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

August 20, 1996

NRC INFORMATION NOTICE 96-49: THERMALLY INDUCED PRESSURIZATION OF NUCLEAR POWER FACILITY PIPING

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 number of scenarios reported by licensees that involve thermal expansion of fluid in closed piping that could lead to overpressurization of the piping and either degraded operability or loss of function of safety systems. 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

Licensees have reported actual and postulated situations in which the thermal expansion of water in piping systems within containment could produce undesirable consequences. Two situations are presented in this notice to illustrate the range of scenarios, the postulated consequences, and the corrective actions taken. Each situation involves the heating of a section of water-filled piping between two closed block or isolation valves. Although the examples involve piping inside containment, this condition could arise elsewhere in the facility.

Beaver Valley Unit 1

The first scenario was reported by the licensee for the Beaver Valley facility in a notification dated July 3, 1996. During surveillance testing of a motor-operated butterfly valve located in the component cooling water inlet line to the residual heat removal heat exchanger, it was observed that the valve which was located inside containment would not open. The licensee investigation revealed that pressure in the piping section between this valve and a closed manual butterfly valve located outside containment was measured as being slightly higher than the system design pressure. After the pressure was relieved by the opening of a drain valve, the remotely operated valve was opened. The pressurization was caused by an increase in trapped water

temperature due to an increase in ambient temperatures from the conditions that existed in the Spring, when the valves were closed, to those that existed after plant heatup to mode 1 with a summer temperature of about 32 degrees C [90 degrees F]. This could potentially jeopardize the structural integrity of the containment penetration. Immediate corrective actions for this and other piping sections without thermal relief included draining fluid from piping sections and opening the inboard valve to provide access to relief protection. The identified root cause was inadequate design reviews relating to containment penetration relief protection.

Maine Yankee

The second scenario was reported by the licensee for the Maine Yankee facility in a notification dated July 19, 1996. The primary component cooling water system at Maine Yankee has a nonsafety-related subdivision that serves the containment air coolers, and a safety-related subdivision that serves the emergency core cooling system equipment. The nonsafety subdivision of the piping has a swing-check valve at the containment inlet (supply) penetration, and an air-operated valve at the containment outlet (return) penetration. In a postulated accident scenario (a loss-of-coolant accident), the containment isolation logic would initiate closure of the outlet valve, thereby causing water flow to cease. Heat from the containment environment would cause the water in the fan coolers between the inlet check valve and closed outlet valve to expand, potentially causing a rupture in the system. The rupture would depressurize the isolated portion of the system and reestablish water flow from the operating safety-related portion located outside containment through the inlet check valve. The water would spill from the rupture and deplete the surge tank, thereby causing failure from overheating of safety-related equipment served by the remainder of the system. Upon identifying this postulated scenario, the licensee promptly shut down the facility. Other closed systems and containment penetrations were evaluated. As a result, the licensee took corrective action which included the installation of a pressure relief valve on each of the six containment air cooler branch lines.

Discussion

Because of thermal expansion, water heated while trapped in closed piping is capable of producing extremely high pressures. This phenomenon is typically a design consideration. Piping design codes as far back as USAS B31.1 have required consideration of fluid pressure caused by heating of fluid trapped between two valves. The potential for thermally induced expansion of fluid trapped in valve bonnets was one reason for issuing Generic Letter 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves." In addition, several information notices have been issued discussing pressurization of water trapped in valve bonnets.

The potential for failure of systems to perform their safety functions as a result of thermally-induced overpressurization is dependent on many factors. These factors include leak-tightness of valve seats, bonnets, packing glands and flange gaskets; piping and component material properties, location and geometry; ambient and post-accident temperature response; pipe fracture mechanisms; fan coastdown characteristics and the effect of fan operation on

water in the associated fan cooling system; relief valves and their settings; and system isolation logic and setpoints. Engineering design and modification evaluations, which include systematic evaluation of heat input to systems and components with consideration of factors such as those above, can detect conditions which may influence system operability under normal operations, operational transients and accident conditions.

Please also note that under the "single-failure concept," thermal over-pressurization is a consequence of the event and is not considered to be an independent active or passive failure. Active or passive failures must also be considered in the same and other systems in evaluating plant response to a postulated accident. If relief valves are installed to prevent overpressure conditions, consideration must be given to the effects of a stuck-open relief valve and consequent diversion of system flow, associated environmental flooding and radiation hazards.

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

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Information Notice No.	Subject	Date of Issuance	Issued to
96-48	Motor-Operated Valve Performance Issues	08/21/96	All holders of OLs or CPs for nuclear power reactors
96-47	Recordkeeping, Decommissioning Notifications for Disposals of Radioactive Waste by Land Burial Authorized Under Former 10 CFR 20.304, 20.302, and Current 20.2002	08/19/96	All U.S. Nuclear Regulatory Commission licensees
96-46	Zinc Plating of Hardened Metal Parts and Removal of Protective Coatings in Refurbished Circuit Breakers	08/12/96	All holders of OLs or CPs for nuclear power reactors
96-45	Potential Common-Mode Post-Accident Failure of Containment Coolers	8/12/96	All holders of OLs or CPs for nuclear power reactors
96-44	Failure of Reactor Trip Breaker from Cracking of Phenolic Material in secondary contact assembly	8/05/96	All holders of OLs or CPs for nuclear power reactors
96-43	Failures of General Electric Magne-Blast Circuit Breakers	08/02/96	All holders of OLs or CPs for nuclear power reactors
96-42	Unexpected Opening of Multiple Safety Relief Valves	08/05/96	All holders of OLs or CPs for nuclear power reactors
96-41	Effects of a Decrease in Feedwater Temperature on Nuclear Instrumentation	07/26/96	All holders of OLs or CPs for pressurized water reactors
96-40	Deficiencies in Material Dedication and Procurement Practices and in Audits of Vendors	07/25/96	All holders of OLs or CPs for nuclear power reactors

OL = Operating License
CP = Construction Permit

water in the associated fan cooling system; relief valves and their settings; and system isolation logic and setpoints. Engineering design and modification evaluations, which include systematic evaluation of heat input to systems and components with consideration of factors such as those above, can detect conditions which may influence system operability under normal operations, operational transients and accident conditions.

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