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

March 12, 1991

Information Notice No. 91-18: HIGH-ENERGY PIPING FAILURES CAUSED BY WALL THINNING

Addressees:

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

Purpose:

This information notice is intended to alert addressees to continuing erosion/corrosion problems affecting the integrity of high-energy piping systems and apparently inadequate monitoring programs. The piping failures at domestic plants indicate that, despite implementation of long-term monitoring programs pursuant to Generic Letter 89-08, "Erosion/Corrosion-Induced Pipe Wall Thinning," piping failures caused by wall thinning continue to occur in operating plants. 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 do not constitute NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances:

On December 31, 1990, while Unit 3 of the Millstone Nuclear Power Station was operating at 86-percent power, two 6-inch, schedule 40 pipes, in the moisture separator drain (MSD) system, ruptured. The high-energy water (approximately 360 degrees F, 600 psi) flashed to steam and actuated portions of the turbine building fire protection deluge system. Two 480-volt motor control centers and one non-vital 120-volt inverter were rendered inoperable by the flooding, resulting in the loss of the plant process computer and the isolation of the instrument air to the containment building.

On July 2, 1990, while Unit 2 of the San Onofre Nuclear Generating Station was operating at full power, the licensee discovered a steam leak in one of the feedwater regulating valve (FRV) bypass lines. The licensee shut down the reactor to depressurize the line for inspection and repair. Ultrasonic testing (UT) revealed wall thinning in an area immediately downstream of the weld attaching the 6-inch bypass line to the 20-inch feedwater piping.

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the elbow and the level control valve. After the pipe rupture occurred in train B, the licensee performed UT inspections of the same section in train A of the LPHD system and found that it had thinned to approximately 0.052 inch. The design requirement for minimum wall thickness in that pipe is 0.117 inch. The licensee replaced the damaged pipe with A106 grade B material and intends to replace that material with A335-P22 erosion resistant material during the next outage.

The licensee performed an analysis and found that the erosion/corrosion of the failed piping was caused by a combination of high velocity flow, a pH level of 9.0 or less in the heater drain system, and flow turbulence caused by valve throttling.

The feedwater pipe rupture at Loviisa Unit 1 occurred in the flange of the flow-measuring orifice (Figure 1). The 360-degree thinning of the interior wall of the flange started near the orifice plate and increased to the point of the rupture. In the area of the rupture, the flange wall had thinned to 0.039 inch. A 20 inch long pipe section attached to the downstream end of the flange had circumferential wall thinning from an initial wall thickness of 0.7 inch to a residual wall thickness of 0.195 - 0.390 inch. Neither this section of pipe nor the flange contained significant amounts of alloying elements. However, the piping downstream of the 20 inch pipe, which contained 0.20 percent chromium, 0.30 percent nickel and 0.30 percent copper, did not exhibit wall thinning.

The utility conducted an investigation and determined that the thinning was caused by erosion/corrosion. In 1982, the utility established a pipe inspection program for two phase (steam/water) systems and, in 1986, augmented the program to include single phase systems; however, the program concentrated on pipe elbows and tee fittings. To check for other degraded flanges, the utility inspected the flow-orifice flanges at Units 1 and 2 and found that 9 of 10 flanges were below minimum wall requirements. The utility replaced the flanges with the same material as the original flanges but is considering changing to a more erosion/corrosion resistant material as a final repair.

The NRC has issued the following related generic communications:

NRC Information Notice 86-106, "Feedwater Line Break," December 16, 1986, and supplements 1, 2, and 3.

NRC Information Notice 87-36, "Significant Unexpected Erosion of Feedwater Lines," August 4, 1987.

NRC Information Notice 88-17, "Summary of Responses to NRC Bulletin 87-01, 'Thinning of Pipe Walls in Nuclear Power Plants'," April 22, 1988.

NRC Bulletin 87-01, "Thinning of Pipe Walls in Nuclear Power Plants," July 9, 1987.

NRC Generic Letter 89-08, "Erosion/Corrosion-Induced Pipe Wall Thinning," May 4, 1989.