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

February 24, 1995

NRC INFORMATION NOTICE 95-11: FAILURE OF CONDENSATE PIPING BECAUSE OF EROSION/CORROSION AT A FLOW-STRAIGHTENING DEVICE

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 possible piping failures caused by flow disturbances that are not accounted for in erosion/corrosion 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.

Description of Circumstances

On November 29, 1994, the Sequoyah Unit 1 reactor tripped from 100-percent power. Approximately 3 hours after the plant trip, Tennessee Valley Authority (TVA, the licensee) observed water pouring from a 16 inch nominal size diameter condensate line between the 1B4 and 1B3 feedwater heaters. A licensee investigation found a 180 degree circumferential crack in the reduced section of a nominal 14 inch pipe. This pipe section was part of a Westinghouse flow-metering device that had been installed during the first refueling cycle to test turbine performance.

The metering device consisted of three flanged sections of pipe: the first section reduced the pipe diameter from 16 inch to 14 inch; the last section expanded the diameter back to 16 inch; and the middle section contained a flow-straightening device, a nozzle, and flow taps. The flow straightener device consisted of three 0.95 cm [0.375 inch] thick, circular plates with drilled flow holes. The plates were spaced about 0.3 meter [1 foot] apart and held together by four 1.27 cm [0.5 inch] rods. The first circular plate fit the pipe flange face and held the fixture in place. The other two plates fit the machined, inside surface of the 14 inch diameter pipe section.

Discussion

TVA found that the pipe failure occurred at the interface of the edge of the middle plate and the inner surface of the pipe wall. The failure resulted from bypass flow around the edge of the plate, which caused very localized erosion along a narrow band, approximately 1.27 cm [0.5 in] wide and 360 degrees around the pipe wall. A 7.6 cm [3 inch] wide, 0.32 cm [0.125 inch] deep machined surface, 360 degrees, on the outer surface of the pipe in the same area of the internal erosion may have contributed to the pipe failure. This surface had been machined to serve as a reference surface and the inner surface was machined to ensure a snug fit of the flow straightener inside the pipe. At the failure area, erosion had further thinned the pipe wall to approximately 0.127 cm [0.05 inch].

The condensate line containing the flow-metering device was in the erosion/corrosion program and modeled with CHECMATE, but it was modeled as a straight 16 inch pipe section without any diameter or thickness change. CHECMATE is a program used by a majority of licensees that predicts erosion/corrosion rates in piping components, ranks the components in order of damage potential, and calculates the time remaining before reaching a user defined acceptable wall thickness. The licensee personnel responsible for operations and engineering were aware that the flow-metering device was installed; however, ambiguities in drawings prompted the personnel responsible for the erosion/corrosion program to assume that these sections had been removed. The pipe configuration had not been visually inspected and it had been modelled as a straight section.

After the pipe failure, the CHECMATE model, including the condensate line with the flow-metering devices, was re-analyzed. The CHECMATE program did not include a model for the flow straightener; the closest model for this device was a straight pipe section. The CHECMATE model would have indicated a high rank for erosion downstream of the nozzle, which would have been modelled as an orifice. Therefore, knowledge that the metering device was installed still may not have prompted an inspection of the area of piping that failed (the area of the flow straightener). Even if the area had been inspected, the band of erosion was so localized that it could have been missed since only grid intersections are inspected.

The licensee determined that the parallel condensate lines still had the temporary metering devices installed and replaced those sections with straight 16 inch sections of pipe. The licensee also determined that the heater drain system had two of these temporary metering sections but decided to leave the lines in service because the flow straighteners had been removed in an outage and present thickness measurements indicated no unacceptable erosion.

The root cause of the failure was the bypass flow around the middle plate of the flow straightener. This bypass flow was not anticipated and the NRC staff is not aware of any previous industry experience that would have demonstrated a need to have the CHECMATE program indicate a high rank for flow straighteners. This example is an indication of how flow disturbances not accounted for by modelling tools can affect the reliability of licensee erosion/corrosion programs.

Related Generic Communications

In NRC Bulletin 87-01, "Thinning of Pipe Walls in Nuclear Power Plants," July 9, 1987, the staff requested licensees and applicants to inform NRC about their programs for monitoring the wall thickness of carbon steel piping.

By NRC Generic Letter (GL) 89-08, "Erosion/Corrosion-Induced Pipe Wall Thinning," May 2, 1989, the staff requested licensees and applicants to implement long term erosion/corrosion monitoring programs.

The NRC also issued several information notices on erosion and corrosion.

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.

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

Technical contacts: B. R. Crowley, RII
(404) 331-5579

N. Economos, RII
(404) 331-5580

K. I. Parczewski, NRR
(301) 415-2705

Attachment:
List of Recently Issued NRC Information Notices

Attachment filed in Jacket

LIST OF RECENTLY ISSUED NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
95-10 Supp. 1	Potential for Loss of Automatic Engineered Safety Features Actuation	02/10/95	All holders of OLs or CPs for nuclear power reactors.
95-10	Potential for Loss of Automatic Engineered Safety Features Actuation	02/03/95	All holders of OLs or CPs for nuclear power reactors.
95-09	Use of Inappropriate Guidelines and Criteria for Nuclear Piping and Pipe Support Evaluation and Design	01/31/95	All holders of OLs or CPs for nuclear power reactors.
95-08	Inaccurate Data Obtained with Clamp-On Ultrasonic Flow Measurement Instruments	01/30/95	All holders of OLs or CPs for nuclear power reactors.
95-07	Radiopharmaceutical Vial Breakage during Preparation	01/27/95	All USNRC medical licensees authorized to use byproduct material for diagnostic procedures.
95-06	Potential Blockage of Safety-Related Strainers by Material Brought Inside Containment	01/25/95	All holders of OLs or CPs for nuclear power reactors.
95-05	Undervoltage Protection Relay Settings Out of Tolerance Due to Test Equipment Harmonics	01/20/95	All holders of Construction Permits for nuclear power reactors.
95-04	Excessive Cooldown and Depressurization of the Reactor Coolant System Following a Loss of Offsite Power	01/19/95	All holders of OLs or CPs for nuclear power reactors.

OL = Operating License
CP = Construction Permit

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Original signed by
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DOCUMENT NAME: 95-11.IN

*See previous concurrence

OFC	OECB:DOPS	TECH ED	SC/OECB:DOPS	EMCB:DE
NAME	SKoenick*	JMain*	EGoodwin*	KParczewski*
DATE	12/14/94	12/19/94	12/19/94	12/21/94

OFC	C/EMCB:DE	OECB:DOPS	C/OECB:DOPS	D/DOPS
NAME	JStrosnider*	RKiessel*	AChaffee/RLD*	BGrimes
DATE	12/21/94	01/17/95	01/19/95	02/2 /95

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DOCUMENT NAME: S:\DOPS_SEC\SEQUOYAH.IN

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OFC	OECB:DOPS	TECH ED	SC/OECB:DOPS	EMCB:DE
NAME	SKoenick*	JMain*	EGoodwin*	KParczewski*
DATE	12/14/94	12/19/94	12/19/94	12/21/94

OFC	C/EMCB:DE	OECB:DOPS	C/OECB:DOPS	D/DOPS
NAME	JStrosnider*	RKiessel*	AChaffee/RLD*	BGrimes
DATE	12/21/94	01/17/95	01/19/95	/ /95

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

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DOCUMENT NAME: G:\SSK2\SEQUOYAH.IN

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NAME	SKoenick*	JMain*	EGoodwin*	KParczewski*
DATE	12/14/94	12/19/94	12/19/94	12/21/94

OFC	C/EMCB:DE	OECB:DOPS	C/OECB:DOPS	D/DOPS
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DATE	12/21/94	01/17/95	01/19/95	/ /95

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NRC Generic Letter (GL) 89-08, "Erosion/Corrosion-Induced Pipe Wall Thinning," May 2, 1989. The staff requested licensees and applicants to implement long term erosion/corrosion monitoring programs.
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DATE	12/14/94	12/19/94	12/19/94	12/21/94

OFC	C/EMCB:DE	OECB:DOPS	C/OECB:DOPS	D/DOPS
NAME	JStrosnider*	RKiessel	AChaffee	BGrimes
DATE	12/21/94	1/18/95	1/19/95	/95

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

Technical contacts: B. R. Crowley, RII/DRS
(404) 331-5579

N. Economos, RII/DRS
(404) 331-5580

K. I. Parczewski, NRR/DE
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NAME	JStrosnider	RKiessel	AChaffee	BGrimes
DATE	12/21/95	/ /95	/ /95	/ /95

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[OFFICIAL RECORD COPY] DOCUMENT NAME: G:\SSK2\SEQUOYAH.IN