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The Northeast Utilities System

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January 16, 1995

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) 94-010-01: Potential Fuel Damage Due to RCP Turning Vane Capscrew Locking Cup Failure

Gentlemen:

Enclosed, please find voluntary Licensee Event Report (LER) 94-010-01 for Seabrook Station This supplement provides the root cause for the conditions reported in LER 94-010-00.

Should you require further information regarding this matter, please contact Mr. James M. Peschel, Regulatory Compliance Manager at (603) 474-9521 extension 3772.

Very truly yours,

Ted C. Feigenbaum

TCF:JMP/act

Enclosures: NRC Forms 366/366A

IE22

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NRC FORM 366 (5-92) U.S. NUCLEAR REGULATORY COMMISSION

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LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Seabrook Station	05000443	1 OF 9

TITLE (4)
Potential Fuel Damage Due To RCP Turning Vane Capscrew Locking Cup Failure

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 NAME	DOCKET NUMBER
										05000
06	03	94	94	-- 10 --	01	01	16	95	FACILITY NAME	DOCKET NUMBER 05000

OPERATING MODE (9)	6
POWER LEVEL (10)	0

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more) (11)

	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
	20.405(a)(1)(iii)		50.73(a)(2)(i)		50.73(a)(2)(viii)(A)		(Specify in Abstract below and in Text, NRC Form 366A)
	20.405(a)(1)(iv)		50.73(a)(2)(ii)		50.73(a)(2)(viii)(B)		
	20.405(a)(1)(v)		50.73(a)(2)(iii)		50.73(a)(2)(x)		

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (Include Area Code)
Mr. James M. Peschel, Regulatory Compliance Mngr.	(603)474-9521 ext. 3772

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 15 single-spaced typewritten lines) (16)

On June 3, 1994 North Atlantic Energy Service Corporation (North Atlantic) identified foreign material resting on the reactor vessel lower core plate. The material was discovered during a routine refueling inspection. Subsequent detailed inspections of the reactor vessel identified portions of one Reactor Coolant Pump (RCP) Turning Vane Cap Screw (TVCS) and two TVCS locking cups in the reactor vessel. An inspection of the fuel assemblies identified erosion on fourteen fuel assembly bottom nozzles, but no degradation to the fuel pins.

The TVCS attaches the RCP turning vane to the thermal barrier flange. The TVCS locking cups prevent the TVCS from turning during plant operation. North Atlantic has replaced the TVCS and locking cups on all four RCPs with a new design. The root cause of the TVCS and locking cup release is that the original equipment design did not adequately consider the flow induced vibration of the locking cup and the loss of TVCS preload torque.

There were no adverse safety consequences as a result of the event. The fuel assembly degradation was limited to the bottom nozzles with no degradation being found on the fuel pins themselves.

On June 3, 1994, North Atlantic Energy Service Corporation (North Atlantic) identified foreign material resting on the reactor vessel lower core plate. The debris was discovered during an underwater inspection being conducted during Seabrook Station's third refueling outage. A detailed reactor vessel video inspection was then performed to identify the debris and determine its source.

The reactor vessel video inspection resulted in the discovery of a reactor coolant pump (RCP) turning vane cap screw (TVCS) and two TVCS locking cups. The TVCS was found on the bottom of the reactor vessel. The locking cups were found on the lower core plate, one locking cup was found intact and the other was found deformed with portions missing. Each reactor coolant pump has twenty-three (23) such bolts and locking cups.

On June 21, 1994, it was discovered that the bottom nozzle of two fuel assemblies (Assembly C26 and E33, see Table 2 and Figure 1) were eroded by a foreign object. No degradation to the fuel pins themselves was discovered. On June 22, 1994, based upon the extent of the erosion to the two fuel assemblies, North Atlantic made a non-emergency 4 hour report pursuant to 10CFR50.72(b)(2)(i) due to the potential for further degradation of the fuel assembly bottom nozzles leading to possible future fuel degradation. Although the TVCSs are not considered to be a basic component, the wearing of the fuel assembly bottom nozzle did have the potential to eventually erode into the fuel pin cladding. The fuel pins are considered to be a basic component because the cladding is a fission product barrier which functions to keep offsite exposure within the limits of 10CFR100. Westinghouse Electric Corporation, the reactor coolant pump vendor, has evaluated the locking cap and TVCS failure and determined that the event is not reportable pursuant to 10CFR21. North Atlantic has also evaluated the aforementioned condition and determined that it did not constitute a significant safety hazard in accordance with 10CFR21.

Seabrook Station is a four loop Westinghouse Pressurized Water Reactor (PWR) with Westinghouse Model 93A-1 RCPs. The hydraulic section of each RCP consists of a casing, impeller, diffuser adapter, and turning vane diffuser. The turning vane diffuser is a stationary component attached to the thermal barrier flange by twenty-three turning vane cap screws, and is located above the pump impeller (see Figure 2, RCP Cutaway View). Each TVCS is a 10 inch long threaded bolt, one and a half inches in diameter. The TVCSs hold the turning vane casting to the thermal barrier flange. This bolted joint is located inside the pump such that the locking cups and TVCS heads are exposed to the reactor coolant fluid; however, the joint is not part of the RCS boundary.

The TVCS locking cups function as a bolt anti-rotation device to prevent the bolts from turning during plant operation. The locking cups are fabricated from 304 stainless steel and inserted into the turning vane counterbore. The spring action of the split locking cup presses two bosses into holes in the counterbore. In addition, the locking cups are staked at two locations into slots in the head of the TVCS.

The TVCS locking cups prevent the turning vane cap screws from turning during plant operations. The tendency of these bolts to turn is due in part to the loss of bolt preload caused by plant thermal cycling. The bolts design preload of approximately 2000 ft-lbs is sufficient to seat the turning vane diffuser gasket to preclude leakage and supply

flexibility to accommodate large differentials in operational motions that occur between the turning vane and thermal barrier. During plant steady state operation, hydrostatic forces can seal the gasket without the need of bolt preload. The bolt preload is needed for the cold condition (i.e. plant startup).

The TVCS and the locking cup dropped into the turning vane diffuser due to degradation of the locking cup and loss of TVCS preload torque. The TVCS and locking cups were carried in the cold leg flow stream into the lower plenum of the reactor vessel where the flow stream carried the objects to the underside of the lower core support plate. It is postulated that the debris found its way through the flow holes in the lower core support plate and began to wear at the fuel assembly bottom nozzles.

Loose Parts Detection

The Seabrook Station Loose Parts Monitoring System (LPMS) was manufactured by Technology for Energy Corporation (TEC). The LPMS is designed to meet the requirements of Regulatory Guide 1.133, "Loose Part Detection Program for the Primary System of Light Water Cooled Reactors." The LPMS utilizes a total of 12 accelerometers mounted on the RCS to detect loose parts. Accelerometers are paired at six natural collection regions in the RCS, the reactor vessel head area, the reactor vessel lower plenum area and on each of the four steam generator tube sheet areas. The LPMS continuously monitors each of the 12 accelerometer channels and is aligned to automatically alarm and actuate when the alarm logic is satisfied. When the LPMS actuates the system starts recording all 12 channels simultaneously. The recordings can then be used for subsequent analysis of the alarm provided that the impact signal that initiated the alarm and actuation is present after the initial impact event.

The LPMS performance is monitored by the Station Staff and is controlled by Seabrook Station Technical Requirement 3, "Loose-Part Detection System." Technical Requirement 3 requires a daily CHANNEL CHECK, a monthly ANALOG CHANNEL OPERATIONAL TEST and an 18 month CHANNEL CALIBRATION. In addition, the Reactor Engineering Department performs a weekly audio evaluation of the 12 channels and a monthly review of overall system performance.

Cycle 3 for Seabrook Station began in November 1992. No indication of any unusual LPMS activity was identified until February 1993. On February 22, 1993 a light noise (LPMS activity) was identified on one of the lower reactor vessel channels (channel 6825-2) during a weekly audio evaluation. This LPMS activity was not sufficient to cause the system to alarm and actuate. This LPMS activity was monitored on a weekly basis and through the use of the TEC Smartmeter, a diagnostic tool that is used for a qualitative on site analysis of LPMS signals. The LPMS activity was at first thought to be associated with Incore Instrumentation (ICI) tubing external to the vessel.

On March 18, 1993 a containment entry was made to attempt to identify the source of the LPMS activity. A hand held ultrasonic probe was used to assist in the troubleshooting. During this containment entry, a noise similar to the LPMS was detected above the seal table on the Moveable Incore Instrumentation (MICI) tubing associated with the ICI thimble at core location J-10.

Subsequent to the containment entry LPMS activity similar to that heard on 6825-2 was heard on the other lower vessel detector, 6825-1. On March 23, 1993 the LPMS activity was sufficient to cause the system to alarm. On April 1, 1993 another containment entry was made to isolate or dampen the LPMS activity at location J-10. At this time the activity was no longer present on the ICI thimble at core location J-10 although the activity was still present on the LPMS.

North Atlantic provided a recording of the LPMS activity to TEC for analysis. The preliminary TEC report characterized the activity as rattling that was not directly on the reactor vessel. Subsequent TEC analysis of a second tape with recording of impacts induced directly at the seal table on 4 ICI thimbles and the seal table were included. TEC utilized these recordings to develop their final report which again characterized the LPMS activity as rattling that could potentially be coming from one of the tapered shrouds protecting the ICI thimbles in the inlet plenum area.

By April 13, 1993 channel 6825-1 no longer had LPMS activity and channel 6825-2 had decreased significantly in magnitude. North Atlantic continued to evaluate the LPMS activity and on May 20, 1993 a third containment entry was made to pursue the origin of the activity. By using the hand-held ultrasonic probe at the seal table it was determined that the ICI thimble at core location M-7 had some activity associated with it. The containment entry information and the TEC analyses were used in an evaluation that concluded that the most likely source of the LPMS activity was the tapered shroud associated with ICI thimble #16 at core location M-7.

Through the summer of 1993 channel 6825-2 continued to exhibit light LPMS activity that seemed to diminish somewhat with time. On September 22, 1993 a reactor trip with the tripping of all 4 RCPs occurred. The LPMS alarmed at the time of the reactor trip, which is a normal reactor trip occurrence. Upon startup from the reactor trip, both lower reactor vessel channels, 6825-1 and 6825-2 were quiet and exhibited no LPMS activity for the remainder of Cycle 3.

It can be postulated that the LPMS activity heard on channels 6825-1 and 6825-2 was caused by the TVCS.

Corrective Action

North Atlantic replaced the TVCSs and locking cups on all four RCPs with a new design. The new TVCSs have been redesigned using 316 stainless steel to reduce their susceptibility to intergranular stress cracking corrosion. The redesigned locking cups are made from 304 stainless steel and is capped at one end. The locking cup will cover the TVCSs with two tabs resting in machined notches in the screws. The top of the locking cup is welded to the turning vane with two 1/8 X 1 inch fillet welds. The welds are sized to exceed the load carrying capability of the locking cup tabs. Each TVCS and locking cup has a unique serial number which identifies the location of these components to a specific RCP.

An eddy current test of the ICI thimbles was performed after the core was reloaded. There was no indication of ICI thimble degradation identified by the eddy current test.

Inspection Results

During the TVCS and locking cup replacement, North Atlantic ascertained the as found status of all the TVCSs and locking cups. The TVCS and one of the locking cups found in the reactor vessel came from the "B" RCP. The remaining locking cup came from the "D" RCP. Refer to Table 1, RCP Inspection Data for details. In addition, during the detailed reactor vessel video inspection the TVCS, locking cups and other debris, including pieces of locking cups were removed from the vessel.

A video inspection was performed of the Cycle 3 fuel assemblies bottom nozzle. The inspection identified fourteen fuel assemblies with worn or burnished bottom nozzles. The inspection results are presented in Table 2, Fuel Assembly Bottom Nozzle Inspection Results. Of the inspected fuel assemblies, only one bottom nozzle was worn to the extent that it would not be reused. However, this assembly was scheduled for discharge after Cycle 3. This assembly had a hemispherical section worn out of the bottom nozzle. It is postulated that the wear was caused by the fretting of the TVCS positioned vertically under the assembly.

North Atlantic also performed a video inspection of the loop 2 cold leg. The loop 2 cold leg contains the "B" RCP and is the flowpath the TVCS followed to the reactor vessel. The inspection found no evidence of damage caused by the TVCS.

Safety Consequences

There were no adverse safety consequences as a result of this event. The fuel assembly bottom nozzle wear caused by the TVCS and the locking cups did not cause any wear to the fuel pins themselves. If the TVCS had migrated past assemblies C26 and E33 to cause wear to a fuel pin, the increased RCS activity would have been detected by radiation monitors and/or RCS sampling. Technical Specification 3.4.8, Specific Activity, limits the specific activity of the RCS and directs a plant shutdown if the limits are exceeded.

Root Cause

The release of the locking cup and the TVCS was evaluated with assistance from the vendor, Westinghouse Electric Corporation. The root cause of the TVCS and locking cup release is the original equipment design did not adequately consider the flow induced vibration of the locking cup and the loss of TVCS preload torque. The flow induced vibration caused the locking cups to erode and release from the turning vane. The TVCS subsequently backed out due to the loss of preload torque and the affects of vibration and gravity at a low/zero operating load.

Previous Occurrences

This is the first event at Seabrook Station involving the discovery of large pieces of foreign material in the reactor vessel.

Plant Conditions

At the time of this event, the plant was in Mode 6, with the reactor defueled.

Table 1
RCP Inspection Data

	RCP A	RCP B	RCP C	RCP D
Missing TVCS Locking Cup		3		6
Missing TVCS		3		
TVCS with Breakaway Torque less than 75 ft-lb	6, 19, 21,	1, 12, 16, 21	11,	3, 6
TVCS locking cups with evidence of damage or with pieces missing	18, 19, 21	17, 18, 19, 20, 22	1, 21	5, 8, 15, 18, 22
TVCS/locking cups which have rotated	19	15, 16, 21		16, 21

Note: Table numbers denote turning vane flange location.

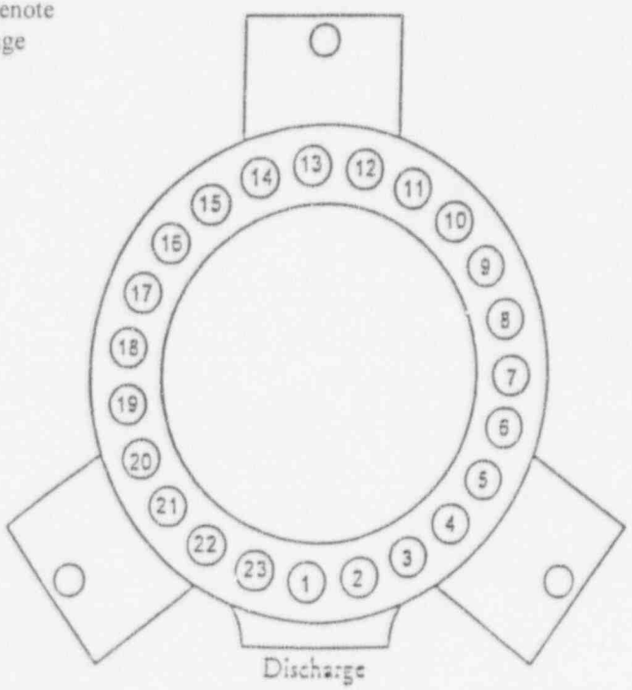

Table 2
Fuel assembly Bottom Nozzle Inspection Results

ASSEMBLY ID	CONDITION	HYPOTHESIZED CAUSE
C26	Hemispherical section worn out of bottom nozzle extending to face 1 of plate	TVCS fretting against surface
E33	Wear gouge on face 3 skirt plate of bottom nozzle	TVCS fretting against surface
C11	Gashes and marring on bottom nozzle, extending to face 1 of nozzle	TVCS locking cup fretting against surface
E22	Gouges on face 3 skirt plate of bottom nozzle	TVCS locking cup fretting against surface
E65	Marring on bottom nozzle	TVCS locking cup fretting against surface
E23, D33, E03	Minor scratches in oxide on bottom nozzle	Debris contact against surface
C22	Random nicks and burnish area on bottom nozzle	TVCS locking cup or debris fretting against surface
C53, C24, C41, C30, C55	Burnishing on bottom nozzle	TVCS locking cup or debris fretting against surface

Figure 1
Location of Bottom Nozzle Damage

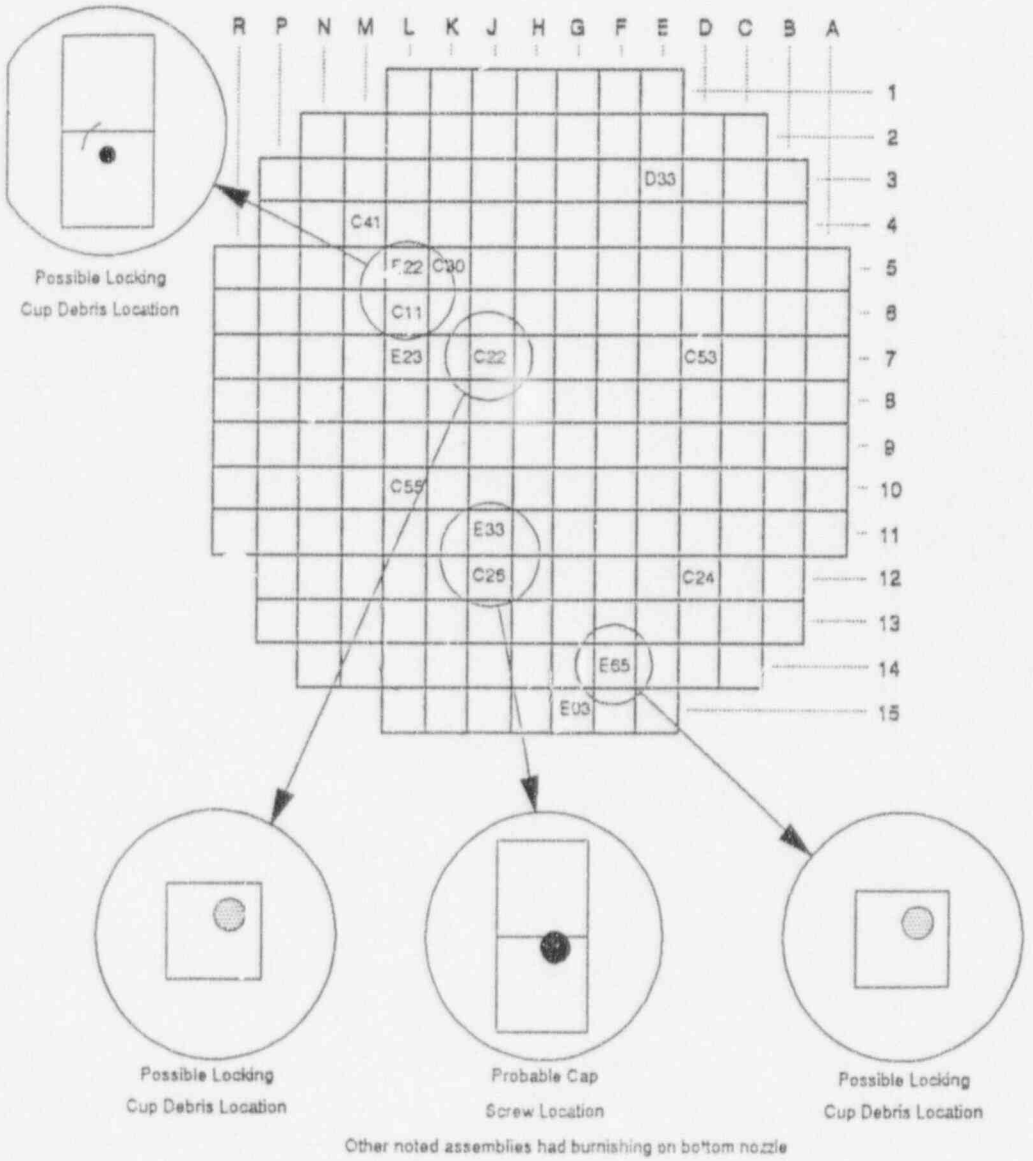

Figure 2
RCP Cutaway View