

UNITED STATES OF AMERICA  
 NUCLEAR REGULATORY COMMISSION  
 OFFICE OF NUCLEAR REACTOR REGULATION

Eric J. Leeds, Director

In the Matter of	)	
	)	Docket Nos. 50-338 and 50-339
VIRGINIA ELECTRIC	)	
AND POWER COMPANY	)	License Nos. NPF-4 and NPF-7
	)	
North Anna Power Station,	)	
Units 1 and 2	)	

DIRECTOR'S DECISION UNDER 10 CFR 2.206

I. Introduction

By letter dated September 8, 2011, Thomas Saporito, (the petitioner) filed a petition pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 2.206, "Requests for Action Under This Subpart." The petitioner requested in his petition that the U.S. Nuclear Regulatory Commission (NRC, the Commission) do the following: (1) take escalated enforcement action against Virginia Electric and Power Company (the licensee) and suspend, or revoke, the operating licenses for North Anna Power Station, Units 1 and 2 (North Anna 1 and 2), (2) issue a notice of violation against the licensee with a proposed civil penalty in the amount of 1 million dollars, and (3) issue an order to the licensee requiring the licensee to keep North Anna 1 and 2, in a "cold shutdown" mode of operation until such time as a series of actions described in the petition are completed. Section II of this Director's Decision describes the bases for these requests.

The Petition Review Board (PRB) met on September 20, 2011, to discuss the petition and denied the request for immediate action contained in the petition. The PRB denied the

request for immediate action, because there was no immediate safety concern to North Anna 1 and 2, or to the health and safety of the public. The PRB concluded that the requirement “to demonstrate to the Commission that no functional damage has occurred to those features necessary for continued operation without undue risk to the health and safety of the public” already exists in 10 CFR Part 100, “Reactor Site Criteria, Appendix A, “Seismic and Geologic Siting Criteria for Nuclear Power Plants.” The PRB communicated this decision to the petitioner in an e-mail dated September 21, 2011, and the petitioner requested an opportunity to address the PRB before its initial meeting to provide supplemental information for the PRB’s consideration.

The petitioner met with the PRB during a telephone conference on September 29, 2011, to discuss his petition (meeting transcript at Agencywide Documents Access and Management System (ADAMS) Accession No. ML11332A046). During this meeting, and by separate e-mail dated September 29, 2011 (ADAMS Accession No. ML11334A152), the petitioner also requested that his letter to a senior allegations coordinator in the NRC’s Region II, Oscar DeMiranda, dated September 8, 2011, (enclosed in the e-mail) be included as a supplement to the petition. The PRB met on October 11, 2011, to discuss the petition. The PRB made an initial recommendation to accept the petition based on the fact that it met all the criteria for acceptance and did not meet any of the criteria for rejection. The PRB communicated its initial recommendation to the petitioner in an e-mail dated October 31, 2011. In an e-mail dated October 31, 2011, the petitioner requested a second opportunity to address the PRB. The petitioner met with the PRB again on November 7, 2011 (meeting transcript at ADAMS Accession No. ML113530035), to provide supplemental information in support of the petition request. In an e-mail dated October 21, 2011 (ADAMS Accession No. ML11308A016), the petitioner expressed concerns about the restart of North Anna 1 and 2, after the earthquake

on August 23, 2011. As the concerns expressed in this e-mail were similar to those expressed in the petitioner's original petition dated September 8, 2011, this e-mail has been considered as a supplement to the petition. The PRB considered the results of these discussions, along with the additional information, in determining its final recommendation to accept the petition for review and in establishing the schedule for reviewing the petition. In the February 22, 2012, acknowledgment letter (ADAMS Accession No. ML11356A164), the NRC informed the petitioner that the petition was accepted for review under 10 CFR 2.206 and had been referred to the Office of Nuclear Reactor Regulation for appropriate action. The proposed Director's Decision was enclosed with the acknowledgment letter for the petition and addressed the concerns raised in the original petition, along with the additional concerns raised during PRB meetings held on September 29, 2011, and November 7, 2011, and in the two supplemental letters to the NRC dated September 8, 2011, and October 21, 2011.

The transcripts of these meetings between the PRB and the petitioner were treated as supplements to the petition and are available in ADAMS for inspection at the Commission's Public Document Room (PDR), located at One White Flint North, Public File Area O1 F21, 11555 Rockville Pike (first floor), Rockville, Maryland. Publicly available documents created or received at the NRC are accessible electronically through ADAMS in the NRC Library section of the Web site at <http://www.nrc.gov/reading-rm/adams.html>. Persons who do not have access to ADAMS or who encounter problems accessing the documents located in ADAMS should contact the NRC PDR reference staff by telephone at 1-800-397-4209, or 301-415-4737, or by e-mail at [PDR.Resource@nrc.gov](mailto:PDR.Resource@nrc.gov).

The NRC staff sent a copy of the proposed Director's Decision to the petitioner and to the licensee for comment on February 22, 2012 (ADAMS Accession No. ML11356A164), and February 28, 2012 (ADAMS Accession No. ML11357A117), respectively. The licensee

responded with comments on March 12, 2012 (ADAMS Accession No. ML120720519). The comments and the NRC staff's response to them are included in the attachment to this Director's Decision.

## II. Discussion

### Background

On August 23, 2011, with North Anna 1 and 2, operating at 100 percent power, the site experienced ground motion from a seismic event (a magnitude 5.8 earthquake reported by the U.S. Geological Survey (USGS)) in Mineral, Virginia, approximately 11 miles from the site. Shortly after the earthquake, both of the North Anna reactors tripped, and offsite power to the station was lost. After the earthquake, both units were stabilized, taken to a hot shutdown condition, and offsite power was restored. During the loss of offsite power, the four emergency diesel generators along with the one alternate alternating current (AC) diesel generator were activated to provide onsite AC power. Subsequent analysis indicated that the spectral and peak ground accelerations for the operating basis earthquake (OBE) and design basis earthquake (DBE) for North Anna 1 and 2, were exceeded at certain frequencies for a short time.

In accordance with 10 CFR Part 100, Appendix A, Section V(a)(2), a nuclear power plant is required to be shut down when the vibratory ground motion exceeds that of the OBE. In addition, the regulations state that "prior to resuming operations, the licensee will be required to demonstrate to the Commission that no functional damage has occurred to those features necessary for continued operation without undue risk to the health and safety of the public." As the August 23, 2011, earthquake resulted in ground accelerations greater than those assumed in the design of North Anna 1 and 2, 10 CFR Part 100, Appendix A, Section V(a)(2) required North Anna 1 and 2, to be shut down and to remain shut down until the licensee for this plant

demonstrated to the NRC that no functional damage occurred to those features necessary for continued operation without undue risk to the health and safety of the public.

Following the earthquake, the NRC dispatched an augmented inspection team (AIT) to North Anna 1 and 2, to better understand the event and the licensee's response. The AIT's findings included the following: (1) operators responded to the event in accordance with established procedures and in a manner that protected public health and safety; (2) the ground motion from the earthquake exceeded the plant's licensed design basis; (3) no significant damage to the plant was identified; (4) safety system functions were maintained; and (5) some equipment issues were experienced. Overall, the AIT concluded that the event did not adversely impact the health and safety of the public. Safety limits were not approached and there was no measurable release of radioactivity associated with the event. An inspection report summarizing the AIT findings was published on October 31, 2011 (ADAMS Accession No. ML113040031).

To demonstrate that no functional damage occurred as a result of the earthquake and that it was safe to operate North Anna 1 and 2, without undue risk to the health and safety of the public, the licensee performed a number of inspections, tests, and analyses, to address the requirements of 10 CFR Part 100, Appendix A, and consistent with the guidance contained in the Electric Power Research Institute (EPRI) document NP-6695, "Guidelines for Nuclear Plant Response to an Earthquake." In Regulatory Guide (RG) 1.167, "Restart of a Nuclear Power Plant Shut Down by a Seismic Event," the NRC endorsed EPRI NP-6695, with exceptions, as an acceptable way of performing inspections and tests of nuclear power plant equipment and structures prior to restart of a plant that has been shut down by a seismic event. The licensee's activities in support of the restart of North Anna 1 and 2, after the earthquake of August 23, 2011, are described in a letter from the licensee dated September 17, 2011 (ADAMS

Accession No. ML11262A151), which enclosed the licensee's "Readiness Assessment Plan" for North Anna 1 and 2. (The licensee's Readiness Assessment Plan was later supplemented numerous times in response to NRC requests for additional information (RAIs) issued to support the development of the NRC's independent technical evaluation of the licensee's plan).

To further support implementation of regulatory requirements, the NRC issued Confirmatory Action Letter (CAL) No. 2-2011-001 to the licensee of North Anna 1 and 2, on September 30, 2011 (ADAMS Accession No. ML11273A078), which confirmed the licensee's commitment that the reactors at North Anna 1 and 2, would not be restarted until the NRC had completed its review and authorized continued operation. In addition, the licensee performed other testing and inspections not included in the NP-6695 guidelines, some of which it performed as a result of questions raised by the NRC staff.

Following completion of the AIT inspection, the NRC sent another team of inspectors, the Restart Readiness Inspection Team (RRIT), to assess the licensee's inspection program and readiness for restarting North Anna 1 and 2. The RRIT began its inspection on October 5, 2011. The RRIT followed Inspection Procedure 92702, "Follow-up on Traditional Enforcement Actions Including Violations, Deviations, Confirmatory Action Letters, Confirmatory Orders, and Alternative Dispute Resolution Confirmatory Orders." Supplemental guidance to this inspection procedure was provided by the EPRI NP-6695; NRC RG 1.166, "Pre-Earthquake Planning and Immediate Nuclear Power Plant Operator Post-Earthquake Actions;" RG 1.167; the AIT inspection report dated October 31, 2011; and input from NRC subject matter experts.

The objectives of the RRIT included the following: (1) assess the licensee's inspection process to ensure damage attributable to the event would be identified, (2) ensure the underlying causes of the dual unit reactor trip and failure of the 2H diesel generator were properly identified and the appropriate corrective actions were assigned, (3) review how

licensee-identified issues were evaluated and dispositioned, (4) observe and review licensee testing of plant systems and selected surveillance test data packages completed since the seismic event, (5) review the tracking and completion of the licensee's committed actions, and (6) support a final determination as to the overall condition of the plant to support restart.

The RRIT's onsite inspection activities were completed on October 14, 2011. There was some earthquake-related damage to nonsafety-related equipment observed at North Anna 1 and 2 (e.g., limited damage to main generator step-up transformer bushings); however, this damage was considered minor (i.e., it was not functional damage that would preclude safe operation of the facility). In addition, nonearthquake-related issues were identified as a result of the inspections. These issues are being reviewed through established licensee and NRC processes to ensure they are adequately addressed without undue risk to the health and safety of the public.

The resolution of issues identified by the RRIT was discussed at an exit meeting between the licensee and the NRC staff held on November 7, 2011, and was documented in the RRIT's inspection report dated November 30, 2011 (ADAMS Accession No. ML113340345). The RRIT concluded that the licensee performed adequate inspections, walkdowns, and testing to ensure that safety-related structures, systems, and components (SSCs) had not been adversely affected by the August 23, 2011, earthquake. The NRC's independent inspections of plant equipment, observation of surveillance testing, and review of completed test data, calculations, root cause evaluations, and documents associated with the station's corrective action and work order programs confirmed the operability and functionality of plant SSCs. The RRIT reviewed the unresolved items from the AIT and determined that the licensee had completed corrective actions such that the systems were operable to support the restart of North Anna 1 and 2.

In addition to the onsite inspection activities, the NRC performed an independent technical evaluation of the information submitted by the licensee to demonstrate that no functional damage occurred at North Anna 1 and 2, as a result of the August 23, 2011, earthquake. The regulatory requirements and guidance used in the NRC's independent technical evaluation of the licensee's restart readiness determination included the following: (1) 10 CFR Part 100, Appendix A, Section V(a)(2); (2) the North Anna 1 and 2, Updated Final Safety Analysis Report (UFSAR); (3) RG 1.167; (4) RG 1.166; (5) NRC Generic Letter (GL) 88-20, Supplement 4, "Individual Plant Examination of External Events (IPEEE)," along with the licensee's response to GL 88-20, Supplement 4; (6) International Atomic Energy Agency Safety Reports Series No. 66, "Earthquake Preparedness and Response for Nuclear Power Plants;" and (7) NRC Inspection Manual, Part 9900, "Operability Determinations and Functionality Assessments for Resolution of Degraded or Nonconforming Conditions Adverse to Quality or Safety," and the associated NRC Regulatory Issue Summary (RIS) 2005-20, Revision 1, "Revision to NRC Inspection Manual Part 9900 Technical Guidance, 'Operability Determinations and Functionality Assessments for Resolution of Degraded or Nonconforming Conditions Adverse to Quality or Safety'." In the summary to the independent technical evaluation issued November 11, 2011, the NRC staff concluded that the licensee acceptably demonstrated that no functional damage occurred at North Anna 1 and 2, to those features necessary for continued operation and that North Anna 1 and 2, could be operated without undue risk to the health and safety of the public.

Although the NRC staff concluded that North Anna 1 and 2, could be safely restarted, the licensee identified several activities (inspections and tests) that would be performed as part of the restart process for North Anna 1 and 2. The NRC monitored the startup of North Anna 1 and 2, to confirm that the plant would be safely operated (see inspection report at ADAMS

Accession No ML113540520). In addition to these startup activities, the licensee identified several long-term action items. These long-term action items include those identified in Section 6.3 of NP-6695 and include changes to the North Anna 1 and 2, UFSAR. These long-term commitments are documented in the NRC-issued CAL No. NRR-2011-002, but are unrelated to the NRC's conclusion that the licensee demonstrated that no functional damage occurred to the North Anna 1 and 2, and that it could be safely restarted.

#### Concerns Raised by the Petitioner and the Response by the NRC

The petitioner raised a number of concerns in his petition dated September 8, 2011, and in supplements to his original petition. These concerns, and the NRC response to these concerns, are discussed in detail in this section. Most of these concerns are addressed, either in full or in part, by the NRC inspections and technical evaluation that evaluated the licensee's actions after the earthquake of August 23, 2011, to support completion of its Readiness Assessment Plan to demonstrate that no functional damage occurred at North Anna 1 and 2, to those features necessary for continued operation and North Anna 1 and 2, could be operated without undue risk to the health and safety of the public. The petitioner's concerns and the NRC's resolution are described below:

- (1) On August 23, 2011, North Anna 1 and 2, automatically tripped offline as a direct result of ground motion caused by an earthquake centered in Mineral, Virginia, approximately 10 miles from North Anna 1 and 2. The licensee has not determined the root cause of this event, nor has it explained why the reactor tripped on "negative flux rate" rather than on loss of offsite power.

The NRC staff has focused on understanding the cause of the reactor trips at North Anna 1 and 2, which occurred after the earthquake of August 23, 2011. Part of the scope of the AIT sent to North Anna 1 and 2, was to ascertain what caused this reactor trip. The AIT

interviewed licensee staff to obtain an accurate account of the sequence of events. In addition, the AIT reviewed plant data and logs to gain an understanding of the plant response. The AIT also reviewed the Post-Trip Event Report to gauge the licensee's assessment of the plant trip and the identified possible causes.

Based on the sequence of events, the AIT found that the reactor trips resulted from high negative rate flux signals and occurred before the loss of offsite power. Based on the plant response data, the licensee determined that reactor trips at both North Anna 1 and 2, were caused by a "Power Range High Negative Neutron Flux Rate" reactor trip signal, which is for an abnormal rate of decrease in nuclear power. The licensee's Post Event Trip Report identified four possible causes for this trip: (1) loss of power to the control rod motor generator sets, (2) a dropped control rod, (3) movement of the nuclear instrumentation detectors, and (4) core barrel movement.

At the time the inspection report for the AIT was issued on October 31, 2011, the licensee was in the midst of conducting a root cause evaluation of the North Anna 1 and 2, reactor trips and planned to assess each one of the potential causes through engineering analysis and testing to determine the most likely underlying cause of the trip signal and any contributing causes.

Subsequently, the licensee completed its root cause evaluation of the North Anna 1 and 2, reactor trips following the earthquake of August 23, 2011. The RRIT reviewed the licensee's documentation for the investigative analysis of the seismic event and identified no issues that would prevent the safe restart of North Anna 1 and 2. The licensee's analysis included a third-party evaluation of the potential response of the core nucleate boiling and the nuclear instrumentation when subjected to seismic motion. The root cause of this event was a synergistic combination of seismically-induced conditions that included core barrel movement,

detector movement, and small reactivity effects from core movement and thickening of the thermal -boundary layer along the fuel rods. The additive effects of the combined conditions resulted in momentary undermoderated core conditions as evidenced by the oscillatory, but overall decreasing, flux profiles from both North Anna 1 and 2.

In addition, the RRIT interviewed, in person and over the phone, licensee personnel who were responsible for the root cause evaluations to understand the process for these evaluations. The RRIT's assessment of the licensee's root cause evaluation found that the investigative analysis methodology focused on the cause of the reactor trips which limited the breadth of the investigation. Following discussions between the RRIT and the licensee, the licensee's Corrective Action Review Board assigned a corrective action to evaluate what additional actions were warranted to minimize complications of a loss-of-offsite-power event. The RRIT did not find that any further action on this issue was necessary.

- (2) Subsequent to the earthquake, the licensee initiated various inspection activities and tests to discover the extent of damage to the nuclear facility, but these inspection and testing activities continue and remain incomplete and non-validated.

To demonstrate that no functional damage occurred as a result of the earthquake and that it was safe to operate North Anna 1 and 2, without undue risk to the health and safety of the public, the licensee performed numerous walkdowns of plant systems and focused inspections of selected structures and components. In addition, NRC inspectors from the AIT, RRIT, NRC fuel experts, and the North Anna 1 and 2, NRC resident inspectors performed independent inspections and walkdowns. Nuclear industry seismic experts and nuclear systems personnel from another utility also conducted independent inspections and walkdowns of limited scope. The purpose of all these inspections was to identify any physical damage or deformation that could potentially impact the operability or functionality of station SSCs.

Following each of the walkdowns and inspections performed by licensee, industry, and NRC personnel, the licensee reviewed any issues identified to determine if they were seismically-related. If so, the licensee entered them into the Corrective Action Program (CAP) for evaluation to determine if they had been seismically-induced and if so, what additional inspections or testing were required to support a position of operability or functionality. Before the station's staff conducted the walkdowns, the licensee provided training to each engineer who took part in the inspection teams to ensure that a consistent approach was used in the walkdowns.

The licensee identified more than 400 surveillance procedures to be performed before declaring North Anna 1 "ready for restart," to demonstrate the availability and operability of components and systems important to nuclear safety or required to mitigate the consequences of an accident as defined in the UFSAR and technical specifications (TSs). For North Anna 2, more than 150 surveillance procedures were identified for performance in addition to those already scheduled to support the refueling outage before restarting the unit.

The RRIT concluded that the licensee's staff adequately inspected plant SSCs to ensure that any damage from the August 23, 2011, seismic event was identified and, if found, would have been properly evaluated and corrected before initiating restart activities. As a result of the inspections performed by licensee, industry and NRC personnel, no significant seismically-induced damage was identified that could affect the operability or functionality of plant SSCs. However, during the inspection, some examples of minor problems were identified, including issues that had not been entered into the CAP or work control program as required, opportunities to enhance the root cause evaluations conducted following the seismic event, committed actions that were not being processed in accordance with program requirements,

and areas that had not been inspected or evaluated before the RRIT engaged the licensee's staff.

The petitioner also raised a number of specific technical issues related to the inspections conducted to demonstrate that no functional damage occurred as a result of the earthquake and that it was safe to operate North Anna 1 and 2, without undue risk to the health and safety of the public. These specific concerns with the inspections include the following:

- (a) Inspections of the North Anna 2 nuclear fuel cannot be used to "bound" the condition of nuclear fuel at North Anna 1. Similarly, inspections of North Anna 2 reactor vessel internals cannot be used to "bound" the condition of reactor vessel internals at North Anna 1. Enhanced licensee inspections should be required for North Anna 1 and 2, to determine the extent of any damage to critical safety-related equipment, systems, and components prior to any restart of the nuclear reactors. The inspection activities should include removal of the entire nuclear fuel core assemblies for both North Anna 1 and 2, for inspection via closed circuit television and inspection of the reactor vessel internals.

The NRC staff's assessment of the nuclear fuel at North Anna 1 and 2, was independent of the fuel activities performed by the licensee. The NRC staff evaluated the design of the North Anna 1 and 2, fuel assemblies, considered information on the seismic forces present during the earthquake, and determined whether sufficient design margin existed for all of the North Anna 1 and 2, nuclear fuel components.

At the request of the NRC staff, the licensee calculated the applied seismic loads on the fuel residing in the North Anna 2 reactor on August 23, 2011, based on measured ground motion. This information was provided to the licensee's fuel vendor, who performed a detailed engineering calculation that demonstrated that these applied seismic loads would not result in

damage or deformation of the fuel assembly components, including the fuel rods, guide tubes, and grid cages. The NRC fuel staff audited these calculations and indicated that these were acceptable in the NRC staff's independent technical evaluation, dated November 11, 2011.

As for the visual inspections of the North Anna 1 fuel, the licensee performed a detailed visual inspection of the North Anna 2 fuel assemblies and reviewed rod cluster control assembly drag tests for both units to confirm no damage or deformations. The NRC staff was onsite during these inspections and tests to verify that the licensee's fuel assessment methods and criteria were consistently applied. During its audit of the fuel vendor calculations, the NRC staff considered the information gathered from these visual inspections and tests.

The licensee conducted additional inspections during the startup of North Anna 1 and 2. The licensee performed control rod and core physics testing during startup of both units. This information provided additional confirmation of adequate performance by the fuel at North Anna 1 and 2.

To ensure that the functionality and the structural integrity of the reactor vessel internal (RVI) components are maintained under the current license period, the licensee conducted inspections of the RVI components in North Anna 2. The licensee determined that inspection of RVI components in North Anna 2 would be representative of North Anna 1, and the NRC staff assessed this determination.

The NRC staff assessment of RVI components considered the inspection results of the North Anna 2 RVI components, the inspection results of the North Anna 1 and 2, reactor vessel supports, and information on the seismic forces present during the earthquake, and determined whether the functionality of the North Anna 1 or 2, RVI components were affected.

Based on a review of the Final Safety Analysis Report (FSAR), Section 4.2.2.2, the NRC staff determined that the same types of materials were used for the RVI components in both

North Anna 1 and 2. Because the materials and configuration of the RVI components in both units are the same, from a metallurgical perspective, they should react similarly. Furthermore, inspections of RVI components in North Anna 2 did not identify any visible damage and the NRC staff concluded in its technical evaluation dated November 11, 2011, that the licensee had satisfactorily resolved this issue.

- (b) The licensee should be required to torque-test all safety-related equipment support, installation, and retention bolts to insure that the bolts have not sheared from the recent earthquake event.

In its letter dated October 31, 2011, the licensee stated that it verified torque on 316 anchor bolts on 51 pipe supports in the North Anna 2 safeguards building, auxiliary building, and North Anna 2 containment. The licensee randomly selected anchor bolts ranging from ½-inch to 1-¼ inches in size for torque verification. Of the 316 anchor bolts that were torque tested, all but five passed the test. The five that did not pass were wrench-tight, were retorqued (which confirmed proper grip), and maintained full-load carrying capability. The five anchor bolts that did not meet the torque checks were in five different supports. The licensee clarified that the remaining bolts in each support passed the torque check, and the affected support remained tight against the wall, indicating that the five wrench-tight bolts were not caused by the August 23, 2011, earthquake.

The licensee reported that in no case were any supports rendered inoperable. The licensee concluded that, because of the low number of cycles of strong motion from the August 23, 2011, earthquake, extensive system inspections, and the tightness sampling performed, there is no concern for vibratory damage to expansion anchors. The NRC staff noted that torque verification is part of the procedures to support the functionality of the piping system. Based on the licensee's inspection results for the bolts, the NRC staff, in its technical

evaluation of November 11, 2011, found that the licensee had appropriately verified the torque of a reasonable number of the bolts on supports. Therefore, the NRC staff concluded that the licensee had demonstrated no functional damage to the pipe supports.

- (c) The licensee should inspect all snubbers throughout the entire facility to ensure the devices remain intact and able to perform their designed function.

The licensee visually inspected all small-bore and large-bore snubbers at both North Anna 1 and 2. In addition, the licensee performed functional testing on 12 snubbers at North Anna 1 and 62 snubbers at North Anna 2. The licensee found no snubbers at either North Anna 1 or North Anna 2 that failed during any functional test. The NRC staff reviewed the results of the licensee's inspection of snubbers throughout North Anna 1 and 2, and found that the licensee demonstrated that no functional damage occurred as a result of the earthquake and that it was safe to operate North Anna 1 and 2, without undue risk to the health and safety of the public.

- (d) The licensee should inspect and validate all nuclear steam supply piping and related piping systems including the nuclear reactor hot and cold leg piping on both units to validate its integrity and to evaluate the seismic capability of the piping to withstand an earthquake event greater than the plant's current design basis and to meet any enhanced plant design basis that may be required.

In its technical evaluation, the NRC staff evaluated the licensee's assessment of the existing pipe stress analyses and inspection of the piping and associated support systems, including scope, inspection and evaluation methods, acceptance criteria, results, and corrective actions, both in the Readiness Assessment Plan sent by letter dated September 17, 2011, and in responses to the NRC staff's RAIs, to show that the operability and functionality of plant SSCs demonstrated the plant's restart readiness.

In its technical evaluation dated November 11, 2011, the NRC staff found that the licensee had performed appropriate verification for the leak-before-break (LBB) analysis and adequately evaluated piping systems and pipe supports. The NRC staff further concluded that the licensee demonstrated that no functional damage had occurred to piping and pipe supports, which are necessary for continued operation without undue risk to the health and safety of the public.

- (e) The licensee should inspect the offsite power structures and facilities providing power to North Anna 1 and 2, including the entirety of the high voltage distribution system. There is a potential for a station blackout (SBO) caused by damage of which the licensee is currently unaware. The licensee needs to inspect the entirety of its high voltage distribution system, including its offsite power physical transmission lines, insulators, and substations. The licensee also needs to inspect electrical relays, circuit breakers, and switches throughout the plant.

As noted in the RRIT's inspection report dated November 30, 2011, detailed inspections of electrical systems and components were performed by the licensee following the seismic event, including a 100 percent inspection of the high voltage switchyard. Systems reviewed in detail included electrical power, emergency diesel generators, alternate AC diesel generator and support systems, emergency electrical, batteries, and vital buss. The inspections were performed by station electrical maintenance technicians, system engineers, members of the licensee's transmission group, and engineers from the licensee's other facilities. The results of these inspections were documented in the licensee's Seismic Event System Deficiencies Log and subsequently evaluated by the licensee to determine if any were seismically induced and what corrective actions were required to address them.

The NRC's RRIT reviewed the results of these inspections and how identified deficiencies had been addressed through the CAP or work order process. The RRIT also accompanied licensee personnel conducting the detailed inspections of the switchyard and walked down selected portions of other electrical systems in the plant in conjunction with system engineers.

The NRC staff did not identify any deficiencies that had not previously been identified by licensee personnel during their inspections nor did it have any concerns with licensee evaluations and dispositions of the issues before declaring the electrical systems fully operable and functional.

The NRC staff's technical evaluation, dated November 11, 2011, also considered issues related to offsite power structures and facilities providing power to North Anna 1 and 2. In its letter dated September 17, 2011, the licensee noted that it had completed, in accordance with NP-6695, a comprehensive external and internal inspection for 4160 volts (V) AC, 480 V AC, Vital/Semi-Vital 120 V AC, and 125 V direct current (DC) equipment. The licensee further noted that it used guidance in RG 1.167 and NP-6695 to develop a methodology for performing inspections to assess significant physical or functional earthquake-related damage to SSCs. The licensee noted that it did not identify any significant physical or functional damage to the electrical systems and components that would render them incapable of performing their design function.

When crediting North Anna 2 inspection activities for demonstrating acceptability of North Anna 1 electrical components, the NRC staff confirmed that the electrical equipment (i.e., batteries, bus work, breakers) and instrument and control equipment (e.g., protection and control cabinets) are similar and functionally-equivalent, and that the equipment orientation and location is the same in each unit. Based on this information, the NRC staff found that the effect

of the August 23, 2011, seismic event on electrical equipment in North Anna 1 should be the same as at North Anna 2 and vice versa. Therefore, the NRC staff found that the inspections of North Anna 1 electrical and instrument and control equipment that is equivalent and installed in the same orientation and general location (e.g., elevation), were acceptable for demonstrating the adequacy of the electrical and instrument and control equipment in North Anna 2 and vice versa.

Using the guidance in Appendix B of EPRI NP-6695, the licensee also developed a list of surveillance tests that needed to be performed before restarting North Anna 1 and 2. The licensee performed these tests to demonstrate the availability and operability of components and systems identified as important to nuclear safety in the North Anna 1 and 2, TSSs, or required to mitigate the consequences of an accident. The NRC staff concluded that these tests demonstrated that the electrical equipment is capable of performing its design function.

After reviewing the licensee's September 17, 2011, letter, the NRC staff developed several questions related to the licensee's evaluation of electrical equipment following the August 23, 2011, earthquake. In its October 3, 2011, response to an NRC staff RAI (ADAMS Accession No. ML11277A267), the licensee provided detailed information on the inspection activities associated with the safety-related batteries at North Anna 1 and 2. The licensee stated that it did not identify any abnormal results when using thermography to find potential evidence of battery degradation. The licensee also performed visual inspections of the battery rack anchorages, feeder cable tie wraps, and battery cell jars (internal and external). The licensee did not identify any visible damage during its battery inspections. The licensee measured battery cell parameters (temperature, specific gravity, electrolyte level, and individual cell voltages) for the North Anna 2 battery banks with no abnormal or adverse trends noted from preseismic event results.

In its technical evaluation, the NRC staff concluded that the licensee had demonstrated that electrical equipment offsite and onsite at North Anna 1 and 2, remains capable of performing its intended design function, and that no functional damage had occurred to the electrical equipment as a result of the August 23, 2011, earthquake. The results of the NRC inspection activities also supported this conclusion, in that the NRC staff observed no significant damage to electrical equipment. The NRC staff also found that it had reasonable assurance that any degradation of equipment, whether created by the August 23, 2011, earthquake or not, should be detected during performance of routine TS surveillance requirements or maintenance activities. Therefore, the NRC staff found that the resumption of plant operation would not result in undue risk to the health and safety of the public.

- (3) The licensee set an overly aggressive schedule for restarting North Anna 1 and 2, that was based on economic considerations rather than safety.

As discussed above, the licensee's schedule for restart of North Anna 1 and 2, after the August 23, 2011, earthquake was based on completion of all activities necessary to demonstrate to the NRC that no functional damage had occurred to those features necessary for continued operation of North Anna 1 and 2, without undue risk to the health and safety of the public. In both the RRIT's inspection report dated November 30, 2011, and the technical evaluation by the NRC staff dated November 11, 2011, the NRC staff found that the licensee had performed the actions necessary to demonstrate meeting this standard.

- (4) The licensee needs to amend its licensing documents, including its licenses and the updated final safety analysis report (UFSAR). As a result of ground motion experienced at, and damage sustained to, North Anna 1 and 2, due to the earthquake of August 23, 2011, which is greater than the licensee's design and safety bases, North Anna 1 and 2, are in an unanalyzed condition and current

licensing documents are erroneous and incomplete. As a result, the licensee cannot rely on them to provide reasonable assurance to the NRC that these nuclear reactors can be operated in a safe and reliable manner to protect public health and safety

The NRC staff has stated its position in RIS 2005-20, and in the accompanying revision to Inspection Manual Part 9900, that the licensee is permitted to start up from an outage as long as it can confirm operability of SSCs described in the TS and demonstrate functionality for other safety-related and important-to-safety SSCs not described in the TS. As such, structures or components may exceed certain design-basis limits and still be considered acceptable for restart if the licensee can confirm that they are operable and/or functional. In the RRIT inspection report dated November 30, 2011, and in the NRC's technical evaluation dated November 11, 2011, the NRC found that SSCs were confirmed as operable and/or functional before plant startup. None of the inspections conducted indicated any significant damage that would render inoperability.

In addition, the provisions of 10 CFR Part 100, Appendix A, Section V(a)(2), require that "if vibratory ground motion exceeding that of the Operating Basis Earthquake occurs, shutdown of the nuclear power plant will be required." The licensee complied with that regulatory requirement on August 23, 2011. This regulation also states that "prior to resuming operations, the licensee will be required to demonstrate to the Commission that no functional damage has occurred to those features necessary for continued operation without undue risk to the health and safety of the public." As documented in its technical evaluation of November 11, 2011, and in its RRIT inspection report of November 30, 2011, the NRC staff determined through its independent evaluation that the licensee met that requirement. There is no requirement for the licensee to submit a license amendment request following an earthquake that exceeds its DBE.

- (5) The licensee needs to conduct new seismic and geological evaluations of the North Anna 1 and 2, site that are independent. These evaluations should ascertain the degree and magnitude of future earthquake events and address a “worst case” earthquake.

The NRC staff is monitoring the licensee’s initiative to further its understanding of the earthquake of August 23, 2011, and its impact on the ground-motion effects likely to be experienced at the North Anna site in the future. The licensee is in discussion with two independent organizations - the USGS and the Department of Geosciences at Virginia Polytechnic Institute and State University - on this issue. With respect to addressing a “worst case” earthquake, the NRC regulations require that the design basis of safety features for each nuclear power plant take into account the potential effects of two levels of earthquake motion. The greater earthquake motion is based on an evaluation of the maximum earthquake potential considering regional and local geology and seismology and the specific characteristics of local subsurface material. This earthquake motion is designated as the safe-shutdown earthquake (SSE) or, in the case of North Anna 1 and 2, the DBE. It is the DBE for which certain SSCs necessary for safe shutdown are designed to remain functional. The lesser earthquake motion represents an earthquake event that has a reasonable chance of occurring during the life of the plant and is designated as the OBE. It is the OBE that produces the ground motion for which those features of the nuclear power plant necessary for continued operation are designed to remain functional. The regulations in Appendix A to 10 CFR Part 100 require that the design bases for earthquakes be determined through evaluation of the geologic and seismic history of the site and surrounding region. A determination is also required of the influences that result from human activities and from local site soil conditions. The largest earthquakes occurring in the site region must be assessed. An evaluation is required to determine whether faults in the

site region are active and could generate earthquakes large enough to be of significance to the earthquake design bases.

According to the North Anna 1 and 2, UFSAR Section 2.5, "Geology and Seismology," the most significant earthquakes in the region of the station affecting its design occurred near the Richmond Basin in 1774 and near the Arvonias Syncline in 1875. These shocks and related zones of earthquake activity are both located within 50 miles of the site and are believed to be associated with faulting in their respective basin-like structures. For the purpose of establishing a DBE, it was assumed that an earthquake equal to the largest shock associated with the Arvonias Syncline might occur close to the site area. With the epicenter of a shock similar to the 1875 Arvonias earthquake shifted to the vicinity of the site, it was estimated that the maximum horizontal ground acceleration (g) at the rock surface would be less than 0.12 g. Accordingly, the DBE for structures founded on rock was taken at 0.12 g for horizontal ground motion and two-thirds that value (0.08 g) for vertical ground motion. For structures founded on soil, the DBE was taken at 0.18 g for horizontal motion and 0.12 g for vertical motion. Seismic design for SSCs is described in North Anna 1 and 2, UFSAR Section 3.7, "Seismic Design."

In evaluating seismic and geologic information regarding the August 23, 2011, earthquake and its impact on the North Anna 1 and 2, site, the licensee has relied extensively on independent organizations, especially the USGS. According to the USGS, on August 23, 2011, a 5.8-moment-magnitude-scale (M<sub>w</sub>) magnitude earthquake occurred near Mineral, VA, at a relatively shallow depth about 6-km from the surface and was felt in the entire United States eastern coastal area. Some chimney and structural damage to residential buildings was observed around the epicenter area. A number of aftershocks have occurred since the main shock, with the largest magnitude being a 4.5 M<sub>w</sub>. There is no known fault source associated with the earthquake and aftershocks, but the USGS focal mechanism

solution of the earthquake indicates that the earthquake was possibly associated with a reverse fault. Since there is no report on any existing fault in the area and no surface ruptures reported during the earthquake, the fault is assumed to be a blind reverse fault.

The earthquake and its aftershocks occurred inside an area seismic source zone called the Central Virginia Seismic Zone (CVSZ). The CVSZ has produced small and moderate earthquakes since at least the 18th century and magnitudes for some significant events since 1984 ranged from 4.0 to 4.6 with the depth between 5 and 8 km. The largest earthquake known to have occurred in the CVSZ before 2011 is a magnitude 5.0-mb (body wave magnitude) Goochland County event in 1875. CVSZ is determined in the USGS Quaternary fault database as an "A" class seismic source, meaning that the CVSZ demonstrated Quaternary faulting of tectonic origin.

According to the USGS, the earthquake epicenter was located at 37.936° N, 77.933° W, approximately 18 km (11 miles) from North Anna 1 and 2. The USGS's estimate of Modified Mercalli Intensity is VI at the North Anna 1 and 2, site. The USGS estimated that the August 23, 2011, earthquake produced a peak ground acceleration of 0.26 g at the North Anna 1 and 2, site using ground-motion prediction equations modified by intensity information obtained by the USGS. Since the fault is assumed to strike north or northeast, that places the seismogenic fault closer to the North Anna 1 and 2, site (<18-km).

In the tectonic summary, the USGS indicates that the earthquake could not be causally associated with a currently mapped fault, but that it originated from a reverse or compression fault with a north or northeast striking plane. Earthquake magnitude estimates for the August 23, 2011, event range from 5.7 to 5.8 (M<sub>w</sub>), which is dependent upon the calculation methodology used. According to the USGS, accurate estimates of the probable fault rupture

geometry will not be understood until longer-term studies have been completed. The recurrence interval for this event cannot be stated with any degree of certainty at this time.

The licensee indicated that the scientific community has not yet completed a full evaluation of the August 23, 2011, earthquake. The licensee has been consulting with the Department of Geosciences at Virginia Polytechnic Institute and State University on this issue and will provide an update regarding any special ground-motion effects by March 31, 2012. The NRC staff agrees that understanding the special ground-motion effect is closely related to the knowledge of the seismic source fault, and will monitor and evaluate licensee's initiative in these areas.

- (6) There are numerous issues with the seismic instrumentation at North Anna 1 and 2, including lack of free field instrumentation, issues associated with conversion of analog data to digital data, issues with lack of on-site personnel with sufficient training in seismic measurements, and potential skewing of ground motion data due to the location of the "scratch plates."

The AIT inspection report identified an unresolved issue (URI), URI 05000338, 339/2011011-06, "Seismic Alarm Panel." Following the seismic event, the licensee installed a temporary uninterruptible power supply (UPS) to ensure that the seismic monitoring panel and its associated alarms that are used to determine if an emergency plan entry is required will remain operable during periods where power is being transferred between the normal supply and the emergency power supply. While the long-term corrective action calls for the UPS to be replaced with a different configuration, the immediate issue has been addressed and functionally tested. The licensee is evaluating means for upgrading the existing seismic monitoring system as a long-term option. The RRIT inspectors determined that the licensee

had taken appropriate actions to address the issue and documented it in its CAP program.

Therefore, no restart concerns were identified by the RRIT.

In Section 2.3, "Seismic Instrumentation," of the NRC staff's technical evaluation dated November 11, 2011, the NRC staff evaluated a number of issues associated with the seismic instrumentation at North Anna 1 and 2. As described in this report, there are two types of seismometers, Engdahl and Kinometrics, located at different elevation levels of the North Anna 1 containment and auxiliary buildings (as indicated in Figure 5 of the NRC staff technical evaluation dated November 11, 2011). The seismic monitors for both types of equipment at the North Anna 1 basemat were connected to the seismic instrumentation panel located in the control room with indication of OBE exceedance. During the earthquake, the annunciation panel lost power for about 8 seconds. Therefore, the licensee's plant operators were not informed about the occurrence or magnitude of the earthquake through the panel annunciator.

Several issues raised in the AIT inspection report regarding the seismometers and annunciation panel in the main control room (MCR) led the NRC staff to develop an RAI regarding the licensee's plans for modernization of the seismic instrumentation at both North Anna 1 and 2, for both rock- and soil-supported structures, to provide a reliable system and to accommodate onsite data interpretation. The licensee's response indicated that the plan for modernization of the seismic instrumentation at North Anna 1 and 2, consists of completed and scheduled work. First, a UPS was seismically qualified and installed in the control room in September 2011. This UPS provides backup power to the Kinometrics equipment and Engdahl peak shock alarms in the control room. The seismic switch event alarm and peak shock alarms provide control room operators with immediate feedback regarding whether the OBE has been exceeded. Second, an autonomous, temporary free-field seismic monitor was installed within the North Anna 1 and 2, owner-controlled area, east of the training building, in September 2011.

In addition, the station abnormal procedure for seismic events was updated to include reference to, and use of, the free-field monitor. Also, a procedure is in place for obtaining and evaluating free-field seismic data as it relates to cumulative average velocity (CAV) and an OBE or DBE exceedance determination. Although the licensee has not formally adopted RG 1.166 into its licensing basis, both of these actions facilitate the licensee's ability to assess earthquake data within 4 hours of an earthquake as described in RG 1.166.

The licensee further indicated that a project has been initiated to replace the existing seismic equipment and MCR indication with more modern equipment. Permanent, free-field seismic equipment will be installed to facilitate the performance of CAV calculations. The upgrade will also include installation of seismic recording instrumentation at the station's independent spent fuel storage installation (ISFSI) pad. The project is currently scheduled to begin equipment installation during the spring 2012 refueling outage.

As described in the AIT inspection report dated October 31, 2011, the NRC staff found that Engdahl seismometers at North Anna 1 and 2, are less reliable than Kinometrics. The licensee installed the free-surface / free-field seismometer with temporary settings. While this does not have the direct connection to the MCR instrumental panel to alert plant operators immediately during an earthquake event, the plant operator can still make an appropriate operating and reporting decision within the 4-hour limit. Therefore, with the combination of Kinometrics and free field seismometer, the NRC staff considered the licensee response acceptable. In addition, the licensee had connected the MCR instrument panel with a noninterruptible seismically-qualified backup power, and therefore, power disruption would not be expected in a future earthquake event.

The licensee also indicated that the Kinometrics seismometers at the plant did not have accurate timing for the recorded time history because the start time of seismic data is estimated.

The NRC staff asked the licensee to address how this potential uncertainty impacts the use of the seismic time history when matching it to other recorded events (e.g., the nuclear instrumentation (NI) signal changes) for the reactor shutdown root cause analysis. Considering this issue, the NRC staff asked the licensee to discuss any plans to update seismic instrumentation at the plant to provide better ground motion recordings for any future earthquake events.

Furthermore, the NRC staff asked the licensee to confirm the operability and reliability of the seismic instrumentation (specifically, channel orientation, sensor calibration, sensitivity test implementation) and alarming systems to ensure they accurately record earthquake ground motion and provide real-time alarm notifications to the plant operators during any earthquake events.

The licensee responded that the applicable Technical Requirements Manual (TRM) TS surveillance requirements have been completed satisfactorily for the seismic instrumentation and alarming systems following the earthquake. These include channel functional testing and channel checks of installed instrumentation for functionality. This also included channel calibrations of all peak acceleration and response spectrum recorders and the associated control room alarm indications. Channel calibrations were also completed for the time-history accelerographs and the seismic switch control room alarm indications. A channel orientation issue was identified for the time-history accelerographs whereby the horizontal sensors were 90 degrees off specified orientation. This discrepancy was entered into the CAP for resolution; however, there is no issue with either affected channel's functionality or the ability to record an earthquake event. Further investigation found no identifiable issues of a vertical recording channel interchanged for a horizontal recording channel for any of the installed systems.

Based on completed inspections and testing following the August 23, 2011, earthquake, there are presently no concerns with the functionality or reliability of the installed seismic instrumentation at North Anna 1 and 2. In addition, the licensee indicated in its response dated October 10, 2011, that the seismic instrumentation at North Anna 1 and 2, will be upgraded to enhance the station's ability to monitor and assess seismic events. The NRC staff agrees with the licensee's short-term transitional usage of the current seismic instrumentation.

The NRC staff asked the licensee to discuss the sensitivity of spectral acceleration value with respect to the methodology used (for example, sampling rates) and any other alternative calculations because in the licensee's letter dated September 17, 2011 (ADAMS Accession No. ML11262A151), Enclosure 1, Attachment 3, page 7, "Kinematics Data for Containment Elevation 291 [feet (ft)] - Vertical Direction," a figure shows a peak recorded value at about 10 hertz (Hz) that is greater than 1 g.

The licensee responded that this figure plots the vertical response spectrum generated from the time-history of the August 23, 2011, earthquake recorded by the Kinematics Instrument located at the North Anna 1 Containment Operating Deck (291-ft elevation). The time-history was recorded to an analog tape that was sent to the vendor, Kinematics, for processing and baseline correction. The resulting corrected time-history was input into a finite element program (STARDYNE, Version 5.11) to generate the response spectrum plot spanning from 0.2 Hz to 50 Hz in increments of 0.2 Hz. Two outside consultants used the same input time-history and independently generated nearly identical response spectra. Kinematics, in its input to the licensee (which was provided to the NRC staff in the letter dated September 17, 2011), also plotted the vertical time-history for comparison to the design-basis OBE and DBE curves. According to Kinematics, its software requires consistent use of input frequencies for all response spectra plotted for comparison. Accordingly, its data analysis

program plots the response spectrum generated from the recorded time-histories at only those frequencies at which the design spectra curves were digitized and were sent to it. Thus, the frequencies used by Kinometrics in plotting the vertical response spectrum lack the refinement and are not consistent with those frequencies that the licensee and other consultants used for plotting the response spectrum.

The Kinometrics results provided in Enclosure 1 to the letter dated September 17, 2011, were compared to the calculations performed by the licensee. The comparison shows differences in the peak spectral acceleration for the vertical direction spectra at the 291-ft elevation. The apparent difference in this instance is attributed to the frequency points at which Kinometrics plotted the vertical spectrum generated from the recorded time-history. The licensee's calculated peak spectral acceleration is 1.06 g at 10 Hz; whereas, the Kinometrics reported peak is only 0.973 g. The licensee explained that the value at 10 Hz provided by Kinometrics was an interpolated value, which caused a difference of less than 1 percent. Therefore, the apparent error was caused because of interpolations used by Kinometrics and not caused by differences in numerical integration methodology or sampling rates. Plotted at consistent frequencies, the Kinometrics data and the licensee's data are consistent, as is the case with the spectra developed from recorded motions by two other consultants.

In its technical evaluation dated November 11, 2011, the NRC staff agreed with the licensee's explanation that spectral acceleration difference is caused by the fact that Kinometrics methodology requires consistent frequency input for response spectrum calculation. The NRC staff also independently calculated response spectrum for the three components at the 291-ft elevation level and the results match with the results provided by the licensee.

The NRC staff concluded in its technical evaluation of November 11, 2011, that the licensee's characterization of the ground motion from the August 23, 2011, earthquake and its

impact on North Anna 1 and 2, were reasonable and acceptable. The NRC staff also concluded in this document that the licensee had reasonably demonstrated the operability of the seismic instrumentation during the seismic event at North Anna 1 and 2. The AIT also identified a URI associated with the seismic alarm panel in the MCR. The RRIT inspectors determined that the licensee had taken appropriate actions to address the issue and documented it in its CAP program. Therefore, the RRIT identified no restart concerns.

- (7) Retrofitting of North Anna 1 and 2, is required due to damage to North Anna 1 and 2, from the earthquake of August 23, 2011.

The NRC's RRIT concluded that the licensee adequately inspected plant SSCs to ensure that any damage from the August 23, 2011, seismic event was identified and, if found, would have been properly evaluated and corrected before initiating restart activities. As a result of the inspections performed by licensee, industry and NRC personnel, no significant seismically-induced damage was identified that could affect the operability or functionality of plant SSCs. The NRC RRIT did not identify any retrofitting as necessary for restart or continued safe operation. During the inspection, some examples of minor problems were identified and are discussed in the NRC staff's inspection report dated November 30, 2011. However, these issues did not rise to the significance of requiring retrofitting of the plant.

- (8) There are concerns with the impact of the August 23, 2011, earthquake on the North Anna 1 and 2, ISFSI including the fact that 25 casks weighing over 115 tons were not supposed to shift as much as 4.5 inches during an earthquake, validation of the integrity of the seals inside the spent fuel casks, assessing whether spent nuclear fuel storage facilities could topple or otherwise sustain significant damage resulting in a release, and assessing whether the licensee's emergency plans adequately addressed damage to the ISFSI as a result of a severe earthquake.

The licensee has taken action to assess the structural integrity and radiation shielding capability of both the TN-32 cask and NUHOMS-HD dry cask storage systems. The licensee reviewed this event for reportability under 10 CFR 72.75, "Reporting requirements for significant events and conditions" (significant reduction in effectiveness of any spent fuel storage cask confinement system), and determined that the TN-32 displacement and NUHOMS-HD 32PTH damage described above was not reportable. In addition, the licensee completed an extensive operability evaluation and determined that the dry storage systems continue to perform their design safety functions. The operability evaluation included extensive walkdowns by the licensee personnel and personnel from Nuclear Analysis and Fuel. These were to determine the condition of the spent fuel dry storage systems, ISFSI pads, and auxiliary equipment for the ISFSIs. The operability evaluation determined that: (a) ISFSI pads did not reveal any cracking or damage, (b) 25 of 27 casks moved by as much as 4.5 inches, (c) visual inspections of the casks did not reveal any damage, (d) spalling damage to the horizontal storage modules (HSMs) was minimal and did not impact the structural integrity or radiation shielding capability of the HSMs, (e) no movement occurred at the bases of the loaded HSMs (spacing between several HSM roofs indicated some very slight movement). (Later surveys, conducted after the operability evaluation, indicated that all but one of the loaded HSMs exhibited a slight (less than 1 inch) sideways shift), (f) inlet/outlet vents were inspected and no abnormal blockage was found, (g) thermal performance measurements for all loaded HSM's were performed and no abnormal temperature differences were found, and (h) radiological surveys of both pads indicated no changes to cask surface dose. Post-seismic inspection results concluded that the NUHOMS-HD 32PTH HSMs and TN-32 casks remain operable and continue to perform their intended design and safety functions.

The NRC staff maintains that there is no immediate safety issue at the North Anna ISFSI. This is based on (1) confirmatory inspections by the AIT to assess the condition of the ISFSIs, which concluded that there are no immediate safety issues associated with the movement of the vertical casks and horizontal storage ISFSI systems, and (2) the licensee's actions to ensure that regulatory requirements continue to be met. In addition, radiological conditions at the ISFSI were normal and monitoring systems were functional. Licensee actions are underway to evaluate and repair, if necessary, the ISFSI dry cask storage systems and components. The NRC staff has requested from the licensee a detailed integrated action plan to include completion target dates. Further, the NRC plans to independently assess the licensee analysis and corrective actions to ensure that the licensee adequately addresses short- and long-term ISFSI issues. The review may include confirmatory walkdowns, inspections, and analyses, as appropriate.

With respect to any damage to the ISFSI, such as the integrity of the seals and the radiation shielding on the casks, the NRC staff believes there is no immediate safety issue. The cask designs are robust and consider severe natural phenomena. As expected, the casks withstood the earthquake at the North Anna site. The spent fuel continues to be surrounded by several tons of steel and concrete and sealed in an inert helium environment. Damage to concrete components was minor and considered cosmetic and did not affect structural integrity or radiation shielding capability. Additionally, the fuel assemblies are designed to withstand a maximum of 4 g axial load and 6 g lateral load. The licensee inspected inlet and outlet vents and found no exterior blockage. Radiation surveys indicate no changes to cask surface dose rates. Thermal performance measurements for all loaded casks found no abnormal temperature differences.

The NRC staff assessed whether spent nuclear fuel storage facilities could topple or otherwise sustain significant damage from a more powerful earthquake that would result in a release of nuclear radioactive particles into the environment. As discussed above, there are two spent fuel dry cask storage systems deployed at the North Anna site: the TN-32 and the NUHOMS-HD. For the TN-32 system, spent fuel is loaded directly into the metal casks equipped with a bolted closure lid. The NUHOMS-HD system places spent fuel in a welded dry shielded canister (DSC) resting on horizontal rails inside the HSM, which uses thick concrete in the walls, floor, and roof slabs.

The cask systems at the North Anna site are designed to accommodate environmental conditions and natural phenomena as well as withstand postulated accidents in accordance with 10 CFR 72.122(b). This involves structural integrity analysis of the DSC held within a transfer cask during fuel loading for the handling drop accidents and the TN-32 cask for the nonmechanistic tip-over condition. The impact inertia forces imposed on the cask structural components for these analyses are many times higher than those associated with the design-basis earthquake. The design analysis indicated that, although some structural component damage may result in some adverse effect on the system shielding function, the cask confinement boundaries (i.e., the DSC of the NUHOMS-HD and the inner shell of the TN-32 metal cask) would not be breached.

For a much more powerful earthquake than that experienced at the North Anna site, the spent fuel cask storage systems may or may not topple. However, as discussed above, even if the cask systems topple, the confinement boundaries of the cask systems would not be breached and no release of radioactive particles would occur.

With respect to assessing whether the licensee's emergency plans are sufficient to deal with an emergency situation where spent nuclear fuel storage facilities are significantly

damaged as a result of a severe earthquake, the NRC staff has also made an evaluation. First, with regard to the toppling of the NUHOMS-HD and TN-32 dry cask storage systems, no credible earthquakes have been identified that would result in such an event occurring. However, NRC standard review plans (SRPs), NUREG-1536 and NUREG-1567, provide that a nonmechanistic cask tip-over be assumed and analyzed to determine what effect would result from such an event. For the NUHOMS-HD system, since the canister is not stored in a vertical cylindrical overpack, no tip-over analysis is performed. For the TN-32, the tip-over structural analysis demonstrates that the confinement boundary or the inner shell of the metal cask would not be breached, and no release path would exist for any of the radioactive particles contained in the cask. There is, however, the potential for some adverse effect on the shielding function of the cask. Any such degradation in shielding, and consequent potential increase in radiation levels around any toppled casks, would be evaluated by the licensee and may or may not result in required actions under the site emergency plan.

With respect to emergency planning for such an eventuality, the North Anna Emergency Plan (NAEP) describes the organization, assessment actions, conditions for activation of the emergency organization, notification procedures, emergency facilities and equipment, training, provisions for maintaining emergency preparedness, and recovery criteria used at North Anna. This emergency plan also addresses any radiological emergencies that may arise at the North Anna ISFSI. Appropriate response actions and notifications have been established in the NAEP.

- (9) The petitioner is concerned that the licensee cannot be trusted to communicate reliable information to the public or the regulator based on the fact that the licensee in the 1970s failed to promptly disclose the discovery of geological information and was subjected to a monetary fine for the violation.

The licensee informed the NRC staff in May 1973 that it had found a family of faults during excavation for a previously planned Unit 3 and Unit 4 for the North Anna Power Station. (These units were not constructed for various reasons). The licensee did not observe any faults in the foundation excavations for the existing North Anna 1 and 2. After a number of investigations, assisted by the USGS, the NRC staff concluded in December 1976 in the safety evaluation report, Supplement No. 5, for North Anna 1 and 2, that none of the faults known to exist at the North Anna site were capable faults within the context of Appendix A of 10 CFR Part 100.

The NRC took enforcement action and assessed a civil penalty after finding in January 1975 that the licensee for North Anna 1 and 2, had submitted multiple “material false statements” regarding the fault beneath the North Anna site. However, the NRC staff considers this a closed issue that has no bearing on its assessment of the August 23, 2011, earthquake.

#### Enforcement Actions Requested by the Petitioner and the Response by the NRC

The NRC staff has evaluated the petitioner’s requests to: (1) take escalated enforcement action against the licensee and suspend, or revoke, the operating licenses for North Anna 1 and 2, and (2) issue a notice of violation against the licensee with a proposed civil penalty in the amount of 1 million dollars. With respect to these two requests, the evaluations of two NRC inspection teams as documented in inspection reports dated October 31, 2011, and November 30, 2011, did not find any violation of NRC regulations that would merit such enforcement actions.

With respect to the petitioner’s third request for enforcement action: to issue an order to the licensee requiring the licensee to keep North Anna 1 and 2, in a “cold shutdown” mode of operation until such time as a series of actions described in the petition are completed, the NRC

staff concludes that it has partially granted that request in that the NRC issued CAL No. 2-2011-001 dated September 30, 2011, which stated the following:

“This Confirmatory Action Letter (CAL) confirms that NAPS [North Anna Power Station] Units 1 and 2 will not enter Modes 1-4 (as defined in the technical specifications), until the Commission has completed its review of your information, performed confirmatory inspections, and completed its safety evaluation review. The permission to resume operations will be formally communicated to Virginia Electric and Power Company (VEPCO) in a written correspondence.

VEPCO shall submit to the NRC all documentation requested by the NRC as being necessary to demonstrate that NAPS Units 1 and 2 can be operated safely following the seismic event that exceeded the safe shutdown event analyzed in the current revision of the Updated Final Safety Analysis Report.

This CAL will remain in effect until the NRC has (1) reviewed your information, including responses to staff’s questions and the results of your evaluations, and (2) the staff communicates to you in written correspondence that it has concluded that NAPS can be operated without undue risk to the health and safety of the public or the environment.”

This CAL, therefore, confirmed the licensee’s understanding that North Anna 1 and 2, could not be restarted unless and until the licensee had demonstrated to the NRC staff’s satisfaction that “... no functional damage has occurred to those features necessary for continued operation without undue risk to the health and safety of the public,” consistent with the requirements of 10 CFR Part 100, Appendix A, Section V(a)(2). Restart was contingent upon addressing a number of issues before startup, many of which issues were identified in whole or in part in the petition as concerns.

Issues in the petition, identified and discussed above as concerns 1, 2, 3, 5, 6, 7, and 8, were discussed and substantially addressed, either in the inspection reports issued October 31, 2011, and November 30, 2011, or in the NRC technical evaluation dated November 11, 2011. The activities by the NRC staff were completed before restart to ensure that, before resuming operations, the licensee had demonstrated no functional damage had occurred to those features at North Anna 1 and 2, necessary for continued operation without undue risk to the health and safety of the public. In that respect, these concerns described in the petition as requiring completion before the restart of North Anna 1 and 2, were addressed before restart, consistent with the third request for enforcement action described in the petition. Issues in the petition, identified and discussed above as concerns 4 and 9, were evaluated by the NRC staff before restart of North Anna 1 and 2, but disposition of these concerns by the NRC staff differs from the course of action requested in the petition. In that respect, these aspects of the petition are denied.

### III. Conclusion

Based on the above, the Office of Nuclear Reactor Regulation has decided to deny the petitioner's first two requests for enforcement action and to partially grant the petitioner's third request. As provided in 10 CFR 2.206(c), a copy of this Director's Decision will be filed with the Secretary of the Commission for the Commission to review. As provided for by this regulation, the Decision will constitute the final action of the Commission 25 days after the date of the Decision unless the Commission, on its own motion, institutes a review of the Decision within that time.

Dated at Rockville, Maryland, this 26<sup>th</sup> day of April 2012.

FOR THE NUCLEAR REGULATORY COMMISSION

*/RA/*

Eric J. Leeds, Director  
Office of Nuclear Reactor Regulation

RESOLUTION OF COMMENTS FROM VIRGINIA ELECTRIC AND  
POWER COMPANY (DOMINION) ON THE PROPOSED DIRECTOR'S DECISION

1. On page 25 the [proposed Director's] Decision states, "Following the seismic event, the licensee installed a temporary uninterruptible power supply (UPS) to ensure that the seismic monitoring panel and its associated alarms that are used to determine if an emergency plan entry is required will remain operable during periods where power is being transferred between the normal supply and the semivital bus (emphasis added)."

Dominion recommends that the sentence be changed to read "... remain operable during periods where power is being transferred between the normal supply and the emergency power supply."

Response:

The U.S. Nuclear Regulatory Commission (NRC) staff modified the final Director's Decision to reflect that power is being transferred between the normal supply and the emergency power supply.

2. On page 26, the [proposed Director's] Decision states, "The seismic monitors for both types of equipment at the North Anna 1 basemat were connected to the seismic instrumentation panel located in the control room with indications of OBE and SSE exceedance (emphasis added)."

Dominion recommends that the end of the sentence be changed to read "with indication of OBE exceedance."

Response:

The NRC staff modified the final Director's Decision to reflect on page 26 that the seismic instrumentation panel located in the North Anna 1 and 2 control room provides indication of OBE exceedance, but not SSE exceedance.

3. On page 28, the [proposed Director's] Decision states, "Considering this issue, the NRC staff asked the licensee to discuss any plans to update seismic instrumentation at the plant to provide better ground motion recordings for any future earthquake events."

Dominion recommends that the additional sentence noted below be added following the above statement consistent with Item 4 of the Action List in the November 11, 2011 Confirmatory Action Letter (CAL). We recommend the sentence, "Consistent with the NRC CAL, Action Item 4, Dominion will implement a design change to replace the existing seismic equipment and main control room indication with upgraded and enhanced seismic monitoring instrumentation equipment, which includes installation of a permanent, free field seismic monitor."

Response:

The NRC staff did not modify the final Director's Decision as a result of this comment. The proposed additional sentence does not fit the context of that section of the Director's Decision as this section describes NRC staff actions taken as part of the augmented inspection team for North Anna 1 and 2, as documented in the inspection report dated October 31, 2011.

4. On page 32 the [proposed Director's] Decision states that, "(e) no movement occurred at the bases of the loaded HSMs [horizontal storage modules] (spacing between several HSM roofs indicated some very slight movement,"

Since the initial operability evaluation, Dominion has performed additional surveys to verify proper alignment of the front face of the HSMs to the approach monuments. The subsequent surveys indicated that all but one of the loaded HSMs exhibited a slight (less than 1 inch) sideways shift.

Response:

The NRC staff modified the final Director's Decision to reflect on page 32 the addition of the following words after the words referenced above "(Later surveys, conducted after the operability evaluation, indicated that all but one of the loaded HSMs exhibited a slight (less than 1 inch) sideways shift)."

5. On page 36 the [proposed Director's] Decision states, "After NRC's investigation, which was assisted by the USGC, it was concluded in 1973 in the safety evaluation report, Supplement No. 3 (emphasis added), that "none of the faults known to exist ....and 10 CFR Part 100.

Dominion recommends that the sentence read as follows, "After NRC's investigation, which was assisted by the USGC, it was concluded in 1976 in the safety evaluation report [SER], Supplement No.2, states in part..." The discussion of seismology is included in SER supplement 2 dated August 1976.

Response:

The NRC staff modified the final Director's Decision to properly reflect the proper reference to Supplement No. 5 to the SER.