10CFR50.73

Virginia Electric and Power Company
Surry Power Station
5570 Hog Island Road
Surry, Virginia 23883

July 3, 2006

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D. C. 20555-0001

Serial No.:	06-483
SPS:CGL	R0
Docket No.:	50-280
	50-281
License No.:	DPR-32
	DPR-37

VOLUNTARY REPORT
MOTOR DRIVEN AFW PUMP HIGH FLOW CONDITION
WITH LOW STEAM GENERATOR PRESSURE

Pursuant to 10CFR50.73, Virginia Electric and Power Company hereby submits the following Voluntary Report applicable to Surry Power Station Units 1 and 2.

Report No. 50-280, 50-281/2006-001-00

This report has been reviewed by the Station Nuclear Safety and Operating Committee and will be forwarded to the Management Safety Review Committee for its review.

Very truly yours,

Donald E. Jernigan,
Site Vice President
Surry Power Station

Enclosure

Commitments contained in this letter: None.

IE22

cc: United States Nuclear Regulatory Commission
Region II
Sam Nunn Atlanta Federal Center
61 Forsyth Street, SW, Suite 23T85
Atlanta, Georgia 30303-8931

Mr. N. P. Garrett
NRC Senior Resident Inspector
Surry Power Station

NRC FORM 366 (6-2004) U.S. NUCLEAR REGULATORY COMMISSION	APPROVED BY OMB: NO. 3150-0104 EXPIRES 06/30/2007
LICENSEE EVENT REPORT (LER) (See reverse for required number of digits/characters for each block)	Estimated burden per response to comply with this mandatory collection request: 50 hours. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the Records and FOIA/Privacy Service Branch (T-5 F52), U. S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to infocollects@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202, (3150-0104), Office of Management and Budget, Washington, DC 20503. If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

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4. TITLE
Voluntary Report - Motor Driven AFW Pump High Flow Condition with Low Steam Generator Pressure

5. EVENT DATE			6. LER NUMBER			7. REPORT DATE			8. OTHER FACILITIES INVOLVED	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV NO.	MONTH	DAY	YEAR	FACILITY NAME: Surry Power Station, Unit 2	DOCKET NUMBER: 05000 - 281
05	04	2006	2006 —	001 —	00	07	03	2006	FACILITY NAME	DOCKET NUMBER: 05000

9. OPERATING MODE: N

10. POWER LEVEL: Unit 1 - 0%, Unit 2 - 100%

11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: *(Check all that apply)*

☐ 20.2201(b)	☐ 20.2203(a)(3)(i)	☐ 50.73(a)(2)(i)(C)	☐ 50.73(a)(2)(vii)
☐ 20.2201(d)	☐ 20.2203(a)(3)(ii)	☐ 50.73(a)(2)(ii)(A)	☐ 50.73(a)(2)(viii)(A)
☐ 20.2203(a)(1)	☐ 20.2203(a)(4)	☐ 50.73(a)(2)(ii)(B)	☐ 50.73(a)(2)(viii)(B)
☐ 20.2203(a)(2)(i)	☐ 50.36(c)(1)(i)(A)	☐ 50.73(a)(2)(iii)	☐ 50.73(a)(2)(ix)(A)
☐ 20.2203(a)(2)(ii)	☐ 50.36(c)(1)(ii)(A)	☐ 50.73(a)(2)(iv)(A)	☐ 50.73(a)(2)(x)
☐ 20.2203(a)(2)(iii)	☐ 50.36(c)(2)	☐ 50.73(a)(2)(v)(A)	☐ 73.71(a)(4)
☐ 20.2203(a)(2)(iv)	☐ 50.46(a)(3)(ii)	☐ 50.73(a)(2)(v)(B)	☐ 73.71(a)(5)
☐ 20.2203(a)(2)(v)	☐ 50.73(a)(2)(i)(A)	☐ 50.73(a)(2)(v)(C)	☒ OTHER
☐ 20.2203(a)(2)(vi)	☐ 50.73(a)(2)(i)(B)	☐ 50.73(a)(2)(v)(D)	Specify in Abstract below or in NRC Form 366A

12. LICENSEE CONTACT FOR THIS LER

NAME	TELEPHONE NUMBER *(Include Area Code)*
Donald E. Jernigan, Site Vice President	(757) 365-2001

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

CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX
N/A									

14. SUPPLEMENTAL REPORT EXPECTED	15. EXPECTED SUBMISSION DATE	MONTH	DAY	YEAR
☐ YES *(If yes, complete 15. EXPECTED SUBMISSION DATE)* ☒ NO				

ABSTRACT *(Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines)*

On May 4, 2006, with Unit 1 defueled and Unit 2 operating at 100% power, while evaluating the use of the auxiliary feedwater (AFW) system for heat removal during plant startup, an AFW system design issue, related to the original plant design, was discovered. The design concern is a motor driven AFW pump unanalyzed high flow condition that could occur during a limited time frame with low steam generator pressure and reactor coolant system (RCS) temperature between 350°F and 500°F. Specific postulated scenarios with certain initiating events, along with an assumed single failure, could result in no operating AFW pumps on a unit. However, the Surry plant design includes an AFW cross-connect. In the event of such circumstances, the AFW cross-connect could have been used to perform the required function of the AFW system. Temporary controls have been established to preclude the high flow condition. Review of the reporting criteria of 10CFR50.73 has concluded that a licensee event report is not required. However, given the safety significance of the equipment involved, this information is being submitted as a voluntary report.

17. NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)*

1.0 DESCRIPTION OF THE EVENT

On May 4, 2006, with Unit 1 in refueling shutdown/defueled and Unit 2 operating at 100% power, while evaluating the use of the auxiliary feedwater (AFW) system (versus the main feedwater system) for heat removal during plant startup, an AFW system design issue was discovered. The design concern is that a motor driven AFW pump [EIIS-BA, P] could be subject to an unanalyzed high flow condition while supplying all three steam generators with the reactor coolant system (RCS) temperature above 350°F and prior to the point at which the steam generator pressure is high enough to operate the turbine driven AFW pump at or near its design capacity and/or to provide sufficient backpressure to limit AFW flow. The time frame during which this high flow condition could occur is limited to when the RCS temperature is between 350°F and 500°F. Specific postulated scenarios with certain initiating events, along with an assumed single failure, could result in no operating AFW pumps on a unit.

A Unit 1 scenario that illustrates the issue is as follows:

- Unit 1 is at 350°F.
- Prior to exceeding 350°F in the RCS, the AFW system is required to be operable in accordance with Technical Specification (TS) 3.6.
- On a Loss of Offsite Power (LOOP) the #3 emergency diesel generator (EDG) preferentially powers Unit 2, which renders motor driven AFW pump 1-FW-P-3B without power.
- The LOOP results in an AFW initiation signal (on both units) when the main feedwater pumps trip. The AFW initiation provides a signal to open the 1-FW-MOV-151A - F motor operated valves (MOVs).
- Motor driven AFW pump 1-FW-P-3A starts following the #1 EDG startup/bus reenergization and flows to all three steam generators through the normally open 1-FW-MOV-151A - F valves.
- Because the steam generator pressure corresponding to 350°F in the RCS is approximately 112 psig and the cavitating venturis may not limit flow sufficiently, 1-FW-P-3A could reach unanalyzed high flow conditions with the potential for inadequate net positive suction head (NPSH) available.
- With 112 psig steam pressure, turbine driven AFW pump 1-FW-P-2 starts and accelerates but does not reach full speed. Because the head of 1-FW-P-3A (even at high flows) is greater than the head of 1-FW-P-2 operating on 112 psig steam, the discharge check valve for 1-FW-P-2 remains closed.
- At some point, the possible unanalyzed high flow condition on 1-FW-P-3A could damage or disable the pump such that 1-FW-P-2 becomes the only available pump.
- Further, if a single failure is assumed for 1-FW-P-2, Unit 1 will not have any operable AFW pumps.

Although the specific postulated scenarios could result in no operating AFW pumps on a unit, the AFW cross-connect could have been used to perform the required function of the AFW system. Thus, the reporting criteria of 10CFR50.73 were not satisfied, and a licensee event report is not required. However, given the safety significance of the equipment involved, this information is being submitted as a voluntary report.

2.0 SIGNIFICANT SAFETY CONSEQUENCES AND IMPLICATIONS

The AFW system provides a source of feedwater to the secondary side of the steam generators at times when the main feedwater system is not available, thereby maintaining the heat sink capabilities of the steam generators. The system is relied upon to prevent core damage and RCS overpressurization in the event of transients, such as a loss of normal feedwater or a secondary system pipe rupture, and to provide a means for plant cooldown following plant transients, as required.

The AFW system for each unit includes two motor driven AFW pumps and one steam (or turbine) driven AFW pump. The amount of AFW flow that is required is dependent upon the amount of decay heat being generated, the rate of cooldown desired for the RCS, and the heat being added to the RCS by operating reactor coolant pumps. The AFW systems for Units 1 and 2 are cross-connected to provide additional redundancy in case a single event, such as a fire or a high energy line break in the main steam valve house, would disable all three AFW pumps on one unit.

The design issue discussed in this report resulted in no significant safety consequences or implications. At the time of discovery of this design issue, the AFW systems met the applicable requirements for operability for both Units 1 and 2, as discussed in Section 4.0. In addition, in the event that the specific postulated scenarios could have resulted in no operating AFW pumps on a unit, as discussed in Section 1.0, the AFW cross-connect could have been used to perform the required function of the AFW system.

Furthermore, a probabilistic risk assessment (PRA) of the issue was performed for Unit 1. One of the factors considered in the PRA is the limited time frame during plant startup and shutdown when the specific RCS conditions exist. The potential core damage risk for Unit 1 was determined to be 1.1E-7/year. The potential core damage risk for Unit 2 is less than the Unit 1 risk since Unit 2 normally has two EDGs available (#2 EDG is dedicated to Unit 2 and #3 EDG preferentially powers Unit 2 on a LOOP with no safety injection signal on Unit 1) to auto-start and load both emergency buses. Thus, this design issue is of low risk significance.

3.0 CAUSE

This unanalyzed AFW pump high flow condition has existed since the original plant design. Manufacturer's performance test curves for the motor driven AFW pumps define head-capacity, NPSH requirements, and brake horsepower (BHP) requirements for flows up to approximately 700 gpm. It has been determined that this unanalyzed high flow condition could result in motor driven AFW pump flows up to approximately 775 gpm. NPSH requirements are not defined for the Surry pumps at this flow rate.

4.0 IMMEDIATE CORRECTIVE ACTION(S)

A plant issue/deviation was issued to document the potential unanalyzed high flow condition for the motor driven AFW pumps. This documentation included an operability determination, which concluded the following for each unit.

Unit 1: Unit 1 was in a refueling outage and defueled when this issue was identified. Unit 1 AFW system operability was not required below an RCS temperature of 350°F. This issue did not affect the ability of the Unit 1 motor driven AFW pumps to supply Unit 2 through the cross-connect, since operation of the system in that alignment is manual and a high flow condition would have been precluded by operator control. This issue was required to be resolved prior to increasing the Unit 1 RCS temperature above 350°F.

Unit 2: With Unit 1 shut down, the Unit 2 AFW system maintained the ability to meet its design basis for RCS conditions above 350°F. For the most limiting accident sequence at or above hot zero power (i.e., MSLB with LOOP), the turbine driven AFW pump would have supplied the required flow. Since an automatic engineered safeguards feature actuation on Unit 1 was not plausible in the shutdown mode, the #3 EDG would not have preferentially powered the 1J bus. Thus, the #3 EDG would have preferentially powered the 2J bus on a LOOP. A single failure of one motor driven AFW pump could have caused the high flow failure of the second motor driven AFW pump. However, the turbine driven AFW pump would have delivered the required design basis flow to the steam generators. Therefore, the AFW system was operable for RCS conditions above 350°F. This issue was required to be resolved prior to increasing the Unit 1 RCS temperature above 350°F (when a safety injection signal could direct the #3 EDG to Unit 1).

5.0 ADDITIONAL CORRECTIVE ACTIONS

Following the operability determination cited above in Section 4.0, a technical evaluation of the unanalyzed high flow condition was initiated. It was determined through flow modeling of the system and pump curve analysis that one motor driven AFW pump could flow to two low pressure steam generators without experiencing a high flow condition when the RCS temperature is between 350°F and conditions approaching hot shutdown (subcritical and RCS temperature $\geq$ 547°F). Furthermore, analysis of the motor insulation, cabling, and breaker settings were found to be acceptable for these conditions. A flow test was performed on May 12, 2006 with Unit 1 at cold shutdown (subcritical and RCS temperature $\leq$ 200°F) and verified that the alignment of one motor driven AFW pump flowing to two steam generators at atmospheric pressure was acceptable.

Temporary Modifications S1-06-088 for Unit 1 and S2-06-040 for Unit 2 were prepared to disable the auto-open function on two MOVs to one steam generator and to close these two MOVs when the RCS temperature is between 350°F and 500°F. This alignment ensures that one AFW pump can feed only two low pressure steam generators and preclude an unanalyzed high flow condition of a single operating motor driven AFW pump. This alignment satisfies the Technical Specification (TS) 3.6.C requirement for AFW operability and TS 3.1.A for two reactor coolant loops operable above an RCS temperature of 350°F. One steam generator is required for RCS heat removal at or below hot shutdown conditions, so no single failure can disable the AFW design function. Above hot shutdown, all six MOVs to the steam generators will be open with the auto-open function on the two MOVs to one steam generator disabled. With the six MOVs open, no single failure can prevent the AFW system from performing its design function for heat removal following design basis accidents and providing the minimum flow rates assumed in the accident analyses. The temporary modifications will remain in place until long term resolution of this design issue is determined and implemented.

6.0 ACTIONS TO PREVENT RECURRENCE

Long term resolution of this design issue is being pursued. The alternative currently being investigated is a definitive assessment of motor driven AFW pump operation at the high flow condition. This assessment will be accomplished by a combination of testing and evaluation. Testing of the spare Surry motor driven AFW pump at the pump vendor to determine NPSH and BHP requirements at the high flow condition was performed on June 20, 2006 with favorable results for flows up to 800 gpm.

Evaluation of the test data with respect to installed components and system requirements is ongoing.

System design modifications will be considered, if necessary.

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7.0 SIMILAR EVENTS

LER 50-280, 50-281/2003-006-00 – Steam Generator AFW Isolation Unanalyzed Condition from Original Design

8.0 MANUFACTURER/MODEL NUMBER

Flowserve (formerly Ingersoll-Rand) Model No. 3HMTA-8.

9.0 ADDITIONAL INFORMATION

None.