UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, DC 20555-0001

January 21, 1998

NRC INFORMATION NOTICE 98-02: NUCLEAR POWER PLANT COLD WEATHER PROBLEMS AND PROTECTIVE MEASURES

Addressees

All holders of operating licenses for nuclear power reactors.

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to alert addressees to potential common-cause failure mechanisms of safety-related systems and systems important to safety caused by extremely cold weather. 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

Wolf Creek

IN 96-36, "Degradation of Cooling Water Systems Due to Icing," described the effects of icing on intake trash racks and traveling screens which resulted in a manual reactor/turbine trip on January 30, 1996, at Wolf Creek. In addition to the degradation of the circulating water and essential service water systems, the turbine-driven auxiliary feedwater pump was degraded during this event. The NRC identified the event as a precursor within the framework of the NRC's accident sequence precursor program, and calculated a conditional core-damage probability of 2.1×10^{-4}.

Circulating water system degradation was initially attributed to water from the spray-wash system freezing on the traveling screens, making them inoperable. To improve the reliability of the circulating water system, the licensee revised plant procedures (1) to eliminate the requirement to operate traveling screens continuously in slow manual mode during cold weather or under unusual icing conditions and (2) to allow the screens to be operated in the automatic mode in which the screens remained stationary without sprays until the system was started either by a timer or a high differential level. The traveling screens were also enclosed in a heated environment.

After IN 96-36 was issued, more information became available about the degradation of the circulating water system. Specifically, on August 5, 1997, the licensee reported that during the event, two of three air release valves on the circulating water warming line had been plugged.

Failure of these valves caused air binding in the piping and caused the warming flow to be nearly zero.

The effect of the resultant air binding was demonstrated during a 5-day test in January 1997 with 2.8 °C (37 °F) lake water, when warming line flow was reduced from 1388 liters per second (22,000 gpm) to approximately 347 liters per second (5,500 gpm). This warming flow degradation would have been more pronounced during the event because the temperature of the lake water was approximately 0 °C (32 °F) during the event and, therefore, contained more air in solution. Although air removal by the water box venting system should have significantly reduced the potential for air binding, approximately one-half of the water box air release valves had been isolated during the January 1996 event.

In response to these findings, the three air release valves on the warming line were replaced and incorporated into the preventive maintenance program. The licensee also revised procedures to ensure (1) manual venting of the circulating water warming line when the inlet temperature fell below 1.1 °C (34 °F), and (2) verification of the presence of circulating water warming flow and the passing of air from the air release valves when the warming line valve was opened in the fall. A procedural step was also added to verify that the water box air release valves were not isolated.

Millstone Unit 2

On January 8, 1996, with the plant at 100-percent power, an ice plug formed in a horizontal, common, service water (SW) strainer backwash drain line that ran through the intake wall in a trough toward a fish basket. This would have prevented automatic backwash of the SW strainers. This pipe had been welded onto the end of the original vertical discharge leg in a modification that had not undergone a formal engineering review. Minor leakage through the strainer backwash isolation valves and an unusually long period of subfreezing temperatures created the conditions needed to form the ice plug. Removal of the ice plug restored the SW strainer backwash capability and operators backwashed the strainers every 4 hours to ensure that another ice plug would not form until the horizontal pipe was eliminated. Nonetheless, the open end of the line was still susceptible to ice buildup. The licensee later reported that the operators had failed to recognize that the ice plug that made the backwash functions of the SW strainers inoperable also made both SW system trains inoperable. The licensee should have declared the SW system inoperable during the event and entered Technical Specification Limiting Condition for Operation 3.0.3, which required a plant shutdown.

On February 29, 1996, the licensee reported that the SW strainer backwash system was also susceptible to a common-mode failure if the intake structure's nonvital heating system failed to operate. The licensee changed an operating procedure to require (1) monitoring of the intake structure temperature when temperature fell below 4.4 °C (40 °F) and (2) using portable space heaters or manual operation of the strainers to prevent freezing. The licensee also proposed replacing the common line with three independent backwash lines, locating the discharge points to minimize the effect of outdoor weather conditions, and protecting differential pressure instrumentation from freezing.

LaSalle Unit 2

On February 4, 1996, operators shut the plant down manually when the oil temperature in the main transformer could not be maintained within design limits because of the loss of the transformer cooling fan and cooling pump. Ice severed the transformer cooling logic cable in its conduit where it entered the underground cable trough. Licensee corrective actions included inspecting other transformer conduits, clearing water and ice from conduits, and sealing the conduits.

McGuire Unit 2

On February 8, 1996, with the plant at 100 percent power, two of three refueling water storage tank (RWST) level transmitters were found to be inoperable because of frozen impulse lines. The lines froze because thermostat setpoints for the strip heaters were set too low for cold weather conditions. The frozen impulse lines affected control room RWST level indication and the ability to automatically switch to the emergency core cooling system sump. To correct this problem, the licensee increased the thermostat setpoint and added inspection of the level transmitter panels to its cold weather preventive maintenance procedure.

Discussion

The January 1996 event at Wolf Creek, described above, led the NRC Office for the Analysis and Evaluation of Operational Data (AEOD) to review the extent of cold weather-related problems at U.S. nuclear power plants over the past 6 years. The results of this study are given in Engineering Evaluation Report AEOD/E97-03, "Nuclear Power Plant Cold Weather Problems and Protective Measures." It contains a compendium of recent cold weather-related events and corrective actions, as well as design, operations, and training lessons learned by the nuclear industry and the U.S. Army Corps of Engineers Cold Regions Research and Engineering Laboratory. The report noted 37 cold weather related events at 23 different sites between 1991 and 1997. The study also reported an increasing trend in the number of these events.

Licensees continue to find that icing and freezing from extreme cold weather conditions is a common-cause failure mechanism that can quickly affect a variety of systems unless mitigating actions are taken in a timely manner. The recent operating experience described in this study suggests that, despite NRC and industry communications on this subject, some licensees have not effectively protected components whose failure could degrade safety-related systems and systems important to safety. Extreme cold weather conditions continued to affect intake structures; process lines; instrument lines; emergency diesel generator oil and grease viscosities; essential chillers; electrical systems; and heating, ventilation, and air conditioning systems. Lack of design oversight, incomplete review of operating experience, and insufficient attention to cold weather preparations were responsible for most of the events.

This information notice requires no specific action or written response. However, recipients are reminded that they are required by 10 CFR 50.65 to take industry-wide operating experience (including information presented in NRC information notices) into consideration, where practical, when setting goals and performing periodic evaluations. 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.

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98-01	Thefts of Portable Gauges	1/15/98	All portable gauge licensees
97-91	Recent Failures of Control Cables Used on Amersham Model 660 Posilock Radiography Systems	12/31/97	All industrial radiography licensees
97-90	Use of Nonconservative Acceptance Criteria in Safety-Related Pump Surveillance Tests	12/30/97	All holders of OLs for nuclear power reactors except those who have ceased operations and have certified that fuel has been permanently removed from the vessel
97-89	Distribution of Sources and Devices Without Authorization	12/29/97	All sealed source and device manufacturers and distributors
97-88	Experiences During Recent Steam Generator Inspections	12/16/97	All holders of OLs for pressurized-water reactors except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor
97-87	Second Retrofit to Industrial Nuclear Company IR 100 Radiography Camera, to Correct Inconsistency in 10 CFR Part 34 Compatibility	12/12/97	All industrial radiography licensees
97-86	Additional Controls for Transport of the Amersham Model No. 660 Series Radiographic Exposure Devices	12/12/97	Registered users of the Model No. 660 series packages, and Nuclear Regulatory Commission industrial radiography licensees

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