UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555-0001

February 5, 1996

NRC INFORMATION NOTICE 96-08: THERMALLY INDUCED PRESSURE LOCKING OF A HIGH PRESSURE COOLANT INJECTION GATE VALVE

Addressees

All holders of operating licenses or construction permits for nuclear power reactors.

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to alert addressees to a loss of operational capability and the recently discovered damage to the internal components of a safety-related power-operated gate valve, both apparently caused by thermally induced pressure locking. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances

On November 11, 1995, Susquehanna Steam Electric Station (SSES), Unit 1, was shut down to repair the main generator. During this forced outage, Pennsylvania Power and Light Co, the licensee for SSES Units 1 and 2, discovered a bent retaining ring in the Unit 1 high pressure coolant injection (HPCI) valve while performing a modification to eliminate susceptibility to pressure locking. This Anchor Darling 14-inch flexible-wedge motor-operated pressure seal gate valve is installed in the discharge line from the HPCI pump. The valve is located about three pipe diameters from the connection to the feedwater system piping, which the licensee believes is the source of heat that caused thermally induced pressure locking and the bent retaining ring.

Discussion

On August 17, 1995, the NRC issued Generic Letter (GL) 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves," to request that licensees take actions to ensure that safety-related power-operated gate valves that are susceptible to pressure locking or thermal binding are capable of performing their safety functions within the current licensing bases of the facility. As stated in GL 95-07, pressure locking occurs in flexible-wedge and double-disk gate valves when fluid becomes pressurized within the valve bonnet and the actuator is not capable of overcoming the additional thrust required because of the differential pressure created across both valve disks.

Various plant operating conditions can introduce pressure locking. Pressure in the valve bonnet might be higher than anticipated when (1) the gate valve is in a line connected to a high-pressure system or (2) the temperature of the fluid in the valve bonnet increases causing thermal expansion. Temperature in the valve bonnet might increase in response to heatup during plant operation, a rise in ambient air temperature caused by leaking components or postulated pipe breaks, or thermal conduction or convection through connected piping. Over time, bonnet pressure could decrease by leakage past the seating surfaces or stem packing. However, during the time to depressurize, the valve may remain pressure locked, and the system may not be able to perform its safety function. Also, valve actuator operation at locked rotor conditions could degrade the motor torque capability of a motor-operated gate valve.

While evaluating the operational configurations of safety-related power-operated gate valves in response to the requested actions of GL 95-07, the licensee found that the HPCI valve, as well as the reactor core isolation cooling (RCIC) system injection valve, was susceptible to thermally induced pressure locking. The HPCI valve is normally closed and is installed about three pipe diameters from the feedwater system, and the intervening piping is insulated. On the basis of its evaluation, the licensee concluded that, during plant operation, heat transferred from the feedwater line could cause bonnet heatup of the HPCI injection valve. This valve had previously been eliminated from consideration of thermally induced pressure locking because of a perceived absence of a heat source.

While Unit 1 was shut down to repair the main generator, the licensee initiated and completed modifications of the HPCI and RCIC valves to eliminate susceptibility to pressure locking by drilling pressure relief holes in the downstream disk of each valve of Unit 1. During disassembly of the HPCI valve, the pressure seal spacer and pressure seal segmented retaining ring were found to be damaged. The inner edge of the retaining ring was bent approximately 3.4 mm [0.135 inch]. The retaining ring consists of four segments and has an outer diameter of about 39.6 cm [15.6 inches], an inner diameter of 34.5 cm [13.6 inches], and a thickness of 22.2 mm [0.875 inch]. The retaining ring serves as a support for the valve bonnet pressure seal and transfers loads from the valve bonnet to the valve body. This bending indicates that the retaining ring had experienced a significant force and supports the licensee's earlier conclusion that this valve was susceptible to thermally induced pressure locking. A calculation by the valve vendor shows that a load of approximately 4.4 Meganewtons [1 million pounds] could cause the identified bending of the retaining ring and corresponds to an internal pressure of approximately 21 to 48 Megapascals [3000 to 7000 psi]. The licensee considers these pressures to be threshold values for physical damage to the valve. The licensee's engineering analysis shows that the heatup of fluid trapped in the valve bonnet could be sufficient to cause a pressure of this magnitude.

The licensee's analysis revealed that the actuator for the HPCI valve did not have sufficient thrust capability to open the valve if this high differential pressure were created across both valve disks. Therefore, the licensee reported that for an indeterminate period of time between April 1992 (when the valve was previously disassembled) and November 11, 1995, the HPCI valve was inoperable, rendering the HPCI system incapable of performing its safety function. No inservice testing of this valve was performed during power operation because the licensee had a cold shutdown justification for this valve that supported operational testing only when shut down. However, the valve was operated numerous times while the reactor was shut down, such as to repair the main generator. The licensee believes that the residual mechanical damage found in the HPCI valve by itself did not affect valve operability.

GL 95-07 does not specifically request that licensees inspect valve internal components for damage caused by past pressure locking or thermal binding. Since pressure locking and thermal binding can occur in varying degrees, licensees should be aware of the potential for valve damage when there is a strong indication of past pressure locking or thermal binding. Licensees should also be aware that the operational configurations associated with this event may occur in pressurized water reactor designs as well. In addition, this event appears to indicate that sufficient heat transfer can occur through a static length of fluid-filled piping to cause thermally induced pressure locking.

Related Generic Communications

- NRC Generic Letter 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves," dated August 17, 1995
- NRC Information Notice 95-30, "Susceptibility of Low-Pressure Coolant Injection and Core Spray Injection Valves to Pressure Locking," dated August 3, 1995
- NRC Information Notice 95-18, "Potential Pressure Locking of Safety-Related Power-Operated Gate Valves," dated March 15, 1995 and Supplement 1, dated March 31, 1995
- NRC Information Notice 95-14, "Susceptibility of Containment Sump Recirculation Gate Valves to Pressure Locking," dated February 28, 1995
- NRC Information Notice 92-26, "Pressure Locking of Motor-Operated Flexible Wedge Gate Valves," dated April 2, 1992

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact one of the technical contacts listed below or the appropriate Office of Nuclear Reactor Regulation project manager.

Dennis M. Crutchfield, Director
Division of Reactor Program Management
Office of Nuclear Reactor Regulation

Technical contacts: Thomas G. Scarbrough, NRR
(301) 415-2794
Internet:tgs@nrc.gov

Howard J. Rathbun, NRR
(301) 415-2787
Internet:hjrl@nrc.gov

Jerry Carter, NRR
(301) 415-1153
Internet:tjc@nrc.gov

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Information Notice No.	Subject	Date of Issuance	Issued to
96-07	Slow Five Percent Scram Insertion Times Caused By Viton Diaphragms in Scram Solenoid Pilot Valves	01/26/96	All holders of OLs or CPs for boiling water reactors
96-06	Design and Testing Deficiencies of Tornado Dampers at Nuclear Power Plants	01/25/96	All holders of OLs or CPs for nuclear power reactors
96-05	Partial Bypass of Shutdown Cooling Flow from the Reactor Vessel	01/18/96	All holders of OLs or CPs for boiling water reactors
96-04	Incident Reporting Requirements for Radiography Licensees	01/10/96	All radiography licensees and manufacturers of radiography equipment
96-03	Main Steam Safety Valve Setpoint Variation as a Result of Thermal Effects	01/05/96	All holders of OLs or CPs for nuclear power reactors
96-02	Inoperability of Power-Operated Relief Valves Masked by Downstream Indications During Testing	01/05/96	All holders of OLs or CPs for PWRs
96-01	Potential for High Post-Accident Closed-Cycle Cooling Water Temperatures to Disable Equipment Important to Safety	01/03/96	All holders of OLs or CPs for PWRs

OL = Operating License
CP = Construction Permit

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original signed by

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Tech Editor reviewed 12/26/95
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Editor comments incorporated