New Hampshire
Yankee

Ted C. Feigenbaum
President and
Chief Executive Officer

NYN- 91160

October 2, 1991

United States Nuclear Regulatory Commission
Washington, D.C. 20555

Attention: Document Control Desk

Reference: Facility Operating License No. NPF-86, Docket No. 50-443

Subject: Licensee Event Report (LER) No. 91-010-01: Reactor Coolant System Unidentified Leakage

Gentlemen:

Enclosed please find Licensee Event Report (LER) No. 91-010-01 for Seabrook Station. This submittal supplements LER No. 91-010-00 which documented a July 25, 1991 event, and is being reported pursuant to 10CFR50.73(a)(2)(i) and 10CFR50.73(a)(2)(ii).

Should you require further information regarding this matter, please contact Mr. Terry L. Harpster, Director of Licensing Services, at (603) 474-9521, extension 2765.

Very truly yours,

Ted C. Feigenbaum

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TCF:GK/

Enclosures: NRC Forms 366, 366A

IE22 1/1

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NRC Form 366
(9-83)

U.S. NUCLEAR REGULATORY COMMISSION
APPROVED OMB NO. 3150-0104
EXPIRES: 8/31/88

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
SEABROOK STATION	0 5 0 0 0 4 4 3	1 OF 0 4

TITLE (4)
Reactor Coolant System Unidentified Leakage

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAMES	DOCKET NUMBER(S)
0 7	2 5	9 1	9 1	— 0 1 0	— 0 1	1 0	0 2	9 1		0 5 0 0 0
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OPERATING MODE (9)	1	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)			
POWER LEVEL (10)	1 0 0	20.402(b)	20.405(c)	50.73(a)(2)(iv)	73.71(b)
		20.405(a)(1)(i)	50.36(c)(1)	50.73(a)(2)(v)	73.71(c)
		20.405(a)(1)(ii)	50.36(c)(2)	50.73(a)(2)(vii)	X OTHER (Specify in Abstract below and in Text, NRC Form 366A)
		20.405(a)(1)(iii)	X 50.73(a)(2)(i)	50.73(a)(2)(viii)(A)	
		20.405(a)(1)(iv)	X 50.73(a)(2)(ii)	50.73(a)(2)(viii)(B)	10 CFR 21
		20.405(a)(1)(v)	50.73(a)(2)(iii)	50.73(a)(2)(x)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER
	AREA CODE
Terry L. Harpster, Extension 2765	6 0 3 — 4 7 4 - 9 5 2 1

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS	

SUPPLEMENTAL REPORT EXPECTED (14)		EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
YES (If yes, complete EXPECTED SUBMISSION DATE)	X NO				

ABSTRACT (Limit to 1400 spaces, i.e., approximately fifteen single-space typewritten lines) (16)

On July 25, 1991, at 8:00 a.m., while in MODE 1 at 100% reactor power, the Reactor Coolant System (RCS)[AB] unidentified leakage rate exceeded the 1.0 gpm Technical Specification (3.4.6.2b) limit. The leak was found to be in the vicinity of the pressurizer, but the exact location could not be determined; therefore a controlled reactor shutdown was initiated.

Following plant shutdown, the leakage source was identified as a failed Raychem "CryoFit" tube coupling located in the pressurizer gas space sample line [KN]. The failure was a 360 degree circumferential fracture at the coupling midpoint. A second failed CryoFit coupling located in the same line was subsequently discovered.

Safety-related use of CryoFit couplings at Seabrook Station has been limited to sampling and instrumentation tubing applications.

NHY has conservatively replaced a large number of CryoFit couplings installed in tubing exposed to RCS chemistry conditions at elevated temperatures. NHY has reviewed applicable industry testing of "Tinel" material and has tested a sample of CryoFit couplings removed from selected locations. The root cause has been determined to be a specification deficiency. The failure mechanism has been determined to be hydrogen embrittlement.

The use of these couplings should be reviewed for applicability in hydrogen environments, paying particular attention to high temperature, high hydrogen, gas space applications at other nuclear facilities.

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
SEABROOK STATION	0 5 0 0 0 4 4 3	9 1	— 0 1 0	— 0 1	0 2 OF 0 4

TEXT (If more space is required, use additional NRC Form 366A's) (17)

Description of Event

On July 25, 1991, at 8:00 a.m., EDT, while in MODE 1 at 100% reactor power, the Reactor Coolant System (RCS) [AB] unidentified leakage rate exceeded the 1.0 gpm Technical Specification (3.4.6.2b) limit. The ACTION associated with this specification requires the leakage rate to be reduced to within limits within 4 hours or be in at least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours.

In response to the RCS Leak, the Unit Shift Supervisor entered Abnormal Operating Procedure OS1201.02, "RCS Leak". In addition, a containment entry was made and the leak was found to be in the vicinity of the pressurizer, but the exact location of the leak could not be determined. Since the RCS leakage was constant at a rate of approximately 5.0 gpm, and its source could not be precisely determined, a controlled reactor shutdown was initiated on July 25, 1991 at 11:41 a.m.

Following the plant shutdown, an inspection of the pressurizer cubicle was conducted. It was determined that the RCS leakage was caused by failure of a Raychem "CryoFit" tube coupling located in the pressurizer gas space sample line [KN] approximately 35 feet downstream of the root isolation valve (RC-V128). The pressurizer gas space sample line is fabricated from Type 316L stainless steel tubing, with tubing segments in this line joined by either welded, CryoFit or compression couplings. The failure which caused the RCS leak was a 360 degree circumferential fracture at the midpoint of a CryoFit coupling.

Raychem CryoFit couplings are made of an alloy comprised primarily of titanium and nickel which exhibits a "shape memory effect." If this material in a manufactured shape, such as a cylinder, is cooled below its phase transformation temperature (approximately -200 degrees F) and the shape of the material is then expanded, the material will return to its originally-manufactured shape as it warms back through its phase transformation temperature. A Cryofit coupling utilizes this "shape memory" phenomena during the installation process. The Cryofit coupling is cooled below the transformation temperature. The ends of the coupling are then expanded and the ends of two lengths of tubing are then inserted into the ends of the coupling. As the coupling warms to room temperature it shrinks around the tubing ends to produce a strong, pressure-retaining joint.

As an immediate follow-up action to this coupling failure, NHY removed for evaluation the failed CryoFit coupling and additional Cryofit couplings from other locations along the pressurizer gas space sample line as well as from the pressurizer liquid space sample line and one RCS hot leg sample line. During the process of removing additional couplings for evaluation, a second failed CryoFit coupling was discovered. This coupling was also located in the pressurizer gas space sample line at a point approximately five inches downstream of the location of the first failed coupling. This second CryoFit coupling fractured after an accidental impact which was imparted to the sample line by an engineer while descending into the pressurizer vault as part of the line inspection effort.

After the discovery of the two failed CryoFit couplings, New Hampshire Yankee (NHY) notified the NRC pursuant to 10CFR50.72(b)(2)(i), on August 14, 1991 of a potential defect in the application of Raychem CryoFit couplings installed in the pressurizer gas space sample line.

Field walkdowns confirmed that over 3000 CryoFit couplings with diameters ranging between one quarter and one half inch were originally installed in Seabrook Station in both safety related and non-nuclear safety applications. Safety-related use of CryoFit couplings has been limited to sampling and instrumentation tubing applications. A typical sampling or instrument tube may contain a combination of welded, CryoFit and/or compression couplings. Only CryoFit couplings are affected by the failure mechanism in question.

Safety Consequences

There were no adverse safety consequences as a result of this event. The RCS leakage rate was sufficiently small to permit an orderly plant shutdown. The leakage was contained in the Reactor Containment Building [NH]. No additional abnormal conditions were noted during the shutdown process. The subsequent liquid and gas released into the Reactor Containment Building were processed through the normal plant radwaste systems. The second degraded CryoFit coupling had been installed in the same line; and if it had failed in addition to the first failed coupling during plant operation, the RCS leakage rate may have increased slightly, but could not have exceeded the makeup capacity of a charging pump during the conduct of an orderly plant shutdown.

All operator actions were determined to be appropriate to ensure the safety of the plant. At no time during this event was there any impact on the health and safety of plant employees or the public.

New Hampshire Yankee has reviewed this event for 10 CFR Part 21 considerations and has determined that this event is not reportable under 10 CFR Part 21. However, New Hampshire Yankee can make no judgement as to the use of those couplings in other nuclear plants. Therefore, New Hampshire Yankee recommends that the use of these couplings should be reviewed for applicability in hydrogen environments, paying particular attention to high temperature, high hydrogen, gas space applications at other nuclear facilities.

Root Cause

The root cause for the failed couplings has been determined to be a specification deficiency. The specification for procurement of the CryoFit couplings did not identify the various process fluids or environmental conditions in which the CryoFit couplings were to be used. Additionally, the specification did not require the vendor to identify any service restrictions applicable to CryoFit couplings based on known fluid chemistry effects.

Metallurgical evaluation results indicate that the failure mechanism is hydrogen embrittlement. Although the detailed failure mechanism is complex and the exact mechanism in this case is currently unknown, the hydrogen embrittlement process appears to occur only in the presence of significant hydrogen at high temperature. Evaluation of failed CryoFit couplings indicates that material degradation progressed from the inside to the outside diameter of the coupling until a 360 degree, circumferential, through-wall failure resulted.

Corrective Action

A controlled reactor shutdown was initiated on July 25, 1991 at 11:41 a.m. in accordance with Technical Specification 3.4.6.2 ACTION b.

Immediate corrective actions were as follows. A root cause analysis was performed to determine the cause of the failures of the CryoFit couplings in the pressurizer gas space sample line. Based on industry information known at the time, technical input from the vendor and preliminary results of testing a small group of CryoFit couplings initially removed from installed locations at Seabrook Station, a hypothesis was formed that CryoFit coupling applications in high hydrogen and high temperature environments are not appropriate. A review of design and procurement documents was conducted to determine the type of service and extent of usage of CryoFit couplings at Seabrook

Station. A field walkdown of accessible tubing systems was conducted to determine the scope of application of CryoFit couplings in safety-related and non-safety-related systems. Criteria for selection of additional CryoFit couplings from installed locations for testing were established. Applying this criteria, a group of CryoFit couplings representative of the range of service at Seabrook Station was removed from installed locations and prepared for testing. New Hampshire Yankee informed the NRC and the industry of the status of CryoFit coupling concerns at Seabrook Station via the 10CFR50.72 report and LER 91-010-00.

Follow-up actions to resolve CryoFit coupling concerns included a review of pertinent literature and applicable industry testing. The review of pertinent literature did not identify any failures of Cryofit couplings. The review of industry testing identified testing performed by the B&W Nuclear Service Company and Framatome as having significant results applicable to Seabrook Station. The B&W tests were performed on Tinel material samples in RCS and secondary side chemistry environments at elevated temperatures. The results of this testing showed no evidence of stress corrosion cracking, intergranular attack, pitting or general corrosion. Framatome conducted tests of Tinel material samples in an RCS chemistry environment. The Tinel material tested by Framatome was similar but not identical to that used at Seabrook Station. The Framatome testing results confirmed our hypothesis that applications of Tinel material in high hydrogen and high temperature environments are not appropriate.

Follow-up actions also included replacement or isolation and testing of selected CryoFit couplings originally installed in Seabrook Station applications. As a conservative measure, NHY replaced or isolated all CryoFit couplings installed in the pressurizer gas and liquid space sample tubing inside Containment, all pressurizer instrumentation tubing, and all remotely unisolable tubing connected to the RCS pressure boundary that experiences RCS chemistry conditions, including instrumentation for actuation of the Reactor Protection System (RPS)[JC] and the Engineered Safety Features Actuation System (ESFAS)[JE]. Additionally, NHY replaced all CryoFit couplings installed in tubing which is exposed to RCS chemistry conditions and whose failure could degrade the performance of the Emergency Core Cooling Systems (ECCS)[BE],[BP],[BQ] . Replacement couplings were either the welded or compression type. The NHY testing program conducted testing on a variety of Cryofit couplings exposed to a spectrum of plant chemistry environments, temperatures, flowing conditions and exposure times. Testing included mechanical property testing, metallography testing, burst testing and hydrogen absorption tests. The results of this testing confirmed that Cryofit couplings are not suitable for high temperature applications exposed to pressurizer gas space chemistry conditions. These test results also confirmed that CryoFit couplings are acceptable for use in applications that experience normal RCS chemistry and temperatures under either stagnant or flowing conditions.

Based on information from the literature review, applicable industry testing and the NHY testing program, NHY is confident that the CryoFit couplings remaining installed in Seabrook Station are capable of performing their intended function for the life of the plant. However, as a conservative measure, NHY will implement a sampling program to verify the corrosion resistance of CryoFit couplings installed in Seabrook Station.

Plant Conditions

At the time of initiation of the RCS leak caused by the first coupling failure, the plant was in MODE 1, Power Operation at 100% reactor power, with an RCS temperature of 587 degrees Fahrenheit and pressure of 2,235 psig. At the time of discovery of the second failed coupling, the plant was in MODE 5, Cold Shutdown.

This is the first event of this type at Seabrook Station.