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

August 12, 2016

NRC INFORMATION NOTICE 2016-11: POTENTIAL FOR MATERIAL HANDLING EVENTS TO CAUSE INTERNAL FLOODING

ADDRESSEES

All holders of an operating license or construction permit for a nuclear power 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 recent operating experience that indicated material handling events could cause internal flooding that exceeds flood levels considered in the facility design basis. The NRC expects 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

<u>Fort Calhoun Station</u>

On August 2, 2013, the engineering staff at Fort Calhoun Station (FCS) identified that the seismic analysis of the intake structure crane did not evaluate the crane's ability to withstand a seismic event when in use. At the time of discovery, the unit was in cold shutdown. An investigation identified that the crane had been used when the raw water pumps were required to be operable. The licensee had previously completed a load drop analysis for the intake structure and determined that a load drop from the crane would not cause damage to the intake structure. However, the engineering staff found that potential damage to the unprotected fire protection headers that exist in the intake structure had not been considered in the load drop analysis. Because the crane had not been verified to withstand seismic effects, the licensee concluded that this piping could be damaged by falling equipment if the intake structure crane was in use during a seismic event. The engineering staff concluded that the volume of flooding that could be produced by this event was outside of the assumptions of the intake structure internal flooding analysis and could result in all four raw water pumps becoming inoperable.

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At FCS, the raw water system performs an essential safety function. In combination with the component cooling water system, the raw water system performs the safety-related design-basis accident heat removal function and the decay heat removal function. Therefore, the licensee identified this condition as one that could have prevented fulfillment of an essential safety function.

The safety significance of this identified condition was low. Unlike many U.S. power reactor facilities, the FCS emergency onsite diesel generators have air-cooled radiators and, therefore, the electric power distribution system does not rely on the raw water system. The licensee also had an existing abnormal operating procedure specifically developed to address a total loss of raw water. Furthermore, the primary corrective action for this identified issue was limited to development of a new seismic analysis that determined the crane could be safely operated with an attached load during a seismic event.

Additional information is available in Fort Calhoun Station Licensee Event Report (LER) 50-285/2013012, dated September 30, 2013.[1] Further information also appears in NRC Inspection Reports 05000285/2013015 and 05000285/2015007, dated November 8, 2013,[2] and April 16, 2015,[3] respectively.

Arkansas Nuclear One, Units 1 and 2

On March 31, 2013, during an Arkansas Nuclear One (ANO) Unit 1 outage, the licensee was moving the Unit 1 main generator stator out of the turbine building when an inadequately designed and untested temporary lifting rig collapsed. The collapse caused the 525-ton stator to fall onto the Unit 1 turbine deck, roll off the damaged deck, and fall approximately 30 feet into the train bay between Unit 1 and Unit 2. The stator impact caused substantial damage to the Unit 1 turbine building structure and power distribution systems, and parts of the collapsing lift rig struck structures and components on the Unit 2 side of the turbine building.

At the time of the event, Unit 1 was shut down in a refueling outage with the reactor vessel head off and fuel in the vessel. The partial collapse of the turbine deck damaged non-vital electrical buses supplying offsite power to Unit 1. This damage to the electrical buses resulted in a loss of normal offsite power to Unit 1 for 6 days, but power was available from emergency diesel generators to power both trains of safety-related equipment in Unit 1.

Unit 2 was operating at 100 percent power with no major evolutions in progress at the time of the event. When the temporary lift rig collapsed, components of the lift rig impacted Unit 2 structures and components. The vibration from the impact triggered a relay contact that opened the breaker supplying power to one of the operating reactor coolant pumps, resulting in an automatic reactor shutdown. The impact also ruptured an 8-inch fire main. The loss of pressure in the fire main caused both the normal diesel-driven and a temporary motor-driven fire pump to start as designed. Operators secured the diesel-driven pump within 15 minutes, but temporary motor-driven fire pump operation continued for over 40 minutes, as indicated by flow from the rupture. Although much of the water flowed out of the turbine building train bay, water from the rupture also flowed to areas of the turbine and auxiliary buildings, causing additional damage. The damage included loss of one offsite source to Unit 2 after water caused an

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[1] Agencywide Documents Access and Management System (ADAMS) Accession No. ML13274A638. ADAMS is accessible through the NRC's public Web site at http://www.nrc.gov, under NRC Library.
[2] ADAMS Accession No. ML13312A876.
[3] ADAMS Accession No. ML15106A891.

electrical fault inside the Unit 2 non-safety switchgear in the turbine building approximately 33 minutes after the collapse.

The NRC staff determined that the temporary lift rig collapse had substantial safety significance for both Unit 1 and Unit 2. The staff found that the direct and indirect damage caused to the electrical distribution system and the complications associated with water around the switchgear would have posed significant challenges to recovery of offsite power, if the onsite sources had not functioned properly. Corrective actions included: (1) modifying procedures related to handling of heavy loads; (2) training the facility staff on the revised requirements for handling heavy loads; and (3) repairing the damaged Unit 1 turbine structure, fire main system, and both Unit 1 and Unit 2 electrical systems.

The NRC dispatched an augmented inspection team to review the facts surrounding the event, as documented in "Arkansas Nuclear One—NRC Augmented Inspection Team Report 05000313/2013011 and 05000368/2013011," dated June 7, 2013.[4] Additional information is available in "Arkansas Nuclear One—NRC Augmented Inspection Team Follow-Up Inspection Report 05000313/2013012 and 05000368/2013012; Preliminary Red and Yellow Findings," dated March 24, 2014.[5] Further information is available in Arkansas Nuclear One, Units 1 and 2, LER 50-313/2013-001-00, dated May 24, 2013,[6] and Supplemental LER 50-313/2013-001-01, dated August 22, 2013.[7]

BACKGROUND

<u>Related NRC Regulations</u>

The regulations in 10 CFR 50.65, "Requirements for monitoring the effectiveness of maintenance at nuclear power plants," paragraph (a)(4), require that each licensee assess and manage the increase in risk that may result from proposed maintenance activities. The scope of this assessment may be limited to structures, systems, and components (SSCs) that a risk-informed evaluation process has shown to be significant to public health and safety.

DISCUSSION

Licensees commonly undertake activities involving movement of heavy components, particularly activities supporting refueling and refurbishment of large plant components. One class of these activities involves refueling and refurbishment of large components using permanently installed cranes that were evaluated as part of each licensee's heavy load handling program. A second class of activities consists of less frequent heavy load movements for maintenance and refurbishment that had not been considered in the scope of the heavy load handling program. This second class of load movements may involve the use of permanently installed cranes that have not been evaluated for use under all plant conditions or temporary overhead handling equipment. The events identified at FCS and ANO are examples of this second class of activities. These heavy load movements may be subject to the requirements of 10 CFR 50.65(a)(4) to assess and manage the risk of heavy load movements associated with maintenance activities.

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[4] ADAMS Accession No. ML13158A242.
[5] ADAMS Accession No. ML14083A409.
[6] ADAMS Accession No. ML13144A220.
[7] ADAMS Accession No. ML13234A241.

Material handling activities evaluated within the scope of each licensee's heavy load handling program have included consideration of the overhead handling system design, testing, and maintenance. The evaluation of the design, testing, and maintenance applied to these handling systems provides assurance that the structure of the handling system is robust. Consequently, traditional load drop analyses only postulated failures in the hoisting machinery and rigging, which would limit potential effects to equipment near the load. However, use of temporary overhead handling systems or permanent overhead handling systems not previously evaluated for use under all plant conditions may not provide the same level assurance in the structural integrity of the system. Therefore, licensees may wish to consider the potential for structural failures and consequential plant damage when assessing measures to manage the risk of heavy load movements using these types of overhead handling systems for maintenance related activities.

Handling system structural failures could affect SSCs well away from the load itself because the overhead handling system structure often spans long distances. Although load drop analyses typically evaluate the effect on SSCs immediately below the load path, the events at FCS and ANO demonstrate the potential for damage to SSCs separate from the load path. The FCS event report addressed potential damage to piping systems under the overhead crane bridge that the licensee did not consider in the completed load drop analysis, because the piping was not under the load. Similarly, the temporary handling system collapse at ANO damaged fire protection system piping outside the footprint of the handling system structure. The consequences of a material handling accident can be magnified by potential internal flooding because flooding from pipe breaks can:

- be of greater magnitude than that considered in the design basis,
- propagate to other areas, and
- affect redundant components.

For these cases, licensees may wish to manage the increase in risk associated with the maintenance activity by enhancing the qualification of the handling system structure, as completed at FCS, or evaluating the effects of structural failures on equipment beyond the immediate vicinity of the load.

CONTACT

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

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

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ADAMS Accession Number: ML16154A022 ***via e-mail** **TAC MF7539**

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