



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D.C. 20555-0001

June 19, 2014

Mr. David A. Heacock  
President and Chief Nuclear Officer  
Virginia Electric and Power Company  
Innsbrook Technical Center  
5000 Dominion Boulevard  
Glen Allen, VA 23060-6711

SUBJECT: NORTH ANNA POWER STATION UNITS 1 AND 2 – STAFF ASSESSMENT OF THE FLOODING WALKDOWN REPORT SUPPORTING IMPLEMENTATION OF NEAR-TERM TASK FORCE RECOMMENDATION 2.3 RELATED TO THE FUKUSHIMA DAI-ICHI NUCLEAR POWER PLANT ACCIDENT (TAC NOS. MF0251 AND MF0252)

Dear Mr. Heacock:

On March 12, 2012, the U.S. Nuclear Regulatory Commission (NRC) issued a request for information letter per Title 10 of the *Code of Federal Regulations*, Section 50.54(f) (50.54(f) letter). The 50.54(f) letter was issued to power reactor licensees and holders of construction permits requesting addressees to provide further information to support the NRC staff's evaluation of regulatory actions that may be taken in response to lessons learned from Japan's March 11, 2011, Great Tōhoku Earthquake and subsequent tsunami. The request addressed the methods and procedures for nuclear power plant licensees to conduct flooding hazard walkdowns to identify and address degraded, nonconforming, or unanalyzed conditions through the corrective action program, and to verify the adequacy of the monitoring and maintenance procedures.

By letter dated November 27, 2012, Virginia Electric and Power Company (Dominion) submitted a Flooding Walkdown Report as requested in Enclosure 4 of the 50.54(f) letter for the North Anna Power Station, Units 1 and 2 (NAPS) site. By letter dated January 30, 2014, Dominion provided a response to the NRC request for additional information for the NRC staff to complete its assessments.

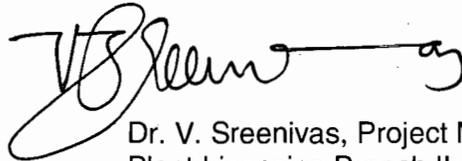
The NRC staff reviewed the information provided and, as documented in the enclosed staff assessment, determined sufficient information was provided to be responsive to Enclosure 4 of the 50.54(f) letter.

D. A. Heacock

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If you have any questions, please contact me at (301) 415-2597 or by e-mail at V.Sreenivas@nrc.gov.

Sincerely,

A handwritten signature in black ink, appearing to read "V. Sreenivas", with a long horizontal flourish extending to the right.

Dr. V. Sreenivas, Project Manager  
Plant Licensing Branch II-1  
Division of Operating Reactor Licensing  
Office of Nuclear Reactor Regulation

Docket No. 50-338 and 50-339

Enclosure:  
Staff Assessment of Flooding Walkdown Report

cc w/encl: Distribution via Listserv

STAFF ASSESSMENT OF FLOODING WALKDOWN REPORT  
NEAR-TERM TASK FORCE RECOMMENDATION 2.3 RELATED TO  
THE FUKUSHIMA DAI-ICHI NUCLEAR POWER PLANT ACCIDENT  
VIRGINIA ELECTRIC AND POWER COMPANY  
NORTH ANNA POWER STATION, UNITS 1 AND 2  
DOCKET NOS. 50-338 AND 50-339

1 INTRODUCTION

On March 12, 2012,<sup>1</sup> the U.S. Nuclear Regulatory Commission (NRC) issued a request for information per Title 10 of the *Code of Federal Regulations*, Section 50.54(f) (50.54(f) letter) to all power reactor licensees and holders of construction permits in active or deferred status. The request was part of the implementation of lessons learned from the accident at the Fukushima Dai-ichi nuclear power plant. Enclosure 4, "Recommendation 2.3: Flooding,"<sup>2</sup> to the 50.54(f) letter requested licensees to conduct flooding walkdowns to identify and address degraded, nonconforming, or unanalyzed conditions using the corrective action program (CAP), verify the adequacy of monitoring and maintenance procedures, and report the results to the NRC.

The 50.54(f) letter requested licensees to include the following:

- a. Describe the design basis flood hazard level(s) for all flood-causing mechanisms, including groundwater ingress.
- b. Describe protection and migration features that are considered in the licensing basis evaluation to protect against external ingress of water into structures, systems, and components (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. 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 guidance in Regulatory Issues Summary 2005-20, Revision 1, Revision to the NRC Inspection Manual Part 9900 Technical Guidance,

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<sup>1</sup> ADAMS Accession No. ML12053A340.

<sup>2</sup> ADAMS Accession No. ML12056A050.

“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.
- 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.

In accordance with the 50.54(f) letter, Enclosure 4, Required Response Item 2, licensees were required to submit a response within 180 days of the NRC’s endorsement of the flooding walkdown guidance. By letter dated May 21, 2012<sup>3</sup>, the Nuclear Energy Institute (NEI) staff submitted NEI 12-07, Revision 0 A, “Guidelines for Performing Verification Walkdowns of Plant Flood Protection Features” to the NRC staff to consider for endorsement. By letter dated May 31, 2012<sup>4</sup>, the NRC staff endorsed the walkdown guidance.

By letter dated November 27, 2012<sup>5</sup>, Virginia Electric and Power Company (Dominion, the licensee), provided a response to Enclosure 4 of the 50.54(f) letter Required Response Item 2, for the North Anna Power Station (NAPS), Units 1 and 2. The NRC staff issued a request for additional information (RAI) to the licensee regarding the available physical margin (APM) dated December 23, 2013<sup>6</sup>. The licensee responded by letter dated January 30, 2014<sup>7</sup>.

The NRC staff evaluated the licensee’s submittals to determine if the information provided in the walkdown report met the intent of the walkdown guidance and if the licensee responded appropriately to Enclosure 4 of the 50.54(f) letter.

## 2 REGULATORY EVALUATION

The SSCs important to safety in operating nuclear power plants are designed either in accordance with, or meet the intent of Appendix A to 10 CFR Part 50, General Design Criteria (GDC) 2: “Design Bases for Protection Against Natural Phenomena;” and Appendix A “Seismic Geological Criteria for Nuclear Plants” to 10 CFR Part 100. GDC 2 states that SSCs important to safety at nuclear power plants shall be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunamis, and seiches without loss of capability to perform their safety functions.

For initial licensing, each licensee was required to develop and maintain design bases that, as defined by 10 CFR 50.2, identify the specific functions to be performed by an SSC, and the specific values or ranges of values chosen for controlling parameters as reference bounds for the design.

The design bases for the SSCs reflect appropriate consideration of the most severe natural phenomena that have been historically reported for the site and surrounding area. The design bases also reflect sufficient margin to account for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

3 ADAMS Package Accession No. ML121440522.

4 ADAMS Accession No. ML12144A142.

5 ADAMS Accession No. ML12334A448.

6 ADAMS Accession No. ML13325A891.

7 ADAMS Accession No. ML14035A230.

The current licensing basis (CLB) is the set of NRC requirements applicable to a specific plant, and a licensee's written commitments for ensuring compliance with, and operation within, applicable NRC requirements and the plant-specific design basis, that are in effect.

### 3 TECHNICAL EVALUATION

#### 3.1 Design Basis Flooding Hazard for North Anna Power Station

The licensee reported the design basis flood hazard for the site is the probable maximum flood (PMF) on Lake Anna generated from the Lake Anna watershed coincident with the effects of backwater, wind surge and wave runoff. The licensee stated that the NAPS site is located on a peninsula on the southern shore of Lake Anna approximately 5 miles upstream from the North Anna Dam. The licensee reported that Lake Anna is divided into the North Anna Reservoir and the Waste Heat Treatment Facility (WHTF) for optimal performance. The licensee reported that the postulated flood event would yield an upper-bound level of stillwater of 264.2 ft. mean sea level (MSL) at the North Anna Dam, 0.2 ft backwater at the site, and 4.2 ft. of wind surge and wave runoff at the circulation water intake structure (or 2.9 ft. of wind surge and wave runoff at the plant site). The resulting PMF level would be 268.6 ft. MSL at the circulation water intake structure and 267.3 ft. at the plant site with plant grade above the PMF levels at 271 ft. MSL. The licensee reported that the safety-related structures at the plant site would not be affected during the PMF event.

However, the licensee indicates that if the lake level in North Anna Reservoir reaches 252 ft MSL during a flood in the Lake Anna watershed, a drainage pipe through the base of the flooding protection dike ("west dike" that protects the Unit 2 turbine building) would be closed by valves to prevent reversed flow via the pipe from the North Anna Reservoir to the recessed area between the west dike and the Unit 2 turbine building. The licensee reported that if the PMF event coincides with local intense precipitation (LIP) in excess of a 10-year storm, the flooding in the recessed area would exceed 257 ft. MSL, resulting in flooding of the turbine building basement to a level below the internal flood barriers. Duration of the postulated flood and warning times are not specified or discussed in the current license basis (CLB) according to the licensee.

The licensee indicates that the LIP event is only generally considered in the CLB for flood protection features at NAPS and that no specific onsite water depths or elevations were addressed for the LIP flood event. The probable maximum hurricane, tsunami, ice-related flooding mechanisms and groundwater ingress were not considered as credible events for the NAPS CLB. However, severe wind and intense precipitation resulting from a hurricane were considered in the PMF event as discussed above.

Based on the NRC staff's review, the licensee appears to have described the design basis flood hazard level(s) as requested in the 50.54(f) letter and consistent with the walkdown guidance.

#### 3.2 Flood Protection and Mitigation

##### 3.2.1 Flood Protection and Mitigation Description

The licensee stated that the plant grade is above the Lake Anna PMF levels coincident with backwater, wind surge and wave runoff effects. Therefore, the licensee reported, safety-related

structures are unaffected by the PMF. However, the licensee indicates that the Unit 2 turbine building basement would be flooded if LIP exceeding the 10-year storm coincided with the PMF event. The licensee stated that to protect the turbine building and ensure safe operation, the following mitigation actions would be taken: 1) initiate the Abnormal Procedure at the lake level of 251 ft. MSL; 2) close the drain pipe valve when the lake level reaches 252 ft. MSL to prevent lake inflow from the west dike drain pipe due to rising lake level; and, 3) manually shut down the both units and close the circulation water valves when the lake level reaches 254 ft. MSL per Abnormal Procedure, 0-AP-40, or 256 ft. MSL per the Technical Requirement Manual (TRM).

The on-site storm drainage system is capable of providing adequate drainage in an event of LIP up to a 100-year storm, and the drainage features in the drainage area west of the site would be functional during the LIP event up to a 50-year storm.

The licensee concluded that adverse weather conditions concurrent with the PMF or precipitation events would not impact the operator's ability to perform the required procedural steps described above.

### 3.2.2 Incorporated and Exterior Barriers

The licensee reported that the site has incorporated and/or exterior barriers that are permanently in-place, requiring no operator manual actions. These barriers include: dike-type barriers at various locations throughout the turbine building basement to prevent water intrusion into areas containing safety-related equipment; the turbine building sumps and pits; the emergency dike and intercepting channel at the service water reservoirs to control and divert service water overflow or breach to the Waste Heat Treatment Facility; and onsite stormwater drainage systems and drainage features in the west basin according to the licensee.

### 3.2.3 Temporary Barriers and Other Manual Actions

The licensee reported that the site has temporary barriers and other manual actions that require operator action. The actions include: 1) implementation of the Corporate Hurricane Response Plan when the projected onsite arrival of hurricane-force wind is greater than 36 hours away; 2) activating the emergency plan when onsite wind speed is greater than or equal to 80 mph; and, 3) initiating the Abnormal Procedures 0-AP-40 and 0-AP-41 under severe weather conditions or flooding events.

The licensee stated that the Abnormal Procedure 0-AP-40 includes taking mitigation actions when the lake level reaches 251 ft. MSL, closing the drain pipe valve when the lake level reaches 252 ft. MSL to prevent lake inflow from the west dike drain pipe due to a rising lake level, and manually shutting down both units and closing the circulation water valves to prevent flooding of the turbine building through the circulating water system when the lake level reaches 254 ft. MSL.

The licensee stated that the Abnormal Procedure 0-AP-41 include reviewing weather bulletins; closing, replacing, or installing temporary measures for manholes, blocks, and missile barriers; monitoring the intake structure for debris; and evaluating the weather-related risks associated with suspended processes such as maintenance and fuel handling.

### 3.2.4 Reasonable Simulation and Results

The licensee performed reasonable simulation activities for site procedures in response to severe weather and flooding events. The licensee reported that the evaluation was based on Operating Experience and tabletop discussions with the department representative responsible for performing the specified actions. The licensee concluded that the evaluation results confirmed that applicable procedures could be executed as written and within the required timeframe under the adverse weather conditions.

### 3.2.5 Conclusion

Based on the NRC staff's review, the licensee appears to have described protection and mitigation features as requested in the 50.54(f) letter and consistent with the walkdown guidance.

### 3.3 Warning Systems

The licensee reported that an Abnormal Procedure (0-AP-41) for severe weather conditions is initiated either by severe weather indications from monitoring the National Weather Service, Virginia Power Weather Center, or actual site conditions. This procedure relies on monitoring the water level at the dam of the North Anna Reservoir and at the water intake structure. The mitigation action would be taken at a reservoir water level of 251 ft. MSL to activate Abnormal Procedure, at 252 ft. MSL for closure of west dike drain pipe, and at 254 ft. for shutting down both units and closing circulation water valves.

The licensee reported that the room water-level warning system and sump alarm systems inside structures are not credited for external flood protection in the CLB.

Based on the NRC staff's review, the licensee appears to have provided information to describe any warning systems as requested in the 50.54(f) letter and consistent with the walkdown guidance.

### 3.4 Effectiveness of Flood Protection Features

The flood protection features at NAPS were found to be overall effective, functional, and maintained in conformance of the CLB. The procedure evaluation determined that the applicable procedures could be executed as written and within the required timeframe for the expected conditions during the external flooding event. One deficiency related to a lack of manhole cover seal and missing conduit seal for the turbine building was identified with evaluation and resulting corrective action was completed by December 31, 2013.

Based on the NRC staff's review, the licensee appears to have discussed the effectiveness of flood protection features as requested in the 50.54(f) letter and consistent with the walkdown guidance.

### 3.5 Walkdown Methodology

By letter dated June 11, 2012,<sup>8</sup> the licensee responded to the 50.54(f) letter that they intended to utilize the NRC endorsed walkdown guidelines contained in NEI 12-07<sup>9</sup>. The licensee's walkdown submittal dated November 27, 2012, indicated that the licensee implemented the walkdowns consistent with the intent of the guidance provided in NEI 12-07. The licensee did not identify any exceptions from NEI 12-07.

Based on the NRC staff's review, the licensee appears to have presented information related to the implementation of the walkdown process as requested in the 50.54(f) letter and consistent with the walkdown guidance.

### 3.6 Walkdown Results

#### 3.6.1 Walkdown scope

The licensee performed walkdowns of flood protection features including: site topography, the site drainage system, structural walls, floors, penetrations and seals, doors, manholes, and dikes. In addition, evaluations were performed on flood protection feature preventative maintenance and credited operator actions. Each mode of plant operation was considered in the development of the flooding walkdown list.

The licensee performed reasonable simulation activities for site procedures in response to severe weather and flooding events. The licensee's evaluation determined that the applicable procedures could be executed as written and within the required timeframe under the conditions associated with impending severe weather. These actions were verified based on Operating Experience and tabletop discussions with the department representative responsible for performing the specified actions.

The licensee used acceptance criteria consistent with the intent of NEI 12-07.

#### 3.6.2 Licensee evaluation of flood protection effectiveness, key findings, and identified deficiencies

The licensee performed an evaluation of the overall effectiveness of the plant's flood protection features. Consistent with the CLB, the licensee found flood protection features and mitigation measures to be available, functional and fairly well maintained, and that credited operator actions could readily be accomplished as outlined in station procedures.

NEI 12-07 defines a deficiency as follows: "a deficiency exists when a flood protection feature is unable to perform its intended function when subject to a design basis flooding hazard." The licensee identified one deficiency because of the flood walkdowns. Conduits from a manhole to the turbine building were not sealed at the ends and resulting corrective action was completed by December 31, 2013.

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<sup>8</sup> ADAMS Accession No. ML12171A010.

<sup>9</sup> ADAMS Accession No. ML12173A215.

NEI 12-07 specifies that licensees identify observations/potential deficiencies in the CAP that were not yet dispositioned at the time the walkdown report was submitted. Dominion stated that conditions identified as unacceptable resulted in fifteen condition reports (CRs) entered into the CAP. The majority of CRs consisted of material conditions including corrosion and degraded weather stripping on doors, restricted storm water flow paths, and partially blocked catch basins and culverts. Other CRs were due to configuration management including unsealed conduits in the manhole as described above. Improvements in flood protection systems and procedural enhancements were completed as scheduled by December 31, 2013.

### 3.6.3 Flood Protection and Mitigation Enhancements

The licensee identified several areas where improvements could be made including: redirecting roof runoff; door sweep installation; manhole gasket inspection and maintenance procedure; periodic inspections of conduit and penetration seals; programmatic controls of yard and storm drain changes; and, revisions to procedural steps in Abnormal Procedure protocols to include flash flood warning and basin water level monitoring. Improvements in flood protection systems and procedural enhancements were completed as scheduled by December 31, 2013.

### 3.6.4 Planned or newly installed features

The licensee determined that no changes were necessitated by the flood walkdowns.

### 3.6.5 Deficiencies Noted and Actions Taken or Planned to Address

The licensee noted one deficiency as a result of the walkdowns as discussed above in Section 3.6.2 above. The licensee identified no other adverse conditions that prevent flood protection features from performing their function as credited in the CLB.

### 3.6.6 Staff Analysis of Walkdowns

NRC staff reviewed the licensee walkdown report dated November 27, 2012.

The walkdown revealed one deficiency with other observations not immediately judged as acceptable entered into the CAP. The licensee identified unsealed manhole conduits leading to the turbine building as the deficiency to be addressed by December 31, 2013. Observations entered into the CAP include redirection of roof downspouts, a new door sweep, inspect of gaskets, conduits and penetrations, control of yard and storm drains, and Abnormal Procedure enhancements. Resolution of all observations was completed as scheduled by December 31, 2013.

Severe weather indications from monitoring the National Weather Service, Virginia Power Weather Center, or actual site conditions are incorporated into a NAPS Abnormal Procedure to provide sufficient warning for initiating flooding mitigation procedures. The licensee concluded that adverse weather would have minimal impact on flood mitigation actions. The licensee performed reasonable simulation activities for site procedures in response to severe weather and flooding events as discussed above (Section 3.2.4).

Based on the NRC staff's review, the licensee appears to have provided results of the walkdown and described any other planned or newly installed flood protection systems or flood mitigation measures as requested in the 50.54(f) letter and consistent with the walkdown guidance. Based on the information provided in the licensee's submittals, the NRC staff concludes that the licensee's implementation of the walkdown process meets the intent of the walkdown guidance.

### 3.6.7 Available Physical Margin

The NRC staff issued a request for additional information (RAI) to the licensee regarding the available physical margin (APM) dated December 23, 2013<sup>10</sup>. The licensee responded by letter dated January 30, 2014<sup>11</sup>. The licensee has reviewed their APM determination process, and entered any unknown APMs into the CAP. The NRC staff reviewed the response, and concluded that the licensee met the intent of the APM determination per NEI 12-07.

Based on the NRC staff's review, the licensee appears to have documented the information requested for any cliff-edge effects, as requested in the 50.54(f) letter and consistent with the walkdown guidance. Further, staff reviewed the response, and concludes that the licensee met the intent of the APM determination per NEI 12-07.

## 3.7 NRC Oversight

### 3.7.1 Independent Verification by Resident Inspectors

On June 27, 2012, the NRC issued Temporary Instruction (TI) 2515/187 "Inspection of Near-Term Task Force Recommendation 2.3 Flooding Walkdowns." In accordance with the TI, NRC inspectors independently verified that the licensee implemented the flooding walkdowns consistent with the intent of the walkdown guidance. Additionally, the inspectors independently performed walkdowns of a sample of flood protection features. The inspection report dated May 7, 2013, documents the results of this inspection. No findings of significance were identified.

## 4 SSC NOT WALKED DOWN

The licensee identified inaccessible features but no restricted access features.

### 4.1 Restricted Access

The licensee identified no restricted access features.

### 4.2 Inaccessible Features

Below-grade storm drain piping was considered inaccessible. Reasonable assurance that the piping system is able to perform its flood protection function is assessed by inspection of ponding at drain inlets at the time of a precipitation event, when corrective action can also be taken. A portion of the decontamination building tunnel could not be accessed due to pipe congestion. A review of conduits, hatches and penetrations in the tunnel revealed no apparent

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<sup>10</sup> ADAMS Accession No. ML13325A891.

<sup>11</sup> ADAMS Accession No. ML14035A230.

flood pathways into the tunnel based on the position of these features above grade or, having terminations within flood protected areas. Due to high radiation, below grade portions of the south wall in the decontamination and waste solidification building were inaccessible; however, the licensee reported that there are no penetrations in this portion of the wall.

## 5.0 CONCLUSION

The NRC staff concludes that the licensee's implementation of flooding walkdown methodology meets the intent of the walkdown guidance. The NRC staff concludes that the licensee, through the implementation of the walkdown guidance activities and, in accordance with plant processes and procedures, verified the plant configuration with the current flooding licensing basis; addressed degraded, nonconforming, or unanalyzed flooding conditions; and verified the adequacy of monitoring and maintenance programs for protective features. Furthermore, the licensee's walkdown results, which were verified by the NRC staff's inspection, identified no immediate safety concerns. The NRC staff reviewed the information provided and determined that sufficient information was provided to be responsive to Enclosure 4 of the 50.54(f) letter.

D. A. Heacock

- 2 -

If you have any questions, please contact me at (301) 415-2597 or by e-mail at V.Sreenivas@nrc.gov.

Sincerely,

/RA/

Dr. V. Sreenivas, Project Manager  
Plant Licensing Branch II-1  
Division of Operating Reactor Licensing  
Office of Nuclear Reactor Regulation

Docket No. 50-338 and 50-339

Enclosure:  
Staff Assessment of Flooding Walkdown Report

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