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

February 3, 2010

NRC INFORMATION NOTICE 2010-05: MANAGEMENT OF STEAM GENERATOR LOOSE PARTS AND AUTOMATED EDDY CURRENT DATA ANALYSIS

ADDRESSEES

All holders of an operating license or construction permit for a nuclear power pressurized-water reactor issued under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," except those who 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 inform addressees of recent operating experience with (1) loose parts (foreign objects) in steam generators and (2) the use of automatic steam generator eddy current data analysis systems. The NRC expects recipients to review the information for applicability to their facilities and to 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

At the Braidwood Station, Unit 1, in 2009, the licensee, Exelon Generation Company, LLC, inspected steam generator tubes using eddy current techniques. As is common practice, the licensee used two independent teams (i.e., primary and secondary teams) to evaluate the data. Each of the two teams used an automated data screening system to evaluate the bobbin coil eddy current data. Human analysts reviewed the results of each of the automated data screening systems to accept, reject, or modify the classification of the signals identified through the automatic data analysis.

During the 2009 inspections, one of the automated data analysis systems identified a distorted signal from the bobbin coil eddy current data slightly above both the expansion transition and the tubesheet on the hot-leg side of the steam generator. The human analyst accepted this signal for further investigation. To resolve the nature of this indication, the licensee used a rotating eddy current probe to inspect the location with the distortion. Based on the result of this subsequent examination, the licensee concluded that mechanical wear between the tube and a foreign object caused the indication. The depth of the wear indication was estimated from the rotating probe as 73 percent through the tube wall. Because of its size, the indication was in situ pressure tested to confirm that it did not significantly compromise the integrity of the tube. The licensee did not observe any leakage during the in situ pressure test and confirmed the tube had adequate integrity. Following the in situ pressure test, the licensee stabilized and

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plugged the tube. The plant technical specifications require the licensee to plug any tubes with flaws equal to or exceeding 40 percent of the wall thickness.

This tube had been inspected during prior outages. Upon review of the historical eddy current data, the licensee concluded that an indication had existed at this location since 2006. The indication in 2006 was smaller than that observed in 2009, whereas the indication in 2007 was similar in size to the indication observed in 2009. As a result, the licensee concluded that the tube should have been plugged in 2007.

As was the case for the 2009 steam generator tube inspections, two independent automated data analysis systems were employed during the 2006 and 2007 inspections at Braidwood Station, Unit 1. During all three inspections, the primary automated data analysis system identified a distorted signal at the location where the flaw was observed in 2009. Because the human analyst rejected these signals in both 2006 and 2007, no further investigation into the nature of the signal was performed. The secondary automated data analysis system did not identify this location as having a distorted signal in the 2006, 2007, or 2009 inspections, although a signal attributed to a potential loose part was initially identified in 2006 and was subsequently rejected by the human analyst during that inspection.

During the 2009 outage, no foreign object was found near the tube with the 73 percent through-wall wear indication. However, the affected tube was located near a cluster of tubes that the licensee had plugged in 2003 because of a foreign object that was identified but could not be removed. During the 2007 outage, the licensee could not locate this foreign object and now postulates that it moved from its original location and caused the 73 percent through-wall wear indication. The licensee also postulates that the foreign object may have broken into smaller pieces that were removed by the blowdown system or during the removal of sludge from the top of the tubesheet (i.e., sludge lancing).

The licensee assessed the cause of this event and determined that it was a historic human performance issue related to the amount of technical rigor applied during the review of the distorted eddy current data that the automated data analysis system identified during the 2006 and 2007 inspections. A contributing cause was that one of the automated data analysis systems did not identify the distorted indication.

The licensee took the following corrective actions:

- It revised the guidelines for the eddy current data analysis to emphasize the requirement to manually review available frequencies associated with distorted top of the tubesheet indications before determining whether an indication requires additional testing and/or analysis.

- It incorporated the lessons learned from this issue in its site-specific performance demonstration training and testing program to ensure that all data analysts and computer screening systems can properly identify the signal as requiring additional eddy current inspection.

- It reevaluated the logic parameters in the automated data analysis system that the secondary data analysis team used.

- It determined and implemented changes to ensure that foreign object wear indications are correctly identified at the top of the tubesheet region.

The licensee also assessed the eddy current method that it had chosen to size the wear indication identified in 2009 (i.e., the rotating eddy current probe). Different sizing methods exist for differently shaped wear scars (e.g., football-shaped and tapered-hole wear scars) and for volumetric indications, like wear, in the free span. For at least one of these techniques (e.g., sizing with a pancake coil), the resultant size would have been much smaller than 73 percent, thereby resulting in a flaw that would not require in situ pressure testing. The licensee used a sizing method that conservatively estimated the flaw size and verified that the integrity of the tube was not compromised through in situ pressure testing.

BACKGROUND

Related Generic Communications

Previous related generic communications include the following:

- NRC IN 2004-10, "Loose Parts in Steam Generators," dated May 4, 2004 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML041170480)

- NRC IN 2004-17, "Loose Part Detection and Computerized Eddy Current Data Analysis in Steam Generators," dated August 25, 2004 (ADAMS Accession No. ML042180094)

- NRC IN 2003-05, "Failure To Detect Freespan Cracks in PWR [Pressurized-Water Reactor] Steam Generator Tubes," dated June 5, 2003 (ADAMS Accession No. ML031550258)

DISCUSSION

In addition to reinforcing the information in NRC IN 2004-10 and NRC IN 2004-17, the recent operating experience at Braidwood, Unit 1 illustrates several important points relative to the management and detection of loose parts and the use of automatic data analysis systems. The loose part that may have caused the wear scar identified in 2009 was first identified in adjacent tubes during a refueling outage in 2003. The licensee stabilized and plugged the tubes surrounding the original location of the loose part because it was unable to remove the loose part; however, the loose part eventually migrated from its original location.

Monitoring the location of loose parts that are left in the steam generator may help licensees detect tubes potentially affected by loose parts. For example, if a loose part is left in the steam generator, the licensee can perform secondary side visual inspections during subsequent outages to verify that the loose part has not moved. If the loose part has moved, additional secondary side visual inspections could be performed to locate the loose part, and primary side inspections could be performed on active tubes surrounding the original location of the loose part to determine whether the loose part has affected these tubes. If visual examination of the loose part's original location is not possible, primary side inspections of the active tubes surrounding the original location could determine whether the loose part has moved and whether additional tubes have been damaged. This process may lead to the more timely detection of wear caused by loose parts.

At Braidwood, Unit 1 only one of the automated data analysis systems identified the distorted signal attributed to the wear scar estimated as being 73 percent through the tube wall. The qualification of an automated data analysis system is important for ensuring that all relevant flaw signals are identified. Ensuring that an automated data analysis tool can detect the various types of flaws that may occur along the entire length of the tube is important for ensuring tube integrity, and plant technical specifications require licensees to perform inspections with the objective of detecting flaws of any type that may satisfy the applicable tube repair criteria.

Most plants with thermally treated Alloy 690 tubing, such as Braidwood, Unit 1 have very little degradation, and the forms of degradation that are observed at these plants tend to be easily detectable. Because many of the signals identified during the automated data analysis screening may not be flaws, it is important that eddy current data analysts do not inadvertently dismiss relevant signals. The experience at Braidwood, Unit 1 highlights the importance of ensuring that human data analysts effectively review eddy current data. A licensee can monitor the performance of a human analyst by inserting a known flaw signal from a “Judas” (or “Cobra”) tube into the data stream that is being reviewed, as discussed in NRC IN 2003-05.

Choosing the appropriate method to size an indication is important for verifying tube integrity. In instances where multiple techniques exist for sizing a flaw, it is important to select the most appropriate technique. If the licensee cannot determine an appropriate technique, a conservative approach should be used to ensure that tube integrity is being maintained as required by the plant technical specifications. At Braidwood, Unit 1 the licensee used a sizing method that conservatively estimated the flaw size and in situ pressure tested the flaw to verify that tube integrity was maintained.

CONTACT

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

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