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

November 30, 1995

NRC INFORMATION NOTICE 95-47, REVISION 1: UNEXPECTED OPENING OF A SAFETY/RELIEF VALVE AND COMPLICATIONS INVOLVING SUPPRESSION POOL COOLING STRAINER BLOCKAGE

Addressees

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

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this revised information notice to alert addressees to a recent failure of a safety/relief valve (SRV) to remain closed during steady-state reactor operation and the attendant complications involving suppression pool cooling including strainer blockage. 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.

Background

Information Notice 95-47, "Unexpected Opening of a Safety/Relief Valve and Complications Involving Suppression Pool Blockage," was issued on October 4, 1995. The notice described a failure of a safety/relief valve to remain closed, and licensee planned followup actions. This revision provides clarifying details on the licensee action plan for monitoring leakage through these valves (using tailpipe temperature monitoring), makes minor corrections on event details, adds an additional related generic communication and notes the NRC staff plans to further evaluate implications of SRV leakage.

Description of Circumstances

On September 11, 1995, the Limerick Unit 1 plant was being operated at 100 percent power when control room personnel observed alarms and other indications that one SRV ("M") was open. Emergency procedures were implemented. Attempts to close the valve were unsuccessful and within 2 minutes a manual reactor scram was initiated. The main steam isolation valves were closed to reduce the cooldown rate of the reactor vessel. The maximum cooldown rate during the event was 69 °C/hr [156 °F/hr]. Before the SRV opened, the licensee was running the "A" loop of suppression pool cooling to remove heat being released into the pool by leaking SRVs.

The licensee has 2-stage vertical discharge SRVs manufactured by Target Rock Corporation. This particular valve design, which is oriented such that condensate collects on the main stage valve seat, is believed to be the cause of the continued problems with main stage leakage and is unique to the Limerick units. Other licensees use Target Rock valves that have a similar 2-stage design, but that are configured to discharge horizontally without condensate collecting on the valve seat. Even though the licensee had modified the valve bodies to promote drainage of condensate buildup, these leaking valves were assumed to still have the same leakage problem through the main stage valve seat.

Shortly after the manual scram, and with the SRV still open, the "B" loop of suppression pool cooling was started. Operators continued working to close the SRV and slow the cooldown of the reactor vessel. Approximately 30 minutes later, fluctuating motor current and flow were observed on the Unit 1 "A" suppression pool cooling loop. Cavitation was believed to be the cause and the loop was secured.

After checking out the pump, the "A" pump was restarted, but at a reduced flowrate of 8 kL/m [2000 gpm]. No problems were observed so the flow rate was gradually increased to 32 kL/m [8500 gpm]. No problems were observed so the licensee continued to operate the pump at a constant flow. A pressure gauge located on the pump suction was observed to have a gradually lower reading, which was believed to be indicative of an increased pressure drop across the pump suction strainer located in the suppression pool. After about 30 minutes of additional operation, the suction pressure remained constant.

The rest of the reactor shutdown was routine and there were no further complications.

Discussion

Safety Relief Valve:

Shortly after the licensee started up following a refueling outage in March 1994, three SRVs ("F," "M," and "S") were leaking, as determined by tailpipe temperatures which ranged from 79 °C [175 °F] to 104 °C [220 °F]. These valves had been refurbished and reset before the restart and they were not leaking when installed. However, SRVs "M" and "S" had been stroked during a 3550 kPa [500-psi] automatic depressurization system operability test. Reactor operation continued from March 1994 until September 1995, except for two short mini-outages. Prior to the recent opening of the "M" SRV, SRVs "D" and "L" were also observed to be leaking. Tailpipe temperatures of the five leaking SRVs were reported as ranging between 102 °C [215 °F] to 141 °C [285 °F] and, because of prior experience, the leakage was believed to be past the main stage valve seat. Tailpipes at Limerick are uninsulated.

After the September 11, 1995, shutdown, the leaking SRVs were removed and the "M" and "S" SRVs sent offsite for inspection to determine the root cause for the "M" SRV opening. The "M" SRV was found to have been leaking through the pilot valve; the other four valves were leaking through the main valve. Disassembly of the "M" SRV disclosed that the pilot valve disk was badly eroded; the nose of the disk had been steam cut 360 degrees around the disk and had separated from the rest of the disk. The interior of the disk and the push rod also showed evidence of erosion. The pilot valve seat was eroded, but to a lesser degree. The reason for the initial leakage is not known. The pilot valve seat and disk were fabricated of Stellite 6 and Stellite 6B, respectively, and were not expected to erode so severely.

The licensee has replaced the five leaking SRVs and has resumed operation. The licensee is investigating techniques for identifying whether the leakage is through the pilot valve or main stage valve. Until such a technique is found, the licensee will assume that all leakage is through the pilot valve. As discussed in a letter dated October 6, 1995, the licensee has established a tailpipe temperature action plan. When the tail pipe temperature exceeds an "alert" level of 107 °C [225 °F], the licensee will log temperature more frequently, project when temperature would be expected to reach 135 °C [275 °F], and initiate preparations for an outage to replace the affected valve(s). The projection will be based on historical trends and industry experience. If the temperature reaches the "action level" of 121 °C [250 °F], a planned outage will be scheduled to replace the affected SRV before tail pipe temperature is expected to reach 135 °C [275 °F].

Steam leakage through the pilot valve of about 450 kg/hr [1000 lb/hr] is estimated to cause a tailpipe temperature of 121 °C [250 °F]. Testing has demonstrated that this amount of leakage will not cause either the pilot valve or the main stage valve to open. Actual experience at Limerick Unit 1 showed that the "M" SRV operated for more than a year with a tailpipe temperature in excess of 121 °C [250 °F] before it failed. The last recorded temperature of the uninsulated tailpipe before the SRV opened was 141 °C [285 °F]; the temperature was recorded as 146 °C [295 °F] a week earlier.

The NRC staff plans to further assess the safety implications of pilot valve leakage, considering possible effects on SRV valve operability and leakage detection capabilities. The staff also plans to examine the efficacy of the Automatic Depressurization System (ADS) operability test and licensee practices of routinely operating suppression pool cooling to cope with leaking SRVs.

Suppression Pool:

Limerick Unit 1 has been in commercial operation since 1986 without having had the suppression pool cleaned; cleaning was scheduled for the 1996 refueling outage. The pool of Unit 2 was cleaned during the 1995 refueling outage.

After a plant cooldown following the blowdown event, a diver was sent into the Unit 1 suppression pool to observe the condition of the strainers and general pool cleanliness. Each strainer is a "T" arrangement with two truncated cones fabricated from perforated plate; the entire cone surface is covered by a 12x12 316 L stainless steel wire mesh. The suction strainer in the "A" loop of suppression pool cooling was found to be covered with a thin "mat" of material, consisting of fibers and sludge. The "B" strainer had a similar covering, but to a lesser extent. These are the two loops that had been used for suppression pool cooling necessitated by the leaking SRVs. The other strainers in the pool were covered with a dusting of sludge. Debris was subsequently brushed off the surface of the strainers, and the suppression pool floor and water were cleaned by use of a temporary filtration system. It is believed that, during operation of the suppression pool cooling system, the strainer filtered out fibers that were in the pool water. The resulting "mat" of fibers improved the filtering action of the strainers thereby collecting sludge and other material on the surface of the strainer. The licensee believes that the SRV opening increased the rate of accumulation on the strainer surfaces. The licensee removed about 635 kg [1400 lb] of debris from the pool of Unit 1. A similar amount of material had previously been removed from the Unit 2 pool.

Analysis showed that the sludge was primarily iron oxides and the fibers were of a polymeric nature. The source of the fibers has not been positively identified, but the licensee has determined that the fibers were not inherent with the suppression pool. There was no trace of either fiberglass or asbestos fibers.

Related Generic Communications

- NRC Information Notice 95-06: "Potential Blockage of Safety-Related Strainers by Material Brought Inside Containment"
- NRC Bulletin 95-02: "Unexpected Clogging of a Residual Heat Removal (RHR) Pump Strainer While Operating in Suppression Pool Cooling Mode"
- NRC Information Notice 93-34 and Supplement 1: "Potential for Loss of Emergency Core Cooling Function due to a Combination of Operational and Post-LOCA Debris in Containment"
- NRC Bulletin 93-02 and Supplement 1: "Debris Plugging of Emergency Core Cooling Suction Strainers"
- NRC Information Notice 92-85: "Potential Failures of Emergency Core Cooling Systems caused by Foreign Material Blockage"
- NRC Information Notice 92-71: "Partial Plugging of Suppression Pool Strainers at a Foreign BWR"

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
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Office of Nuclear Reactor Regulation

Technical contacts: Robert Elliott, NRR
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Information Notice No.	Subject	Date of Issuance	Issued to
94-13, Supp. 2	Control and Oversight of Contractors during Refueling Activities and Clarification of Applicability of Section 50.120 of Title 10 of The Code of Federal Regulations to Contractor Personnel	11/28/95	All holders of OLs or CPs for nuclear power reactors.
95-13, Supp. 1	Potential for Data Collection Equipment to Affect Protection System Performance	11/22/95	All holders of OLs or CPs for nuclear power reactors.
91-29, Supp. 3	Deficiencies Identified during Electrical Distribution System Functional Inspections	11/22/95	All holders of OLs or CPs for nuclear power reactors.
94-86, Supp. 1	Legal Actions Against Thermal Science, Inc., Manufacturer of Thermo-Lag	11/15/95	All holders of OLs or CPs for nuclear power reactors.
95-52	Fire Endurance Test Results for Electrical Raceway Fire Barrier Systems Constructed from 3M Company Interam Fire Barrier Materials	11/14/95	All holders of OLs or CPs for nuclear power reactors.
95-51	Recent Incidents Involving Potential Loss of Control of Licensed Material	10/27/95	All material and fuel cycle licensees.
95-50	Safety Defect in Gammamed 12i Bronchial Catheter Clamping Adapters	10/30/95	All High Dose Rate Afterloader (HDR) Adapters.
95-49	Seismic Adequacy of Thermo-Lag Panels	10/27/95	All holders of OLs or CPs for nuclear power reactors.

OL = Operating License
CP = Construction Permit

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Orig. signed by DM Crutchfield

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