UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
OFFICE OF NEW REACTORS
WASHINGTON, DC 20555-0001

February 1, 2013

NRC INFORMATION NOTICE 2012-25: PERFORMANCE ISSUES WITH SEISMIC INSTRUMENTATION AND ASSOCIATED SYSTEMS FOR OPERATING REACTORS

ADDRESSEES

All holders of an operating license or construction permit for a nuclear power reactor or non-power (research or test) reactor under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," except those that have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel.

All holders of and applicants for a power reactor early site permit, combined license, standard design certification, standard design approval, or manufacturing license under 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to inform addressees of an occurrence where seismic instrumentation and associated monitoring and alarm systems did not provide reliable indications or alarms. Thus, plant operators were unable to promptly determine if the ground motion levels exceeded the Operating Basis Earthquake (OBE) ground motion levels. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this IN are not NRC requirements; therefore, no specific action or written response is required.

DESCRIPTION OF CIRCUMSTANCES

Mineral, Virginia Earthquake on August 23, 2011, and its impact to nuclear power plants

On August 23, 2011, a magnitude (Mw) 5.8 earthquake occurred near Mineral, Virginia. The ground motion resulting from the earthquake was felt strongly by the local community and was also felt in most of the eastern United States. The nuclear power plant closest to the epicenter, North Anna Power Station (NAPS), declared an Alert because of the significant earthquake vibrations felt on site, and both units experienced automatic reactor trips from 100 percent power, initiated by the Power Range Nuclear Instrument High Negative Flux Rate Reactor Trip. All safety system functions were maintained throughout the event. After a detailed inspection of the plant, the licensee identified no significant damage to the safety-related structures, systems, and components (SSCs) of the plant. Shortly after the earthquake, the NRC dispatched an

Augmented Inspection Team (AIT) to NAPS to gather additional information and conduct a review of the event. The AIT report identified potential generic issues related to the performance and operability of seismic instrumentation for nuclear power plants.

Several licensees of other nuclear power plants, including the Surry Nuclear Power Station (SNPS), declared Notifications of Unusual Events for seismic vibration felt by station personnel, during the August 23, 2011, seismic event. Although no damage to safety-related SSCs was identified, issues were noted with the functioning of seismic instrumentation at SNPS.

Additional information appears in NRC AIT Inspection Report 05000338/2011011, 05000339/2011011, 07200016/2011001, and 07200056/2011002, dated October 31, 2011, on the NRC's public Web site within Agencywide Documents Access and Management System (ADAMS) Accession Number ML113040031.

BACKGROUND

For licensees whose construction permit was issued prior to January 10, 1997, Appendix A to 10 CFR Part 100, "Seismic and Geological Siting Criteria for Nuclear Power Plants," Section VI, "Application to Engineering Design," Paragraph (a)(3), "Required Seismic Instrumentation," states that "Suitable instrumentation shall be provided so that the seismic response of nuclear power plant features important to safety can be determined promptly to permit comparison of such response with that used as the design basis. Such a comparison is needed to decide whether the plant can continue to be operated safely and to permit such timely action as may be appropriate." Regulatory Guide (RG) 1.12, Revision 1 (April 1974), "Instrumentation for Earthquakes", describes an acceptable approach to using seismic instrumentation to satisfy the requirements of Appendix A to 10 CFR Part 100.

For applicants for a construction permit or operating license under 10 CFR Part 50, or a design certification, combined license, design approval or manufacturing license under 10 CFR Part 52, on or after January 10, 1997, Appendix S to 10 CFR Part 50, "Earthquake Engineering Criteria for Nuclear Power Plants," Paragraph IV(a)(4), "Required Seismic Instrumentation," states that "Suitable instrumentation must be provided so that the seismic response of nuclear power plant features important to safety can be evaluated promptly after an earthquake". Paragraph IV(a)(3), "Required Plant Shutdown," requires shutdown of the nuclear power plant if the OBE is exceeded. RG 1.12, Revision 2 (March 1997), "Nuclear Power Plant Instrumentation for Earthquakes", describes an acceptable approach to using seismic instrumentation to satisfy the requirements of Appendix S to 10 CFR Part 50.

Part B, "Discussion," of Revision 2 to RG 1.12 states, "Instrumentation is provided in the free-field and at foundation level and at elevation in Seismic Category I structures. Free-field instrumentation data will be used to compare measured response to the engineering evaluations used to determine the design input motion to the structures and to determine whether the OBE has been exceeded…. The instruments located at the foundation level and at elevation…will be used in long-term evaluations." The seismic instrumentation at a number of operating reactor plants is installed consistent with RG 1.12, Revision 1, which does not specifically require seismic instrumentation to be installed on the free surface in the free field.

DISCUSSION

When an earthquake occurs, data recorded by the seismic instrumentation is used by the operators to make a rapid determination of the degree of severity of the event, including the need to shutdown the plant when the OBE is exceeded. The data, coupled with plant walkdowns, is used to make the initial determinations of whether the plant must be shutdown, if it has not already been shut down by the plant operators or the perturbations resulting from the seismic event.

At NAPS, portions of the seismic instrumentation panel inside the main control room were not connected to an uninterruptible power supply and therefore were not functioning during the momentary power outage (approximately 8 seconds) of the emergency busses while the emergency diesel generators started and loaded following the loss of offsite power. This resulted in an inability of the plant operators to promptly determine if the ground motion levels exceeded the OBE or Safe Shutdown Earthquake (SSE, also referred to as Design Basis Earthquake) levels, since the 3.1 seconds of strong ground motion portions of the earthquake in each of the three orientations occurred during the 8 second power outage. Although the seismic event resulted in an automatic shutdown (initiated by a power range nuclear instrument high negative flux rate) of both operating units at NAPS, the licensee could not immediately confirm conclusively that the plant had its OBE or SSE levels exceeded until the Kinemetrics tri-axial seismic time history accelerograph recording was analyzed. The Kinemetrics tri-axial seismic time history accelerograph recorder had been powered via a battery-backed power supply.

An additional consequence of the momentary loss of power to the seismic instrumentation panel in the control room was that the site could not use the seismic response entry criteria to enter the Emergency Action Level (EAL) matrix for a seismic event. The entry criteria for the Seismic Response EAL required that the Engdahl strong motion accelerograph peak shock annunciator illuminate, which would indicate a seismic event greater than OBE. Since there was a momentary loss of power, this annunciator did not illuminate. It is important to note that the lack of control panel alarm from the seismic monitoring panel did not delay an Alert declaration. The Shift Manager used a different EAL matrix entry criteria, (i.e., Shift Manager judgement), and appropriately declared an Alert.

NAPS, which had instrumentation conforming to RG 1.12, Revision 1, had no seismic monitoring instrumentation located on the free surface in the free field. Free field instrumentation data can generally be compared more accurately to the original design input motion to validate the seismic engineering design for the structures, systems and components at the site. The recordings from instrumentation located at the containment basemat, because of influence of the structure itself as well as interaction with the surrounding materials and structures, are typically not as accurate for determining input ground motion data from the earthquake.

The data recorded by the Engdahl (scratch-plate) style seismometers was not as complete as the data recorded by the Kinemetrics (accelerometer-based) equipment for the instruments located on the basemat of Unit 1. The recorded data indicated significant differences in the amplitude of the motion recorded at various frequencies between the scratch-plate style

seismometers and the accelerometer based seismic instrumentation. Further, no data was recorded for two frequencies of interest on the scratch-plate instruments, while the accelerometer based instruments indicated seismic motion was occurring and recorded data for those frequencies.

One other site discovered a seismic instrumentation issue as a result of the Mineral, VA earthquake. At SNPS, subsequent to the earthquake, the United States Geological Survey (USGS) provided seismic data which indicated that ground motion accelerations (nominally 0.04 to 0.05g, where g is the acceleration due to gravity) were of sufficient magnitude to trigger the seismic monitors, which have a setpoint of 0.01 g. However, the Kinemetrics SMA-3 seismic monitors at the site did not trigger during the event, leading the licensee to declare the seismic monitors inoperable. The USGS data confirmed that the Surry site did not exceed the OBE ground motion. Additional information appears in NRC Integrated Inspection Report 05000280/2012002, 05000281/2012002, dated May 10, 2012, on the NRC's public Web site within ADAMS Accession Number ML12131A564.

SNPS troubleshooting efforts revealed that all three sensor masses for the Kinemetrics triggering unit were misaligned. The masses were locked on their stops in all three orthogonal directions and could not trigger at the 0.01g setpoint. The triggering unit's calibration is done in the Instrumentation and Control shop and then returned to the field location for re-installation. It is likely that the sensor masses became misaligned sometime between shop calibration and triggering unit re-installation. Post installation testing consisted of mechanically agitating the trigger unit, which did not detect the misalignment. The vendor recommends a technique of gently blowing on the trigger sensor to verify that the masses will respond to ground motion. The masses were subsequently re-centered, and each trigger sensor and response was functionally tested to verify proper operation.

CONCLUSION

Plant operators rely upon the proper calibration and functioning of seismic instrumentation and the associated seismic alarm system to enable them to make timely decisions about whether a plant may continue to operate and whether it fully conforms with its licensing basis during and following an earthquake. In addition, the examples in this IN illustrate the importance of licensees understanding the design, operation and performance of their seismic instrumentation. By evaluating the performance of seismic instrumentation and associated alarm systems and considering the appropriate actions, licensees can assure more accurate earthquake ground motion recording and better information for plant operators during any seismic activity at their plant sites.

CONTACT

This IN requires no specific action or written response. Please direct any questions about this matter to the technical contacts listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) or Office of New Reactors project manager.

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Note: NRC generic communications may be found on the NRC's public Web site, http://www.nrc.gov, under NRC Library.

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