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

December 11, 2020

INFORMATION NOTICE 2007-21, Supplement 1: PIPE WEAR DUE TO INTERACTION OF FLOW-INDUCED VIBRATION AND REFLECTIVE METAL INSULATION

Addressees

All holders of operating licenses, construction permits, or combined licenses for nuclear power reactors, except those that have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel.

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to alert addressees to recent information related to wear of nuclear power plant piping caused by flow-induced vibration (FIV) conditions that has not been captured in industry operating experience reports. In this supplement to IN 2007-21, "Pipe Wear Due to Interaction of Flow-Induced Vibration and Reflective Metal Insulation," dated June 11, 2007 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML071150051), the NRC staff discusses additional recent instances of piping wear due to FIV conditions. The NRC expects that addressees will review the information for applicability to their facilities and consider actions, as appropriate, to identify and address similar problems. However, suggestions contained in this IN are not NRC requirements; therefore, the NRC requires no specific action or written response to this IN.

Description of Circumstances

In IN 2007-21, the NRC staff described multiple wear marks on the chemical and volume control (CVCS) system stainless steel piping downstream of the CVCS system letdown orifices at Catawba Nuclear Station (Catawba), Unit 1, identified during the refueling outage in the fall of 2006. The licensee determined that these marks were the result of abrasive wear between the stainless steel reflective metal insulation (RMI) end caps and the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (BPV Code) Class 2 piping. The cause of this abrasive wear was most likely FIV causing an interaction between the end cap and the piping. The licensee assembled RMI by clipping together short segments of insulation with the end caps located at the intersection of each insulation segment. The Catawba, Unit 1, licensee discovered a total of 84 wear marks from its initial and extent-of-condition inspections and repaired the piping by light grinding. In addition, the licensee used ultrasonic examination of the repaired areas to confirm acceptable pipe thickness and liquid penetrant testing to confirm the absence of surface cracks. The licensee installed temporary stainless steel "cuffs" directly on the piping at some RMI end cap locations, and placed fiberglass insulation pads

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where it could not install the "cuffs." As follow-up actions, the licensee planned to consider installing an improved RMI design and to inspect Catawba, Unit 2, for similar piping wear.

Since the issuance of IN 2007-21, additional licensees have identified instances of RMI fretting (also referred to as abrasive wear) of nuclear power plant piping in other systems. Examples include Beaver Valley Power Station Units 1 and 2 Integrated Inspection Report 05000334/2019004 and 05000412/2019004, page 4 (ADAMS Accession No. ML20044D313) and Arkansas Nuclear One Integrated Inspection Report 05000313/2020002 and 05000368/2020002, page 26 (ADAMS Accession No. 20218A442). In the spring of 2020, the licensee of Arkansas Nuclear One (ANO), Unit 2, identified multiple wear marks on piping in the ASME BPV Code Class 1 pressurizer spray line. In some instances, the wear marks were circumferentially oriented and only detectable by visual examination after RMI removal. The depth of wear marks ranged from a simple surface scratch to a 25-percent through-wall deep groove that stretched up to 360 degrees around the circumference of the pipe. See Figures 1 and 2 in the enclosure to this IN. The ANO, Unit 2, licensee determined that fretting wear from FIV between the ASME BPV Code Class 1 piping and the RMI end caps caused the damage.

At ANO, Unit 2, the licensee confirmed that the RMI end caps had been installed in accordance with plant procedures and vendor instructions. The licensee repaired the deeply worn areas of the ASME BPV Code Class 1 piping that did not meet the required minimum wall thickness by welding to restore the piping to the original construction code. The licensee repaired the other worn areas of the piping by surface conditioning to meet the original construction code. The licensee then added stainless steel "cuffs," or banding, to protect the Class 1 piping at the ANO, Unit 2, locations that experienced abrasive wear.

Discussion

The NRC regulations in General Design Criterion 1, "Quality standards and records," of Appendix A, "General Design Criteria for Nuclear Power Plants," to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic licensing of production and utilization facilities," require the following:

> Structures, systems, and components important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed. Where generally recognized codes and standards are used, they shall be identified and evaluated to determine their applicability, adequacy, and sufficiency and shall be supplemented or modified as necessary to assure a quality product in keeping with the required safety function.

The ASME BPV Code contains no specific requirements for licensees to remove insulation periodically to visually inspect piping for RMI wear. For example, the ASME BPV Code requirements for visual examinations (VT-2) do not require removal of piping insulation. However, the NRC regulations in 10 CFR Part 50, Appendix A, General Design Criterion 1, include general requirements for the design, fabrication, erection, and testing of nuclear power plant piping with provisions to supplement codes and standards as necessary to assure a quality product in keeping with the required safety function.

The NRC staff notes that RMI wear of ASME BPV Code Class 1 piping could result in an unisolable leak from the reactor coolant pressure boundary in nuclear power plants. For

example, one of the wear marks on the pressurizer spray line at ANO, Unit 2, reached a depth of 25 percent of the through-wall thickness of the piping. The ANO licensee discovered the wear in this section of the pressurizer spray line because of its piping inspections in response to vibration-related failures of snubber connections to the pressurizer spray line. Unchecked, this type of wear could cause a small break loss of coolant accident and challenge the plant emergency core cooling systems.

The NRC staff is issuing this supplement to IN 2007-21 to alert licensees to the potential for FIV to cause RMI wear that could impact the integrity of nuclear power plant piping. Without specific ASME BPV Code requirements to remove insulation periodically to inspect piping, licensees might not be aware of ongoing piping wear. Thus, the abrasive wear can continue without detection and impact the leak tightness and structural integrity of the piping.

To mitigate the wear of affected piping, some licensees have installed temporary stainless steel "cuffs" or banding (or, alternatively, fiberglass insulation if "cuffs" could not be added) directly on the outer surface of the piping at the RMI end cap locations. This mitigation method provides a physical barrier that protects the piping from abrasive wear until the insulation can be replaced with an improved design.

Contacts

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 Office of Nuclear Reactor Regulation project manager.

/RA/

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Figures 1 and 2

Note: NRC generic communications may be found on the NRC public Web site, http://www.nrc.gov, under Electronic Reading Room/Document Collections.

Figure 1. First example of ANO, Unit 2, Pressurizer Spray Line Wear caused by Flow-Induced Vibration between Piping and RMI End Cap

Figure 2. Second example of ANO, Unit 2, Pressurizer Spray Line Wear caused by Flow-Induced Vibration between Piping and RMI End Cap

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