flood could cause a surcharge to groundwater, considering flood duration and soil conditions.]
7. [Discuss warning time; may include information from relevant forecasting methods (e.g., products from local, regional, or national weather forecasting centers) and ascension time of the flood hydrograph to a point (e.g. intermediate water surface elevations) triggering entry into flood procedures and actions by plant personnel. Reference NEI 15-05 for LIP.]
8. [Discuss period of site preparation (after entry into flood procedures and before flood waters reach site grade).]
9. [Discuss period of inundation.]
10. [Discuss period of recession, when flood waters completely recede from site and plant is in safe and stable state that can be maintained.]
11. [Additional notes regarding plant mode of operations.]
12. [Discuss other plant-specific factors (e.g. waterborne projectiles).]

1.3. NEI 12-06, Rev. 1a, Section G.4 – Evaluation of Mitigating Strategies for the MSFHI

1.3.1.NEI 12-06, Rev. 1a, Section G.4.1 – Assessment of Current FLEX Strategies

Document the evaluation that demonstrates existing FLEX strategies are acceptable without modification for the MSFHI.

1.3.1.1. Document for each exceedance how FLEX is viable. Reference Section G.4.1 in NEI 12-06 revision 1a. Address each of the evaluation bullets in this section.

1.3.1.2. Conclusions

Document which of the following conclusions are drawn from the assessment and provide a basis for the conclusions:

- If the evaluation demonstrates that the existing FLEX strategies can be deployed as designed for all applicable-flood causing mechanisms then the MSA is then considered complete.

- If the evaluation demonstrates that the existing FLEX strategies cannot be implemented as designed, then document the basis for selecting FLEX, AMS, or THMS.

1.3.1.3. NEI 12-06, Rev. 1a, Section G.4.2 – Assessment for Modifying FLEX Strategies

Document the items in Section G.4.2 in NEI 12-06 revision 1a. Address each of the evaluation bullets in this section.

If the existing FLEX strategies cannot be implemented as designed and "Modified FLEX" is selected to address the deficiencies, expand upon the documentation in Section 2.3.1 and provide the following:

- Summary of the changes to the FLEX strategies;
- Description of any revised sequence of events, if applicable, demonstrating the necessity of revised FLEX actions;
- Description and justification of any modifications (equipment, procedures, etc.), if applicable, to address the revised FLEX actions; and
- Identify any validation items that will need to be re-preformed based on the changes. Validation documentation does not need to be submitted and should be performed following any modifications or procedure revisions.

#### 1.3.1.4. NEI 12-06, Rev. 1a, Section G.4.3 and G.4.4 – Assessment of Alternative and Targeted Hazard Mitigating Strategies

Document the items in Section G.4.3 or G.4.4 as applicable in NEI 12-06 revision 1a. Address each of the evaluation bullets in this section.

If the existing FLEX strategies cannot be implemented as designed and "AMS" or "THMS" is selected to address the deficiencies, expand upon the documentation in Section 2.3.1 and document the evaluation that concludes that the selected strategy will mitigate the MSFHI. The following items should be included:

- The sequence of events for the flood hazard(s);
- A detailed description of the mitigating strategies;
- A detailed list of equipment necessary for the mitigating strategies;
- A description of how the provisions in Sections 3, 6, and 11 of NEI 12-06, Rev. 1a have been addressed;
- Describe any validation items that will need to be performed based on the changes. Validation documentation does not need to be submitted and should be performed following any modifications or procedure revisions.
- For a THMS, document the justification for not maintaining the containment capability.

The documentation identified in this assessment should be included in and be of the same level of detail as that included in the Program Document.

**2016 Mitigating Strategies Assessments for Flooding**
**Documentation Requirements**
**(DRAFT Plant G.4.4 Submittal)**

**Acronyms:**

- MSFHI – Mitigating Strategies Flood Hazard Information (from the FHRR and MSFHI letter)
- FHRR – Flood Hazard Reevaluation Report
- DB – Design Basis
- AMS – Alternative Hazard Mitigating Strategies
- THMS – Targeted Hazard Mitigating Strategies

1. Documentation

1.1. NEI 12-06, Rev. 1a, Section G.2 – Characterization of the MSFHI

Document the characterization of the MSFHI. This can be done by summarizing and/or referencing the FHRR submittal and associated RAI/Audit responses.
Site needs to complete. Input information from the MSFHI letter.

1.2. NEI 12-06, Rev. 1a, Section G.3 – Comparison of the MSFHI and FLEX DB Flood
Site needs to complete. Input information from the MSFHI letter.
Document the nature of any element not bounded for all applicable flood-causing mechanisms. The following table format can be used for each applicable flood mechanism. Identify if individual controlling flood-causing mechanisms or a bounding set of parameters are utilized. The table can be used to define individual controlling mechanisms or bounding parameters. If one set of bounding parameters are utilized, note the associated mechanism for each parameter. This information should have already been developed with the FHRR submittal, and associated RAI responses, and can be referenced in lieu of presenting again with the table below.

*Table 1 – Flood Causing Mechanism A or Bounding Set of Parameters*

| | Flood Scenario Parameter | FLEX Design Basis Flood Hazard | MSFHI | Bounded (B) or Not Bounded (NB) |
|---|---|---|---|---|
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| | 2. Max Wave Run-up Elevation (ft. MSL) | | | |
| | 3. Max Hydrodynamic/Debris Loading (psf) | | | |
| | 4. Effects of Sediment Deposition/Erosion | | | |
| | 5. Concurrent Site Conditions | | | |
| | 6. Effects on Groundwater | | | |
| Flood Event Duration | 7. Warning Time (hours) | | | |
| | 8. Period of Site Preparation (hours) | | | |
| | 9. Period of Inundation (hours) | | | |
| | 10. Period of Recession (hours) | | | |

| | | | | |
|---|---|---|---|---|
| Other | 11. Plant Mode of Operations | | | |
| | 12. Other Factors | | | |

Additional notes, 'N/A' justifications (why a particular parameter is judged not to affect the site), and explanations regarding the bounded/non-bounded determination.

1. None
2. None
3. None
4. [Discuss velocity and scour results and provide comparisons with CDB, permissible velocities, presence of scour resistant material, etc.]
5. [Discuss conditions that could exist concurrent with this flood-causing mechanism or combined-effect flood (e.g. high winds, ice formation, etc.)]
6. [Discuss if and how this flood-causing mechanism or combined-effect flood could cause a surcharge to groundwater, considering flood duration and soil conditions.]
7. [Discuss warning time; may include information from relevant forecasting methods (e.g., products from local, regional, or national weather forecasting centers) and ascension time of the flood hydrograph to a point (e.g. intermediate water surface elevations) triggering entry into flood procedures and actions by plant personnel. Reference NEI 15-05 for LIP.]
8. [Discuss period of site preparation (after entry into flood procedures and before flood waters reach site grade).]
9. [Discuss period of inundation.]
10. [Discuss period of recession, when flood waters completely recede from site and plant is in safe and stable state that can be maintained.]
11. [Additional notes regarding plant mode of operations.]
12. [Discuss other plant-specific factors (e.g. waterborne projectiles).]

1.3. NEI 12-06, Rev. 1a, Section G.4 – Evaluation of Mitigating Strategies for the MSFHI

1.3.1.NEI 12-06, Rev. 1a, Section G.4.1 – Assessment of Current FLEX Strategies

External Flood Hazard Assessment from OIP:
Per Plant G.4.4 UFSAR (Section 3.4.1), the maximum flood elevation is 603'-0" at the site. This is above the grade elevation (594-6"). The maximum flood elevation is a rising river level event that provides 96 hours of warning time. Therefore, time is available to relocate equipment and stage necessary measures to support plant response to rising water levels.

In accordance with NEI 12-06 section 6.2.1, Susceptibility to External Flooding, Plant G.4.4 screens in for an assessment for external flood hazard.

The current Plant G.4.4 FLEX strategies utilize a combination of Phase 1 (RCIC) and Phase 2 (portable pumps and generators) to maintain core cooling, containment and spent fuel pool cooling functions. The OIP and six month updates do not specifically list the strategy for a flood condition. Plant G.4.4 will utilize the current flood abnormality procedure, PGOA 0010-16 Flood Emergency Procedure, for all flooding events, including flood induced ELAP and LUHS (FLEX) events. This procedure will be initiated upon forecast of increasing river level by the US Weather Bureau or actual river level of >582 feet. During the warning time of 96 hours, Plant G.4.4 will shutdown both reactors, cool to cold shutdown (mode 4), remove the containment head, disassemble the reactor and flood the cavities to provide cooling and make up to the reactors. This strategy does not maintain the containment function.

Mitigation Strategies Flooding Hazard Information (MSFHI) for the most limiting flood hazard:

- Probable Maximum Flood
  - Combined effects: cool season PMP, 100-year snowpack, upstream dam failure and the effects of coincident wind wave activity
  - Maximum still water elevation is 8 feet above site grade
  - Maximum water elevation is 10 feet above site grade
  - Duration ~ 10 days
  - Warning time: Initiated by a flood forecast by NWS or River Level is greater than 582'. Actions triggered is actual river level is greater than 586' or predicted to exceed plant grade in less than 96 hours.

1.3.1.1. Document for each exceedance how FLEX is viable. Reference Section G.4.1 in NEI 12-06 revision 1a. Address each of the evaluation bullets in this section.

**Impacts of MSFHI:**
The MSFHI has been used in the evaluation of FLEX strategies.

**Storage:**
The FLEX / Flood equipment will be stored in different locations. Plant G.4.4 will have two storage locations, one robust building that is not protected for flood and one commercial building that is above the flood levels. The flood pump will be relocated prior to the flood waters reaching grade level. In the event of a flood, the FLEX equipment from the robust building will be relocated to the upper commercial building.

**Robustness of plant equipment:**
No plant equipment will be required after flood water is at grade level. All plant equipment used for FLEX prior to being secured meets the requirements of robustness as defined in Appendix A.

**Connection points:**
There are no connections points for the flood strategy. Electrical power will be removed by plant personnel and water will be pumped to the open reactor cavity.

1.3.1.2. Conclusions

The current FLEX strategies were developed using the DB flood information per Plant G.4.4 UFSAR Section 3.4.1. The new MSFHI is slightly higher and therefore, the MSFHI is not bounded by the FLEX DB. The containment function will not be maintained and therefore a targeted mitigation strategy will be utilized.

The following summarizes all the applicable flooding hazards at Plant G.4.4 and the status of FLEX for each:

- LIP – FLEX works as designed
- Riverine – FLEX does not work as designed, the containments need to be open to implement the strategy.

- Combined effects (riverine plus dam failure) – FLEX does not work, THMS used as described in this document, the containment needs to be open to implement the strategy.

Document which of the following conclusions are drawn from the assessment and provide a basis for the conclusions:

- If the evaluation demonstrates that the existing FLEX strategies can be deployed as designed for all applicable-flood causing mechanisms then the MSA is then considered complete.

- If the evaluation demonstrates that the existing FLEX strategies cannot be implemented as designed, then document the basis for selecting FLEX, AMS, or THMS.

  The current FLEX strategies were developed using the DB flood information per Plant G.4.4 UFSAR Section 3.4.1. The new MSFHI is slightly higher and therefore, the MSFHI is not bounded by the FLEX DB. The containment function will not be maintained and therefore a targeted mitigation strategy will be utilized. The river height of this flood will require the units to be shutdown and cooled down to < 212°F. This will also require opening the containment and flooding the reactors and reactor cavities to maintain cold shutdown. Because of not fully maintaining the containment function, a THMS is required.

  Section 1.3.1.3 is N/A.

#### 1.3.1.3. NEI 12-06, Rev. 1a, Section G.4.2 – Assessment for Modifying FLEX Strategies

Document the items in Section G.4.2 in NEI 12-06 revision 1a. Address each of the evaluation bullets in this section.

If the existing FLEX strategies cannot be implemented as designed and "Modified FLEX" is selected to address the deficiencies, expand upon the documentation in Section 1.3.1 and provide the following:

- Summary of the changes to the FLEX strategies;

- Description of any revised sequence of events, if applicable, demonstrating the necessity of revised FLEX actions;

- Description and justification of any modifications (equipment, procedures, etc.), if applicable, to address the revised FLEX actions; and

- Identify any validation items that will need to be re-preformed based on the changes. Validation documentation does not need to be submitted and should be performed following any modifications or procedure revisions.

#### 1.3.1.4. NEI 12-06, Rev. 1a, Section G.4.3 and G.4.4 – Assessment of Alternative and Targeted Hazard Mitigating Strategies

Document the items in Section G.4.3 or G.4.4 as applicable in NEI 12-06 revision 1a. Address each of the evaluation bullets in this section.

If the existing FLEX strategies cannot be implemented as designed and “AMS” or “THMS” is selected to address the deficiencies, expand upon the documentation in Section 1.3.1 and document the evaluation that concludes that the selected strategy will mitigate the MSFHI. The following items should be included:

- The sequence of events for the flood hazard(s);
- A detailed description of the mitigating strategies;
- A detailed list of equipment necessary for the mitigating strategies;
- A description of how the provisions in Sections 3, 6, and 11 of NEI 12-06, Rev. 1a have been addressed;
- Describe any validation items that will need to be performed based on the changes. Validation documentation does not need to be submitted and should be performed following any modifications or procedure revisions.
- For a THMS, document the justification for not maintaining the containment capability.

The documentation identified in this assessment should be included in and be of the same level of detail as that included in the Program Document.

See attachment 1 for details of the THMS.

# Attachment 1
# Plant G.4.4 Flood THMS

## Sequence of events for the flood hazard:

| Action item | Elapsed Time | Action | Time Constraint Y/N | Remarks / Applicability |
|---|---|---|---|---|
| 1 | - 96 hrs | Event Notification per PGOA 0010-16 Flood Emergency | N | Plant at 100% power |
| 2 | - 96 hrs | Call out additional staff. | N | OCC staffed and reactor services called in for reactor disassembly. |
| 3 | - 96 hrs | Monitor river level. | N | Establishes response action |
| 4 | - 96 hrs | Secure from dry cask operation if in progress | N | Only necessary if in progress. |
| 5 | - 94 hrs | Initiate Unit 1 and Unit 2 shutdown | N | Both Units will be shut down concurrently and decay heat removed using the normal procedures as specified for the RHR system |
| 7 | - 94 hrs | Place mobile Makeup Demineralizer System in operation | N | Provide additional water as required. |
| 8 | - 93 hrs | Start setup portable pump (Darley pump) for Cavity and SFP makeup | N | Follow PGOA 0010-16 |
| 9 | - 87 hrs | Start removal of DW shield plugs | N | Per forced outage schedule |
| 10 | - 87 hrs | Both units achieve Mode 3 | Y | Need to be in Mode 3 on both units for the pending Rx disassembly |
| 11 | - 85 hrs | Seal EDG Fuel Storage and plug IRSF pit lines | N | Prevent water entering diesel storage tank. |
| 12 | - 82 hrs | Mode 4, Cold Shutdown achieved on both units | Y | Need to be in Mode 4 to break primary containment and remove DW head. |
| 13 | - 82 hrs | Start water addition to Suppression Chambers through RHR system test lines per PGOP 4100-11 | N | |
| 14 | - 78 hrs | Shield plugs removed | N | Need plugs removed to remove DW head |
| 15 | - 76 hrs | Darley pump setup complete | N | This needs to be established prior to cavity flood |
| 16 | - 72 hrs | Transfer FLEX equipment to higher elevations above predicted flood levels | N | Protect FLEX equipment |
| 17 | - 72 hrs | Obtain DW samples | N | Preparation for DW head removal |

# Attachment 1
# Plant G.4.4 Flood THMS

| Action item | Elapsed Time | Action | Time Constraint Y/N | Remarks / Applicability |
|---|---|---|---|---|
| 18 | - 72 hrs | Water addition to suppression chambers complete | N | |
| 19 | - 68 hrs | Set up to remove Unit 1and Unit 2 DW head | N | Once in Mode 4, Cold Shutdown, DW head can be removed. |
| 20 | - 65 hrs | DW head removal set up complete | N | Need to be ready to remove DW head once Mode 4 has been established |
| 21 | - 62 hrs | Unit 1 DW head removed and stored | N | Need the DW head removed to remove Rx vessel head |
| 22 | - 59 hrs | Unit 2 DW head removed and stored | N | Need the DW head removed to remove Rx vessel head |
| 23 | - 35 hrs | Unit 1 Rx vessel head removed and stored | Y | This allows the cavity to be filled to maintain cold shutdown |
| 24 | - 24 hrs | Unit 2 Rx vessel head removed and stored | Y | This allows the cavity to be filled to maintain cold shutdown |
| 25 | - 22 hrs | Unit 1and Unit 2 cavity filled | N | Allows for sufficient water above the core to maintain cold shutdown. |
| 26 | - 22 hrs | Darley pumps connected and alignment for reactor cavity make up. | N | PGOA 0010-16 |
| 27 | - 1 hr | Open plant doors on ground elevation. | N | Equalize loading on buildings. |
| 28 | 0 hrs | ELAP occurs due to flood Directed by PGOA 0010-16 | N | EDGs and SBO DGs not protected from flood water |
| 29 | ~2 min | Operating crew enters applicable EOPs and abnormal procedures for LOOP. | N | QGA 100 RPV Control<br>PGOA 6100-03 Loss of Offsite Power |
| 30 | ~5 mins | Start de-energize station loads prior to water going above grade level | N | Personnel safety |
| 31 | ~5 mins | DC load shedding initiated per PGOA 6100-03 | N | QOA 6900-07 Loss of AC Power to the 125 VDC Battery Charger with Simultaneous Loss of Auxiliary Electric Power. Initiation of load shedding is not time critical – completion of load shedding is time critical. |
| 32 | 30 mins | DC load shedding completed | Y | QOA 6900-07 |
| 33 | 30 mins | Complete de-energize station loads. | N | Personnel Safety |

## Attachment 1
## Plant G.4.4 Flood THMS

| Action item | Elapsed Time | Action | Time Constraint Y/N | Remarks / Applicability |
|---|---|---|---|---|
| 34 | ~60 mins | Control Room crew has assessed SBO and plant conditions and declares an Extended Loss of AC Power (ELAP) event. | N | This is not time critical. Plant G.4.4 will be in a flood condition prior to this declaration. |
| 35 | 90 mins | FLEX DC load shed complete. | N | DC coping analysis assumes FLEX load shed is complete by 90 minutes. |
| 36 | 24 hrs | Initial equipment from National SAFER Response Center becomes available. | N | Per NEI 12-06, Section 12 (NSRC). |
| 37 | 24 -72 hrs | Continue to maintain critical functions of core cooling and SFP cooling. Utilize initial NSRC equipment in spare capacity. | N | Not time critical/sensitive since Phase 2 actions result in indefinite coping times for all safety functions. |
| 38 | 10 days | Flood water subsides below grade level, start plant restoration. | N | Time based on recent MSFHI |

## A detailed description of the mitigating strategies:

**Maintain Core Cooling:**

The following actions will be initiated four days prior to the predicted arrival of a flood of elevation 594'6" or greater, with both Units being shut down and decay heat being removed using the normal procedures as specified for the RHR system. Flood stage levels on the Mississippi River are predicted several weeks in advance by the U.S. Army Corps of Engineers. In the highly unlikely event that a maximum probable flood is predicted, the plant will be shut down and cooled four days prior to the predicted time at which water will go above plant grade elevation of 594.5'. This will reduce decay heat from the reactor to a level which can be removed by natural circulation cooling between the reactor and the reactor cavities and fuel storage pools.

Upon entry into PGOA 0010-16, Plant G.4.4 will call out additional personnel as necessary to shutdown both reactors and once shutdown and cooled down, disassemble the reactors. Unit shutdown will commence within the first two hours of entry into the procedure. Operators will be briefed and start a normal unit shutdown per PGGP 3-1, Reactor Power Operations and PGGP 2-1, Normal Unit Shutdown. Both reactors will be shutdown in parallel.

A flood watch schedule will be established to monitor for rising river levels. Subsequent actions and decisions to continue with plant shutdown and disassemebly will be based on the river rate

of rise and level. An onsite mobile makeup demineralizer system will be placed in operation to fill the CCSTs and provide additional water to flood the reactor cavity. FLEX equipment from the lower FLEX storage area will be transferred to the FLEX storage building near the upper parking lot which is an elevated site not susceptible to the river flood. Specific flood equipment as listed in the equipment section will be obtained and staged in preparation for maintaining the reactor cavity water level once the units are shutdown and the cavities flooded.

Both units will enter mode 4 approximately 14 hours after entry into PGOA 0010-16 or hour -82 per the time line. At this time, Unit 1's containment head will be removed and stored. After removal of the Unit 1 containment head, the staff will commence removal of the Unit 2 containment head. Both containment heads will be removed at hour -59 per the time line. Once both containment heads are removed, setup and removal of both reactor heads will commence. Both reactor heads will be removed and stored at hour -24 per the time line. After both reactor heads are removed, the reactor cavities will be filled. Under this condition, no heat removal nor related electrical power supply systems are needed. The recirculation loops will be isolated to prevent leakage from the pump seals limiting the water loss from the reactors. Units will be maintained in cold shutdown (<212°F) via natural circulation. Water level will be maintained in the normal cavity filled level.

Additionally during the warning time period, other activities will occur. Both suppression chambers will be filled, the outdoor water storage tanks will be filled, sealing the EDG Fuel Storage tanks and plug drain lines in IRSF pit will be completed. The flood pumps (Darley pumps) will be connected and alignment for reactor cavity make up established.

Ninety six (96) hours after procedure initiation, water level is predicted to reach grade level. At this time, plant doors will be opened to ensure pressure is equalized. Power will be removed by de-energization of station loads. This will be designated as "Time 0". The operating crew will enter the applicable EOPs and abnormal procedures for LOOP. DC load shedding will commence and declaration of an ELAP will be made. The ELAP is caused when the plant staff removes power to the site per procedure. Since this is a planned evolution, all preparations will be complete and plant staff will be staged at key locations to implement the actions. Once DC load shed is complete, the operating crew will continue to maintain the critical functions of core cooling and spent fuel pool cooling until flood waters subside and recovery can be entered.

## A detailed list of equipment necessary for the mitigating strategies:

- Portable pump [Darley Model HE20V]
- Emergency Portable Pump 'A'
- Emergency Portable Pumps 'B'
- Emergency Portable Pumps 'C'
- Trash pumps in H building
- Two 10' sections of 4" suction hose with suction strainer
- Pump discharge hose, approximately 400 feet of 2 ½ inch fire hose for two pumps.

- Ten day supply of gasoline, 400 gallons of gasoline (approximately 40 gallons per day)
- Scaffolding
- Reactor and Containment disassembly equipment
    - (list equipment)
- (site list any additional equipment needed)

## A description of how the provisions in Sections 3, 6, and 11 of NEI 12-06, Rev. 1a have been addressed:

- **Section 3 Establish Baseline Coping Capability**

The general criteria and initial plant conditions were review during the development of the THMS. All applicable aspects of these sections have been incorporated into the THMS.
**Section 3.2.1.3** was reviewed and since this is a specific BDB event, flood, some of the initial conditions do not apply.

3.2.1.3.1 "No specific initiating event is used. The initial condition is assumed to be a loss of off-site power (LOOP) at a plant site resulting from an external event that affects the off-site power system either throughout the grid or at the plant with no prospect for recovery of off-site power for an extended period. The LOOP is assumed to affect all units at a plant site." This is specific to a flood event. The LOOP will be caused when plant staff removes power from the site due to the flood conditions.
3.2.1.3.2. "All design basis installed sources of emergency on-site ac power and SBO alternate ac power sources are assumed to be not available and not imminently recoverable. Station batteries and associated dc buses along with ac power from buses fed by station batteries through inverters remain available." The plant staff will induce the loss of power based on flood levels. Once the flood waters subside, on-site ac power will be recovered. The dc buses along with ac power from buses fed by station batteries will be available during the event.
3.2.1.3.5. "Fuel for FLEX equipment stored in structures with designs which are robust for the applicable hazard(s) remains available." The plant staff will continue to protect fuel stored in the EDG storage tanks, but due to the flood, this fuel will not be accessible until the flood water subsides.
3.2.1.3.8. "Installed electrical distribution system, including inverters and battery chargers, remain available provided they are protected consistent with current station design." Some of the electrical distribution systems will not be available (site to indicate those buses that will be inundated with flood water). All electrical distribution systems located above ??? elevation will remain available.

**Section 3.2.1.4**, Reactor Transient – the units will be shut down and cooled down prior to the predicted arrival of a flood of elevation 594'6" or greater.
**Section 3.2.1.5**, Reactor Coolant Inventory Loss – the units will be shut down and cooled down prior to the predicted arrival of a flood of elevation 594'6" or greater. The coolant

losses will be reduced as compared to the initial mitigating strategies assessment. The reactor recirculation pumps will be isolated which will isolate any leakage due to pump seal leakage. Loss due to evaporation is considered for make up to the reactor cavities.
**Section 3.2.1.6**, SFP Conditions – the units will be in a condition where the cavities and SFPs are connected. Make up to the SFPs will be via the Darley pump to the reactor cavities. All assumptions in this section for the SFP have been reviewed and apply to the development of the THMS.
**Section 3.2.1.7**, Event Response Actions – the response is based on the timeline established for the flood event. Additional plant staff will be available to complete all actions specified in the THMS. All principles in this section have been reviewed and are met by the THMS
**Section 3.2.1.8**, Effects of Loss of Ventilation – the loss of ventilation has been considered in the development of the FLEX strategies. These considerations will apply for the THMS. The conditions and timing under which ventilation will be lost are unchanged as compared to the original FLEX strategy.
**Section 3.2.1.9** Personnel Accessibility – areas requiring personnel access have been evaluated. Plant staff will be able to access upper areas of the reactor and turbine buildings during the event. Boats will need to be utilized in some areas of the site for access. This will not impede any actions in the THMS. (Site, need to describe location of boats for access. Also need to indicate the number of boats available and list these in the equipment section earlier in this document. Consideration of strategy timing needs to be described.)
**Section 3.2.1.10**, Instrumentation and Controls – all instruments and controls will be available for use during the warning period. After the plant staff removes power from the units, the only instruments required for mitigation will be SFP level. Readings can be obtained locally or via the SFPI.
**Section 3.2.1.11**, Containment Isolation Valves – all valves will be in the isolated position and do not require operation during the event.
**Section 3.2.1.12**, Qualification of Plant Equipment – prior to the flood water reaching plant grade, all plant equipment required for the THMS is qualified to current plant design. After the flood reaches grade and the staff removes power from the units, only portable equipment will be required.
**Section 3.2.1.13,** FLEX Analyses, Methodologies and Generic Topics – this section has been reviewed and applicable topics are incorporated in the development of the THMS.
**Section 3.2.2, Minimum Baseline Capabilities**
Phase 1 will be during the warning period. Plant equipment used to shut down and cool down the plant will be used. In addition to this equipment, refueling equipment will be used to disassemble the reactors and flood the reactor cavities.
Phase 2 equipment consists of a portable make up pump, Darley pump, to supply make up water to the reactor cavities. Small generators will be available for use if required. The THMS does not require the use of portable generators during the event.
Phase 3 equipment from off site will be available and used for spares if required. An off-site staging area has been established for Phase 3 equipment.
All aspects of section 3.2.2 were considered in the development of the site FLEX FSGs. The THMS will also incorporate the guidelines needed to support the development of

other FSGs for a flood event. FSGs that will be used during the flood; control room vent/habitability, lighting, plant area ventilation, and deployment of spare equipment.

- **Section 6 Assess External Flooding Impact**

6.1 and 6.2: Section 6.1 of NEI 12-06 is information for the utility and has been reviewed. Section 6.2 review follows:
Plant G.4.4 is a not a dry site. Per section 6.2.2, characterization of the Applicable Flood Hazard was performed. This analysis is in section 1.1 of this submittal.

**6.2.3.1 Protection of FLEX Equipment:**

Plant G.4.4 will meet the following section for protection:
"6.2.3.2.1.1.c FLEX equipment can be stored below flood level if time is available and plant procedures/guidance address the needed actions to relocate the equipment. Based on the timing of the limiting flood scenario(s), the FLEX equipment can be relocated to a position that is protected from the flood, either by barriers or by elevation, prior to the arrival of the potentially damaging flood levels. This should also consider the conditions on-site during the increasing flood levels and whether movement of the FLEX equipment will be possible before potential inundation occurs, not just the ultimate flood height."

Plant G.4.4 will have two storage locations, one robust building that is not protected for flood and one commercial building that is above the flood levels. In the event of a flood, the FLEX equipment from the robust building will be relocated to the upper commercial building. Equipment required to implement the THMS will be relocated to the area of deployment, which is above the predicted flood levels. In the event the flood levels are above the predicted levels, the flood pump and related equipment can be moved to a higher location.

**6.2.3.2 Deployment of FLEX Equipment:**

The equipment necessary for the strategy will be deployed prior to the flood waters reaching grade elevation. All of the necessary support equipment will also be staged prior to the predicted arrival of a flood of elevation 594'6" or greater. Per section 6.2.3.2.:
"1. For external floods with warning time, the plant may not be at power. In fact, the plant may have been shut down for a considerable time and the plant configuration could be established to optimize FLEX deployment. For example, the FLEX pump could be connected, tested, and readied for use prior to the arrival of the critical flood level. Further, protective actions can be taken to reduce the potential for flooding impacts, including cooldown, borating the RCS, isolating accumulators, isolating RCP seal leak off, obtaining dewatering pumps, creating temporary flood barriers, etc. These factors can be credited in considering how the baseline capability is deployed."

# Attachment 1
# Plant G.4.4 Flood THMS

Plant G.4.4 units 1 and 2 will be shut down and cooled down to less than 212° F for at least 3 days prior to the predicted arrival of a flood of elevation 594'6" or greater. The FLEX pump (Darley pump) will have been set up and readied for use.

"2. The ability to move equipment and restock supplies may be hampered during a flood, especially a flood with long persistence. Accommodations along these lines may be necessary to support successful long-term FLEX deployment."

Supplies for a duration of 10 days will be staged and available for use.

"3. Depending on plant layout, the ultimate heat sink may be one of the first functions affected by a flooding condition. Consequently, the deployment of the FLEX equipment should address the effects of LUHS, as well as ELAP."

Plant G.4.4 THMS will not require the use of the UHS equipment. The ELAP will be self-induced prior to the predicted arrival of a flood of elevation 594'6" or greater. Any power needs will be established prior to the ELAP.

"4. FLEX equipment will require fuel that would normally be obtained from fuel oil storage tanks that could be inundated by the flood or above ground tanks that could be damaged by the flood. Steps should be considered to protect or provide alternate sources of fuel oil for flood conditions. Potential flooding impacts on access and egress should also be considered."

The below ground fuel tanks will be protected prior to the predicted arrival of a flood of elevation 594'6" or greater. Fuel for the Darley pump for a 10 day duration will be staged near the pump.

"5. Connection points for FLEX equipment should be reviewed to ensure that they remain viable for the flooded condition."

The discharge of the Darley pumps will be directly into the reactor cavity. There are no connections required for the THMS. All fuel pool gates will be open and the reactor cavities connected to the fuel pool. This allows for discharging the output from the Darley pump into the fuel pool to maintain level in both reactor cavities.

"6. For plants that are limited by storm-driven flooding, such as Probable Maximum Surge or Probable Maximum Hurricane (PMH), expected storm conditions should be considered in evaluating the adequacy of the baseline deployment strategies."

This does not apply to Plant G.4.4.

"7. Since installed sump pumps will not be available for dewatering due to the ELAP, plants should consider the need to provide water extraction pumps capable of operating in an ELAP and hoses for rejecting accumulated water for structures required for deployment of FLEX strategies."

Water extraction will only be required once the flood waters subside. There will be small trash pumps and the FLEX pumps available for dewatering areas of the plant.

"8. Plants relying on temporary flood barriers should assure that the storage location for barriers and related material provides reasonable assurance that the barriers could be deployed to provide the required protection."

Plant G.4.4 does not rely on temporary flood barriers for the THMS.

"9. A means to move FLEX equipment should be provided that is also reasonably protected from the event."

The Darley pump is a small pump that can be moved by operators. This pump does not need a separate vehicle to transport the pump.

**6.2.3.3 Procedural Interfaces**

Plant G.4.4 has developed a procedure for flood, PGOA 0010-16, Flood Emergency Procedure. This procedure incorporates all necessary actions for the THMS.

**6.2.3.4 Considerations in Utilizing Off-site Resources**

Plant G.4.4 will have a staging area designated for any off-site resources. This staging area is above the flood levels. Site access will be limited and the use of boats will be required to access various areas of the plant. Any additional pumps required for the THMS will be small and can be transported via boat to the location needed.

- **Section 11 Programmatic Controls**

**11.1**, Quality Attributes – the Darley is a commercially available pump. This pump was procured for use during floods.
**11.2** Equipment Design – the Darley pump design basis has been reviewed. The pump will meet all performance requirements for the THMS. The pump curve is available for reference as an attachment in PGOA 0010-16. All design factors in section 11.2 have been considered.
**11.3** Equipment Storage – the Darley pump will be stored in the Protected Area Warehouse. The pump will be relocated prior to the predicted arrival of a flood of elevation 594'6" or greater.
**11.4** Procedure Guidelines – all procedures developed for the THMS meet the guidelines specified in this section.
**11.5** Maintenance and Testing – PMs have been established the Darley pump. These PMs fully meet the Exelon PM program requirements. The Exelon program was developed using EPRI guidance. For unavailability, the Darley will be added to the FLEX unavailability program.

**11.6** Training – Operators and plant staff have been trained on PGOA 0010-16, Flood Emergency Procedure. This is included in the Operator training program for periodic training per the training plan.
**11.7** Staffing – additional staff will be called out prior to the event. The plant will be fully staffed to perform all tasks necessary to shut down and disassemble the units to the predicted arrival of a flood of elevation 594'6" or greater.
**11.8** – Configuration Control – the THMS will be included in the FLEX program.

## Validation items that will need to be performed:

| Action item | Elapsed Time | Action | Time Constraint Y/N | Remarks / Applicability |
|---|---|---|---|---|
| 10 | - 87 hrs | Both units achieve Mode 3 | Y | This will be validated using past refuel outage performance data. |
| 12 | - 82 hrs | Mode 4, Cold Shutdown achieved on both units | Y | This will be validated using past refuel outage performance data. |
| 23 | - 35 hrs | Unit 1 Rx vessel head removed and stored | Y | This will be validated using past refuel outage performance data. |
| 24 | - 24 hrs | Unit 2 Rx vessel head removed and stored | Y | This will be validated using past refuel outage performance data. |
| 32 | 30 mins | DC load shedding completed | Y | DC load shedding has been validated for FLEX strategies. There are no new actions or environmental factors apply for this load shed, therefore, re-validation of this action is not required. |

## Justification for not maintaining the containment capability:

The function of the primary containment is to isolate and contain fission products released from the Reactor Primary System following a design basis Loss of Coolant Accident (LOCA) and to confine the postulated release of radioactive material. The primary containment consists of a drywell, which is a steel pressure vessel, enclosed in reinforced concrete, and a suppression chamber, which is a steel torus-shaped pressure vessel, connected by vent pipes. The primary containment surrounds the Reactor Primary System and provides an essentially leak tight barrier against an uncontrolled release of radioactive material to the environment.

The safety design basis for the primary containment is that it must withstand the pressures and temperatures of the limiting DBA without exceeding the design leakage rate. The DBA that postulates the maximum release of radioactive material within primary containment is a LOCA. In the analysis of this accident, it is assumed that primary containment is OPERABLE such that

release of fission products to the environment is controlled by the rate of primary containment leakage.

In MODES 1, 2, and 3, a DBA could cause a release of radioactive material to primary containment. In MODES 4 and 5, the probability and consequences of these events are reduced due to the pressure and temperature limitations of these MODES. Therefore, primary containment is not required to be OPERABLE in MODES 4 and 5 to prevent leakage of radioactive material from primary containment.

In this configuration, there will be 490,000 gallons of water above each reactor core. The reactor recirculation system will be isolated preventing inventory loss due to normal pump seal leakage. The loss due to evaporation 4 days after shutdown will be approximately 50 gallons per minute per reactor. The reactors will be able to be maintained in cold shutdown for the duration of the event via natural circulation.

The THMS for Plant G.4.4 will require both units to be shut down and cooled down prior to the predicted arrival of a flood of elevation 594’6” or greater. Both units will be in Mode 4 prior to the removal of the containment heads.