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NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
OFFICE OF NEW REACTORS
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July 26, 2011

NRC INFORMATION NOTICE 2011-17: CALCULATION METHODOLOGIES FOR OPERABILITY DETERMINATIONS OF GAS VOIDS IN NUCLEAR POWER PLANT PIPING

ADDRESSEES

All holders of, or applicants for, an operating license or construction permit for a nuclear power reactor issued 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 or applicants for an early site permit, standard design certification, standard design approval, manufacturing license, or combined 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 instances of gas accumulation in safety-related systems in which the resulting operability determination of the as-found condition relied on computer models that were not demonstrated to be technically appropriate for the intended application. Specifically, the computer models had not been sufficiently qualified by benchmarking against test or plant data. The NRC expects that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. Suggestions contained in this IN are not NRC requirements; therefore, no specific action or written response is required.

BACKGROUND

Gas accumulation in systems that are designed to be full of water has been a longstanding issue associated with commercial nuclear power plant operations. To address this problem, the NRC issued Generic Letter (GL) 2008-01, "Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems," on January 11, 2008 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML072910759). GL 2008-01 asked addressees to submit information to demonstrate that the subject systems were in compliance with the current licensing and design bases and applicable regulatory requirements, and that suitable design, operational, and testing control measures were in place for maintaining this compliance.

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NRC Inspection Manual Temporary Instruction (TI) 2515/177, "Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems (NRC Generic Letter 2008-01)," dated June 9, 2009 (ADAMS Accession No. ML082950666), provided background information and guidance for NRC inspectors to verify that the onsite documentation, system hardware, and licensee actions are consistent with the information provided in the licensee's response to GL 2008-01.

For parts of a nuclear plant system that are filled with water as part of their design basis, a gas void is considered a degraded or nonconforming condition or both that could potentially render the system inoperable. When a gas void is identified, the operability of the system in its as-found condition can be evaluated using NRC Inspection Manual, Part 9900, Technical Guidance, "Operability Determinations & Functionality Assessments for Resolution of Degraded or Nonconforming Conditions Adverse to Quality or Safety," dated April 16, 2008 (ADAMS Accession No. ML073531346).

The NRC Office of Nuclear Reactor Regulation (NRR) prepared, "Guidance to NRC/NRR/DSS/SRXB Reviewers for Writing Temporary Instruction (TI) 2515/177 Suggestions for the Region Inspections," Revision 11, dated May 23, 2011 (ADAMS Accession No. ML111660749), to offer further technical guidance for use by NRC inspectors when inspecting licensee operability determinations associated with gas voids. It covers topics such as void transport behavior and pump response to voids. NRR revises this guidance as needed to provide NRC inspectors with the most recent insights such as knowledge gained through industry response to GL 2008-01 and plans to place any future revisions under ADAMS Package Accession No. ML112070155.

DESCRIPTION OF CIRCUMSTANCES

Millstone Power Station Unit 3

On October 20, 2008, with Millstone Power Station Unit 3 at zero percent power, as part of GL 2008-01 activities, the licensee discovered a 15-percent gas void in the accessible portion of the 24-inch-diameter pipe connecting the refueling water storage tank (RWST) to the emergency core cooling system (ECCS) pumps. Licensee engineering staff determined that under some postulated loss-of-coolant accident scenarios, the gas void could have been transported to specific ECCS pumps, rendering them inoperable. The licensee determined the cause to be a latent design error, as the system design did not account for the as-built pipe deviation from horizontal that trapped gas in the 24-inch-diameter section of pipe. The pipe should have had either a greater slope towards the RWST or a vent valve installed in the 24-inch-diameter section. Licensee corrective actions included installing a vent valve on this line to provide a venting location.

The licensee's thermal-hydraulic and void size modeling to assess operability used the RELAP5 computer code (licensee test results and analysis are publicly available under ADAMS Accession Nos. ML091170150, ML091170137, and ML091870829). The licensee qualified the use of the RELAP5 computer model through benchmarking against test data obtained using mockups of the specific Millstone Unit 3 ECCS configuration to demonstrate applicability of the RELAP5 computer model to the Millstone Unit 3 ECCS piping application. Where necessary, the licensee performed additional calculations to supplement the RELAP5 calculations to

provide results consistent with the test data. Additional information appears in Millstone Unit 3 Licensee Event Report 05000423/2008-004-00, dated December 19, 2008 (ADAMS Accession No. ML090070031).

The NRC inspected the licensee's operability determination and identified no findings of significance. Additional information appears in Millstone Unit 3 NRC Special Inspection Team Report 05000423/2008010, dated March 23, 2009 (ADAMS Accession No. ML090820433).

Point Beach Nuclear Plant

On September 30, 2010, the NRC completed an inspection of Point Beach Units 1 and 2, which included an inspection using TI 2515/177 as documented in Point Beach Units 1 and 2 NRC Integrated Inspection Report 05000266/2010004; 05000301/2010004, dated November 9, 2010 (ADAMS Accession No. ML103130057). The NRC inspectors reviewed the licensee's procedures for conducting surveillances and determining void volumes to ensure that the void criteria were satisfied and would be reasonably ensured to be satisfied until the next scheduled void surveillance. The licensee established void volume acceptance criteria for piping system high points to be used during field verifications. The void volumes were derived based on pipe internal diameter and as-built slope, and internal height of the void. In addition, the licensee relied on the use of the computer software GOTHIC to perform two-phase and two-component analysis of gas movement to predict how a void volume in piping is translated into a transient void fraction at the entrance of a pump following pump start. The licensee provided supporting information that did not rely upon the GOTHIC computer model to demonstrate acceptability.

The NRC inspection report describes several issues related to whether the GOTHIC computer model had been sufficiently qualified through benchmarking against test or plant data to demonstrate the applicability of the computer model to the type of analysis being conducted, and the applicable terms, conditions and limitations for its use. While the licensee referenced some testing to qualify the GOTHIC computer model for use in predicting quantitative void transport behavior, the NRC inspection report provides examples of how the test configuration and conditions differed from the actual plant configuration and conditions. The NRC inspection report states that the inspectors discussed these observations with NRR and that it was determined that these observations required further evaluation by NRR to better understand the acceptability of the application of the test results. The licensee subsequently provided supporting information that did not rely upon GOTHIC.

DISCUSSION

During the NRC staff's reviews of licensee responses to GL 2008-01 and subsequent NRC inspections, the NRC reviewed instances of gas accumulation in safety-related systems in which the resulting operability determination of the as-found condition relied on a computer model that was not demonstrated to be technically appropriate for the intended application. Specifically, the computer model had not been acceptably qualified by benchmarking against test and plant data to demonstrate its applicability to the type of analysis being conducted, and the applicable terms, conditions and limitations for its use. This, along with basing analyses on inappropriate pump suction void criteria, could result in licensees establishing inappropriate or unsupported values for gas void volumes that could impact system operability.

The above example of Millstone Unit 3 illustrates a case where a licensee acceptably qualified the use of a computer model (RELAP5) to assess past ECCS operability in response to a gas void the licensee discovered. This benchmarking, and therefore the applicability, of the RELAP5 computer model for predicting gas transport was limited to the Millstone Unit 3 piping application. Conversely, the above example at Point Beach describes issues related to whether the GOTHIC computer model had been acceptably qualified through benchmarking to demonstrate applicability for the specific application. Qualification issues also exist for other calculation methodologies such as other computer programs and manual calculation methods.

CONTACT

This IN requires no specific action or written response. Please direct any questions about this matter to the technical contacts listed below or to the appropriate 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..