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

April 12, 2008

NRC INFORMATION NOTICE 2008-05: FIRES INVOLVING EMERGENCY DIESEL GENERATOR EXHAUST MANIFOLDS

ADDRESSEES

All holders of operating licenses for nuclear power reactors, 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 fires at nuclear power facilities involving emergency diesel generator (EDG) exhaust manifolds. The NRC expects that addressees will review the information for applicability to their facilities and consider taking 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

The Office of Nuclear Reactor Regulation recently reviewed operating experience related to EDG fires that have occurred since the beginning of 2003. The following describes several EDG fires that occurred at commercial nuclear power plants.

Calvert Cliffs Nuclear Power Plant, Unit 1

During a surveillance test conducted on August 12, 2007, a small fire ignited on the Calvert Cliffs Nuclear Power Plant, Unit 1, EDG 1B exhaust manifold. The EDG 1B was approximately 1-hour and 20 minutes into a monthly surveillance run and at full load for 17 minutes when the fire occurred. Lube oil leaked from multiple, loose engine top cover bolts onto the exhaust manifold and caused the fire. Operators extinguished the flames with a carbon dioxide fire extinguisher. The small fire lasted approximately 6 minutes. The licensee terminated the surveillance test and unloaded and shut down the EDG. The licensee then examined the engine top cover and discovered that 15 of the 122 bolts were at less than the 40–55 foot-pounds (ft-lbs) torque value specified by the vendor. The licensee tightened these bolts to 55 ft-lbs and verified that all engine top cover bolts on all of the onsite Fairbanks Morse EDGs (1B, 2A, and 2B) were within the vendor-specified torque value. The EDG 1B was returned to an operable status after satisfactory post-maintenance testing. The licensee's procedure for performing the EDG inspection did not specify a torque value for the engine top cover bolts.

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The procedure did not reference or incorporate the torque value of 40–55 ft-lbs recommended by the "Fairbanks Morse Engine Technical Manual" (NRC Integrated Inspection Report Nos. 05000317/2007004 and 05000318/2007004, dated November 8, 2007, Agencywide Documents Access and Management System (ADAMS) Accession No. ML073170049).

Arkansas Nuclear One (ANO), Unit 2

On August 27, 2003, the licensee performed a planned monthly surveillance test run of the ANO, Unit 2 EDG 2K-4A (Fairbanks Morse) and EDG 2K-4B. During this run, a small flash fire occurred on the exhaust manifold that self-extinguished after a few seconds. The fire resulted from oil leaking past the exhaust manifold gasket for cylinders 7, 8, and 9 and onto the external surface of the exhaust manifold. The oil on the exhaust manifold flashed into flames when the surface temperature reached approximately 260 °C (500 °F). Licensee corrective actions included replacing all exhaust manifold gaskets. Eleven months earlier, the licensee had prepared a maintenance action item for EDG 2K-4B noting that an oil leak had developed on the exhaust manifold for cylinders 7, 8, and 9. (NRC Integrated Inspection Report Nos. 0500313/2003004 and 0500368/2003004, dated November 4, 2003, ADAMS Accession No. ML033090130)

On April 15, 2007, the licensee performed a surveillance run of the ANO Unit 2 EDG 2K-4A. During this run, operators observed smoke coming from underneath the insulation on both four-barrel collectors, one on each side of the EDG. The operators observed that, occasionally, a small flash flame would appear and self extinguish. The flame and smoke ceased by the time full load was achieved and the 24-hour run was completed with no additional flame or smoke. The insulation on this EDG had been replaced 4 days earlier. The licensee determined that the actual insulation material was not damaged but the insulation cover material had started to burn as the EDG exhaust system heated up. The cover material was rated only to 260 °C (500 °F), and the expected temperature of the exhaust piping was 538 °C (1,000 °F). The licensee had also installed the same type of insulation 13 days earlier on EDG 2K-4B. As part of its corrective action, the licensee replaced the insulation on both EDGs with insulation with an outer wrap appropriately rated for the expected temperatures. (NRC Integrated Inspection Report Nos. 05000313/2007003 and 05000368/2007003, dated August 3, 2007, ADAMS Accession No. ML072180555)

On May 11, 2007, the licensee performed a monthly surveillance run of the ANO Unit 2 EDG 2K-4A. The EDG had been running fully loaded for approximately 10 minutes when the operators observed a small fire that appeared to originate from under the insulation on an exhaust manifold. The operators observed the fire for approximately 20 seconds and concluded that it was not going to burn out. The operators extinguished the fire with a fire extinguisher. Control room operators unloaded and secured the EDG. The licensee removed the insulation from the four-barrel collector adjacent to the exhaust manifold and discovered that approximately 16 square inches were saturated with oil. The licensee determined the source of the oil was front cover of the EDG and the root cause was uncorrected equipment problems. The licensee did not adequately implement corrective actions from a 2003 diesel exhaust manifold fire in that the periodic inspections for oil leakage by operators and system engineers did not identify the oil leakage from the front cover. (NRC Integrated Inspection

Report Nos. 5000313/2007003 and 05000368/2007003, dated August 3, 2007, ADAMS Accession No. ML072180555)

On August 3, 2007, the licensee started and loaded the ANO, Unit 2 EDG 2K-4A for a monthly surveillance test. The EDG had been running fully loaded for approximately 1-minute when the operators observed a fire on the exhaust system. The fire appeared to originate from the inspection cover plate on the bottom side of the four-barrel collector assembly, which connects the exhaust header to the turbocharger. When control room operators unloaded the EDG, the intensity of the fire diminished significantly. After the EDG was secured, two small flames were observed coming from the inspection cover plate. An operator extinguished the flames using a fire extinguisher. The licensee determined the root cause of this event was a warped four-barrel inspection cover plate. This inspection cover plate had been removed from an existing four-barrel collector then installed on a spare four-barrel collector when the spare was installed during maintenance on May 11, 2007. The licensee's maintenance procedure used for the replacement of the four-barrel inspection cover plate did not specify performing flatness checks. As a result, oil leakage from the inspection cover plate caused an exhaust system fire. (NRC Integrated Inspection Report Nos. 05000313/2007004 and 05000368/2007004, dated October 24, 2007, ADAMS Accession No. ML073520276)

North Anna Power Station, Unit 2

In September 2006, a fire occurred on the North Anna Power Station Unit 2 EDG H exhaust manifold. The licensee determined the fire was caused by lube oil leakage past an exhaust manifold connection onto the external surface of the manifold. The licensee attributed the lube oil leakage to the elongation of exhaust manifold bolts. The Unit 2 EDG exhaust manifold bolting had been replaced in the spring of 2006. As corrective actions, specific preventive maintenance inspections were implemented to monitor the condition of newly installed exhaust manifold bolts and replace degraded bolting if required. In addition, a preventive maintenance task was generated to replace exhaust manifold bolting on a six-year frequency. (NRC Integrated Inspection Report Nos. 05000338/2006004 and 05000339/2006004, dated October 30, 2006, ADAMS Accession No. ML063030486)

Fermi Power Plant, Unit 2

On January 31, 2003, the licensee performed a post-maintenance test run of the Fermi Power Plant, Unit 2 EDG 11. During this run, the licensee noticed fuel oil spilling from the clean fuel drain header vent (J-tube) onto the injector deck. The fuel oil migrated from the deck onto the hot exhaust manifold. The high temperature of the exhaust manifold ignited the fuel oil on both sides of EDG 11. Plant personnel extinguished the fire, and the operators shutdown the EDG. Fourteen days earlier, the licensee had installed temporary plastic sleeves on the drain lines of the clean fuel drain header for all four EDGs without following the temporary modification process. The plastic sleeves on the drain line of the clean fuel drain header restricted flow causing the fuel oil to flow out the J-tube vent. The fuel oil then collected on the injector deck, migrated, and collected on the exhaust manifold insulation and ignited. (NRC Integrated Inspection Report No. 05000341/2003008, dated October 28, 2003, ADAMS Accession No. ML033040141)

Peach Bottom Atomic Power Station

On April 19, 2003, a small fire occurred on the Peach Bottom Atomic Power Station EDG E2 exhaust manifold heat shield. Lube oil leakage from an engine top cover bolted flange connection dripped onto the protective heat shield that covers the hot exhaust manifold where it smoldered and occasionally flashed into a small flame, then burned out. After completion of the EDG E2 test, operations personnel removed the EDG E2 from service and performed corrective maintenance to repair the lube oil leak. The cause of the lube oil leakage was that several bolts on the EDG E2 top cover flange were found at approximately one-half of the torque values specified by the EDG manufacturer. This occurred because the licensee's EDG maintenance procedure did not specify tightening the bolts to the EDG manufacturer torque values and instead specified a tightness value of 'wrench-tight'. (NRC Integrated Inspection Report Nos. 05000277/2003003 and 050000278/2003003, dated July 24, 2003, ADAMS Accession No. ML032050207)

BACKGROUND

NRC fire protection regulations for commercial nuclear power plants ensure that, in the event of fire in any area of the plant, at least one train of equipment needed to achieve and maintain safe-shutdown conditions in the reactor will remain free of fire damage. The regulations in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," require each operating nuclear power plant to have a fire protection plan. This plan must satisfy Appendix A to Part 50, "General Design Criteria for Nuclear Power Plants," specifically General Design Criterion (GDC) 3, "Fire Protection," as required by 10 CFR 50.48(a).

Components within the scope of 10 CFR 50.55a are included in the scope of 10 CFR 50.65, "Requirements for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants" (the "Maintenance Rule"). The Maintenance Rule requires that licensees monitor the performance or condition of structure, system, and components (SSCs) against licensee-established goals in a manner sufficient to provide reasonable assurance that such SSCs are capable of fulfilling their intended function. Such goals are to be established, where practicable, commensurate with safety, and they are to take into account industry-wide operating experience. When the performance or condition of a component does not meet established goals, appropriate corrective actions are to be taken.

DISCUSSION

Licensees rely on EDGs to provide emergency alternating current power in response to loss of offsite power events. EDGs are required to be operable as specified in plant technical specifications. Although these EDG exhaust manifold fires since 2003 did not disable the EDGs, the fires caused the licensees to shut down the EDGs, rendering them unavailable until the licensees could correct the causes of the fires.

The several fires were attributed to leaking exhaust manifold connections on Fairbanks-Morse opposed piston EDGs. This type of EDG is susceptible to oil leaking past the piston rings into

the cylinder. The top piston is especially susceptible as there is oil on the surfaces above the piston. During standby conditions and at low loads, oil leaking past the piston rings will collect in the cylinders. At low loads, the exhaust temperatures are not sufficient to burn the oil in the cylinder, and the excess oil will be exhausted into the exhaust manifold with the exhaust gases. At full load, the combustion temperature is sufficient to completely burn any oil seeping past the piston rings. Any oil carried over into the engine exhaust can ignite when in contact with a hot exhaust manifold and in the presence of air. In particular, oil that passes through leaking exhaust manifold connections can collect in the insulation on the exterior of the exhaust manifold and can ignite when the exhaust manifold becomes hot.

In addition, several exhaust manifold fires were caused by oil leakage that migrated to the hot exhaust manifold. The oil leakage was attributed to loose fasteners on inspection covers and top covers. In some cases, the licensee's maintenance procedure did not specify or reference the vendor-recommended torque values for the fasteners.

CONTACT

This IN does not require any specific action or written response. Please direct any questions about this matter to the technical contacts listed below or the appropriate project manager in the NRC's Office of Nuclear Reactor Regulation.

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