UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
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INFORMATION NOTICE 2006-15: VIBRATION-INDUCED DEGRADATION AND FAILURE OF SAFETY-RELATED VALVES

ADDRESSEES

All holders of operating licenses for nuclear power reactors except those who have permanently ceased operation and have certified that fuel has been permanently removed from the vessel.

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to alert addressees of vibration-induced degradation and failure of valves supplied by Fisher Controls and other manufacturers. The agency expects that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, the suggestions contained in this IN are not NRC requirements; therefore, no specific action or written response is required.

DESCRIPTION OF CIRCUMSTANCES

During a plant startup in October 2003, Vogtle Electric Generating Plant, Unit 1, experienced a failure of an auxiliary feedwater (AFW) discharge control valve. The valve was a 4-inch, model SS-120, manufactured by Fisher Controls. Although the valve indicated full open, operators noted that AFW loop flow was reduced and did not change during valve throttling. The valve degradation was attributed to the flow-induced metal fatigue failure of a cotter pin designed to secure the pilot plug assembly retaining nut to the valve stem. Consequently, the retaining nut backed off completely, releasing the pilot plug spacer and a washer from the pilot plug, allowing them to be transported downstream and block flow through a restricting orifice. A similar failure of an AFW discharge control valve occurred in 1989 at Vogtle.

The valve vendor issued an advisory regarding this failure mechanism in 1988. In this advisory, the vendor stated that failures of Fisher Controls type AP, EP, EWP, and SS-120 valves may occur and recommended that all valves affected by the advisory be disassembled to inspect the main-plug/pilot-plug restraining nut assembly. The assembly is held together by a large nut which is restrained from turning by either a star lockwasher with bend-up tabs, or a single cotter pin design. The vendor stated that the hex nut may unscrew because of improper installation of either type locking mechanism. Specifically, reuse of the star lockwasher has resulted in fatigue and subsequent breaking of the tabs, and the cotter pin design has failed from improper replacement or reuse which has allowed the pin to vibrate and fail through fatigue.

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In response to this failure event, the licensee performed visual inspections of 15 similar valves and identified that all of the motor-driven AFW discharge control valves were missing cotter pins. The cotter pins associated with the turbine-driven AFW discharge control valves appeared unaffected, probably because of the much lower operational flow time. The licensee repaired the valves by staking the threads on the valve stem against the retaining nut, instead of securing the nuts with cotter pins.

DISCUSSION

Over the years, nuclear power plants have experienced vibration-induced degradation of plant equipment during operation at the original licensed power and under power uprate conditions. The NRC has issued several INs on this subject, including NRC IN 83-70, "Vibration-Induced Valve Failures," dated October 25, 1983 (http://www.nrc.gov/reading-rm/doc-collections/gen-comm/info-notices/1983/in83070.html), to alert nuclear power plant licensees of instances of valve failures and system inoperability that occurred as a result of normal operational vibration.

In January 2004, NRC IN 2002-26, Supplement 2, "Additional Flow-Induced Vibration Failures After a Recent Power Uprate," (Agencywide Documents Access and Management System (ADAMS) Accession No. ML040080392) was issuedwhich described that increased steam and feedwater flow can increase the vibration of plant equipment, including valves and valve actuators. The higher vibration levels can impact the appropriate inspection intervals for some plant components.

San Onofre Nuclear Generating Station, Units 1 and 2, experienced degradation of butterfly valves in 2003, as discussed in NRC IN 2005-23, "Vibration-Induced Degradation of Butterfly Valves," dated August 1, 2005 (ADAMS Accession No. ML051740299). The failures resulted from lost taper pins used to connect the valve disc to the valve stem. These valves were manufactured by Fisher Controls. Problems have been attributed to failed taper pin connectors in butterfly valves supplied by other manufacturers. In 1989, Turkey Point Nuclear Plant, Unit 4, lost taper pins in a 36-inch intake cooling water isolation valve manufactured by the Henry Pratt Company. In 2003, Davis-Besse Nuclear Power Station, Unit 1, lost taper pins in a 10-inch decay heat removal cooler valve with the brand name Valtek marketed by the Flowserve Corporation.

In June 2005, the licensee at Hope Creek Generating Station shut down the unit and entered into its emergency plan because it exceeded limits for unidentified leakage inside primary containment. This event was discussed in "Hope Creek Nuclear Generating Station - NRC Integrated Inspection Report 05000354/2005005 and Exercise of Enforcement Discretion," dated January 26, 2006 (ADAMS Accession No. ML060270171). The licensee identified an approximately 285-degree circumferential crack in the position-indicating tube for the "A" residual heat removal shutdown cooling return testable check valve. This through-wall leak was caused by vibration of the attraction sleeve (located at the end of the actuator rod), in the presence of the switch magnetic force, resulting in the attraction sleeve fretting and wearing through the position-

indicating tube. Licensee corrective actions included modifying both the "A" and "B" train check valves by removing the position indicator tubes. Six additional check valves that use the same position indicator tube underwent ultrasonic testing, which revealed no similar wear indications.

In summary, operating experience associated with vibration-induced valve degradation shows that certain valve sub-components (such as yoke-to-bonnet hold-down studs and nuts, stem-to-disc connectors, valve stem clamp setscrews) may be more susceptible to failure. Changes to system flow characteristics and vibrational harmonics may serve as indicators that further evaluation of these effects on system components is needed. Initiatives to preclude valve failures may include identifying components that could be subjected to vibration-induced stress and wear, fully understanding the long-term effects that vibration-induced stress may have on these components (including sub-components that may be prone to early failure), and thoroughly evaluating and inspecting components on a schedule consistent with the overall risk significance associated with a failure.

CONTACTS

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

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