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April 13, 1994

U.S. Nuclear Regulatory Commission
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Gentlemen:

TENNESSEE VALLEY AUTHORITY - SEQUOYAH NUCLEAR PLANT UNIT 1 - DOCKET NO. 50-327 - FACILITY OPERATING LICENSE DPR-77 - LICENSEE EVENT REPORT (LER) 50-327/94001

The enclosed voluntary LER provides details concerning the formation of gas in the reactor head and the steam generator tubes during low reactor coolant system pressure operation.

Sincerely,

Ken Powers

Enclosure
cc: See page 2

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NRC Form 366 (5-92)

U.S. NUCLEAR REGULATORY COMMISSION

Approved OMB No. 3150-0104
Expires 5/31/95

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Sequoyah Nuclear Plant (SQN), Unit 1	0 5 0 0 0 3 2 7	1 OF 0 7

TITLE (4)

Formation of Gas in the Reactor Head and the Steam Generator (S/G) Tubes

EVENT DAY (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)
1 2	2 1	9 3	9 4	0 0 1	0 0	0 4	1 3	9 4		0 5 0 0 0

OPERATING MODE (9)	5	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following)(11)			
POWER LEVEL (10)	0 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)	XX OTHER (Specify in Abstract below and in Text, NRC Form 366A)
		20.405(a)(1)(iii)	50.73(a)(2)(i)	50.73(a)(2)(viii)(A)	
		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 (AREA CODE)
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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)

This event is being reported as a voluntary LER to inform the NRC staff of a condition involving the accumulation of gas in the reactor head and the S/G tubes during low reactor coolant system (RCS) pressure operation. On December 21, 1993, with Unit 1 in Mode 5 in a refueling outage, Operations personnel wrote a problem evaluation report concerning the potential that gas may have formed in the reactor head and the S/G tubes. Operations based this hypothesis on the amount of water that had to be added and then subsequently let down from the RCS while performing the containment integrated leak-rate test. Technical Support personnel have evaluated this condition and concluded that at low RCS pressure (the RCS was at atmospheric pressure), nitrogen is coming out of solution in the reactor head and the S/G tubes. Nitrogen is used as a cover gas on the volume control tank (VCT). The nitrogen pressure in the VCT was approximately 20 pounds per square inch gauge. Therefore, gas was being transported from the VCT to the RCS via the charging system. An additional evaluation has determined that, as the result of the gas accumulation, reactor vessel water level was reduced to the top of the RCS hot legs. The pressurizer level during this event remained steady at approximately 60 percent. The root cause of this event was insufficient knowledge and the lack of a questioning attitude concerning management's evaluation of off-normal plant conditions and the solubility of nitrogen in the RCS. SQN management will review the lessons learned from this event with appropriate site personnel.

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Sequoyah Nuclear Plant (SQN), Unit 1	0 5 0 0 0 3 2 7	9 4	-- 0 0 1	-- 0 0	0 2 OF 0 7

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

I. PLANT CONDITIONS

Unit 1 was in Mode 5 in a refueling outage. Reactor coolant system (RCS) temperature was approximately 120 degrees Fahrenheit and RCS pressure was atmospheric.

II. DESCRIPTION OF EVENT

A. Event

This event is being reported as a voluntary LER to inform the NRC staff of a condition involving the accumulation of gas in the reactor head and the steam generator (S/G) tubes during low RCS pressure operation.

On December 21, 1993, Operations personnel wrote a problem evaluation report (PER) concerning the potential that gas may have formed in the reactor head and the S/G tubes. Operations based this hypothesis on the amount of water that had to be added and then subsequently let down from the RCS while performing the containment integrated leak-rate test (CILRT).

An incident investigation (II) was initiated as a result of this condition. The II evaluated the details of the CILRT. The CILRT commenced on December 17 and was completed on December 20. The RCS was vented through the pressurizer to the containment atmosphere. During the CILRT, water was added to the RCS, and then subsequently let down from the RCS in order to maintain pressurizer level. As a result, Operations personnel determined that gas may exist in the reactor head and the S/G tubes and wrote the PER. After discussions with management personnel, Operations determined that the most appropriate action was to vent the reactor head. Operations also decided that the substitution of four filled reactor coolant loops for a residual heat removal (RHR) loop would not be allowed since gas may exist in the system.

Technical Support personnel have evaluated this condition and concluded that at low RCS pressure (the RCS was at atmospheric pressure), nitrogen was coming out of solution in the reactor head and the S/G tubes. Nitrogen was being used as a cover gas on the volume control tank (VCT). The nitrogen pressure in the VCT was approximately 20 pounds per square inch gauge (psig). Therefore, nitrogen was being placed into solution in the VCT. This water was being transported from the VCT through the charging pumps and into the RCS. Once the water was in the RCS, the nitrogen was coming out of solution as a result of the pressure drop and temperature increase from the VCT to the RCS.

An operability evaluation was written that concluded the utilization of four filled reactor coolant loops as a substitute for an RHR loop was not permitted. The evaluation concluded that a bubble existed in the S/G tubes, thus, preventing the reactor coolant loops from being "filled." The evaluation also specified that the reactor head be vented once the reactor vessel level indication system upper-range water level indicator reaches 80 percent.

The incident investigation performed by Technical Support personnel has determined that as the result of the gas accumulation, reactor vessel water level was reduced to the top of the RCS hot legs. The pressurizer level remained steady at approximately 60 percent during this entire event. The gas volume in the reactor head and the S/G tubes was determined by the amount of nitrogen that could be introduced into the system. The RCS temperature and pressure was approximately 120 degrees F atmospheric pressure. The VCT temperature decreased from approximately 75 degrees F in September to approximately 50 degrees F in January. The nitrogen pressure in the VCT was approximately 20 psig. The solubility of nitrogen at these conditions provides a sufficient gas generation rate to account for the magnitude of gas in the reactor head and the S/G tubes. Once the gas filled the reactor head and the S/G tubes, the gas traveled into the RCS hot legs to the pressurizer surge line. The pressurizer was vented to the containment atmosphere through the pressurizer relief tank. Therefore, the gas traveled through the pressurizer to the containment atmosphere. Since air is mostly nitrogen, the additional nitrogen from the RCS was not detected in the containment atmosphere.

Based on this information, SQN has concluded that as the result of system configuration, the gas accumulation had reached equilibrium. The gas volume could not have gotten any larger. The gas generation rate would not have changed. However, as long as the pressurizer was vented to containment, the gas escaped through the above described route. Therefore, the integrity of the RHR pumps was maintained during this event.

B. Inoperable Structures, Components, or Systems That Contributed to the Event

None.

C. Dates and Approximate Times of Major Occurrences

September 6, 1993	The RCS sweeps and vents were completed. This removed gas from the RCS. The VCT was aligned to the RCS with a nitrogen cover gas. The RCS pressure was reduced to atmospheric pressure.
December 17, 1993	The CILRT commenced. Pressurizer level decreased as containment pressure increased. Water was added to the RCS in order to maintain pressurizer level.

December 20, 1993 — The CILRT was completed. Pressurizer level increased as containment pressure decreased. Water was let down from the RCS in order to maintain pressurizer level.

December 21, 1993 — Operations personnel wrote a PER describing the potential formation of gas in the reactor head and in the top of the S/G tubes.

Technical Support personnel began the evaluation of this condition.

Operations personnel vented the reactor head.

December 21, 1993 — Operations and Technical Support personnel documented that four filled reactor coolant loops shall not be substituted for an RHR loop until the RCS sweeps and vents are completed. This is the result of the gas accumulation in the S/G tubes.

December 28, 1993 — An Operations shift order was written to monitor the reactor vessel level indication system (RVLIS) upper-range indicator. The order indicated that the reactor head should be vented once the subject RVLIS indicator reads 80 percent (80 percent is equivalent to approximately 18 inches below the flange). The RVLIS indicator read 88 percent at that time.

January 2, 1994 — Operations personnel vented the reactor head.

January 9, 1994 — Operations personnel vented the reactor head.

January 13, 1994 — Technical Support personnel determined that the reactor vessel water level reached the top of the RCS hot legs before the initial vent of the reactor head on December 21, 1993. Plant management was briefed on the incident investigation.

January 14, 1994 — The NRC Resident was briefed on the findings of the incident investigation.

January 24, 1994 — RCS sweeps and vents were performed. The RCS was pressurized.

D. Other Systems or Secondary Functions Affected

None.

E. Method of Discovery

Operations personnel discovered this condition while observing plant conditions during the CILRT.

F. Operator Action

Upon the determination that gas may exist in the reactor head and the S/G tubes, Operations personnel vented the reactor head.

G. Safety System Responses

None.

III. CAUSE OF EVENT

A. Immediate Cause

The cause of this event was the nitrogen cover gas on the VCT coming out of solution. This resulted in the formation of a gas bubble in the reactor head and in the S/G tubes.

B. Root Cause

The root cause of this event was insufficient knowledge and the lack of a questioning attitude concerning the following:

1. Management's evaluation of off-normal plant conditions.
2. The solubility of nitrogen in the RCS.

These factors allowed the formation of a gas bubble in the reactor head and the S/G tubes without the knowledge of plant personnel.

C. Contributing Factors

None.

IV. ANALYSIS OF THE EVENT

A review of this condition has determined that, as the result of gas coming out of solution in the reactor head, the reactor vessel water inventory was reduced to the top of the RCS hot legs. The gas was being introduced into the RCS from the nitrogen cover gas on the VCT. Since the VCT was at a higher pressure and lower temperature than the RCS, the nitrogen was being transported through the RCS to the reactor head and the S/G tubes, where the gas came out of solution. This caused the reactor vessel water level to continually decrease until the water level reached the top of the RCS hot legs. Once the water level reached the top of the RCS hot legs, the gas

traveled down the hot legs to the pressurizer surge line. The pressurizer was vented to containment through the pressurizer relief tank. Therefore, the gas traveled through the pressurizer and into the containment atmosphere. The pressurizer level during this timeframe remained at approximately 60 percent (7,500 gallons of water). The reactor vessel water level could not have fallen to any lower level as the result of the system configuration. The gas had to travel down the hot leg and was then vented to the containment atmosphere. Therefore, the lowest possible reactor vessel water level was the top of the hot legs.

The accumulation of gas into the reactor head occurred from approximately September 6 until December 21, 1993. During this timeframe, one train of RHR was not available for service several different times (approximately 4 percent of the time). The primary side of the S/Gs contained gas; therefore, the reactor coolant loops were not considered filled. However, even though the S/Gs cannot produce steam with the subject conditions, the S/Gs are capable of being a heat sink because of the large contained volume of secondary water. A heat sink is also provided by the bulk volume of water in the RCS, both of which would delay the time to boiling in the core if RHR were lost.

Unit 1 has been shut down since March 1993. The decay heat that presently exists in the reactor core has been calculated to be less than 0.65 megawatts (MW). At decay heat levels less than 1.7 MW, thermal surge line flooding need not be postulated. Therefore, all the water in the pressurizer (approximately 7,500 gallons) was available to replinish any water loss in the reactor vessel. Based on a water level in the reactor vessel equivalent to mid-loop, the time to reactor core boiling has been calculated to be 135 minutes. This calculation is very conservative in that credit was not taken for any of the water in the pressurizer as well as any water that might be in the S/Gs. A review of the maintenance activities performed on the RHR system during the subject timeframe concluded that the RHR system would have been available to have been returned to service before core boiling commenced.

Based on the above information, it has been concluded that although the level in the reactor vessel was reduced to the top of the RCS hot legs, RHR suction and, thus, adequate reactor core cooling was not challenged. Therefore, there was no danger to the health and safety of the public as a result of this event.

V. CORRECTIVE ACTION

A. Immediate Corrective Action

Once Operations personnel had determined that gas potentially existed in the reactor head and the S/G tubes, an operability evaluation was written that instructed Operations not to use four filled reactor coolant loops as a substitute for an RHR loop.

An Operations shift order was issued instructing Operations personnel to vent the reactor head once RVLIS upper-range indication reads 80 percent.

B. Action to Prevent Recurrence

SQN management will review the lessons learned from this event with the appropriate site personnel. Subjects including off-normal plant conditions, nitrogen solubility, depressurized RCS conditions, and the monitoring of plant parameters will be discussed.

The appropriate plant procedure will be revised to address operation of the RCS at atmospheric pressure.

The utilization of RVLIS in areas other than postaccident and mid-loop conditions will be evaluated.

VI. ADDITIONAL INFORMATION

A. Failed Components

None.

B. Previous Similar Events

A review of previous similar reportable events at SQN was performed. This review concluded that there have been no previous reportable events concerning this subject at SQN.

VII. COMMITMENTS

1. SQN management will review the lessons learned from this event with the appropriate site personnel by June 1, 1994.

2. The appropriate plant procedure will be revised by May 20, 1994, to address operation of the RCS at atmospheric pressure.

3. The utilization of RVLIS in areas other than postaccident and mid-loop conditions will be evaluated by June 30, 1994.