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

December 18, 1991

NRC INFORMATION NOTICE 91-18, SUPPLEMENT 1: HIGH-ENERGY PIPING FAILURES CAUSED BY WALL THINNING

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 continuing erosion/corrosion problems affecting the integrity of high energy piping systems and to alert addressees to apparently inadequate erosion/corrosion monitoring programs. 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

On March 12, 1991, the NRC issued Information Notice (IN) 91-18, "High Energy Piping Failures Caused by Wall Thinning," to describe ruptures and leaks in secondary systems carrying high energy fluids at the Millstone Nuclear Power Station, Unit 3, the San Onofre Nuclear Generating Station, Unit 2, and a foreign plant.

Following the pipe rupture at the Surry Power Station in 1986, the NRC issued Bulletin 87-01, "Thinning of Pipe Walls in Nuclear Power Plants," July 9, 1987. In this bulletin, the staff requested licensees and applicants to inform the NRC about their programs for monitoring the wall thickness of carbon steel piping in both safety-related and nonsafety-related high energy fluid systems. IN 91-18 included references related to this bulletin. IN 82-22, "Failures of Turbine Exhaust Lines," July 9, 1982, also provides relevant information regarding pipe wall thinning in steam lines.

In 1989, following an audit of the erosion/corrosion programs at ten plants, the NRC issued Generic Letter (GL) 89-08, "Erosion/Corrosion-Induced Pipe Wall Thinning," May 2, 1989. In this generic letter, the staff requested licensees and applicants to implement long term erosion/corrosion monitoring programs. The staff made this request to obtain assurances that procedures or administrative controls were in place to maintain the structural integrity of all carbon steel systems carrying high energy fluids.

The Electric Power Research Institute (EPRI) released computer codes CHEC and CHECMATE in June 1987 and April 1989, respectively, to assist in selecting for testing those areas of the piping systems with highest probabilities for wall thinning. The CHEC calculation applies to pipes containing a single liquid phase and the CHECMATE calculation applies to pipes containing both liquid and vapor phases.

On June 11, 1987, the Technical Subcommittee Working Group on Piping Erosion/Corrosion of the Nuclear Management and Resources Council (NUMARC) issued a summary report describing a method using the CHECMATE computer code for monitoring carbon steel components exposed to the conditions conducive to erosion/corrosion.

Description of Circumstances

At Millstone Unit 2, on November 6, 1991, while the licensee, the Northeast Nuclear Energy Company (NNECo), was operating the plant at 100 percent of full power, a rupture occurred in train B of the moisture separator reheater (MSR) system. An 8-inch elbow, located between the first stage MSR drain tank and the feedwater heater, ruptured at its extrados (Figure 1). The elbow was located downstream from a 4-inch flow control valve and a 4- to 8-inch expander. The high energy water in the pipe (approximately 463 F, 470 psig) flashed to steam, actuating portions of the turbine fire protection deluge system. The water level in the steam generator decreased slightly. The licensee had not selected the ruptured elbow for ultrasonic testing (UT) in its erosion/corrosion monitoring program.

The ruptured elbow was made of carbon steel with nominal wall thickness of 0.322 inch. Wall thickness at the failed area was eroded to 95 percent of the initial nominal value. Other areas, away from the failed area, showed a loss of 22 percent of the wall thickness. The identical elbow in the A train had a maximum wall loss of 34 percent of the initial nominal value.

Discussion

The licensee has had a program for monitoring high energy fluid piping since 1981. The criteria for choosing components to be inspected include component location and service conditions as determined by the engineering judgement of the plant personnel. In contrast, more relevant parameters that could indicate erosion or corrosion wastage include piping material and geometry, fluid properties (flow, temperature, and acidity), and fluid contents (the acidity-controlling agent and the concentration of dissolved oxygen).

In its response to GL 89-08, NNECo indicated that its Engineering Procedure EN-21153, "Thickness Testing of Secondary Piping," describes its monitoring program, established in accordance with EPRI guidelines and using the CHEC program to select for testing those areas of the piping systems with highest probabilities for wall thinning. The licensee also selects areas on the basis of plant experience. However, although the pipe wall thickness testing program was included in the licensee's procedures, the licensee had not implemented the methodology using the EPRI computer codes at Unit 2. This omission may account for the licensee not having tested previously the piping that ruptured on November 6, 1991.

The licensee did use an earlier version of the CHEC computer code in limited analyses at its other nuclear units. The licensee's program did not reflect the use of current versions of EPRI codes (either CHEC or CHECMATE). The Unit 3 rupture described in the March 12, 1991, issuance of this information notice prompted NNECo to commit to perform CHEC or CHECMATE analyses at all its units by December 31, 1991. However, at the time of the second rupture on November 6, 1991, the licensee was implementing this program at its corporate engineering office and not at Unit 2. The Unit 2 personnel were consequently relying on inspection procedures that did not possess the benefit of the EPRI's methodology for selecting areas of piping for UT inspection. After November 6, 1991, NNECo performed a CHECMATE analysis that did identify this portion of the MSR system as highly susceptible to erosion or corrosion and thus as a candidate for UT inspection.

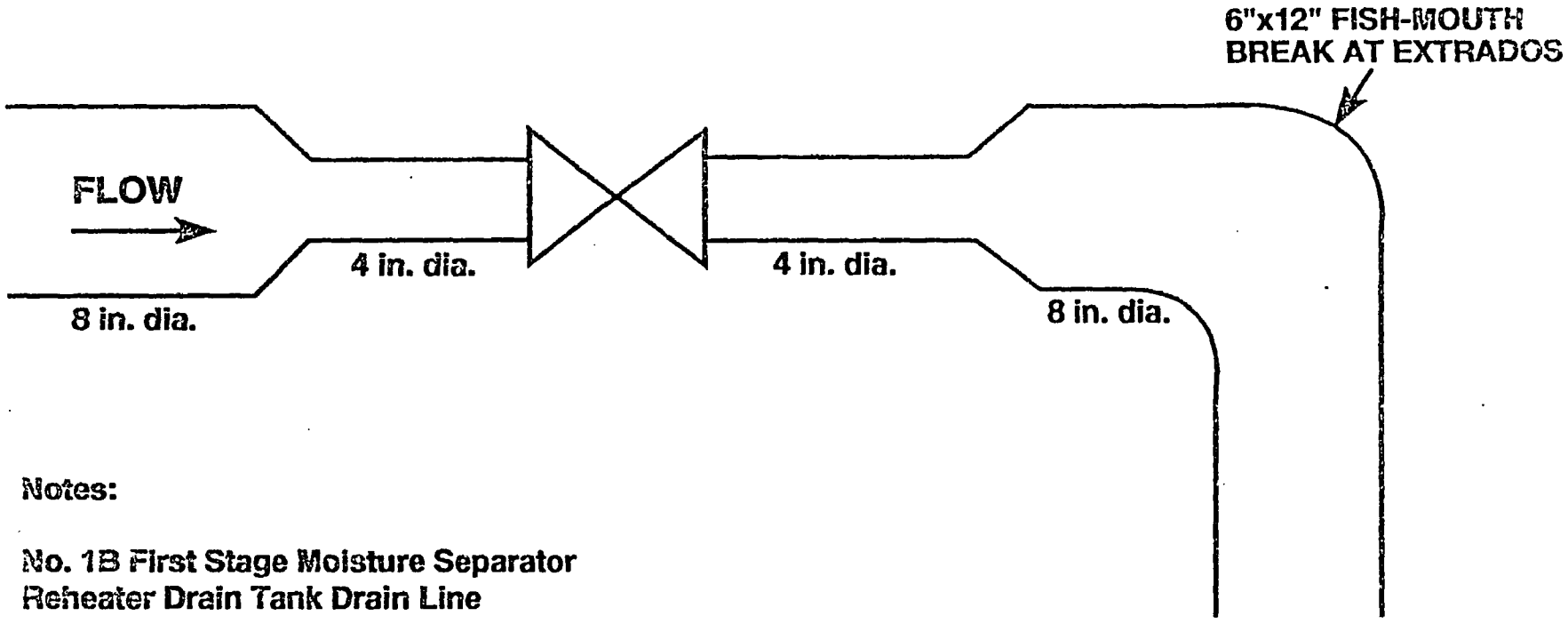
This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact one of the technical contacts listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

Charles E. Rossi, Director
Division of Operational Events Assessment
Office of Nuclear Reactor Regulation

Technical contacts: K. I. Parczewski, NRR
(301) 504-2705

Vern Hodge, NRR
(301) 504-1861

Attachments:
1. Figure 1, "Rupture of Elbow in Secondary System at Millstone Unit 2 on November 6, 1991"
2. List of Recently Issued NRC Information Notices



Notes:

No. 1B First Stage Moisture Separator
Reheater Drain Tank Drain Line

Pipe: Carbon Steel
No Chromium Content

Fluid: H_2O @ 470 psig, 463°F
pH: 8.2 → 8.7
O_2: <2ppb

Figure 1. Rupture of Elbow in Secondary System at Millstone Unit 2 on November 6, 199

LIST OF RECENTLY ISSUED NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
91-82	Problems with Diaphragms in Safety-Related Tanks	12/18/91	All holders of OLs or CPs for nuclear power reactors.
91-81	Switchyard Problems that Contribute to Loss of Offsite Power	12/16/91	All holders of OLs or CPs for nuclear power reactors.
91-80	Failure of Anchor Head Threads on Post-Tensioning System During Surveillance Inspection	12/11/91	All holders of OLs or CPs for nuclear power reactors.
91-79	Deficiencies in the Procedures for Installing Thermo-Lag Fire Barrier Materials	12/06/91	All holders of OLs or CPs for nuclear power reactors.
88-92, Supp. 1	Potential for Spent Fuel Pool Draindown	11/29/91	All holders of OLs or CPs for nuclear power reactors.
91-78	Status Indication of Control Power for Circuit Breakers Used in Safety-Related Applications	11/28/91	All holders of OLs or CPs for nuclear power reactors.
90-57, Supp. 1	Substandard, Refurbished Potter & Brumfield Relays Represented as New	11/27/91	All holders of OLs or CPs for nuclear power reactors.
91-77	Shift Staffing at Nuclear Power Plants	11/26/91	All holders of OLs or CPs for nuclear power reactors.
91-76	10 CFR Parts 21 and 50.55(e) Final Rules	11/26/91	All holders of OLs or CPs and vendors for nuclear power reactors.

OL = Operating License
CP = Construction Permit