TENNESSEE VALLEY AUTHORITY

6N 38A Lookout Place
Chattanooga, Tennessee 37402-2801

OCT 22 1990

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

Gentlemen:

TENNESSEE VALLEY AUTHORITY - SEQUOYAH NUCLEAR PLANT UNIT 2 - DOCKET NO. 50-328 - FACILITY OPERATING LICENSE DPR-79 - LICENSEE EVENT REPORT (LER) 50-328/90012

The enclosed LER provides details of an event where a quantity of gas accumulated in the centrifugal charging pump suction header exceeded the maximum allowed gas volume. This condition represented a potentially unanalyzed condition. Although the consequences of this event are unclear, TVA considers this event to be significant; therefore, this event is being reported as a voluntary LER.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

J. R. Bynum, Vice President
Nuclear Operations

Enclosure
cc (Enclosure):
Mr. J. N. Donohew, Project Manager
U.S. Nuclear Regulatory Commission
One White Flint, North
11555 Rockville Pike
Rockville, Maryland 20852

INPO Records Center
Institute of Nuclear Power Operations
1100 Circle 75 Parkway, Suite 1500
Atlanta, Georgia 30339

NRC Resident Inspector
Sequoyah Nuclear Plant
2600 Igou Ferry Road
Soddy Daisy, Tennessee 37379

Mr. B. A. Wilson, Project Chief
U.S. Nuclear Regulatory Commission
Region II
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30323

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PDR ADOCK 05000327
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(6-89) Expires 4/30/92

LICENSEE EVENT REPORT (LER)

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TITLE (4) Gas accumulation in centrifugal charging pump suction piping as result of gas stripping in miniflow line orifices

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)
									Sequoyah, Unit 1	0 5 0 0 0 3 2 7
0 8	2 2	9 0	9 0	0 1 2	0 0	1 0	2 2	9 0		0 5 0 0 0

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)	0 7 7	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)
Geof Hipp, Compliance Licensing	6 1 5 8 4 3 - 7 7 6 6

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
X	YES (If yes, complete EXPECTED SUBMISSION DATE)	NO	1 1	0 1	9 1

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

This report is being submitted as a voluntary LER. On August 22, 1990, with both units in Mode 1, Unit 2 was discovered to be in a potentially unanalyzed condition when a quantity of gas was found in the centrifugal charging pump (CCP) suction header that exceeded the maximum allowed gas volume. It was subsequently determined that hydrogen gas had been coming out of solution on both units and accumulating in the suction piping as a probable result of gas stripping by the CCP miniflow orifices. On September 6, 1990, Unit 1 was also discovered to have more than the maximum allowed gas volume in piping that could be aligned to the CCP suction. The suction piping is being monitored and periodically vented. Positive displacement charging pumps are being operated as the preferred charging source at this time. Related Nuclear Experience Review items that were previously closed are being reviewed. Long-term corrective actions, which are expected to involve hardware modifications, are still being developed.

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

Description of Event

At 2234 Eastern daylight time (EDT) on August 22, 1990, with Unit 1 in Mode 1 (100 percent power, 2,235 pounds per square inch [psig], 578 degrees Fahrenheit [F]) and Unit 2 in Mode 1 (77 percent power, 2,235 psig, and 571 degrees F), Unit 2 was discovered to be in a potentially unanalyzed condition when a quantity of gas was found in the centrifugal charging pump (CCP) (EIIS Code CB) suction header that exceeded the maximum allowed gas volume.

At 1635 EDT on August 20, 1990, while preparing to perform Surveillance Instruction (SI) 40, "Centrifugal Charging Pump," an attempt was made to change operation from the 2A-A to the 2B-B CCP. When the 2B-B CCP was started and run in parallel with 2A-A CCP, no anomalies were observed. However, when the 2A-A CCP was stopped, the operator observed fluctuations in pump flow and motor current on 2B-B and secured the pump after returning 2A-A to service. After venting the pump casing and discharge piping, the pump was restarted at 1954 EDT. Similar fluctuations in pump flow and current were observed, and the pump was again stopped. At 2130 EDT, the pump casing and discharge piping were again vented. The pump suction piping was also vented without complete success at Valve VLV-62-513, which is on the 2B-B CCP suction line. The venting operations continued, and at 0215 EDT on August 21, 1990, a length of piping from the 2A-A residual heat removal (RHR) heat exchanger (EIIS Code BP) discharge to the CCP suction header was vented at Valve VLV-62-699. The 2B-B CCP was started and normal operating parameters were observed. The pump was subsequently tested using SI-40. Vibration diagnostics, pump flow, and discharge pressure indicated acceptable pump performance. However, nonintrusive ultrasonic testing indicated that a small pocket of gas was present in the horizontal section of suction piping from the RHR discharge to the CCPs and that the vertical section up to Valve 2-FCV-63-8 was void. FCV-63-8 is located on the vertical section of the RHR discharge to the CCP suction header at an elevation above VLV-62-699, i.e., the section up to FCV-63-8 cannot be vented by VLV-62-699, and no additional vent exists in this line up to FCV-63-8. See attached sketch and Updated Final Safety Analysis Report, (UFSAR) Figure 6.3.2-1.

An evaluation of the event was completed on August 22, 1990, which concluded that hydrogen gas was coming out of solution and accumulating in certain pipe locations. In consultation with Westinghouse Electric Corporation, it was determined that continued operation was acceptable provided that the gas volume does not exceed six cubic feet in the suction piping to the CCPs. The condition was verified to exist on both units with ultrasonics. Shiftly venting of the piping at VLV-62-699 was specified on both units until the gas accumulation rate could be quantified and an appropriate venting frequency could be determined. Subsequently, the Unit 2 piping was vented at 2015 EDT on August 22, 1990. Based on a volume control tank (VCT) level drop of approximately two percent during that venting, it was concluded at 2234 EDT, that the piping may have had approximately 10 cubic feet of gas vented in addition to that trapped in the vertical section up to FCV-63-8. Because this condition would represent more than the six cubic feet of gas allowed, the NRC Operations Center was notified at 2317 EDT of a potentially unanalyzed condition on Unit 2.

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After the possible unanalyzed condition was discovered, the frequency of venting was increased initially to every four hours and then to every two hours on both units. The effort to quantify the rate of gas accumulation using ultrasonics was also continued. Westinghouse indicated that they believed the major contributor to the gas coming out of solution was gas stripping by the flow restricting orifices in the CCP miniflow lines. To test this belief, both Unit 2 CCPs were stopped on August 24, 1990, and the positive displacement charging pump (PDCP) was placed in service to provide normal charging flow. After approximately five hours, both venting and ultrasonics indicated a greatly reduced rate of gas accumulation. Consequently, operation was also shifted to the PDCP on Unit 1 and the frequency of venting was reduced to shiftly for both units.

Operation of the PDCPs continued on August 25 and 26 while temporary alterations were being prepared for approval to allow vent hoses to remain installed on both units between Valve VLV-62-699 and Valve VLV-63-599, which is on a return line to the chemical volume control system (CVCS) holdup tank. These temporary alterations would facilitate periodic venting of the CCP suction piping until long-term corrective actions could be implemented. Evaluation of potential corrective actions continued on August 27 and 28, 1990. The immediate objective was to develop a method to install a vent in the vertical section of piping below FCV-63-8 to vent the trapped volume of gas estimated at 4.3 cubic feet on both units. By August 29, 1990, a method had been developed and work was started on a design change notice (DCN) and safety evaluation to address the modification. Also, on August 29, 1990, a gas accumulation rate of approximately 0.57 cubic feet per hour was calculated for Unit 2 based on ultrasonic data collected to date. The rate of accumulation is believed to vary depending on VCT pressure and reactor coolant system (RCS) dissolved hydrogen concentration.

An additional pocket of gas was discovered on Unit 1 with ultrasonics on August 31, 1990, upstream of FCV-63-8 (which is normally closed) in a section of piping between the 1A-A RHR pump discharge and Valve FCV-72-40, which controls flow to the RHR spray header (EIIS Code BE) in upper containment. The volume of gas in this pocket was quantified as 1.6 cubic feet, which in combination with the 4.3 cubic feet below FCV-63-8, was just within the allowed 6 cubic feet. A similar pocket of gas was believed to exist on Unit 2 but could not be quantified until asbestos insulation was removed. A night order was written on August 31, 1990, directing that, if the Unit 1 or Unit 2 PDCP failed and a CCP was placed in service, then FCV-63-8 was to be tagged, Limiting Condition for Operation (LCO) 3.5.2 was to be entered, and the gas bubble above FCV-63-8 was to be vented through FCV-72-40. At 1635 EDT on September 6, 1990, the system engineer discovered with ultrasonics that the pocket of gas above FCV-63-8 on Unit 1 had increased to 1.9 cubic feet which, added to the 4.3 cubic feet below FCV-63-8 exceeded the 6 cubic foot limit in piping that could be aligned to the CCP suction. Because of uncertainty as to whether this condition potentially rendered both CCPs or just one CCP inoperable, LCO 3.0.3 was entered as of 1635 EDT on Unit 1. At 1840 EDT, on September 6, 1990, FCV-63-8 valve on Unit 1 was tagged out of service, which meant that the section of piping immediately upstream of the valve could no longer be aligned to the CCPs. Because the volume of gas that could reach the CCPs was no longer above the six cubic feet limit, LCO 3.0.3 was exited at 1840 EDT. NRC

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Operations Center was notified at 2010 EDT that the plant had been in a potentially unanalyzed condition. Although only Unit 1 was known to have exceeded the six-foot cubic limit, it was decided to vent gas on both units. The section of piping upstream of FCV-63-8 was vented at 0543 EDT (Unit 1) and 0630 EDT (Unit 2) on September 7, 1990, and again at 1020 EDT (Unit 1) and 1343 EDT (Unit 2) through FCV-72-40. Ultrasonics indicated that pockets of gas upstream of FCV-63-8 on both units had been eliminated and 1-FCV-63-8 was returned to service. LCO 3.5.2 was entered while FCV-63-8 was tagged out of service. It was subsequently determined that exceeding the 6-cubic foot limit would potentially make only one CCP inoperable and, accordingly, did not represent an unanalyzed condition. This determination was clarified to the NRC Operations Center by telephone call at 1655 EDT on September 21, 1990.

Cause of Event

The physical phenomenon causing the hydrogen gas to come out of solution is believed to be primarily gas stripping at the CCP miniflow line flow restricting orifices. In the original plant design, the CCP miniflow returned to the VCT rather than to the pump suction line. However, as a result of a Westinghouse generic letter concerning the potential for overfilling the VCT after swapover from the VCT to the refueling water storage tank (RWST), the miniflow was rerouted to the CCP suction line downstream of the VCT outlet valves.

During the review for previous similar events throughout the industry, several Nuclear Experience Review (NER) items were found that identified events that were possible precursers to the current SQN event. These items included NRC information notices (IENs) 82-19, 83-77, 87-57, and 88-23; Institute for Nuclear Power Operations (INPO) operating experience notices 87-2196, 88-2477, 88-2973, and 90-3950; INPO recurring significant event notice 89-02; and Westinghouse letters WAT-D-7795, WAT-D-6241, and TVA-88-825. A special review team was formed to investigate the adequacy of the disposition of the previous NER items to determine if the hydrogen problem at SQN could have been recognized at an earlier date. The team concluded that TVA did not identify the potential for gas binding from hydrogen ingestion at the CCPs after receipt of industry information. The principal reason of the failure to identify the potential for gas binding was an incomplete review for IEN 88-23, "Potential for Gas Binding of High-Pressure Safety Injection Pumps during a Loss-of-Coolant Accident." The TVA review principally focused on piping elevations located above the VCT because of the emphasis on this configuration in the industry information. In responding to IEN 88-23, the major emphasis was placed on comparing SQN to Farley Nuclear Plant, where the IEN 88-23 event occurred. Because SQN has no emergency core cooling system (ECCS) piping above the VCT, it was concluded that an event similar to Farley's would not occur. In hindsight, it appears that TVA did not fully understand the hydrogen gas desorption mechanism. Additionally, an inadequate review was performed on Westinghouse Letter TVA-88-825. This letter referenced the local pressure phenomena discussed by the IEN, referring to it as a "two-phase" mixture and identified mechanisms for gas desorption at low pressure points in piping systems, such as valves, tees, elbows, or orifices. Westinghouse Letter TVA-88-825 indicated that evaluation of the issue is plant-specific and recommended that since hydrogen accumulation is difficult to predict, the

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accumulation is best determined by venting. The evaluation conducted did address the issue on a plant specific basis. However, because indications did not exist in the plant at the time that the potential existed for hydrogen to come out of solution, a recommendation to vent was not made. In general, during the 1987-88 timeframe, the tendency was to approach engineering issues analytically. This tendency was based on the strength of TVA's engineering staff and the perceived sensitivity to causing unnecessary plant perturbations during the later stages of the restart effort.

Analysis of Event

Although it could not be definitively determined that the identified condition would have prevented the CCPs from performing their intended function, this event is being reported as a voluntary LER because TVA considers the event to be of significance and of interest to the industry. The CVCS and ECCS are described in Sections 9.3.4 and 6.3, respectively, of the SQN UFSAR.

Westinghouse provided TVA with a letter that concluded that the CCPs would operate with up to six cubic feet of gas in the suction lines. The six cubic foot limit was based on engineering judgment from the results of more detailed analyses done for Farley and Beaver Valley Nuclear Plants. The analyses included scale models of the physical piping for those plants and a significant amount of testing. While Westinghouse had reasonable confidence that Sequoyah was bounded by the results of these tests, they could not say definitively what would have happened for any amount over six cubic feet.

When the unit 2 suction header to the CCPs was vented by the opening of VLV-62-699 on August 22, 1990, the amount of gas vented from the header was not directly measured; however, it was estimated at approximately 10 cubic feet based on the change in VCT level. In addition, approximately 4.3 cubic feet of gas remained trapped in a vertical section of pipe below FCV-63-8. As a result, the total amount of entrained gas could have exceeded the six cubic feet allowed by Westinghouse. On September 6, 1990, the total volume of gas in the CCP suction piping again exceeded six cubic feet on Unit 1 as previously described. From a safety significance standpoint, it is doubtful that the entire volume of gas would have been drawn through the charging pumps all at once. The 4.3 cubic feet trapped in the vertical pipe run is on the recirculation line from the RHR pumps to the suction header. Thus, it is most probable that the gas would have been drawn through the pumps in stages (i.e., initial injection and then again on recirculation). While it is unknown how much gas would have been drawn through initially, the Sequoyah piping configuration is conducive to mixing upon recirculation.

As discussed in Westinghouse letters TVA-90-979 and -980, in the event of an accident situation, it is likely that there would have been some effect on the ECCS pump operation. Most probable would have been some form of cavitation as seen during the recent attempt to start the 2-B CCP. Even though cavitation could have occurred, it may be possible for the pump to reprime itself and continue to operate. In addition, the pumps could have even sustained a limited amount of damage and continued to provide adequate flow based on time in postaccident sequence until such time the RHR pumps

could provide flow for heat removal. There is no definitive answer as to whether or not the pumps would have been adversely affected or to what extent. While the operators do monitor pump performance, it is not reasonable to take credit for operator action in the first few minutes of a design basis accident.

To summarize, the ECCS pumps could have been affected either at initial swapover from the VCT to the RWST or upon recirculation from the sump. However, it is believed that the pumps could have reprimed and continued to operate acceptably or have continued to operate with some form of damage or degradation.

Corrective Action

The immediate actions taken were to evaluate the gas accumulation problem and to maintain pump operability by venting the suction piping periodically. Operation of the PDCPs was initiated on both units to avoid the gas stripping mechanism. Arrangements were made for temporary alterations to leave vent hoses installed to facilitate venting. In addition, a method was developed for installing a vent valve below Valve FCV-63-8 to vent the gas trapped in the vertical section of piping. Required engineering documentation for this modification was initiated.

The long-term corrective action plans are still being developed. The plan currently underway is to install vent valves above and below FCV-63-8 to vent the vertical sections of piping. These permanent vents are expected to be installed on both units by the end of October 1990. Potential future modifications include a continuous vent system from piping high points to the VCT. SQN plans to continue operating the PDCPs as the preferred charging source, to continue periodically venting the CCP suction headers, and to continue monitoring the gas accumulation rate. Long-term modifications may include returning the CCP miniflow path to the VCT, or installing multistage orifices in the CCP miniflow lines to reduce gas stripping.

The proposed modification alternatives require further study before a final long-term corrective action can be approved. Industry experience and any impact on accident analyses and operating procedures must be considered. Consequently, TVA will continue to develop a long-term corrective action plan and will notify NRC by supplement to this LER when the plan is finalized.

As a result of a preliminary system engineering review of system interfaces, piping configurations and probable hydrogen gas generation mechanisms, TVA has a high level of confidence that there are no other accumulations of hydrogen gas in accident mitigation or safe shutdown system that could prevent the proper operation of those systems. However, as additional follow-up actions and to address the incomplete review of IEN 88-23, the following corrective actions will be implemented:

1. TVA will reevaluate IEN 82-19, 83-77, 87-57, 88-23 (plus supplements), and Westinghouse Letter TVA-88-825. The reevaluation will include consideration of corrective actions taken by other utilities and those suggested by Westinghouse. This action will be completed by March 1, 1991.

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2. TVA will review IE Notices received during 1987 and 1988, which required an engineering evaluation to determine if there were associated Westinghouse letters or INPO information related to the notice and whether TVA's analytical evaluation concluded the notice was not applicable at SQN. If, during the look-back process, notices are identified that require further resolution, the NER items will be reopened and a response date will be established. This action will be completed by March 1, 1991.

3. TVA will review Westinghouse letters received during 1987 and 1988 to determine whether TVA's evaluation specifically addressed Westinghouse recommendations and whether the response was concurred with by the SQN project engineer. This action will be completed by March 1, 1991.

4. The NER program has been modified to require that for future Westinghouse generic letters (i.e., those carbon copied to NER by Westinghouse) for which the site is not specifically complying with the Westinghouse recommendations, a documented concurrence between the project engineer and the plant manager shall be made.

Additional Information

No previous reported occurrences of excessive hydrogen gas accumulation in CCP suction piping at SQN could be identified. However, a gas accumulation event was discovered at SQN on June 28, 1990, when an emergency boration line flange leak resulted in recognition that hydrogen was being accumulated in the lines. Corrective action included a review of the NER items related to this LER, but the connection between the events was not recognized. When the CCP event occurred, the connection was recognized and Nuclear Engineering began reviewing the related NER history and responses at SQN.

Commitments

1. TVA will continue to develop the long-term corrective action plan and will notify NRC by supplement to this LER when the plan is finalized.

2. TVA will reevaluate IEN 82-19, 83-77, 87-57, 88-23 (plus supplements), and Westinghouse Letter TVA-88-825. The reevaluation will include consideration of corrective action taken by other utilities and those suggested by Westinghouse. This action will be completed by March 1, 1991.

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