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)
NORTH ANNA POWER STATION, UNITS 1 AND 2	0 5 0 0 0 3 3 8	1 OF 0 7

TITLE (4)

AIR IN HIGH HEAD SAFETY INJECTION PUMP SUCTION LINES

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)
1 0	1 3	8 8	8 8	0 2 2	0 2	0 5	0 1	8 9	NORTH ANNA, UNIT 2	0 5 0 0 0 3 3 9
										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)	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)	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)	VOULNTARY
		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
G. E. Kane, Station Manager	7 0 3 8 9 4 - 5 1 5 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)

At 1000 hours on October 13, 1988, with Units 1 and 2 at 100 percent power (Mode 1), it was determined that various pipes of the Safety Injection System (SI) and Chemical Volume and Control System (CVCS) collected or trapped gas which might affect the functions of these systems. There was a concern that the gas pockets may adversely effect pump operation.

Voids were detected in some of the Low Head Safety Injection (LHSI) to High Head Safety Injection (HHSI) pump suction piping, and in the Refueling Water Storage Tank (RWST) piping to the HHSI pumps. Affected piping, with vent paths, have been vented. Ultrasonic inspection of this piping verified the piping is adequately filled. A Justification for Continued Operation was approved by the Station Nuclear Safety and Operating Committee to allow continued operation for piping which could not be vented. High point vents have been installed on susceptible piping on Unit 2. High point vents will be installed on susceptible piping on Unit 1 prior to restart of power operations.

This event posed no significant safety implications. Multiple pump performance tests at full flow have not indicated any adverse effects from voiding. An engineering evaluation was performed which determined that an acceptable level in the suction piping to each of the HHSI pumps is 50 percent full. This 50 percent level in a static system is theoretically equivalent to approximately 7.7 cubic feet of gas in the suction header and associated pump suction piping. The health and safety of the general public were not affected at any time during this event.

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IE22 1/1

1.0 Description of Event

At 1000 hours on October 13, 1988, with Units 1 and 2 at 100 percent power (Mode 1), it was determined that various pipes of the Safety Injection System (SI) (EIIS System Identifier BP) and Chemical Volume and Control System (CVCS) (EIIS System Identifier CB) collected or trapped gas which might affect the functions of these systems. Surry Power Station, while evaluating NRC Information Notice 88-23, Potential for Gas Binding of High-Pressure Safety Injection Pumps during a Loss-of Coolant Accident, dated May 12, 1988, had conducted ultrasonic testing (UT) on various SI and CVCS pipes and had detected the presence of some voids including voids in lines not addressed in NRC Information Notice 88-23.

NRC Information Notice 88-23 addressed hydrogen accumulation, at the Farley Power Station, in the High Head Safety Injection (HHSI) pump (EIIS System Identifier BP, Component Identifier P) suction piping between the Volume Control Tank (VCT) and the HHSI pumps. The problem at Farley Power Station was attributed to a piping configuration which extended 32 feet above the VCT. Because of system operating parameters, which includes a hydrogen blanket on the VCT, this piping configuration allowed dissolved hydrogen to come out of solution and accumulate in the piping.

The North Anna piping configurations between the VCT and the HHSI pumps are different than those at Farley Power Station. The North Anna review of NRC Information Notice 88-23, therefore, concluded that the similar systems at North Anna were not susceptible to the same phenomena assuming the piping is fully vented when put into service.

As a result of the Surry UT inspections, North Anna performed UT inspections on the lines included in the scope of NRC Information Notice 88-23, as well as, the HHSI emergency suction supply lines from the Low Head Safety Injection (LHSI) pumps (EIIS Component Identifier P) and the Refueling Water Storage Tank (RWST) (EIIS System Identifier BQ, Component Identifier TK). This piping is normally isolated from the HHSI pumps by closed motor operated valves.

Evaluation of the North Anna piping included in the scope of NRC Information Notice 88-23 were as follows:

UNIT 1

1) Between the HHSI pumps and the normally closed valve (1-SI-MOV-1863A) from the LHSI pumps. The inspection indicated that a 0.9 cubic foot void existed. The piping was vented and the gas was analyzed to be a mixture of 17% oxygen, 68% nitrogen and 15% hydrogen.

2) Between the HHSI pumps and the normally closed valves (1-SI-MOV-1115B and D) from the RWST. The inspection indicated that a 0.4 cubic foot void existed in the piping. This piping does not contain a vent and therefore the composition of the void could not be determined.

On February 3, 1989, inspections indicated that a 3.8 cubic foot void existed in the piping.

UNIT 2

1) Between the HHSI pumps and the normally closed valves (2-SI-MOV-2115B and D) from the RWST. A UT inspection on the Unit 2 piping compared with calculations related to a UT performed on the corresponding piping indicated the presence of a void ranging from 0.4 to 0.74 cubic feet of gas. This piping does not contain a vent, therefore, the composition of the gas could not be determined.

A December, 1988 inspection indicated that a 4.22 cubic foot void existed in the piping.

Evaluation of the North Anna lines corresponding to the Surry lines not included in NRC Information Notice 88-23 were as follows:

UNIT 1

1) Between the "B" LHSI pump and the normally closed valve, 1-SI-MOV-1863B, for the HHSI pump alternate suction path. The inspection indicated that 34.8 cubic feet of air existed. The air was vented from the piping.

UNIT 2

1) Between the "A" LHSI pump and the normally closed valve, 2-SI-MOV-2863A, for the HHSI pump alternate suction path. The inspection indicated that 69.6 cubic feet of air existed. The air was vented from the piping.

2) Between the "B" LHSI pump and the normally closed valve, 2-SI-MOV-2863B, for the HHSI pump alternate suction path. The inspection indicated that 38.6 cubic feet of air existed. The air was vented from the piping.

3) Between the RWST and the normally closed valves, 2-SI-MOV-2115B and D, for the HHSI pump alternate suction path. The inspection indicated that 48.8 cubic feet of air existed. The air was vented from the piping.

*U.S. GPO: 1988-520-589/00070

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

Based upon the results of an independent consultant's evaluation, the pump manufacturer's concurrence with the consultant's report, and our engineering evaluation, gas voids in the HHSI suction piping would not have challenged the operability of the HHSI pumps. Therefore, this report is classified as a Voluntary Report.

2.0 Significant Safety Consequences and Implications

HHSI pump operability has been repeatedly demonstrated by full flow periodic testing. The periodic test flows water to the suction of the HHSI pumps via suction from the RWST. Full flow testing is performed every 18 months during a refueling outage. This testing is at flow rates that would occur during design basis conditions. The performance of the HHSI pumps during these tests has not provided any indication of degradation due to gas binding from voids in the suction piping from the RWST.

In addition, the loss of a HHSI pump has been previously evaluated in the Updated Final Safety Analysis Report and is compensated for by the availability of two other full sized HHSI pumps per unit. The HHSI pumps, for Units 1 and 2, are cross connected on the discharge side to ensure that the availability of HHSI to the reactor coolant system is met.

An engineering consultant was requested to analyze the effects on pump operation. The consultant concluded that the gas pockets found in the high points of the Safety Injection System are not likely to be transported intact from the as found location to the HHSI pump suction. The pipes drop significantly in elevation between the areas where the larger volumes of gas were found and the pump suction header. The piping from the pump suction header drops again prior to reaching the individual pump suction. Gas being less dense than water tends to remain in the high points and, therefore, would resist being swept through the low points of a system unless the flow velocities are sufficiently high. The maximum velocities expected in this system conservatively approach 8 to 10 feet per second nominal velocity typically used for pump suction piping design. Velocities of this magnitude are not expected to sweep large volumes of gas intact to the pump suction.

The consultant further concluded that small quantities of air will have no measurable impact on pump performance or unit reliability over time and that gas voids are eventually scoured away. The pump manufacturer has reviewed the consultant's report and concurs with its conclusions.

Also, an engineering evaluation was performed in order to provide the basis for establishing the minimum water level in the HHSI pump suction piping which could ensure safe operation of the pumps.

*U.S. GPO: 1988-520-589/00070

The methodology used to perform the evaluation was based on whether there would be sufficient flow velocity created during a worst case condition to sweep gas from the 6 inch horizontal piping down the vertical piping to the HHSI pump. The evaluation was performed by developing a modified two phase flow pattern model. The purpose of model was to establish the type of flow regime present in the pipe under the worst case conditions, with one charging pump operating at pump runout. In this case flow was assumed to be 650 gpm. In contrast, by design two pumps are expected to be operating with a pump flow of 400 gpm each.

The evaluation concluded that a stratified flow regime is expected even if the 6 inch horizontal piping were only half full. A stratified flow would not tend to sweep gas with it down the vertical pipe run as would be the case if a slug flow was determined to exist. Although there are two elbows located in the horizontal piping which would tend to provide some wave action due to the change in flow direction, the 14.5 foot per second (fps) velocity present when the pipe is half full was judged to be sufficiently close to the low 8 - 10 fps velocities typically used for pump suction design to be compatible with the calculation conclusions.

Another potential factor in gas carryover to the HHSI pump is vortexing at the vertical/horizontal interface of the 6 inch suction piping. This phenomena has been observed in flow model testing by Westinghouse related to the Residual Heat Removal pumps. In that testing it was noted that vortexing is dependent on the water level in the horizontal piping and the fluid velocity. The model testing indicated that gas would not be carried toward the pump suction as a slug but in smaller gradual amounts. Since the amount of gas observed in the individual HHSI pump suction piping has been relatively small, the amount of gas to which the pumps can be subjected to is limited.

Based on the above evaluation, it was demonstrated that a 50% water level in the individual 6 inch pump suction piping is acceptable. A 50% level in a static system is theoretically equivalent to approximately 7.7 cubic feet of gas in the suction header and associated pump suction piping. When in operation, the dynamics of the suction flow results in a non horizontal flow distribution in the suction header. Therefore, an actual 50% level reading in the individual pump suction piping will correspond to a total suction header gas void of less than 7.7 cubic feet.

3.0 Cause of the Event

The potential for this event was caused by not completely venting the system following refill and, in the case of the HHSI pump suction piping, a tendency for hydrogen to come out of solution depending on system operating conditions.

4.0 Immediate Corrective Action

Voids in the LHSI pump discharge piping and the RWST outlet piping have been vented. Ultrasonic inspection of the piping has verified that they are adequately filled.

A Justification for Continued Operation was approved by the Station Nuclear Safety and Operating Committee to allow continued operation for piping which could not be vented.

5.0 Additional Corrective Actions

An engineering consultant has performed an evaluation of the voids, piping, and pumps and concluded that binding of the HHSI pumps will not occur from the volume of gas which was vented from the systems or the remaining void in the suction piping which cannot be vented. The pump manufacturer has concurred with this evaluation.

An engineering evaluation was performed in order to quantify an acceptable water level at which the HHSI pumps could be operated. The evaluation determined that the individual HHSI pump suction piping can be as low as 50 percent full and the HHSI pumps will operate acceptably and not be affected from gas voiding.

The piping is being inspected on a weekly basis using ultrasonic inspection techniques in order to demonstrate that the piping remains adequately full and to monitor the effects of plant operation on the piping. Venting of the piping is also occurring on a weekly basis (where vents are available). Results of the inspections are being trended.

Procedure deviations to the HHSI pump and LHSI pump maintenance operating procedures have been implemented to require additional venting of high points following maintenance on the system.

An entry on the INPO Nuclear Network System was issued to alert the industry of this event.

The JCO to allow continued operation for piping which could not be vented has been revised to reflect the consultant's evaluation, engineering evaluation and inspection results.

Vents have been installed in Unit 2 piping high points that previously did not have vents.

Applicable Maintenance Operating Procedures used to restore systems to service have been reviewed and revised, as necessary, to require venting of piping following maintenance and ensure that suction piping from tank or vessel nozzles are properly submerged.

6.0 Actions to Prevent Recurrence

The gas void monitoring program will be continued until it can be conclusively demonstrated that each subsystem is stabilized in an acceptably solid condition or a partial voided condition is within the limits determined to be acceptable by the engineering evaluation. The monitoring program will also be used to determine the proper frequency for periodically venting the piping.

Vents will be installed in Unit 1 piping high points that did not previously have vents prior to restart of power operations.

7.0 Similar Events

No similar events have been reported at North Anna Power Station. However, in March 1986, with Unit 2 in cold shutdown (Mode 5) following a refueling outage, the HHSI pumps were declared inoperable due to inadequate fill and venting.

8.0 Additional Information

On February 25, 1989, Unit 1 experienced a reactor trip (reference LER N1/89-005-00 dated March 27, 1989). During this reactor trip, the piping from the RWST to the HHSI pumps was used to provide sufficient makeup (150 gpm) to the reactor coolant system.. The HHSI pumps did not experience any detrimental effects from gas voids in the suction piping.

Unit 2 full flow testing of the HHSI pumps, with the suction piping at the beginning of the test at approximately 50% level, had no adverse effects on the HHSI pumps.

The trending program used to monitor this phenomena has shown some fluctation in the size of the gas void in the HHSI pump normal suction header depending upon the system operating conditions while in Mode 1, Power Operation.

VOLUNTARY

Vepco

VIRGINIA ELECTRIC AND POWER COMPANY
NORTH ANNA POWER STATION
P. O. BOX 402
MINERAL, VIRGINIA 23117

May 1, 1989

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

Serial No. N-88-028B
NAPS/JHL: nih
Docket Nos. 50-338
50-339
License Nos. NPF-4
NPF-7

Dear Sirs:

The Virginia Electric and Power Company hereby submits the following Licensee Event Report applicable to North Anna Unit Nos. 1 and 2. The revision to this report provides the results of an engineering evaluation on gas voids in the suction piping of the High Head Safety Injection (HHSI) pump.

Report No. LER 88-022-02

This report has been reviewed by the Station Nuclear Safety and Operating Committee and will be forwarded to Safety Evaluation and Control for their review.

Very truly yours,

M L Bowling

for G. E. Kane
Station Manager

Enclosure

cc: U. S. Nuclear Regulatory Commission
101 Marietta Street, N. W.
Suite 2900
Atlanta, Georgia 30323

Mr. J. L. Caldwell
NRC Senior Resident Inspector
North Anna Power Station

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