Exelon Generation.

10 CFR 50.54(f)

RS-12-170

November 27, 2012

U.S. Nuclear Regulatory Commission
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Quad Cities Nuclear Power Station, Units 1 and 2
Renewed Facility Operating License Nos. DPR-29 and DPR-30
NRC Docket Nos. 50-254 and 50-265

Subject: Exelon Generation Company, LLC's 180-day Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding the Flooding Aspects of Recommendation 2.3 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident

References:

1. NRC Letter, Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident, dated March 12, 2012
2. NRC Letter, Endorsement of Nuclear Energy Institute (NEI) 12-07, "Guidelines For Performing Verification Walkdowns of Plant Flood Protection Features," dated May 31, 2012
3. Exelon Generation Company, LLC's 90-day Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding Recommendations 2.1 and 2.3, of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident (Flooding), dated June 11, 2012

On March 12, 2012, the Nuclear Regulatory Commission (NRC) issued Reference 1 to all power reactor licensees. Enclosure 4 of Reference 1 contains specific Requested Actions, Requested Information, and Required Responses associated with Recommendation 2.3 for Flooding. On June 11, 2012, Exelon Generation Company, LLC (EGC) submitted the 90-day response requested in Enclosure 4 of Reference 1, confirming that EGC would use the NRC-endorsed flooding walkdown procedure (Reference 3).

For flooding Recommendation 2.3 (walkdowns), Enclosure 4 of Reference 1 states that within 180 days of the NRC's endorsement of the walkdown process (Reference 2), each addressee will submit a final response, including a list of any areas that are unable to be inspected due to inaccessibility and a schedule for when the walkdown will be completed. This letter provides the Quad Cities Nuclear Power Station, Units 1 and 2 180-day response to Reference 1 for Flooding Recommendation 2.3.

There were no deficiencies identified during the walkdowns requiring follow-up in the corrective action program.

Enclosure 1 to this letter provides the requested information for Quad Cities Nuclear Power Station Units 1 and 2.

This letter contains no new regulatory commitments.

Should you have any questions concerning the content of this letter, please contact Ron Gaston at (630) 657-3359.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 27th day of November 2012.

Respectfully,

Glen T. Kaegi

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

Enclosures:

1. Flooding Walkdown Report In Response To The 50.54(f) Information Request Regarding Near-Term Task Force Recommendation 2.3: Flooding for the Quad Cities Nuclear Power Station, Units 1 and 2

cc: Director, Office of Nuclear Reactor Regulation
Regional Administrator - NRC Region III
NRC Senior Resident Inspector – Quad Cities Nuclear Power Units 1 and 2
NRC Project Manager, NRR – Quad Cities Nuclear Power Units 1 and 2
Illinois Emergency Management Agency - Division of Nuclear Safety

Enclosure 1

Flooding Walkdown Report In Response To The 50.54(f) Information Request Regarding Near-Term Task Force Recommendation 2.3: Flooding for the Quad Cities Nuclear Power Station, Units 1 and 2

(40 pages)

FLOODING WALKDOWN REPORT

IN RESPONSE TO THE 50.54(f) INFORMATION REQUEST REGARDING NEAR-TERM TASK FORCE RECOMMENDATION 2.3: FLOODING

for the

QUAD CITIES NUCLEAR POWER STATION (Unit 1 & Unit 2)
22710 206th Avenue, Cordova, IL 61242
Renewed Facility Operating License Nos. DPR-29 & DPR-30
NRC Docket Nos. 50-254 & 50-265

Exelon Generation Company, LLC

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October 31, 2012

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Contents

1. EXECUTIVE SUMMARY

Per NRC's request, a flooding protection walkdown was conducted at Quad Cities Nuclear Power Station (Quad Cities Station) to identify and address plant-specific degraded, nonconforming, or unanalyzed conditions of the plant's flood protection features, including flood protection mitigation procedures. The flooding walkdown was conducted between September 10 and September 14, 2012 and included visual inspections and reasonable simulations.

The scope of the flooding walkdown was developed following a detailed review of all relevant licensing documents. Since the site is inundated during the design-basis Probable Maximum Flood (PMF) event, Quad Cities Station is licensed to mitigate the affects of a flood by implementing procedures to prevent damage to the reactor core. The main flood emergency procedure (QCOA 0010-16) invokes a concurrent shutdown of both units using the standard operating procedure for reactor shutdown and removal of decay heat. In addition, reactor disassembly is initiated to allow for natural circulation of cooling water between the reactors, reactor cavities, and storage pools. Additional procedural steps are initiated to provide for make-up of water during the flooding emergency. Since the flood emergency procedure is the critical component of the plant's flood mitigation strategy, the main focus of the flooding walkdown was the review of the flood emergency procedure and the associated standard operating procedures.

Quad Cities Station does not have incorporated/exterior or temporary features that are credited in the Updated Final Safety Analysis Report (UFSAR) documents with providing flood protection. Exterior below-grade walls are not explicitly mentioned as protecting space credited as dry and providing flood protection against extreme groundwater conditions. However, following industry-wide guidance, below-grade structures (i.e., basement walls and basement slabs) of Unit 1 and Unit 2 Reactor and Turbine Buildings were included in the walkdown scope. The exterior walls and slabs were visually inspected for degraded and non-conforming conditions.

The methodology and acceptance criteria for the evaluation of flood protection features was developed based on NEI report 12-07 (Rev 0-A), *Guidelines for Performing Verification Walkdowns of Plant Protection Features*. The verification process for all implementing procedures included a reasonable simulation (i.e., a detailed procedure walk-through with the staff responsible for implementation of the procedure). For procedures or procedural steps that have not been performed in the past, a drill or exercise was performed as part of the reasonable simulation to verify that the procedure can be performed as specified. Since standard operating procedures are an integral part of the of the flood mitigation strategy at Quad Cities Station, these procedures were also reviewed to verify that they can be implemented during a flood emergency and will not be challenged by flooding conditions.

Visual inspections of below-grade walls of Unit 1 and 2 Reactor and Turbine Buildings were conducted to verify there are no potential observable structural deficiencies that may impact the structure's ability to withstand hydrostatic loads and keep below-grade areas dry. In addition, penetration seals were also visually inspected and documented as a component of the wall features. There were twenty-five (25) areas with below-grade walls and slabs, which were visually inspected during the walkdown. The majority of walls and slabs were accessible; however, seven (7) penetrations were considered inaccessible. Since the penetrations are not credited as individual flood protection features in the CLB, review of available drawings and engineering judgment were used to assess whether they could potentially impact the ability of below-grade walls to function as flood barriers. There was no evidence of leakage below these inaccessible penetrations.

Electrical conduits entering the turbine and reactor buildings were evaluated to determine whether they can provide a pathway for groundwater into safety-related buildings. There are several locations on the west side of the turbine building where electrical conduits, connected to electrical manholes or handholes, penetrate the Turbine Buildings below grade. Conduits that were not visible during the walkdown were considered inaccessible, due to junction boxes or other obstructions preventing access to the penetrations. Reasonable assurance that inaccessible penetrations and seals are present and will perform the external flood protection function was demonstrated if, during visible inspection, there was no evidence of past or current groundwater seepage observed on below-grade walls below these penetrations. In addition, all safety-related below-grade SSCs in the Turbine Buildings are located in watertight vaults providing protection from flooding. The penetrations through the watertight vaults are periodically tested per procedure, any small conduits which are not tested per procedure have been evaluated by engineering and have been determined not to affect the functionality of the safety related equipment and, therefore, the walkdown team determined that visual inspection of electrical manholes/handholes was unnecessary. The flood emergency procedure and the associated procedures (including standard shutdown procedures) were reasonably simulated to ensure that they can be performed as specified and protect the reactor from core damage during flooding conditions. Overall, twelve (12) reasonable simulations related to the implementation of the flood emergency procedure were performed. Based on the results of the evaluation and the review of operator and outage logs, the critical path items of the flood emergency procedure can be implemented as written. The concurrent disassembly of both reactors is, however, not clearly described in the flood emergency procedure. Interviews were conducted with the appropriate personnel in order to determine an appropriate and accurate timeline for the implementation of the associated procedural steps.

2. PURPOSE

a. Background

In response to the nuclear fuel damage at the Fukushima Daiichi power plant due to the March 11, 2011 earthquake and subsequent tsunami, the United States Nuclear Regulatory Commission (NRC) established the Near Term Task Force (NTTF) to conduct a systematic review of NRC processes and regulations, and to make recommendations to the Commission for its policy direction. The NTTF reported a set of recommendations that were intended to clarify and strengthen the regulatory framework for protection against natural phenomena.

On March 12, 2012, the NRC issued an information request pursuant to Title 10 of the Code of Federal Regulations, Section 50.54 (f) (10 CFR 50.54(f) or 50.54(f)) (Reference 3) which included six (6) enclosures:

- [NTTF] Recommendation 2.1: Seismic
- [NTTF] Recommendation 2.1: Flooding
- [NTTF] Recommendation 2.3: Seismic
- [NTTF] Recommendation 2.3: Flooding
- [NTTF] Recommendation 9.3: EP
- Licensees and Holders of Construction Permits

In Enclosure 4 of Reference 3, the NRC requested that licensees "perform flood protection walkdowns to identify and address plant-specific degraded, nonconforming, or unanalyzed conditions and cliff-edge effects (through the corrective action program) and verify the adequacy of monitoring and maintenance procedures." (See note below regarding cliff-edge effects.)

Structures, systems, and components (SSCs) important to safety at nuclear power plants must be designed to withstand the effects of natural phenomena, including floods, without loss of capability to perform their intended safety functions. For flooding walkdowns, identifying/addressing plant-specific degraded, nonconforming, or unanalyzed conditions (through the corrective action program) and verifying the adequacy of monitoring and maintenance procedures is associated with flood protection and mitigation features credited in the current design/licensing basis. New flood hazard information will be considered in response to Enclosure 2 of Reference 3.

On behalf of Exelon Generation Company, LLC (Exelon), this report provides the information requested in the March 12, 2012 50.54(f) letter; specifically, the information listed under the "Requested Information" section of Enclosure 4, paragraph 2 ("a" through "h"). The "Requested Information" section of Enclosure 4, paragraph 1 ("a" through "j"), regarding flooding walkdown procedures, was addressed via Exelon's June 11, 2012, acceptance (Reference 1) of the industry walkdown guidance (Reference 2).

Note Regarding Cliff-Edge Effects

Cliff-edge effects were defined by the NTTF Report (Reference 5), which noted that 'the safety consequences of a flooding event may increase sharply with a small increase in the flooding level'. While the NRC used the same term as the NTTF Report in the March 12 50.54(f) information request (Reference 3), the information the NRC expects utilities to obtain during the Recommendation 2.3: Flooding Walkdowns is different. To clarify, the NRC has now differentiated between cliff-edge effects (which are dealt with under Enclosure 2 of Reference 3) and a new term, Available Physical Margin (APM). APM information is required to be collected during the walkdowns. Refer to section 4G for further details regarding APM information.

b. Site Description

Quad Cities Station is located approximately 3.2 miles north of the Town of Cordova, Illinois. The plant is located on the Mississippi River at its confluence with Wapsipinicon River at Mile Mark 506.8 and at an elevation of 594.5 ft Mean Sea Level (MSL). There are no structural flood protection systems (i.e. exterior active or passive flood protection features) in place for Quad Cities Station.

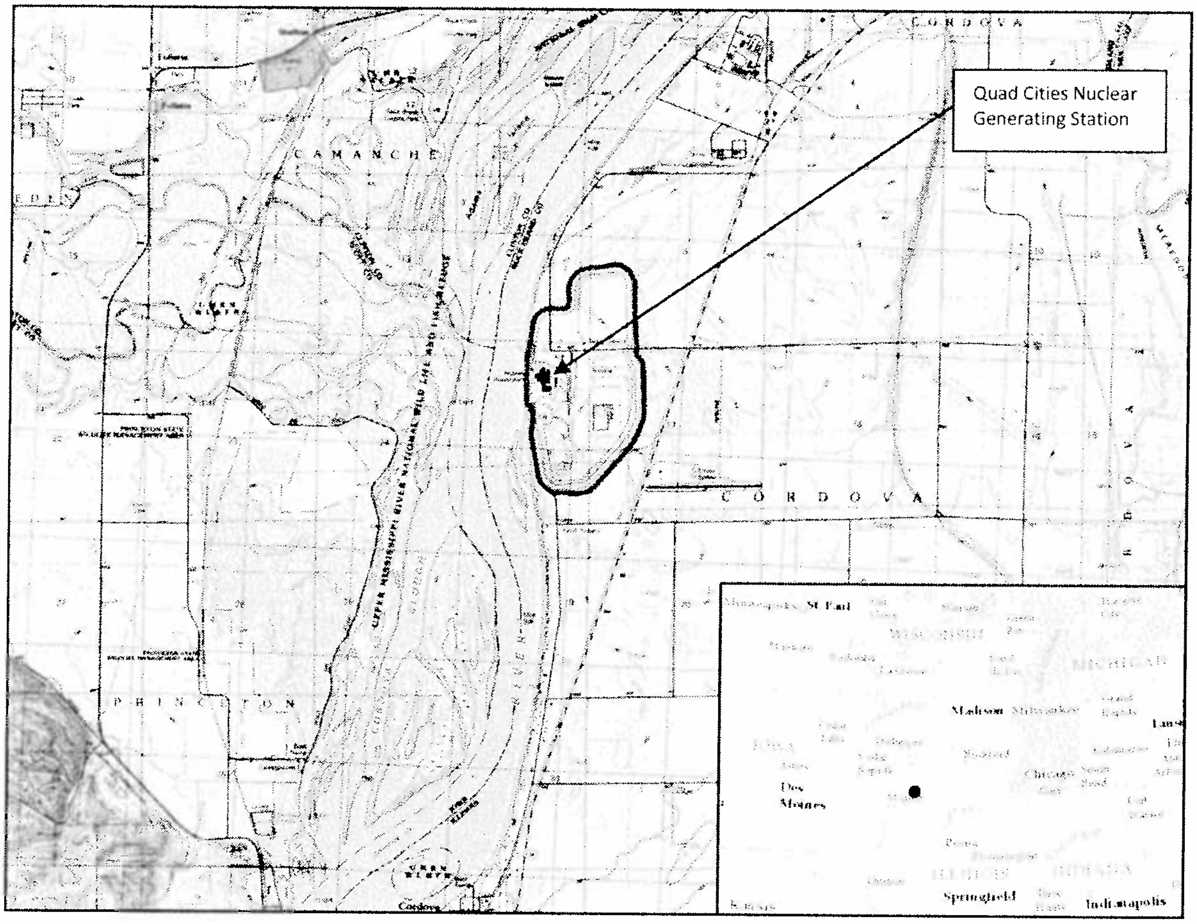

Figure 1: Site Location

Quad Cities Station's external flood response efforts are designed with the intent to mitigate the damage resulting from the occurrence of the PMF of the Mississippi River. According to Section 3.4 of the Quad Cities Updated Final Safety Analysis Report (UFSAR), there would be adequate time for a safe shutdown of both reactors prior to the flood reaching the plant grade and the plant can be maintained in a safe condition up to a flood of 603 ft MSL. If a flood ever exceeded the plant's grade, independently powered portable pumping equipment would be deployed above the projected flood elevation to supply the make-up water required in the storage pools and reactor vessels due to the evaporative cooling losses. It is also estimated that a flood producing an elevation of 603 ft MSL would be expected to recede down to grade level in about eight (8) days. The original design-basis flood, described in Section 2.4.3 of the Quad Cities UFSAR, was based on a 200-year flood with a peak discharge of 385,000 cfs and a peak flood stage of 589 ft MSL was considered to be the PMF at the time of the plant design. However, the UFSAR also states that floods exceeding the 200-year flood are plausible and would result in significantly greater flood elevations than the original PMF. To estimate flood stages associated with floods exceeding those of the original PMF, a stage-discharge curve was developed to estimate flows corresponding to a flood stage at plant grade of 594.5 ft MSL. Furthermore, the approximate PMF was estimated to be 1,200,000 cfs and reaching a flood stage of 601 ft MSL. The UFSAR does not discuss the effect of wind-generated waves. Local Intense Precipitation (LIP) evaluation is not included in the UFSAR and is, therefore, considered a beyond design-basis event.

c. Requested Actions

Per Enclosure 4 of Reference 3, the NRC requested that each licensee confirm use of the industry-developed, NRC-endorsed, flood walkdown procedures or provide a description of plant-specific walkdown procedures. In a letter dated June 11, 2012 (Reference 1), Exelon confirmed that the flooding walkdown procedure (Reference 2), endorsed by the NRC on May 31, 2012, will be used as the basis for the flooding walkdowns.

Other NRC-requested actions include:

(1) Perform flood protection walkdowns using an NRC-endorsed walkdown methodology;

(2) Identify and address plant-specific degraded, nonconforming, or unanalyzed conditions, as well as cliff-edge effects, through the corrective action program, and consider these findings in the Recommendation 2.1 hazard evaluations, as appropriate;

(3) Identify any other actions taken or planned to further enhance the site flood protection;

(4) Verify the adequacy of programs, monitoring and maintenance for protection features; and

(5) Report to the NRC the results of the walkdowns and corrective actions taken or planned.

Enclosure 4 of Reference 3 also states, "If any condition identified during the walkdown activities represents a degraded, nonconforming, or unanalyzed condition (i.e. noncompliance with the current licensing basis) for an SSC, describe actions that were taken or are planned to address the condition using the guidance in Reference 6, including entering the condition in the corrective action program. Reporting requirements pursuant to 10 CFR 50.72 should also be considered."

d. Requested Information

Per Enclosure 4 of Reference 3,

1. The NRC requests that each licensee confirm that it will use the industry-developed, NRC endorsed, flooding walkdown procedures or provide a description of plant-specific walkdown procedures. Exelon's letter dated June 11, 2012 (Reference 1), confirmed that the flooding walkdown procedure (Reference 2), endorsed by the NRC on May 31, 2012, will be used as the basis for the flooding walkdowns.
2. The NRC requests that each licensee conduct the walkdown and submit a final report which includes the following:
   a. Describe the design basis flood hazard level(s) for all flood-causing mechanisms, including groundwater ingress.
   b. Describe protection and mitigation features that are considered in the licensing basis evaluation to protect against external ingress of water into SSCs important to safety.
   c. Describe any warning systems to detect the presence of water in rooms important to safety.

d. Discuss the effectiveness of flood protection systems and exterior, incorporated, and temporary flood barriers. Discuss how these systems and barriers were evaluated using the acceptance criteria developed as part of Requested Information item 1.h.

e. Present information related to the implementation of the walkdown process (e.g., details of selection of the walkdown team and procedures) using the documentation template discussed in Requested Information item 1.j, including actions taken in response to the peer review.

f. Document results of the walkdown including key findings and identified degraded, nonconforming, or unanalyzed conditions. Include a detailed description of the actions taken or planned to address these conditions using the guidance in Regulatory Issues Summary 2005-20, Revision 1, Revision to NRC Inspection Manual Part 9900 Technical Guidance, "Operability Conditions Adverse to Quality or Safety," including entering the condition in the corrective action program.

g. Document any cliff-edge effects identified and the associated basis. Indicate those that were entered into the corrective action program. Also include a detailed description of the actions taken or planned to address these effects. See note in Section 1a regarding the NRC's change in position on cliff-edge effects.

h. Describe any other planned or newly installed flood protection systems or flood mitigation measures including flood barriers that further enhance the flood protection. Identify results and any subsequent actions taken in response to the peer review.

3. METHODOLOGY

a. Overview of NEI 12-07 (Walkdown Guidance)

In a collaborative effort with NRC staff, NEI developed and issued report 12-07 (Rev 0-A), *Guidelines for Performing Verification Walkdowns of Plant Protection Features*, dated May 2012 (Reference 2). The NRC endorsed NEI 12-07 on May 31, 2012 with amendments. NEI 12-07 was updated to incorporate the amendments and re-issued on June 18, 2012. On June 11, 2012, Exelon issued a letter to the NRC (Reference 1) stating that the endorsed flooding walkdown procedure (Reference 2) will be used as the basis for the flooding walkdowns. NEI 12-07 provides guidance on the following items:

- Definitions
  - Incorporated Barrier/Feature
  - Temporary Barrier/Feature
  - Exterior Barrier/Feature
  - Current Licensing Basis (CLB)
  - Design Bases
  - Inaccessible
  - Restricted Access
  - Deficiency
  - Flood Protection Features
  - Reasonable Simulation
  - Visual Inspection
  - Cliff-Edge Effects

- Available Physical Margin
- Variety of Site Conditions
- Flood Duration

- Scope
  - Basis for Establishing Walkdown Scope
  - Identify Flood Protection Features (Walkdown List)
- Methodology
  - Develop Walkdown Scope
  - Prepare Walkdown Packages
  - Walkdown Team Selection and Training
  - Perform Pre-Job Briefs
  - Inspection of Flood Protection And Mitigation Features
    - General
    - Incorporated or Exterior Passive Flood Protection Features
    - Incorporated or Exterior Active Flood Protection Features
    - Temporary Passive Flood Protection Features
    - Temporary Active Flood Protection Features
    - Procedure Walk-through and Reasonable Simulation
  - Review of the Maintenance and Monitoring of Flood Protection Features
  - Review of Operating Procedures
  - Documentation of Available Physical Margins
  - Documenting Possible Deficiencies
  - Restricted Access, or Inaccessible
- Acceptance Criteria
- Evaluation and Reporting Results of the Walkdown
- Related Information Sources
- Examples
- Walkdown Record Form
- Sample Training Content
- Walkdown Report

b. Application of NEI 12-07

Exelon's approach to the flooding walkdowns included three phases:

Phase 1 – Preparation, Training, Data Gathering, and Scoping

Phase 2 – Inspections and Reasonable Simulations

Phase 3 – Final Reporting

The purpose of Phase 1 was to obtain a clear understanding of the site's flood mitigation strategy; develop scope, methodology, and acceptance criteria for the walkdowns; and logistical planning. The following activities were performed during Phase 1:

- Data gathering (CLB documents, procedures, and O&M procedures and documentation);

- Site visit to preview features and plant conditions;
- Desktop review of CLB documents to identify and describe the CLB flood hazard;
- Desktop review of CLB documents to identify and describe flood protection/mitigation strategy;
- Development of Walkdown List;
- Development of Walkdown methodology and acceptance criteria;
- Logistics and strategy planning; and
- Preparation of Walkdown Packages.

The purpose of Phase 2 was to execute the Flooding Walkdown, which included:

- Visual Inspection;
- Reasonable Simulation;
- Evaluation of maintenance/monitoring procedures; and
- Documentation of observations and possible deficiencies.

The purpose of Phase 3 was to develop the Walkdown Report to document the methodology and findings of the Flooding Walkdown and provide a response to "Requested Information" section of the "Recommendation 2.3: Flooding" enclosure from the 10CFR50.54 (f) letter. The Walkdown Report was developed per the template provided in NEI 12-07 [Rev. 0-A], Appendix D.

c. Reasonable Simulations

A procedure walk-through, or "Reasonable Simulation", was conducted for temporary and/or active features that require manual/operator actions to perform their intended flood protection function. The purpose of the reasonable simulations was to verify the procedure or activity can be executed as specified/written. Per NEI 12-07 (Reference 2), reasonable simulation included the following:

- Verify that any credited time-dependent activities can be completed in the time required. Time-dependent activities include detection (some signal that the event will occur, has occurred, or is occurring), recognition (by someone who will notify the plant), communication (to the control room), and action (by plant staff).
- Verify that specified equipment/tools are properly staged and in good working condition.
- Verify that connection/installation points are accessible.
- Verify that the execution of the activity will not be impeded by the event it is intended to mitigate or prevent. For example, movement of equipment across unpaved areas on the site could be impeded by soft soil conditions created by excessive water.
- Review the reliance on the station staff to execute required flood protection features. If during the review several activities are identified to rely on station staff, then perform and document an

evaluation of the aggregate effect on the station staff to demonstrate all actions can be completed as required.

- Verify that all resources needed to complete the actions will be available. (Note that staffing assumptions must be consistent with site access assumptions in emergency planning procedures.)
- Show that the execution of the activity will not be impeded by other adverse conditions that could reasonably be expected to simultaneously occur (for example, winds, lightning, and extreme air temperatures).
- Personnel/departments that have responsibility for supporting or implementing the procedure should participate in the simulation effort.
- The simulation should demonstrate that the personnel assigned to the procedure do not have other duties that could keep them from completing their flood protection activities during an actual event. Actions that would be performed in parallel during an event should be simulated in parallel; not checked individually and the results combined.
- Reasonable simulation need not require the actual performance of the necessary activities if the activities have been previously performed and documented, or it has been periodically demonstrated and documented that the activities can be completed in the credited time.

The Flooding Walkdown activities for Quad Cities Station predominantly involved reasonable simulations since the flood mitigation strategy is to execute the flood emergency procedure, which prepares the plant for safe shutdown prior to the advent of the UFSAR flood event. The following categories of reasonable simulations were performed:

- Simple Simulations – simulations/walk-throughs with short performance times that have been previously performed, and records for which are available to document the successful implementation of the procedure in the credited time.
- Complex Simulations - simulations/walk-throughs with long performance times that have been previously performed, and records for which are available to document the successful implementation of the procedure in the credited time.
- Drills or Exercises – activities that have not been performed before and that, therefore, require the actual performance of the activity to demonstrate that they can be completed in the credited time.
- Records/Desktop Evaluation - for procedures that are considered standard operating procedures, such as plant shutdown procedures. Only the portions of these procedures that are applicable to the flood response should be validated. The validation/evaluation should include review of past performance records to verify that the procedure can be executed in the credited time. The evaluation should also include the possible effect flooding conditions on execution of the procedure and whether the available warning time is sufficient to execute the procedure.

As part of the reasonable simulations, visual inspections were performed to verify that tools, materials, and components required to execute the procedures were in working order, stored, and accessible per the requirements of the procedures. The Walkdown Record Form provided in NEI 12-07 (Rev. 0-A), Appendix B, and Reasonable Simulation Worksheets were used to document the results of the Flooding Walkdown and reasonable simulations, respectively.

Overall, twelve (12) reasonable simulations of procedural steps or standard shutdown procedures were performed to evaluate the effectiveness of the flood emergency procedure. Table 1 provides a summary of reasonable simulations performed during the walkdown. A detailed description of each reasonable simulation is provided in Section 4 d of this report.

Table 1: List of Reasonable Simulations

Simulation #	Simulation Name
1	Flood Warning and Flood Watch
2	Mobile Makeup Demineralizer System
3	Moving and Staging of Darley Model HE20V Portable Pump
4	De-energize Station Loads
5	Add Water to Tori/Drywells through the RHR System Test Lines
6	Filling the Reactor Cavities and Dryer-Separator Pools
7	Filling Radwaste Tanks using Fire System
8	Place Drywell Loads in PTL
9	Seal Diesel Oil Storage Tank Vents
10	Open Plant Doors
11	Reactor Disassembly
12	Normal Unit Shutdown

d. Walkdown Inspection Guidance

A "Walkdown Inspection Guidance" was developed by Exelon to supplement NEI 12-07 (Reference 2), based largely on Appendix A of NEI 12-07 (Examples). The guidance was intended to supplement, not supersede, NEI 12-07 and provide inspection guidance for specific features, listed below.

- Incorporated or Exterior Passive Features:
    - Site Elevations and Topography
    - Earthen Features (i.e., Flood Protection Berm, Dike, Levee)
    - Concrete and Steel Structures
    - Wall, Ceiling, and Floor Seals (e.g. Penetration Seals, Cork Seals)
    - Passive Flood Barriers or Water Diversion Structures
    - Drains and Catch Basins
    - Plugs and Manhole Covers
    - Drainage Pathways (Swales, Subsurface Drainage System, etc.)
    - Piping and Cable Vaults and Tunnels, Electrical Cable Conduit

  - Floor Hatches
  - Flap Gate/Backwater Valve/Duckbill Valve
  - Flood Wall
- Incorporated or Exterior Active Features:
  - Credited Watertight Doors
  - Credited Non-Watertight Doors
  - Pumps
  - Water Level Indication
  - Gate Valves
- Temporary Passive Features:
  - Portable Flood Barriers and Inflatable Rubber Seals
  - Flood Gate
- Temporary Active Feature
  - Pumps

4. RESULTS

The information requested in Reference 3, Enclosure 4, under paragraph 2 of the "Requested Information" section, is provided below. The contents of each item were developed in accordance with Reference 2, Appendix D.

a. Requested Information Item 2(a) – Design Basis Flood Hazards

Describe the design basis flood hazard level(s) for all flood-causing mechanisms, including groundwater ingress.

The original flood design basis flood, described in Section 2.4.3 of the Quad Cities UFSAR, was based on a 200-year flood with a peak discharge of 385,000 cfs and a peak flood stage of 589 ft MSL. The 200-year flood was considered to be the PMF at the time of the plant design. However, the UFSAR also states that floods exceeding the 200-year flood are plausible and would result in significantly greater flood elevations than the original PMF. To estimate flood stages associated with floods exceeding those of the original PMF, a stage-discharge curve was developed by plotting river stages for the following floods: 225,000 cfs (1951 flood); 307,000 cfs (1965 flood); 347,000 cfs (100-year flood); 385,000 cfs (200-year flood); 465,000 cfs; 500,000 cfs; 600,000 cfs; and 700,000 cfs. The stage-discharge curve and the water surface profile for the Upper Mississippi River were presented in the UFSAR as Figure 2.4-1. The UFSAR references the stage-discharge curve and estimates that flows of 587,000 cfs would correspond to a flood stage at plant grade of 594.5 ft MSL. Furthermore, the PMF is estimated to be approximately 1,200,000 cfs and reaching a flood stage of 601 ft MSL. Additionally, the UFSAR states that, should the actual PMF reach an elevation of 603 MSL, the plant can be shut down and maintained in a safe condition. The UFSAR does not discuss the affect of wind-generated waves. Local Intense Precipitation (LIP) evaluation is not included in the UFSAR and is, therefore, considered a beyond design-basis event.

There are no incorporated/exterior or temporary flood protection features designed to protect the site against a flood greater than 594.5 ft MSL. The site is allowed to flood during the PMF and external flood control efforts are directed toward mitigation and prevention of damage to the reactor core during flooding conditions.

No additional flood-causing events (i.e., local intense precipitation, lock and dam failure, ice jams, and groundwater ingress) were considered in the UFSAR documents as a plausible flood hazard. Groundwater ingress was included in this report as a potential flooding source even if not explicitly described in the UFSAR and any exterior walls (above or below grade) protecting space credited as dry in the UFSAR were inspected. The inspection of the walls also noted any degrading or nonconforming conditions for associated penetrations/seals.

b. Requested Information Item 2(b) – Protection and Mitigation Features

Describe protection and mitigation features that are considered in the licensing basis evaluation to protect against external ingress of water into SSCs important to safety.

The Quad Cities Station is inundated during the PMF event and external flood mitigation efforts are directed toward safe shutdown of the reactor and prevention of damage to the reactor core during flooding conditions. The flood emergency procedure (QCOA 0010-16, rev. 16) describes the steps to be taken by the plant operators in the event of an upcoming flood and during the flooding conditions. During the flood, plant doors are opened to allow water to freely enter the plant and equalize pressure once river rises to elevation 594 ft MSL. The reactor is maintained in a safe state by implementing actions described in the procedure. These actions are initiated by flood stages reaching certain elevations or by flood warnings. According to the UFSAR, U.S. Army Corps of Engineers (USACE) predicts that a flood of this magnitude (PMF) would recede to below-grade level in approximately eight (8) days.

The flood emergency procedure goes into effect either when (1) the actual river level exceeds 586 ft MSL, as monitored by the gauge at the plant intake bay, or (2) water level is predicted to be above 594 ft MSL in less than 72 hours. These symptoms initiate several actions, including staging of the gasoline-driven pump used for providing make-up cooling water to the storage pools and reactor vessels. The pump, along with necessary hosing, scaffolding (as needed) and fuel is initially set up at the access hole MH1-5A with the discharge routed to the fuel storage pool. As the flood waters rise, the pump must be moved to alternative locations inside the reactor building.

The shutdown is followed by the removal of decay heat (by normal procedures) and disassembly of both reactors according to procedure MA-AB-756-600. The disassembly includes removal of shield plugs, drywell heads and reactor vessel heads.

Throughout the removal of the decay heat and reactor disassembly process, the plant begins the necessary preparations to flood the reactor vessels and cavities, as well as the tori and the radwaste tanks (to prevent buoyancy). Prior to filling the tori and the drywells with river water through the RHR system using the diesel fire pumps (procedure QCOP 4100-11), all electrical equipment inside the drywell, which could be affected based on flood up level, is placed in Pull To Lock (PTL) / de-energized. The reactor vessels and cavities are then filled using the core spray system, following the procedure QCOP 0201-06. The sources of water for the reactor flooding are the two 350,000 gallon storage tanks, the 100,000 gallon clean demineralized water storage tank, the Mobile Makeup Demineralizer and once those are empty, the river water. Radwaste tanks are also filled with river water through the fire system and vents to fuel oil storage tanks are sealed. Once the reactor vessels are filled with water, the gates between storage pools are removed to promote natural circulation cooling between the reactor cavities and storage pools. Finally, all station loads are de-energized and all plant doors are opened in preparation for the flood to ensure equalization of water pressure on both sides of the walls.

The portable gasoline-driven pump is used to provide make-up water evaporated from the reactors and the storage pools throughout the course of the flood.

The UFSAR does not address specific plant configurations during various modes of operation with respect to flooding. No adverse weather conditions were explicitly stated in the UFSAR and assumed to occur concurrently with the implementation of the flood emergency procedure.

c. Requested Information Item 2(c) – Flood Warning Systems

Describe any warning systems to detect the presence of water in rooms important to safety.

The site is allowed to be flooded during the PMF and, therefore, no room water level warning systems are credited in the plant's external flooding licensing basis.

d. Requested Information Item 2(d) – Flood Protection System/Barrier Effectiveness

Discuss the effectiveness of flood protection systems and exterior, incorporated, and temporary flood barriers. Discuss how these systems and barriers were evaluated using the acceptance criteria developed as part of Requested Information Item 1.h [in Enclosure 4 of the March 12, 2012, 50.54(f) letter]

Section 6 of NEI 12-07 defines "acceptance" as:

> *"Flood protection features are considered acceptable if no conditions adverse to quality were identified during walkdowns, verification activities, or program reviews as determined by the licensee's Corrective Action Program. Conditions adverse to quality are those that prevent the flood protection feature from performing its credited function during a design basis external flooding event and are 'deficiencies'. Deficiencies must be reported to the NRC in the response to the 50.54(f) letter."*

As indicated in Section 3 d, inspection guidance was developed, supplementing NEI 12-07, to provide more specific criteria for judging acceptance. All observations that were not immediately judged as acceptable were entered into the site's Corrective Action Program (CAP) where an evaluation of the observation can be made.

As described in Section 4 b, Quad Cities Station's flood protection strategy against external flooding is governed by a flood emergency procedure. The flood emergency procedure invokes other procedures and actions intended to safely shut down the reactor, initiate reactor disassembly, and provide make-up cooling during the design-basis flood when other cooling systems are not operational. The evaluation of the flood emergency procedure was performed in accordance with NEI 12-07 guidelines using the acceptance criteria developed prior to the execution of the walkdown. Due to the complexity of the flood emergency procedure, the evaluation of its effectiveness was performed by first evaluating all procedural steps, actions and associated procedures individually. This was followed by identification of critical path items and desktop evaluation of the procedure as a whole. The individual procedural steps, actions, and associated procedures were drilled or simulated during the walkdown to verify that the actions can be completed in the credited time and to estimate the manpower resources required to complete each task or procedure.

The desktop evaluation of the flood emergency procedure included evaluation of available resources based on past staffing logs and estimates of staff available to respond to emergency. All of these resources and times were obtained from appropriate site personnel that were involved in the simulations/evaluations/ drills. This section is summarized into the following sub-sections:

1. Field evaluation of Flood Emergency Procedure – an evaluation of effectiveness of procedural steps, actions, and associated procedures based on reasonable simulations/drills. Times stated for performing each procedure or procedural step were based on the actual performance of the drill/exercise or, in case of simulations that were performed in the past, on past records. For routine tasks that do not require performance times to be recorded (e.g., scaffold erection) the estimates were provided by the staff responsible for execution of the task/procedure.
2. Desktop evaluation of Flood Emergency Procedure – an identification of critical path items and an evaluation of overall effectiveness of the entire flood emergency procedure.
3. Evaluation of Incorporated Passive Barriers – an evaluation of below-grade walls and slabs against ground water ingress.
4. Site Topography – evaluation of site topography (i.e., contours, slopes, grades, imperviousness, structures, fences, etc.) against that assumed in the UFSAR site drainage evaluation.

<u>FIELD EVALUATION OF FLOOD EMERGENCY PROCEDURE (QCOA 0010-16)</u>

Flood Forecast/Flood Warning

- Flood forecast and the ability to provide a sufficient flood warning are two critical components of the flood emergency procedure. The flood emergency procedure requires that the Shift Operations Supervisor monitor the weather and flood forecast using available sources such as the National Weather Service (NWS) - Chicago Office, US Army Corps of Engineers, and Exelon's internal weather monitoring system. The flood emergency procedure goes into effect when the actual river level exceeds elevation 586 ft MSL, as monitored by the gauge at the plant intake bay, or is predicted to exceed elevation 594 ft MSL in less than 72 hours.

  Monitoring of river levels at the plant intake bay is performed during the day shift by an Environmental Chemist or other assigned staff. Once a flood emergency is declared, a flood watch is established and river levels are monitored every two (2) hours to determine the rate of rise. In addition, the NWS website provides continuous monitoring of actual river stages at 10-minute increments for a river gauge located 5 miles upstream at Camanche, Iowa.

- Manpower resources required for implementation of this task are as following:

	Type of Resources	Required Quantity of Resources	Duration of Resources Required to Perform Task
1)	Environmental Chemist or Other Available Staff	1	Daily Monitoring of Flood Levels (increases to every two (2) hours following a flood emergency)
2)	Shift Operations Supervisor	1	Continuous monitoring of flood & weather forecast

- The AMEC Team interviewed the Shift Operations Supervisor to evaluate whether the plant staff are knowledgeable of procedural steps related to flood warning and flood watch and whether the plant will have the ability to receive sufficient flood warning to allow for successful implementation of the flood emergency procedure. Based on AMEC's evaluation, the site has resources and ability to monitor actual and predicted river levels as described in the flood emergency procedure. The site would mostly rely on the NWS website and the flood predicting gauge at Camanche, which provides a reasonable prediction of flooding conditions at the site.

- The procedural steps related to flood forecast and flood warning can be implemented successfully by the plant staff. The Shift Operations Supervisor interviewed during the walkdown was knowledgeable of the procedure and was able to perform the required actions as written.

Mobile Make-up Demineralizer System (QCOP 4300-08)

- Section D.4 requires placing the Mobile Makeup Demineralizer System in operation per QCOP 4300-08 to fill Contaminated Condensate Storage Tanks (CCSTs) and provide additional water as required. This step will be initiated immediately when actual river level exceeds elevation 586 ft MSL or water level is predicted to be greater than elevation 594 ft MSL within 72 hours. This is a standard operating procedure that is executed on a regular basis.

- Manpower resources required for implementation of this task are as follows:

	Type of Resources	Required Quantity of Resources	Duration of Resources Required to Perform Task
1)	Unit Supervisor	1	**1 hour 40 minutes**
2)	Equipment Operator	1	**1 hour 40 minutes**
3)	Chemistry Personnel	1	**1 hour 40 minutes**

- The Operations staff was able to successfully simulate the procedural step as written with no conflicts/issues.

- Based on the reasonable simulation, the evaluated procedural step can be performed successfully per Section D.4. The Operations staff showed sufficient knowledge and ability to perform this step in the procedure.

Moving and Staging of Portable Pump

- The portable make-up pump (Darley Model HE20V) is used to provide make-up water evaporated from the reactors and the storage pools throughout the course of the flood. River water is used as a source for make-up water once the plant is flooded and the plant's main cooling systems are disabled. The pump and the suction hoses are located in the Protected Area Warehouse. The fire hoses, which are used to convey river water into the storage pools, are stored in the C-Van west of the Fire Fighting Training Building. The pump is initially set up at plant grade elevation near a storm drain manhole located 25 ft southeast of the 1/2 trackway outer door. The procedure states that make-up water would be first drawn from the storm drain manhole as river levels increase and river water backflows through the storm drain system. Once the flood waters rise above plant grade elevation, the pump is moved inside the reactor building and set up on the 1/2 trackway stairwell or at a location that would remain within the limitations of the pumping criteria (i.e., maximum 5-ft suction and available discharge head). A scaffold would also be erected to provide an alternate location for staging the pump.

- Manpower resources required for implementation of this task are as following:

	Type of Resources	Required Quantity of Resources	Duration of Resources Required to Perform Task
1)	Equipment Operators	4	**3 hours**
2)	Operations Supervisor	1	**3 hours**
3)	Mechanical Maintenance	4	**3 hours 20 minutes**

- The AMEC Team observed a drill of this procedural step, which included connecting two suction hoses and one fire hose to the portable pump in the Protected Area Warehouse to verify that the hoses can be connected as written. The hoses were disconnected before the portable make-up pump was transported inside the reactor building. The Operation staff indicated where the make-up pump would be staged and showed the path through which the hoses would be routed to the storage pools. The AMEC team did not observe any obstructions that would prevent the hoses from being routed as specified. The Mechanical Maintenance staff was interviewed to estimate the time to erect the scaffolding, as specified in the procedure.

  The site has a sufficient supply of gasoline for the operation of the make-up pump. Dedicated fuel for the operation of the make-up pump is stored in five (5) 5-gallon containers in the Storeroom. The plant has significant reserves of gasoline, which are stored in an on-site storage tank outside the protected area. In case of a flood emergency, the plant staff would ensure that additional gasoline supplies are available for the operation of the pump.

  During the visual inspection, it was observed that the fuel line leading to the fuel tank was damaged and could not be connected to the tank. However, the Operations staff was able to replace the damaged hose within 30 minutes. All other components, including hoses and fittings, were in good condition.

- Based on the observed drills/exercises and reasonable simulations, the Moving and Staging of Portable Pump procedural step, including the erection of scaffolding, can be performed as specified. The Operations staff performed drills/exercises or procedure walk-throughs and demonstrated that they have a good understanding of the procedure and can perform the tasks as specified. The manpower resources required to perform the procedure were determined to be adequate.

Normal Unit Shutdown (QCGP 2-1)

- QCGP 2-1, Normal Unit Shutdown, is a procedure that is initiated when the river level is predicted to reach elevation 594 ft MSL within 72 hours. This is a standard operating procedure that is performed on a regular basis and, therefore, only a desktop review of the procedure was performed to evaluate the timing and resources needed for its execution.

- Manpower resources required for implementation of this task are as follows:

	Type of Resources	Required Quantity of Resources	Duration of Resources Required to Perform Task
1)	Senior Reactor Operator	2	**14 hours 5 minutes**
2)	Reactor Operator	2	**14 hours 5 minutes**
3)	Equipment Operator	4	**14 hours 5 minutes**

- The Operation staff presented operator logs, outage schedules and refuel logs to support the determination whether Normal Unit Shutdown (QCGP 2-1) can be performed in the credited time. Operator and outage logs from the last four refueling outages (Q1R20, Q2R20, Q1R21, and Q2R21) were reviewed and the slowest performance time was used from Q2R21 for the evaluation of the flood emergency procedure. The procedure will not be challenged by flooding conditions since it is performed from the control room before flood waters inundate the site.

- Based on the provided operator logs, outage schedules, and refuel logs, Normal Unit Shutdown can be performed in the credited time.

Reactor Disassembly (MA-AB-756-600)

- MA-AB-756-600, Rector Disassembly, is a standard operating procedure performed during every refueling outage. According to the flood emergency procedure (rev. 16), reactor disassembly would be initiated following a load decrease of Units 1 and 2 to subcritical during shutdown when the predicted flood crest exceeds elevation 594 ft MSL in less than 72 hours or when the actual river levels are above elevation 594 ft MSL[1]. The review of the procedure included a desktop evaluation and a reasonable simulation/interview conducted with the Reactor Services Manager to evaluate the timing, lay down areas, and resources needed for the execution of the procedure, and to verify that a concurrent disassembly of both reactor units can be accomplished. The flood emergency procedure specifically calls for removal of shield plugs from the reactor cavities, drywell heads, and reactor vessel heads of Unit 1 and 2.

[1] The revision of the flood emergency procedure in place at the time of the walkdown(Revision 16) incorrectly stated that reactor disassembly could be initiated as late as when water levels are above elevation 594 ft MSL. The statement has been aligned with the guidance in the "Symptoms" section of the procedure such that elevation 586 ft MSL is used instead. The issue was addressed by IR 01420885.

- Manpower resources required for implementation of this task[2]:

	Type of Resources	Required Quantity of Resources	Duration of Resources Required to Perform Task
1)	Senior Reactor Operator	1	**58 hours**
2)	Reactor Operator	1	**58 hours**
3)	Equipment Operator	2	**2 hours**
4)	Instrument Maintenance	2	**4 hours**
5)	Mechanical Maintenance Staff (interchangeable with Boiler Makers)	30	**58 hours**
6)	Mechanical Maintenance Supervisor	4	**58 hours**
7)	Laborers	8	**58 hours**
8)	Vendor Representative (PAR)	2	**58 hours**
9)	Vendor Representative (Simmers Crane)	2	**58 hours**
10)	Vendor Representative (BIACH)	2	**20 hours**
11)	Boiler Makers (interchangeable with Mechanical Maintenance Staff)	32	**58 hours**
12)	Reactor Services (Floor Manager)	2	**63 hours**
13)	Reactor Services (Tech Director)	4	**63 hours**
14)	Reactor Services (Project Manager)	2	**63 hours**
15)	Reactor Services (Fuel Handlers)	12[3] (if needed)	**58 hours**

- The Reactor Services Manager presented a detailed schedule for disassembly of both units. The schedule included a sequence of individual tasks and a time required for completion of the tasks. The duration of each task was estimated based on the previous refueling outages and the respective operator and outage logs (Q1R20, Q2R20, Q1R21, Q2R21) with Reactor Services Manager's input. AMEC thoroughly reviewed the presented sequence and timing to verify that the sequence can be accomplished and that the duration of each task can be verified by operator and outage logs. AMEC also reviewed refueling floor drawings to ensure that lay down areas are

[2] Manpower resource requirements were based on previous performances during outages, as presented by the Reactor Services Manager during the reasonable simulation/procedure walk-through.
[3] Reactor Services (Fuel Handlers) are not required for execution of the procedure; however, they would be available to provide additional assistance during reactor disassembly.

available for disassembled reactor components. The time duration and the sequence of individual tasks, including the preceding and subsequent tasks, are provided in Table 2 below.

Table 2: Reactor Disassembly Duration

<table>
<tr><th>Duration (Hours)</th><th colspan="2">Action</th></tr>
<tr><td>9</td><td colspan="2">Load Decrease per QCGP 2-1</td></tr>
<tr><td>8</td><td colspan="2">Remove Cavity Shield Blocks (U1 & U2)</td></tr>
<tr><td>5</td><td colspan="2">Dryer Separator Pit Blocks (U1 & U2)</td></tr>
<tr><td>5</td><td colspan="2">Fuel Pool Slot Blocks (U1 & U2)</td></tr>
<tr><td>1.5</td><td colspan="2">Stairs (U1)</td></tr>
<tr><td>1.5</td><td colspan="2">Cavity Ladder Cage (U2)</td></tr>
<tr><td>3</td><td colspan="2">Drywell Head Bolts (U1 & U2)</td></tr>
<tr><td>3</td><td colspan="2">Drywell Head Removal (U1 & U2)</td></tr>
<tr><td>3</td><td colspan="2">Loosen Head Vent Piping (U1 & U2)</td></tr>
<tr><td>3</td><td colspan="2">Remove Piping (U1 & U2)</td></tr>
<tr><td>4</td><td colspan="2">Remove Insulation (U1 & U2)</td></tr>
<tr><td>1.5</td><td colspan="2">Carousel (U1)</td></tr>
<tr><td>3</td><td colspan="2">De-tension Head (U1)</td></tr>
<tr><td>3</td><td colspan="2">Remove Nuts (U1)</td></tr>
<tr><td>1.5</td><td colspan="2">Carousel Off (U1) Unload Nuts</td></tr>
<tr><td>1.5</td><td colspan="2">Carousel (U2)</td></tr>
<tr><td>1.5</td><td>Rx Head Strongback (U1)</td><td rowspan="4">In Parallel (critical path 6 hours)</td></tr>
<tr><td>2</td><td>Remove RX Head (U1)</td></tr>
<tr><td>3</td><td>De-tension Head (U2)</td></tr>
<tr><td>3</td><td>Remove Nuts (U2)</td></tr>
<tr><td>1</td><td colspan="2">Carousel Off (U2)</td></tr>
<tr><td>1.5</td><td colspan="2">Rx Head Strongback</td></tr>
<tr><td>2</td><td colspan="2">Remove RX Head (U2)</td></tr>
<tr><td>1.5</td><td colspan="2">Flood Cavity & Dryer Separator Pools</td></tr>
<tr><td>3</td><td colspan="2">Remove Fuel Pool Gates (U1 & U2)</td></tr>
<tr><td></td><td colspan="2"></td></tr>
<tr><td>71.5</td><td colspan="2">Total</td></tr>
</table>

The times provided in Table 2 allow for a small margin of error in each step, should minor staffing or execution issues arise in the event of an external flood. Each disassembled part of the reactor has its own specific location to be staged. These locations are shown in drawing M-7, General Arrangement Reactor Floor Plan.

After reviewing the dimensions of the disassembled parts and lay down areas on the reactor refuel floor, AMEC confirmed that lay down areas are sufficient for staging of disassembled parts of both reactor units. As a general note, the majority of all equipment and tools being used are located on the refuel floor and stored in the dryer/steam separator pits. Furthermore, there is an adequate supply of tools for a dual Unit disassembly. This allows for easy access and short preparation time.

- Based on the reviewed information, including outage and operator logs, drawings, and reasonable simulation/procedure walk-through with the Reactor Services Manager, the reactor disassembly can be performed in the credited time before flood levels reach elevation 594 ft MSL. Since the lay down areas are located above the design-basis flood elevation, they would not be impacted or reduced by flooding. However, the Reactor Disassembly procedure does not provide specific guidance and sequence for concurrent disassembly of both reactor units during the flood emergency. Given the time duration required for reactor disassembly and a 72-hour advanced flood warning, as specified in the flood emergency procedure, it is critical that the Reactor Disassembly procedure be implemented as efficiently as possible.

Seal the Emergency Diesel Generator (EDG) Fuel Oil Storage Tank Vent

- Section D.11.a states when flood levels are predicted to remain greater than elevation 594 ft MSL, the site will seal EDG fuel oil storage tank vents with Permagum and plastic bags with tie-wraps.

- Manpower resources required for implementation of this task are as follows:

	Type of Resources	Required Quantity of Resources	Duration of Resources Required to Perform Task
1)	Equipment Operator	1	**30 minutes**

- The Operations staff was able to successfully simulate the procedural step as written with no conflicts/issues.

- Based on the reasonable simulation, the evaluated procedural step can performed successfully per Section D.11.a. The Operations staff showed sufficient knowledge of the action being performed.

Place Drywell Loads in Pull-To-Lock

- Section D.11.b requires that the drywell coolers, drywell equipment and the floor drain sump pumps loads be placed in Pull-To-Lock (PTL). This means that the loads will be de-energized, which is scheduled to occur if the river level predicted flood crest remains greater than elevation 594 ft MSL. This part of the procedure is completed in the Control Room.

- Manpower resources required for implementation of this task are as follows:

	Type of Resources	Required Quantity of Resources	Duration of Resources Required to Perform Task
1)	Reactor Operator	1	**10 minutes**

- The Shift Operations Supervisor demonstrated the knowledge of the procedural step and the ability to successfully perform the procedural step as written. As a result, no conflicts/issues were found.

- Based on the reasonable simulation, the evaluated procedural step can be performed successfully per Section D.11.b. The Shift Operations Supervisor showed sufficient knowledge of the action needed to be performed.

Add Water to Tori/Drywells through the Residual Heat Removal (RHR) System Test Lines

- Section D.11.c & d requires water to be added to the tori through the RHR system test lines per QCOP 4100-11. The water will be added until the tori are filled completely and then the drywells will be filled to a level attained when the tori are full. This step will be initiated if the predicted flood crest remains greater than elevation 594 ft MSL. A reasonable simulation of the procedure was performed to evaluate whether the Operations staff can perform the procedure, as written.

- Manpower resources required for implementation of this task are as follows:

	Type of Resources	Required Quantity of Resources	Duration of Resources Required to Perform Task
1)	Equipment Operators	3	**9.8 hours**
2)	Reactor Operator	1	**9.8 hours**

- The Shift Operations Supervisor was able to successfully demonstrate via detailed discussion that the procedural steps can be performed as written and no conflicts/issues were found. The process of filling the tori is specified in procedure QCOP 4100-11 section F.3. The task will be performed in parallel with Reactor Disassembly. The estimated time to perform the task is the time duration for all necessary preparations, Fire Water Supply System (FWSS) connection to the RHR system, filling the tori and filling the drywells. Since this is an abnormal procedure, Calculation No: QDC-1000-M-0847 Rev. 1 was used as a reference for the time duration of the task. Based on the volume of the tori and drywells and injection rate of 2,000 gpm, as presented in the calculation, it would take 9.3 hours to completely fill the tori and drywells. The calculation did not take into account the necessary preparations and connecting the FWSS to the RHR system, which were estimated to be 0.5 hours. The Operations staff also identified the valves that need to be closed/opened as part of the execution of the procedure and hoses and fittings used to connect to the fire header.

- Based on the reasonable simulation, the evaluated procedural step can be performed successfully per Section D.11.c & d. The Operations staff showed sufficient knowledge of the action needed to be performed.

Filling the Reactor Cavities and Dryer-separator Pools

- Section D.11.e & f requires water to be added to the reactor cavities and the dryer-separator pools using the core spray system with suction from the CCSTs per QCOP 0201-06 and using the FWSS per QCOP 4100-11. This step will be initiated if the predicted flood crest remains greater than elevation 594 ft MSL. A reasonable simulation of the procedure was performed to evaluate the timing and resources needed for the execution of the procedure.

- Manpower resources required for implementation of this task are as follows:

	Type of Resources	Required Quantity of Resources	Duration of Resources Required to Perform Task
1)	Equipment Operator	1	**3 hours 15 minutes**
2)	Reactor Operator	1	**3 hours 15 minutes**
3)	Instrument Maintenance	2	**3 hours 15 minutes**

- The Shift Operations Supervisor was able to successfully demonstrate via detailed discussion and procedure walk-through that the procedural steps can be performed as written. As a result, no conflicts/issues were found. The process will be done in parallel with Reactor Disassembly. The estimated time to perform the task is the time duration for all necessary preparations, filling the reactor cavities and the dryer-separator pools using suction from the CCSTs and then if/when the CCSTs have been emptied, using the fire suppression system, as needed. The task can be initiated before the reactor heads are removed, reducing the duration of this task on the reactor disassembly critical path to 1.5 hours. It should be noted that this is not a typical process for filling the reactor cavities and dryer-separator pools and, therefore, it has not been performed in the past. However, Calculation No: QDC-1000-M-0847 Rev. 1 demonstrated that the actual filling of reactor cavities and dryer-separator pools would take approximately 1.3 hours.

- Based on the reasonable simulation, the evaluated procedural step can be performed successfully per Section D.11.e & f. The Shift Operation Supervisor showed sufficient knowledge of the action needed to be performed.

Filling Radwaste Tanks Using the Fire System

- Section D.11.g requires that all radwaste tanks be filled using river water from the fire suppression system to prevent uplift and possible damage that could result in the spread of contaminated water. This will occur when the river level predicted flood crest remains greater than elevation 594 ft MSL.

- Manpower resources required for implementation of this task are as follows:

	Type of Resources	Required Quantity of Resources	Duration of Resources Required to Perform Task
1)	Equipment Operator	3	**12 hours 20 minutes**
2)	Radiation Technician	1	**12 hours 20 minutes**

- The Operations staff demonstrated adequate knowledge of the procedural step and the ability to successfully perform the procedural step as written. There are 27 radwaste tanks located at Quad Cities Station. While the flood emergency procedure calls for filling of all radwaste tanks, only 22 of the radwaste are located at or below the PMF elevation of 603 ft MSL. There are 5 additional tanks that are located at an approximate elevation of 620 ft MSL and would not need to be filled. The volume of the radwaste tanks ranges from 1,000 gallons to 200,000 gallons. Based on the reasonable simulation, which included a procedure walk-through, the time duration to fill the tanks will vary between 5 minutes to 12 hours, depending on the size of each tank. The estimated time to perform the task is the time duration for all necessary preparations and the filling of all tanks starting with the largest one. The Equipment Operator identified each tank and described how the tanks would be filled by opening the inspection hatches on the tanks and using the local fire hose stations. Several radwaste tanks would be filled using the domestic water in shower drains located directly above one of the tanks and using the condensate transfer system.

- Based on the reasonable simulation, the evaluated procedural step can be performed successfully per Section D.11.g. The Operations staff showed sufficient knowledge and the ability to successfully execute the task.

De-energizing Station Loads for a Flood Emergency

- Attachment E (QCOA 0010-16 - Flood Emergency Procedure) requires that all station loads be de-energized for a flood emergency when the river level is predicted to be greater than elevation 594 ft MSL and following the completion of all remaining procedural steps, before the plant doors are opened. The execution of the procedure requires a Control Room action, as well actions performed in the field.

- Manpower resources required for implementation of this task are as follows:

	Type of Resources	Required Quantity of Resources	Duration of Resources Required to Perform Task
1)	Reactor Operator	1	**30 minutes**
2)	Equipment Operator	2	**30 minutes**

- The Shift Operations Supervisor demonstrated the knowledge of the procedural step and the ability to successfully perform the procedural step as written. As a result, no conflicts/issues were found.

- Based on the reasonable simulation, the evaluated procedural step can be performed successfully per Attachment E (QCOA 0010-16 - Flood Emergency Procedure) and the Shift Operations Supervisor showed sufficient knowledge of the action needed to be performed.

Open Plant Doors

- Step D.11.k calls for the opening of plant interior and exterior doors to permit the free flow of water through the plant when the water is within one foot of the plant's grade elevation. This action is intended to allow for the floodwaters to evenly fill the plant and equalize the pressure on building walls.

- Manpower resources required for implementation of this task are as following:

	Type of Resources	Required Quantity of Resources	Duration of Resources Required to Perform Task
1)	Equipment Operator	2 teams of 2	**1.5 hours**

- A reasonable simulation of the opening the plant interior and exterior doors involved a visual inspection of a representative sample of interior and exterior doors led by Operations staff. The time duration to open and secure all doors was based on previous performance.

  The inspected doors were in good condition and did not show signs that they would malfunction during a flood event. The procedure does not specify how the doors would be secured to remain opened; however, the Operator demonstrated how the doors would be secured.

- Based on the reasonable simulation, all plant doors can be opened and secured during a flooding event, as specified.

DESKTOP EVALUATION OF FLOOD EMERGENCY PROCEDURE (QCOA 0010-16)

Following the completion of reasonable simulations and evaluation of individual procedural steps and actions, AMEC performed a desktop evaluation of the flood emergency procedure. During the desktop evaluation, timing and resource data obtained during the walkdown were analyzed and compiled together. The major emphasis of the desktop evaluation focused on answering the following questions:

1. Are required resources available during overlapping tasks?
2. Is there a sufficient flood warning available to allow for safe reactor shutdown and staging of the diesel-driven emergency make-up pump and the associated components and consumables?
3. Are consumables available for the entire durations of the design basis flood?
4. Can the flood emergency procedure be performed under adverse weather conditions or if there is a loss of off-site power?

Availability of Resources

Actual staffing logs, Emergency Preparedness (EP) Dialogics Database, and interviews with Operations staff were used to determine whether sufficient resources are available to implement the entire flood emergency procedure. The staffing at Quad Cities Station is at its minimum levels during weekend shifts, when only eighteen (18) Operations staff would be available to immediately respond to emergency. The remaining staff would report to the plant, based on their Emergency Classification Level, and following the procedure for emergency response. Initially, the Emergency Response Organization (ERO) would be staffed based on the ERO staffing response requirements. The ERO would initiate calls to all available staff to report to duty. The Station's emergency procedures do not specify response times for staff other than the ERO; however, it is reasonable to use a conservative assumption that the staff needed for implementation of the procedure would report to duty within 4 hours after the emergency has been declared. To quantify the number of staff available for implementation of the procedure, the following assumptions were used:

1. Response time less than one hour – 10% of all available personnel.
2. Response time less than four hours – additional 70% (80% total) of all available personnel.
3. Unable to respond to an emergency due to adverse weather conditions or due to other reasons – 20% of all available personnel.

A summary of available staff, based on the above-mentioned assumptions, and the staffing logs is presented in Table 3 below. The lowest staffing levels, i.e. weekend shifts, were used to determine the actual number of staff available to immediately respond to a flood emergency. As indicated in the evaluation of the Reactor Disassembly tasks, Reactor Services and outside vendors are typically involved in reactor disassembly during refueling outage. Response time requirements for Reactor Services staff are not available; however, based on the reasonable evaluation with Reactor Services Manager it was determined that at minimum eight (8) Reactor Services staff would be available to report to duty within one hour. The remaining twelve (12) staff would be able to respond to duty within 4 hours. Response time for outside vendors will likely be longer than for Exelon staff, but the 9-hour lag between the initiation of unit shutdown and reactor disassembly would provide sufficient time to arrange for transport of outside vendors to site.

Table 3: Personnel Available to Respond to Emergency

Source - EP Dialogics Database			Response Time		
Group	Number	Total	<1 hr	<4 hrs	Unable to Respond
Mechanical Maintenance (craft)	64	184	7	45	12
Mechanical Maintenance (supervisors)	9		1	7	1
Electrical Maintenance (craft)	34		4	24	6
Electrical Maintenance (supervisors)	7		1	5	1
Instrument Maintenance (craft)	33		4	24	5
Instrument Maintenance (supervisors)	6		1	5	0
Radiation Protection (craft)	26		3	19	4
Radiation Protection (supervisors)	5		1	4	0

Source - EP Dialogics Database			Response Time		
Normal on-shift staffing	Number	Total	<1 hr	<4 hrs	Unable to Respond
Senior Reactor Operators	5	18	Always on site		
Reactor Operators	4				
Equipment Operators	9				

Off-shift personnel available for short notice call-out (estimate based on general work-hour rules and normal department staffing			Response Time		
Off-shift personnel	Number	Total	<1 hr	<4 hrs	Unable to Respond
Senior Reactor Operators	20	75	2	14	4
Reactor Operators	25		3	18	4
Equipment Operators	30		3	21	6

Table 4 provides a summary of manpower resources needed for implementation of the early procedural tasks (i.e., unit shutdown and moving and staging of the portable pump), as specified in the procedure. The subsequent tasks are initiated at later stages. The evaluation of resources availability for implementation of the procedure was performed using a Gantt chart and is not provided as part of this report.

Table 4: Resource Utilization based on Availability (Early Procedural Tasks)

	Response Time					
	< 1 hr			< 4 hr		
	Available	Utilized	Delta	Available	Utilized	Delta
Mechanical Maintenance (craft)	7	-	7	52	4	48
Mechanical Maintenance (supervisors)	1	-	1	8	-	8
Senior Reactor Operators	7	2	5	26	4	22
Reactor Operators	7	2	5	25	-	25
Equipment Operators	12	4	8	30	9	21

The flood emergency procedure would be initiated by the Shift Manager, who would coordinate with Unit Supervisors and determine the actions needed to be performed immediately. The Shift Manager would also determine whether conditions of an Emergency Action Level are met and declare Emergency Classification Level, as appropriate. Depending on the Emergency Classification Level, the Emergency Response Organization would be activated to coordinate emergency activities on site.

Flood Warning

As described previously, successful implementation and execution of the flood emergency procedure is dependent on early flood warning. Accurate flood predictions for the Mississippi River are provided by the NWS and are available online. The closest flood predicting gauge is located approximately five (5) miles upstream at Camanche, Iowa. The gauge forecasts river levels for up to six (6) days in advance and takes into account past precipitation and the precipitation amounts expected approximately 24 hours into the future from the forecast issuance time. Additional gauges with river forecasting capabilities are located in Clinton and LeClaire, Iowa. These gauges would allow the site to predict the applicable flood hazard, as written in the flood emergency procedure. Furthermore, it is expected that additional advanced river forecasts would be provided by the USACE during a flood of this magnitude.

Availability of Consumables

The plant has a sufficient supply of gasoline for operation of the make-up pump during the flood emergency. Approximately twenty-five (25) gallons of fuel are stored in the Storeroom. If needed, additional gasoline from on-site tanks could be transferred into portable containers and transported to the reactor building where the make-up pump will be staged.

Evaluation of Overall Effectiveness of the Flood Emergency Procedure

The overall effectiveness of the flood emergency procedure is dependent on a 72-hour flood warning when river levels are predicted to exceed plant grade elevation of 594 ft MSL. Based on the evaluation of the flood emergency procedure, the critical path items for successful execution of the procedure are the shutdown and the subsequent disassembly of both reactors. The reactor disassembly procedure requires a significant number of staff and can, at the earliest, be initiated 72 minutes after the reactor has entered subcritical mode (conservatively 9 hours after load decrease begins at 150 MW/hr following the unit shutdown). Disassembly of both reactors, including flooding of reactor cavities and dryer separator pools, would be completed 71.5 hours after the shutdown of both reactors has been initiated. The procedure would be fully implemented before flood waters reach plant grade, to ensure that both reactors can be maintained in a safe condition when safety-related equipment is inoperable. Since both reactors would be shut down and cooled for three days prior to flooding of the plant, decay heat would be reduced to a level that can be removed by natural circulation cooling between the reactor and the reactor cavities and storage pools. Additionally, it is anticipated that a flood exceeding plant grade elevation would be predicted well in advance, and the site would have a longer than the 72-hour flood warning stated in the flood emergency procedure. For the purpose of the evaluation, the more conservative assumption of 72-hour flood warning was used.

The remaining procedural steps can be accomplished efficiently (as described earlier in this section) and in parallel with reactor disassembly. The sequence of the procedural steps allows for proper staffing with available resources. The reactor disassembly requires the largest number of staff and vendors. While exact emergency response times for vendors could not be verified, based upon the staffing evaluation above, it was determined that the 9-hour lag between the unit shutdown and the initiation of reactor disassembly would provide sufficient time to ensure that vendors or alternate staff are on site and available to perform their duties.

Adverse weather conditions (e.g., high winds, localized flooding, and freezing temperatures) can be expected during the execution of the flood emergency procedure. However, the majority of the procedural steps would likely not be affected by these conditions, since they are performed from the control room or inside. For procedural steps performed outside, site conditions were evaluated to determine whether adverse weather conditions could delay the completion of the task. The task most likely to be affected by adverse weather conditions is the initial staging of the make-up pump outside the reactor building and the transport of hoses from the C-Van to the protected area. These tasks are initiated early enough in the execution of the procedure to provide an additional margin of safety, with respect to adverse weather conditions. In case of loss of off-site power, Emergency Diesel Generators would be used to power the equipment and systems required for the execution of the flood emergency procedure.

The flood emergency procedure does not specifically state modes of operation for which the procedure is applicable. For evaluation of the PMF, full power mode operation was considered the most critical plant failure mode. This mode would require the highest number of resources and the longest duration. During other modes of operation, e.g. refueling outage, additional manpower resources would be available to assist with implementation of the procedure. The implementation of the procedure during other modes of operation would not require additional equipment to mitigate the effects of an external flood and the Station would be able to use the same equipment as during full power mode operation.

EVALUATION OF INCORPORATED PASSIVE BARRIERS

The exterior below-grade structures of reactor and turbine buildings were included on the walkdown list as incorporated passive barriers. The structures were evaluated for their effectiveness to prevent groundwater ingress and withstand potential hydrostatic loads associated with extreme groundwater conditions. The penetrations through the exterior walls were also inspected as part of the visual inspection of the walls and basement slabs. The penetrations and the associated seals were, however, not treated as separate features and were recorded as observations associated with the Walkdown Record Form for the wall or slab feature.

The following acceptance criteria were used for visual inspections of below-grade walls and penetrations seals:

Below–Grade Walls / Basement Floor Slabs

- No signs of degradation of structural members.
- No significant surface cracks.
- No signs of significant degradation.
- No significant spalling, scaling, or cracking of concrete surfaces

Penetrations / Seals:

- No indication of degradation that would allow flood waters to penetrate into the flood protected area. Conditions that should be recorded include (but are not limited to) damage, undocumented openings or holes (such as those due to abandoned equipment), etc.
- Visible penetrations are sealed with no visible gaps.
- Penetration sleeves, link seals, piping, and conduit should have an absence of corrosion on the exposed steel surface.
- Conduit seal material should have an absence of water stains below the penetrations.
- Material should appear to be as indicated in plant documents and in generally good condition.

Based on the visual inspection, the condition of below-grade walls and floor slabs of Unit 1 and Unit 2 Reactor Buildings and Unit 1 and Unit 2 Turbine Buildings, including penetrations/seals, were considered acceptable. The features would be able to withstand hydrostatic loads associated with potential extreme groundwater conditions and keep the below-grade areas dry.

The majority of the below-grade walls were inspected by the walkdown team and determined to be in acceptable condition. A relatively small portion of torus walls were designated by the walkdown team to be inaccessible and were not inspected during the walkdown. Reasonable assurance that the walls can provide their intended flood protection function was based on a visual inspection of the remainder of torus walls and the absence of non-conforming or degraded conditions of the representative sample.

As part of the evaluation of incorporated passive barriers, electrical drawings were reviewed to determine whether electrical conduits entering the building below grade could become pathway for groundwater ingress. There are several locations on the western side of the turbine building where electrical conduits connected to electrical manholes or handholes penetrate through the exterior Turbine Buildings' walls. The conduits were not visible during the walkdown and were considered inaccessible, due to junction boxes or other obstructions preventing visual inspection of the features. Reasonable assurance that the conduits will not become pathway for groundwater was provided by visual inspection of the wall features and the absence of evidence of past and current groundwater seepage. According to Station's electrical drawings, all conduits passing through concrete walls were grouted in place using non-shrinkable grout product and sealed by design. In addition, all below-grade safety-related SSCs in the Turbine Buildings are located in watertight vaults providing protection from flooding. The penetrations through the watertight vaults are periodically tested per procedure, any small conduits which are not tested per procedure have been evaluated by engineering and have been determined not to affect the functionality of the safety related equipment and, therefore, the walkdown team determined that visual inspection of electrical manholes/handholes was unnecessary.

SITE TOPOGRAPHY

Evaluation of site topography was not included in the scope of the walkdown, since an LIP analysis was not considered part of the UFSAR. The site is allowed to be flooded during the design-basis flood and any potential changes to topography since the completion of the construction would not have a negative effect on flood mitigation strategy.

e. Requested Information Item 2(e) – Implementation of Walkdown Process

Present information related to the implementation of the walkdown process (e.g., details of selection of the walkdown team and procedures) using the documentation template discussed in Requested Information Item 1.j [in Enclosure 4 of the March 12, 2012, 50.54(f) letter], including actions taken in response to the peer review.

The members of the walkdown team were carefully selected to ensure that the team includes individuals who are experienced in conducting visual inspections of plant structures, systems and components and flood protection features. The team for Quad Cities Station included two Water Resources Engineers, an Electrical Engineer, and a Structural Engineer. Both water resources engineers are flooding specialists and have significant experience with inspections and evaluations of flood protection features. The remaining two engineers are employees of AMEC's Nuclear Services division and are experienced in conducting visual inspection of plant SSCs.

Each member of the team completed Exelon's Walkdown Training, Nuclear Generation Employee Training (NGET), and NANTeL's generic verification walkdowns of plant flood protection features course, including passing the NANTeL exam based on NEI 12-07. In preparation for the walkdown, the team members became knowledgeable of the site's current licensing basis and operating procedures by thoroughly reviewing them during the first phase of the project. Where specific knowledge was necessary to inspect a flood protection feature/procedure, at least one member of the walkdown team had the ability to determine if the condition of the feature/procedure needed to be entered into the Corrective Action Program (CAP).

The approach used for implementation of the walkdown process was to break down the evaluation of the procedures and features based on staff's individual experience and expertise. All team members had a thorough understanding of the procedures and actions required to be accomplished to mitigate the design basis flood; however, AMEC's staff with relevant nuclear inspection experience focused predominately on nuclear specific tasks (e.g., Reactor Disassembly). The flooding specialists focused predominately on evaluation of flood prediction warnings and on visual inspection of penetrations and below-grade walls/slabs. The remaining reasonable simulations were divided among individuals with specific knowledge of the evaluated task/action.

A pre-job brief was performed at the beginning of each workday. The subjects discussed in the pre-job briefs included but were not limited to positive component verification, inspection methodology, acceptance criteria, field documentation requirements, reporting degraded conditions and previous walkdown lessons learned. A high-radiation pre-job brief was performed with the walkdown team and radiation protection personnel, as necessary. Subjects discussed in high-radiation pre-job briefs included but were not limited to tasks required to complete the job, time required to complete the tasks, dose rate surveys, maximum dose rates and total allowable dose.

A "camera on a stick" was used to perform visual inspection of flood protection features that were not accessible from the plant floor.

Observations captured during the walkdowns were documented using the Filed Observation Report. Walkdown Record Forms provided in Appendix B of NEI 12-07 (Rev 0-A) were completed based on the observations made during the visual inspection. Degraded or non-conforming conditions were documented using a camera, when possible.

A daily project report was generated at the end of each workday documenting the following:

- Industrial Safety/First Aid
- Radiological Information
- ALARA Information
- Production Performance
- Deficiencies Identified
- Operability Issues Identified
- General Problems
- IRs
- Items Requiring Further Review
- Lessons Learned

Observations not immediately judged as acceptable were reported to Exelon personnel immediately and entered in the CAP, as necessary.

f. Requested Information Item 2(f) – Findings and Corrective Actions Taken/Planned

Results of the walkdown including key findings and identified degraded, non-conforming, or unanalyzed conditions. Include a detailed description of the actions taken or planned to address these conditions using the guidance in Regulatory Issues Summary 2005-20, Rev 1, Revision to NRC Inspection Manual Part 9900 Technical Guidance, "Operability Conditions Adverse to Quality or Safety", including entering the condition in the corrective action program.

Observations Not Immediately Judged as Acceptable

None

Observations Designated through CAP as Deficient

None

Observations Awaiting Final Disposition in CAP

None

Features in Restricted Access Areas

None

Features in Inaccessible Areas

Penetrations/Seals

Higher areas of torus below-grade walls were inaccessible for visual inspection during the walkdown. Reasonable assurance for these areas was based on a visual inspection of a representative sample of the walls and the absence of any non-conforming or degraded conditions for the representative sample.

Seven (7) penetrations/seals were not visually inspected during the walkdown and are considered inaccessible. Reasonable assurance that these penetrations will provide their intended flood protection function was determined by review of available drawings and absence of evidence of past or current groundwater seepage below the penetration/seal. Based on the visual inspection and review of available drawings, it is reasonable to conclude that the condition of all inaccessible penetrations/seals is acceptable and would not compromise the below-grade walls' and slabs' ability to function as a flood protection barrier. Table 10 in Section 5 provides a list of all inaccessible features.

Actions Taken or Planned to Address Deficiencies

None

g. Requested Information Item 2(g) – Cliff –Edge Effects and Available Physical Margin

Document any cliff-edge effects identified and the associated basis. Indicate those that were entered into the corrective action program. Also include a detailed description of the actions taken or planned to address these effects.

Cliff-edge effects were defined in the NTTF Report (Reference 5) as "the safety consequences of a flooding event may increase sharply with a small increase in the flooding level." As indicated in Sections 3.12 of NEI 12-07 (Reference 2), the NRC is no longer expecting the Recommendation 2.3: Flooding Walkdowns to include an evaluation of cliff-edge effects. The NRC is now differentiating between cliff-edge effects, which are addressed in Enclosure 2 of Reference 3, and Available Physical Margin (APM).

As indicated in Sections 3.13 of NEI 12-07 (Reference 2), APM describes the flood margin available for applicable flood protection features at a site (not all flood protection features have APMs). The APM for each applicable flood protection feature is the difference between licensing basis flood height and the flood height at which water could affect an SSC important to safety.

APM information is not applicable to the site and was not collected during the flooding walkdown for the following reasons:

1. Quad Cities Station's SSCs, with the exception of the portable make-up pump, are allowed to be flooded during the design-basis flood event. In addition, the portable make-up pump can be staged at different elevations.
2. LIP evaluation is not included in the UFSAR and, therefore, the Station does not have any flood protection features protecting against LIP flooding.

3. Extreme groundwater conditions were not considered in the UFSAR and were assumed to be at plant grade.

h. Requested Information Item 2(h) – Planned/Newly-Installed Flood Protection Enhancements

Describe any other planned or newly installed flood protection systems or flood mitigation measures including flood barriers that further enhance the flood protection. Identify results and any subsequent actions taken in response to the peer review.

Quad Cities Station is currently investigating multiple flood protection enhancements (e.g. concurrent reactor disassembly). Upon completion of this study, the station will incorporate flood protection enhancements as determined to be necessary.

5. CONCLUSIONS

The flooding walkdown at Quad Cities Station was conducted between September 10 and September 14, 2012, and included a visual inspection of below-grade walls and the associated penetrations, a visual inspection of basement slabs, and reasonable simulations of the flood emergency procedure and the associated tasks and procedures.

A summary of the flooding walkdown results is provided in Table 5 through Table 10 below. The below grade-walls and slabs were inspected and arranged by areas or rooms for a total of twenty-five (25) features. Associated penetrations/seals were visually inspected during the walkdown; however, they were not considered individual flood protection features and only penetrations/seals not readily judged as acceptable or inaccessible penetrations/seals were listed in Table 8 and Table 10, respectively. The below-grade wall and slab features were immediately judged as acceptable and no further actions were required. For penetrations/seals considered inaccessible, reasonable assurance that these components will provide their intended flood protection function was provided by visual inspection of the walls features and review of relevant drawings. There was no evidence of past or current groundwater seepage through the penetrations/seals.

Twelve (12) reasonable simulations of the flood emergency procedure and the associated procedures (including standard shutdown procedures) were performed to ensure that they can be performed as specified and protect the reactor from core damage during flooding conditions (Table 6). The reasonable simulations included review of operator and outage logs, procedure walk-throughs, and/or drills/exercises. Based on the evaluation of reasonable simulations, the critical path items of flood emergency procedure can be implemented with available manpower resources in 71.5 hours to ensure that both units are safely shut down and reactor cooling is provided to remove decay heat. The concurrent disassembly of both reactors is, however, not clearly described in the flood emergency procedure. Additionally, the overall implementation of the procedure has a low margin of safety given the 72-hour flood warning (the implementation of critical path items requires 71.5 hours).

Table 5: Summary – Features Included in the Walkdown Scope

Feature Type	Total Number
Passive – Incorporated	25
Passive – Temporary	0
Active – Incorporated	0
Active – Temporary	0

Table 6: Reasonable Simulations

#	Description	Purpose
1	Flood Warning and Flood Watch	Provide sufficient flood warning to safely shut down both reactors and implement dependent flood emergency actions.
2	Mobile Makeup Demineralizer System	Provide additional water to the CCSTs for filling of reactor cavities/dryer separator pools
3	Moving and Staging of Darley Model HE20V Portable Pump	Provide make-up water to the fuel pool for cooling when the remaining SCCs are inoperable.
4	De-energize Station Loads	Disconnect all electrical equipment prior to flood water reaching plant grade elevation.
5	Add Water to Tori/Drywells through the RHR System Test Lines	Abnormal activity to use fire water supply system to fill tori/drywells prior to filling reactor cavities and dryer separator pools to maintain cooling temperatures.
6	Filling the Reactor Cavities and Dryer-Separator Pools	Provides a method(s) to fill reactor cavities and dryer-separator pools to the level of spent fuel pools to allow for natural circulation cooling between the reactor cavities, dryer separator pools, and the spent fuel pool.
7	Filling Radwaste Tanks using Fire System	Prevent the tanks from becoming buoyant and damaging plant equipment, and a possible release contaminated water.
8	Place Drywell Loads in PTL	Disconnect all electrical equipment prior to filling drywells
9	Seal Diesel Oil Storage Tank Vents	Prevent introduction of river water into diesel oil storage tanks.

#	Description	Purpose
10	Open Plant Doors	Allow free flow of water through plant to equalize hydrostatic pressure and prevent collapse of exterior walls.
11	Reactor Disassembly	Procedure to allow the flooding of reactor cavities/dryer separator pools and natural circulation between the reactor/cavities and spent fuel pools.
12	Normal Unit Shutdown	Procedure to shut down the reactor using control rods and subsequently allow initiation of reactor disassembly.

Table 7: List of Features Immediately Judged as Acceptable

#	Feature ID #	Description	Passive/Active Incorporated/Temporary
1	1-RB-W010	Exterior below-grade walls of 1A RHR Room	Incorporated Passive
2	1-TB-W001 1-TB-W004-001	Exterior below-grade walls of 1A Vault (Service Water Pump [SWP] 1A) Room	Incorporated Passive
3	1-RB-W001 1-RB-W002	Exterior below-grade walls of 1B Core Spray Pump Room	Incorporated Passive
4	1-RB-W012 1-RB-W013	Exterior below-grade walls of 1B RHR Room	Incorporated Passive
5	1-TB-W004-002	Exterior below-grade walls of 1B-C Vault (SWP 1B-C) Room	Incorporated Passive
6	1-TB-W004-003	Exterior below-grade walls of 1D Vault (SWP 1D) Room	Incorporated Passive
7	2-RB-W002 2-RB-W012	Exterior below-grade walls of 2A Core Spray Pump Room	Incorporated Passive
8	2-RB-W011 2-RB-W010	Exterior below-grade walls of 2A RHR Room	Incorporated Passive
9	2-TB-W002 2-TB-W001_1	Exterior below-grade walls of 2A Vault (SWP 2A) Room	Incorporated Passive

#	Feature ID #	Description	Passive/Active Incorporated/Temporary
10	2-RB-W009	Exterior below-grade walls of 2B RHR Room	Incorporated Passive
11	2-TB-W001-2	Exterior below-grade walls of 2B-C Vault (SWP 2B-C) Room	Incorporated Passive
12	2-TB-W001-3	Exterior below-grade walls of 2D Vault (SWP 2D) Room	Incorporated Passive
13	2-RB-HPCI-S 1-RB-HPCI-N	Exterior below-grade walls of High Pressure Coolant Injection (HPCI) Access Tunnel	Incorporated Passive
14	1-TB-W009 1-TB-W010 1-TB-W011	Exterior below-grade walls of U1 Condensate Booster Pump Area	Incorporated Passive
15	1-RB-W015 1-RB-W016	Exterior below-grade walls of U1 HPCI Room	Incorporated Passive
16	1-RB-TO-E 1-RB-TO-S 1-RB-TO-W	Exterior below-grade walls of U1 Torus Basement	Incorporated Passive
17	1-TB-MEZW	Exterior below-grade walls of U1 Turbine Bldg Mezzanine Level	Incorporated Passive
18	2-TB-W004 2-TB-W006 2-TB-W011	Exterior below-grade walls of U2 Condensate Booster Pump Area	Incorporated Passive
19	2-RB-W016 2-RB-W015	Exterior below-grade walls of U2 HPCI Room	Incorporated Passive
20	2-RB-TO-N 2-RB-TO-E 2-RB-TO-W	Exterior below-grade walls of U2 Torus Basement	Incorporated Passive
21	2-TB-MEZW	Exterior below-grade walls of U2 Turbine Bldg Mezzanine Level	Incorporated Passive
22	1-RB-S001	Floor slabs of U1 Reactor Building	Incorporated Passive
23	1-TB-S001	Floor slabs of U1 Turbine Building	Incorporated Passive

#	Feature ID #	Description	Passive/Active Incorporated/Temporary
24	2-RB-S001	Floor slabs of U2 Reactor Building	Incorporated Passive
25	2-TB-S002	Floor slabs of U2 Turbine Building	Incorporated Passive

Table 8: List of Features Not Immediately Judged as Acceptable

#	Feature ID #	Description	Observation	Component Operability	Resolution
N/A	N/A	N/A	N/A	N/A	N/A

Table 9: List of Features in Restricted Access Areas

#	Feature ID #	Description	Reason	Resolution
N/A	N/A	N/A	N/A	N/A

Table 10: List of Features in Inaccessible Areas

#	Feature ID #	Description	Reason	Resolution
1	7-PEN (penetration #1, drawing FL-12)	24-in diameter opening/sleeve (typical seal per drawing B-610/B-611)	Pipe shielding prevented the access to and visual inspection of the penetration.	Reasonable assurance that the component can provide its intended function was provided by absence of past or current evidence of groundwater seepage below the penetration.
2	11-PEN (penetration #1, FL-33)	20–in diameter sleeve for 12-in line (typical seal per drawing B-610/B-611)	The penetration was located high in the wall above the reactor building equipment drain tank in high rad area.	Reasonable assurance that the component can provide its intended function was provided by absence of past or current evidence of groundwater seepage below the penetration.
3	12-PEN (penetration #1; drawing FL-36)	20-in diameter opening/sleeve (typical seal per drawing B-610/B-611)	The penetration was located high in the wall above the reactor building equipment drain tank in high rad	Reasonable assurance that the component can provide its intended function was provided by absence of past or current evidence of groundwater seepage below

			area.	the penetration.
#	**Feature ID #**	**Description**	**Reason**	**Resolution**
4	14-PEN (penetration #1, drawing FL-43)	12-in diameter opening/sleeve	The penetration was not identified in the field.	N/A – no further action needed.
5	1-Pen-UI-003 (B-102, Section G-G; U1 Mezzanine Level South Wall)	8-in diameter pipe sleeve w/ 3-in by ¼-in seal ring	Visual inspection of the seal would require breaking the plane of the wall.	Reasonable assurance that the component can provide its intended function was provided by absence of past or current evidence of groundwater seepage below the penetration.
6	1-Pen-UI-004 (B-102, Section G-G; U1 Mezzanine Level South Wall)	8-in diameter pipe sleeve w/ 3-in by ¼-in seal ring	Visual inspection of the seal would require breaking the plane of the wall.	Reasonable assurance that the component can provide its intended function was provided by absence of past or current evidence of groundwater seepage below the penetration.
7	1-Pen-UI-005 (B-102, Section G-G; U1 Mezzanine Level South Wall)	6-in diameter pipe sleeve w/ 3-in by ¼-in seal ring	Visual inspection of the seal would require breaking the plane of the wall.	Reasonable assurance that the component can provide its intended function was provided by absence of past or current evidence of groundwater seepage below the penetration.

6. REFERENCES

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2. Nuclear Energy Institute (NEI), Report 12-07 (Rev 0-A). *Guidelines for Performing Verification Walkdowns of Plant Protection Features.* May 2012 [NRC endorsed May 31, 2012; updated and re-issued June 18, 2012].
3. U.S. Nuclear Regulatory Commission. Letter to Licensees. *Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3 of the Near Term Task Force Review of Insights from the Fukushima Dai-ichi Accident.* March 12, 2012.

4. U.S. Nuclear Regulatory Commission. *Demonstrating the Feasibility and Reliability of Operator Manual Actions in Response to Fire.* NUREG-1852. October 2007.
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12. MA-AB-756-600, Reactor Disassembly
13. QCOP 0201-06, Filling the Reactor Vessel / Reactor Cavity using the Core Spray System
14. QCOP 4100-11, Using Diesel Fire Pumps via Safe Shutdown Hose Line for Reactor Vessel Level Control or Flood Emergency Injection Source
15. QCOP 4300-08, Makeup Demineralizer System Mobile Demineralizer
16. ER-AA-450, Structures Monitoring, Rev. 1
17. Calculation No: QDC-100-M-0847 Rev. 1, Station/Unit: Quad Cities/1 and 2, Title: Use of Fire Water System for External Flood Protection Measures
18. Flood Barrier Drawings (FL-1 through FL-52)
19. B-610, Rev F, Typical Details for Sealing Floor and Wall Openings
20. B-611, Sheet 1, Rev B, Typical Details for Sealing Floor and Wall Openings
21. B-611, Sheet 2, Rev A, Penetration Seal Detail
22. 4E-1056, Rev M, Electrical Installation – General Notes Unit 1 and 2
23. 4E-1056A, Rev E, Electrical Installation – General Notes Unit 1 and 2
24. 4E-1056B, Rev B, Electrical Installation General Notes
25. 4E-1050, Cable Routing Turbine and Reactor Bldg Ground Floor