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

September 24, 2015

NRC INFORMATION NOTICE 2015-09: MECHANICAL DYNAMIC RESTRAINT (SNUBBER) LUBRICANT DEGRADATION NOT IDENTIFIED DUE TO INSUFFICENT SERVICE LIFE MONITORING

ADDRESSEES

All holders of and applicants for 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 nuclear 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." All applicants for a standard design certification, including such applicants after initial issuance of a design certification rule.

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to alert addressees to potential degradation of the lubricant (grease) in mechanical dynamic restraints (snubbers) not identified due to insufficient service life[1] monitoring (SLM). 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.

DESCRIPTION OF CIRCUMSTANCES

Limerick Generating Station, Unit 1

At the beginning of 2014, during the 15th refueling outage (1R15) at the Limerick Generating Station, Unit 1, Exelon Generation Company (licensee) functionally tested a sample of safety- related snubbers in accordance with its technical specification (TS) surveillance requirements (SRs). The use of the TS SRs in lieu of American Society of Mechanical Engineers (ASME) *Boiler and Pressure Vessel Code* (BPV Code), Section XI, requirements for the Limerick Generating Station, Unit 1, was authorized by the NRC staff in response to Relief

[1] The term "service life" is defined by the ASME *Code for Operation and Maintenance of Nuclear Power Plants* (OM Code) as, "the period of time an item is expected to meet the operational readiness requirements without maintenance." The ASME OM Code is incorporated by reference in 10 CFR 50.55a, "Codes and standards," with conditions.

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Request I3R-05 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML080500584). Four mechanical snubbers were found not to meet the test acceptance criteria, which resulted in an increase in the testing scope as required by the TS SR. One snubber failed its test due to high drag, and three snubbers failed their tests due to high acceleration. An apparent cause evaluation, failure analyses, and comparison testing were performed. The apparent cause of the drag failure was confirmed to be due to dried grease throughout the snubber based on visual examination of the internal parts. The apparent cause of the high acceleration test failures was degradation of the test machine.

Diablo Canyon Nuclear Power Plant, Unit 1

At the beginning of 2014, during the 18th refueling outage (1R18) at the Diablo Canyon Nuclear Power Plant, Unit 1, the Pacific Gas & Electric Company (licensee) functionally tested a sample of safety-related snubbers in accordance with its Third Interval Snubber Program submitted to the NRC in its letter DCL-10-157, dated December 21, 2010 (ADAMS Accession No. ML103560316). For snubber inservice examination and testing, the licensee implemented the requirements of ASME *Code for Operation and Maintenance of Nuclear Power Plants* (OM Code), Subsection ISTD, and its Engineering Control Guidance 99.1, and identified five mechanical snubber failures during functional testing. These five failures, from two separate defined test plan groups, resulted in an increase in the testing scope of 51 additional snubbers. These snubber failures were a result of grease degradation due to aging.

Browns Ferry Nuclear Plant, Unit 3

At the beginning of 2014, during the 16th refueling outage (U3R16) at the Browns Ferry Nuclear Plant, Unit 3, Tennessee Valley Authority (licensee) functionally tested a sample of safety-related snubbers in accordance with its Technical Requirement Manual (TRM) TR 3.7.4. For snubber inservice examination and testing, the NRC staff authorized the use of Browns Ferry Nuclear Plant, Unit 3, TRM TR 3.7.4 in lieu of the ASME BPV Code, Section XI, requirements in response to Relief Request 3-ISI-2 (ADAMS Accession No. ML063330648). A total of four Pacific Scientific Arrestor (PSA) mechanical snubbers failed during their functional test to meet the specified acceptance criteria. These failures resulted in an expanded scope of functional testing of snubbers. Based on failure analysis, it was determined that two PSA-3 snubbers failed due to dried grease and damage to internal parts. One PSA-35 snubber failed due to sticky, tacky grease, and damage to snubber internal parts. Another PSA-10 snubber failed due to loose internal parts.

Arkansas Nuclear One, Unit 2

During the 22nd refueling outage (2R22) in 2012 at Arkansas Nuclear One, Unit 2, Entergy Operation, Inc. (licensee) functionally tested a number of safety-related snubbers in accordance with the 10 percent test plan in the 2004 Edition of the ASME OM Code, Subsection ISTD. During this functional testing, seven mechanical snubbers did not meet the specified acceptance criteria, resulting in a scope expansion. Two of the seven snubbers were later evaluated and it was concluded the functional test results were not failures. During scope expansion, all of a specific type large bore mechanical snubber model (that exhibited the failure) were tested. The predominant cause appeared to be dry or “caked” grease, which would imply a degraded condition of the grease. Similarly, during a previous Arkansas Nuclear One, Unit 2

refueling outage (2R19) in 2008, there were eight functional failures of mechanical snubbers. The failures resulted in five scope expansions. The primary issue was drag failures associated with over-greasing or dried grease.

Oyster Creek Generating Station

During the 23rd refueling outage (1R23) in fall 2010 at Oyster Creek Generating Station, Exelon Generation Company (licensee) functionally tested a sample of safety-related snubbers in accordance with its TS 4.5.M, "Shock Suppressors (Snubbers)." While performing the functional testing of selected snubbers, four functional failures caused Exelon to expand their inspection scope, and an additional 40 percent of the installed mechanical snubbers were tested. The apparent cause of the failures for all four snubbers was either hardened or missing grease. While inspecting four snubber testing failures that occurred during refueling outage 1R23, the NRC inspector identified a non-cited violation of TS 4.5.M.1.f, "Service Life Monitoring." Specifically, Exelon's snubber testing program, contained in SP-1302-52-045, "Requirements for Functional Testing of Snubbers," does not evaluate snubber maintenance and test records to identify common cause failures of snubbers due to environmental (temperature, vibration, and humidity) conditions and adjust snubber service life expectations accordingly, such that snubber service life reviews can be accomplished effectively without service life affecting reactor operations. Exelon took immediate corrective action to repair or replace the failed snubbers, performed an analysis to ensure the snubber failures had no impact on system operation, and entered this issue into its corrective action program (ADAMS Accession No. ML110390509).

BACKGROUND

Related NRC Generic Communications

NRC Information Notice (IN) 1994-48, "Snubber Lubricant Degradation in High-Temperature Environment," summarizes the degradation of the lubricants used in mechanical snubbers when snubbers are placed in a high-temperature environment (ADAMS Accession No. ML031060631).

NRC Generic Letter (GL) 1984-13, "Technical Specification for Snubbers," (ADAMS Accession No. ML031150710).

Related Guidance and Applicable Standards

ASME Standard QME-1-2007, "Qualification of Active Mechanical Equipment Used in Nuclear Power Plants," as endorsed by Regulatory Guide 1.100, Revision 3, "Seismic Qualification of Electrical and Active Mechanical Equipment and Functional Qualification of Active Mechanical Equipment for Nuclear Power Plants," provides one acceptable method for qualification testing of dynamic restraints such as snubbers, including the monitoring of lubrication degradation. Nuclear power plant applicants and licensees may specify the use of ASME Standard QME-1-2007, as endorsed in Regulatory Guide 1.100, Revision 3, in procurement specifications for new or replacement dynamic restraints.

NUREG/CR-5870, "Results of LWR [light-water reactor] Snubbers Aging Research," dated May 1992, provides aging research results and recommendations for snubbers used in nuclear power plants (NPPs) to enhance the understanding of snubber aging and its consequences (ADAMS Accession No. ML040340438).

DISCUSSION

At operating NPPs, safety-related snubbers are used as restraining devices to control the movement of piping systems and equipment during abnormal dynamic conditions (such as earthquakes, turbine trips, safety/relief valve discharge, and rapid valve closures). The design of a snubber allows free thermal movement of a component during normal operation conditions, but restrains the component during abnormal dynamic conditions. Adequate lubrication is essential to the proper functioning of snubbers.

The operational readiness of snubbers at an NPP is established by the combination of inservice examination, testing, and SLM of snubbers during refueling outages as required by 10 CFR 50.55a and the applicable ASME BPV Code or ASME OM Code. Many snubbers were originally procured and installed with the expectation that they would be maintenance free for the duration of the manufacturer's recommended design life. The physical condition of snubbers is evaluated by visual inspections which, depending on the number of unacceptable snubbers identified during the previous inspection interval, could be performed once every 48 months. Also, if the licensee is using ASME OM Code Case OMN-13 after meeting the prerequisite requirements, the inservice visual examination can be performed once every 10 years.

Past industry experience with snubber failures has demonstrated that the failure modes of mechanical snubbers might not be identified by visual inspection or physical stroking. In particular, functional testing under static load conditions is more effective than visual inspection or physical stroking in confirming snubber operational readiness. In that only a small sample of the snubber population is selected for testing, SLM plays a very important role in maintaining the operational readiness of snubbers at an NPP.

During refueling outages, licensees typically select a small sample of snubbers for functional testing to demonstrate their operational readiness in accordance with the applicable ASME BPV Code or ASME OM Code, plant-specific TS/TRM, or NRC authorized relief or alternatives. In accordance with the specific sampling method, snubbers may be selected randomly or based on the size, design, configuration, operating environment, load capacities and distribution of the snubber population, using various sample techniques considering test failure rates. With the small sample of snubbers selected for functional testing each refueling outage, it might take decades before all of an NPP's snubbers are tested. Furthermore, some snubbers might never be tested during their service life.

In the examples above, most of the snubber failures were determined to be caused by grease degradation, such as: (1) oil separation from grease; (2) dried or "caked" grease; (3) excessive grease; (4) sticky and tacky grease; and (5) hardened or missing grease. A well-planned SLM program for snubbers can minimize the number of snubber failures due to degradation of grease. An effective SLM program would include provisions for preventive maintenance (such as regreasing, partial disassembly for an internal inspection, or additional functional testing for SLM for mechanical snubbers) based on the results of performance monitoring and the evaluation of the service conditions for snubbers.

In NRC IN 1994-48, the NRC staff alerted licensees to potential grease degradation due to high temperature. The high grease temperature might result from the installation area environmental conditions or internal conditions caused by vibration. In addition to high temperature, the NRC staff has observed that additional factors might contribute to degradation of the snubber lubricant (grease). For example, grease degradation might result from the following:

- vibration
- elevated temperature for extended periods of time (e.g., high room temperature, high fluid temperature, and snubber installed in close proximity to high-temperature components)
- hazardous environment at the snubber location
- aging of the snubber and grease
- snubber installed from spare inventory without a recent preservice test
- shelf life of the grease exceeding the manufacturer's recommendation.

The ASME BPV Code or ASME OM Code, plant-specific TS/TRM, or NRC-authorized relief or alternatives require licensees to perform SLM to evaluate service life of each safety-related snubber at least once each fuel cycle. An effective SLM program would consider these service conditions in evaluating the need for preventive maintenance for potentially affected snubbers prior to the end of their service life. In addition, the review of historical records or manufacturer recommendations may need to be supplemented with other information, such as plant conditions and operating experience, in evaluating the need for preventive maintenance of snubbers.

In addition, NUREG/CR-5870 concludes that aging may deteriorate mechanical snubber performance, particularly when snubbers are exposed to one or more environmental stressors. Performance is related to drag force, breakaway force, and acceleration threshold. Primary influences affecting degradation are elevated temperature, vibration, moisture, and dynamic transients. An effective SLM program would identify and monitor service conditions, and implement appropriate preventive maintenance of snubbers.

Alternatively, Section QDR, "Qualification of Dynamic Restraints," in ASME Standard QME- 1- 2007 provides guidance for qualification testing of snubbers. Section QR-5000, "Qualification Principles," and Nonmandatory Appendix QDR-A, "Functional Specification for Dynamic Restraints," in ASME QME-1-2007 provide guidance for evaluation of aging effects, determination of qualified life (as defined in ASME QME-1, Section QR), and development of a replacement schedule for the lubricant, if applicable.

A key factor in the determination of service life of mechanical snubbers during SLM is the condition of the grease with consideration of the shelf life for the replacement grease. For example, the original lubricant Nuclear Radiation Resistance Grade (NRRG)-159 for mechanical snubbers was discontinued by the manufacturer around 1995, and was replaced with the new lubricant NRRG-2. Therefore, NRRG-159 that has been maintained in long-term storage may not be effective. The typical shelf life of grease is about 5 years under normal storage conditions, but some manufacturers have indicated that stored grease may be used for up to 10 years. The lubricant suppliers or vendors may provide their own certified useful recommended shelf life. Grease for safety-related components that is used beyond its recommended shelf life is still subject to the regulatory requirements in 10 CFR Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants."

CONCLUSION

Safety-related snubbers are important restraining devices to control the movement of piping systems and equipment during abnormal dynamic conditions. The design of a snubber allows free thermal movement of a component during normal operating conditions, but restrains the

component during abnormal dynamic conditions. In addition to appropriate operation of the mechanical parts of snubbers, adequate lubrication is essential to the proper functioning of snubbers. The operational readiness of snubbers is maintained by the combination of inservice examination, testing, and SLM as required by 10 CFR 50.55a and the applicable ASME BPV Code or ASME OM Code, the plant specific TS/TRM, or NRC authorized relief or alternatives.

The NRC expects that addressees will review the information in this IN for applicability 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.

CONTACT

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