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

March 25, 1994

NRC INFORMATION NOTICE 94-25: FAILURE OF CONTAINMENT SPRAY HEADER VALVE TO OPEN DUE TO EXCESSIVE PRESSURE FROM INERTIAL EFFECTS OF WATER

Addressees

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

Purpose

The U.S. Nuclear Regulatory Commission is issuing this information notice to alert addressees to the potential for valves to fail to open because of unexpectedly high differential pressures caused by the inertial effects of water moving in partially filled piping 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

On September 13, 1993, at the Waterford Steam Electric Station, Unit 3, the train A containment spray header isolation valve failed to open when it was actuated following the successful completion of a test on the containment spray system.

The containment spray system configuration includes a shutdown cooling heat exchanger and two check valves located in the piping between a containment spray pump and the subject isolation valve (Attachment 1). The isolation valve is a 25-cm [10-inch] WKM solid gate valve, which is closed by air pressure and opened by a spring, and is designed to open with a differential pressure of 2070 kPa [300 psi] across the gate. The design rating of the piping near the valve is 2170 kPa [300 psig] and the design shutoff head of the pump is approximately 2000 kPa [275 psig].

During the test, the operators had successfully cycled the isolation valve open and closed as required by the inservice surveillance testing program. Subsequently, the operators started the containment spray pump. These two functions are tested separately to prevent the actual spraying of water into the containment. After completing this testing, the operators attempted to open the isolation valve to refill the containment spray riser, but the valve

would not open. Therefore, the licensee declared train A of the containment spray system inoperable. The header subsequently became depressurized and the operators were able to open the valve.

The licensee performed a special test on train A of the containment spray system to determine the pressures that were developed in the piping. With the isolation valve closed, the pump was started, run, and shut down while pressure measurements were made at various locations in the piping. The discharge pressure of the pump, which was run with minimum recirculation flow, was measured at 1900 kPa [260 psig]. The pressure at the inlet of the heat exchanger, downstream of the first check valve, was measured at 2230 kPa [308 psig]. The pressure between the second check valve and the containment isolation gate valve reached 3330 kPa [469 psig] and then stabilized at 3210 kPa [450 psig], 1310 kPa [190 psi] higher than the pump discharge pressure. Data gathered during this testing also indicated that air had been allowed to enter the piping system during maintenance activities.

Discussion

The licensee concluded that excessive differential pressure across the isolation valve, which had developed during the earlier surveillance test, had prevented the isolation valve from opening on September 13. Apparently the air in the piping had allowed the pump discharge water to accelerate to a higher-than-normal velocity. As the air was forced into the space between the isolation valve and the check valves, it was compacted to a pressure that was higher than the pump discharge pressure by the inertia (the hydraulic ram effect) of the water. This excessive pressure was then trapped against the isolation valve when the second check valve closed.

The licensee initially believed that the high pressure would occur only during the surveillance tests because during an emergency actuation the isolation valve was expected to open before the pump started. However, further investigation revealed that, if offsite power was maintained, the containment spray pump might start before the isolation valve opened. This could cause the valve to remain shut under accident conditions. Consequently, as an interim solution, the licensee has requested and received a technical specification amendment allowing the train A isolation valve to remain open during normal operation. In order to prevent the inadvertent spraying of the containment, the licensee is taking compensatory measures such as disabling the pump or closing and disabling the isolation valve before performing maintenance on the system.

The licensee performed an evaluation and determined that the system was not degraded due to the overpressure condition. The licensee also performed system evaluations on containment spray train B, and concluded that, due to a shorter piping configuration and a better capability for venting this system, train B should be considered operable until a permanent solution is

implemented. This conclusion was supported by testing which showed that, although somewhat higher-than-expected differential pressures did occur in this train also, the containment isolation valve would consistently open.

The licensee is exploring various options for a permanent solution. These include using a different isolation valve or delaying the pump starting time to ensure that the isolation valve will open before pressure build-up can occur.

The event illustrates that valve stroke-time inservice testing alone does not ensure the capability of a valve to operate under all postulated design conditions. This event also indicates that the inertia of water (hydraulic ram effects) may not have been accounted for in the design of certain systems.

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Brian K. Grimes, Director
Division of Operating Reactor Support
Office of Nuclear Reactor Regulation

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(817) 860-8145

Paula A. Goldberg, RIV
(817) 860-8168

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(501) 968-3290

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(301) 504-1311

Attachments:
1. Figure: Containment Spray System (Typical of Two Trains)
2. List of Recently Issued NRC Information Notices

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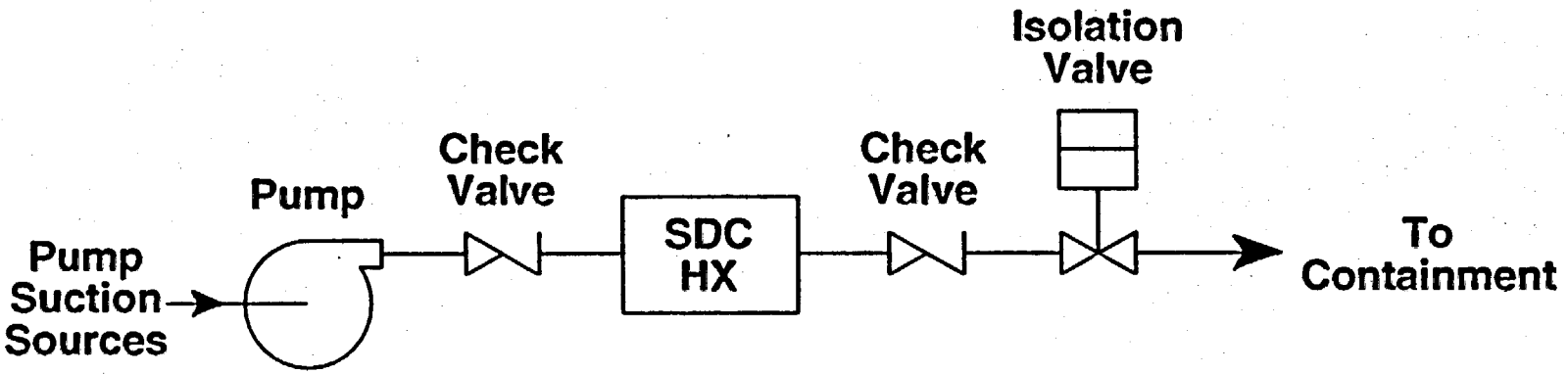
Containment Spray System
(Typical of Two Trains)



LIST OF RECENTLY ISSUED NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
94-24	Inadequate Maintenance of Uninterruptible Power Supplies and Inverters	03/24/94	All holders of OLs or CPs for nuclear power reactors.
94-23	Guidance to Hazardous, Radioactive and Mixed Waste Generators on the Elements of a Waste Minimization Program	03/25/94	All NRC Licensees.
94-22	Fire Endurance and Ampacity Derating Test Results for 3-Hour Fire-Rated Thermo-Lag 330-1 Fire Barriers	03/16/94	All holders of OLs or CPs for nuclear power reactors.
94-21	Regulatory Requirements when No Operations are being Performed	03/18/94	All fuel cycle and materials licensees.
94-20	Common-Cause Failures due to Inadequate Design Control and Dedication	03/17/94	All holders of OLs or CPs for nuclear power reactors.
94-19	Emergency Diesel Generator Vulnerability to Failure from Cold Fuel Oil	03/16/94	All holders of OLs or CPs for nuclear power reactors.
94-18	Accuracy of Motor-Operated Valve Diagnostic Equipment (Responses to Supplement 5 to Generic Letter 89-10)	03/16/94	All holders of OLs or CPs for nuclear power reactors.

OL = Operating License
CP = Construction Permit

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OFFICE	*OGCB/NRR	*TECH ED	*REGION IV	*REGION IV	*REGION IV
NAME	DCKirkpatrick	RSanders	TFWesterman	PAGoldberg	LJSmith
DATE	12/06/93	12/08/93	01/11/94	01/11/94	01/11/94

*EMEB/DE	*C:EMEB/DE	*D:DE	*PDIV-1	*REGION IV	*C:EAB/DORS
PCampbell	JNorberg	MWHodges	DWigginton	SCollins	AChaffee
01/05/94	01/05/94	01/06/94	01/10/94	01/11/94	01/28/94

*C:SCSB/DSSA	*AC:OGCB/DORS	D:DORS/NRR
RLobel for RBarrett	AJKugler	BKGrimes
02/10/94	03/03/94	03/21/94

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R. Barrett 2/10/94 SCSB Richard Lobel for

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GHMarcus	BKGrimes
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C:SPLB/DSSA CMcCracken 02/ /94

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The event indicates that valve stroke-time inservice testing does not ensure the capability of a valve to operate under all postulated design conditions such as water hammer. The event also indicates that water hammer effects may not have been accounted for in the design of certain systems.

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