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)
Calvert Cliffs, Unit 2	0 5 0 0 0 3 1 8	1 OF 0 5

TITLE (4)
Reactor Trip Caused by Reactor Pump Surge Capacitor 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 NAMES	DOCKET NUMBER(S)
										0 5 0 0 0
0 9	0 5	8 6	8 6	— 0 0 6 —	0 1	0 2	0 5	8 7		0 5 0 0 0

OPERATING MODE (9): 1
POWER LEVEL (10): 1 0 0

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

20.402(b)	20.405(c)	X 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)	
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)	
L. S. Larragoite, Licensing Engineer	3 0 1	2 6 0 - 4 9 8 3

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
B	A B	C A P	W 1 2 0	Y					
E	S B	F S V	A 6 1 0	Y					

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 2358 on September 5, 1986, while operating in MODE 1 at 100% power, the Calvert Cliffs Unit 2 reactor automatically tripped on a low reactor coolant flow trip signal initiated by Reactor Coolant Pump (RCP) 21A breaker tripping open. The atmospheric steam dump valve for 22 Steam Generator (SG) failed to reseat following the trip causing additional primary cooldown and was manually isolated. At 0010 on September 6, 1986 an Auxiliary Feedwater Actuation Signal was generated due to a temporary low level in SG 22. The low level occurred while manually controlling SG levels to limit the primary cooldown rate. Troubleshooting determined the RCP breaker trip was due to a failed surge capacitor. The surge capacitor was replaced and the pump was returned to service at 0825 on September 6, 1986. The atmospheric steam dump failed to reseat due to its associated steam dump solenoid valve leaking air by its seats and maintaining pressure on the actuator. The solenoid valve internals were replaced.

The corrective action is to replace RCP surge capacitors with inductors located at the RCP breaker switchgear. Additionally, the atmospheric steam dump valve positioner's technical manual was changed (upon recommendation by the manufacturer) to include a shimming procedure for the positioner's linkage.

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On September 5, 1986, at 2358, while Calvert Cliffs Unit 2 was operating in MODE 1 at 100% power, the reactor (EIIS AC-RCT) was automatically tripped on a Low Reactor Coolant Flow Trip signal resulting from Reactor Coolant Pump (RCP) (EIIS AB-P) 21A breaker (EIIS AB-BKR) tripping open. Emergency Operating Procedure (EOP)-0 (Post Trip Immediate Actions) and EOP-1 (Reactor Trip) were properly carried out.

Following the trip, the primary cooldown rate was faster than expected and the atmospheric steam dump valve (EIIS SB-PCV) for 22 Steam Generator (SG) (EIIS SB-SG) was noted to still be open. The dump valve was manually isolated at 0010 on September 6, 1986. While manually controlling SG level to limit the primary cooldown rate, an Auxiliary Feedwater Actuation Signal (EIIS JB) was generated at 0010 when 22 SG level passed through the actuation setpoint (-170 inches) and reached a level of -175 inches. The motor driven Auxiliary Feedwater Pump (EIIS SJ-P) started automatically as expected and was secured when SG level was promptly restored.

Post trip review data showed the reactor protection system (EIIS-JC) functioned properly and no Technical Specification limits were exceeded. There are no safety consequences since this event was much less severe than the Loss of Coolant Flow Analysis in the Final Safety Analysis Report, Section 14.9. Also, the reactor was at 100% power, so the event would not have been more severe under alternative circumstances.

Investigation revealed high pressure air was leaking by the seat of the steam dump solenoid valve (EIIS SB-FSV). This valve applies high pressure air directly to the atmospheric steam dump valve actuator to allow quick opening. The valve internals of the steam dump solenoid were replaced. Although not believed to be related, the atmospheric steam dump's positioner (EIIS SB-CPOS) was also replaced due to signs of rubbing wear on the linkage. Upon completion of repairs, the atmospheric steam dump was stroke tested in the normal and quick actuation modes.

Further inspection of the atmospheric steam dump's positioner showed the cause of the rubbing wear was due to the linkage being improperly aligned within the positioner's box. Upon recommendation by the manufacturer, the Technical Manual for the positioner was changed to include a shimming procedure (using flat washers at the joints) for the linkage.

Both the differential and ground overcurrent relays were found tripped on 21A RCP breaker. Investigation determined the root cause to be a RCP surge capacitor (EIIS AB-CAP) internally shorted to ground. There are three surge capacitors (one for each phase) installed for each RCP motor. Although not needed while the pump is operating, these surge capacitors were installed to provide protection to the stator insulation from the initial voltage surge seen by the windings when the feeder breaker is closed. The protection provided decreases as the surge capacitors distance from the motor increases. Consequently, the surge capacitors are mounted directly on the RCP motor.

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

The manufacturer has provided recommended maximum operating conditions for these surge capacitors which are: less than 100 rads/hr, 70 psig external pressure, 10% above nameplate rated voltage, 149 degrees Fahrenheit ambient temperature and a vibration of 0.2 g. Of these, both temperature and vibration appear to be exceeded during operation. Although RCP bays are approximately 120 degrees Fahrenheit, containment cooling air does not reach inside the capacitor enclosures. Temperature dots installed on RCP surge capacitor porcelain housings indicate that at one time during a 15 month period, the temperature was 180 degrees Fahrenheit but 190 degrees Fahrenheit. The measured vibration on the RCP motor casing is less than the manufacturer's recommended maximum vibration. However, measurements taken on the surge capacitor terminal boxes for Unit 1 RCPs (during the fall 1986 refueling outage) showed maximum peak g vibration levels ranging from 0.28 to 2.40.

As noted in LER 86-04 for the Unit 1 trip on July 20, 1986, BG&E has reviewed both the effectiveness of surge capacitors in providing protection to winding insulation and an alternate system which can provide the same protection. The electrical system from breaker to RCP motor has been modeled by computer to show the voltage surge seen by the stator windings without any protection, with surge capacitors, and with inductors located at the RCP breaker switchgear. Additionally, our spare RCP motor has been used with an equivalent length of cabling and a pulse generator to experimentally obtain data to compare to the computer model. The model and experimental data compare favorably, show that surge capacitors do provide some reduction in the voltage surge, and that inductors are a viable alternative to surge capacitors. Additionally, since the RCP breaker switchgear is outside the containment, the potential problems associated with the environment of the containment are removed. Finally, inductors have an inherently greater reliability than capacitors.

BG&E has met with the RCP motor vendor. The above test data and computer model were reviewed and their surge protection expert concurs that inductors can provide the necessary protection to the RCP motor stator insulation. Therefore, Calvert Cliffs will replace RCP motor surge capacitors with approximately 100 uH inductors mounted at the RCP breaker switchgear.

Each surge capacitor consists of 54 capacitor "packets" electrically connected and stacked in series. Each "packet" is made of two thin metallic foil sheets, separated by a mylar dielectric, and wrapped in two more sheets of mylar. These are all enclosed in an insulating sheath (made of a glass filled polyester material) and housed in an airtight, helium filled porcelain container with a metal base plate.

All Unit 2 RCP surge capacitors were checked. Three surge capacitors were replaced due to a 3% increase in measured capacitance (from baseline data). This indicated a failure in at least two of the fifty-four surge capacitor packets with an associated decrease in voltage rating. Two surge capacitors had loose terminal lugs (EIIS E-CON). Although electrical continuity was present and no degradation in capacitance material was found, these surge capacitors were also replaced.

The reason for the loose terminal lugs on the surge capacitors is unknown. There are several possible causes: vibration, thermal expansion and contraction, manufacturing or design deficiencies, or mishandling. The surge capacitors are heavy (70 pounds), bulky (26 inches long and 8 inches in diameter) and the terminal lugs provide an easy surface to grab when handling. Additionally, lockwashers or equivalent devices are not used in the surge capacitor.

Calvert Cliffs Unit 1 has experienced similar events on April 2, 1976; October 24, 1977; October 26, 1977; June 6, 1983; and July 20, 1986. Unit 2 has had similar events on September 7, 1979 and April 15, 1984. In each case, a low Reactor Coolant Flow Trip resulted from a RCP breaker opening due to a shorted surge capacitor. BG&E has noted several deficiencies in the design of surge capacitors and several improvements have been made by the manufacturer in their structural design. Surge capacitors presently used are the third modification to this style surge capacitor. Until the July 20, 1986 Unit 1 trip, all previous failures were occurring at the edge of the capacitor "packets" at the capacitor/insulating sheath junction. This mode of failure was the basis for previous modifications to reduce the possibility of abrasion to the mylar from the insulating boards rough interior.

As noted in LER 86-04 for the Unit 1 trip on July 20, 1986, an analysis was done on the failed capacitor material. Unlike the previous failures, this failure appeared to be the result of an arc tracking along the mylar dielectric from one foil strip to the other foil strip on the other side of the mylar dielectric. Although moisture could be one possible cause, a series of high temperature (up to 100 degrees Celsius) and high humidity environment tests on a good surge capacitor were inconclusive. Examination of the surge capacitors, removed from the September 5, 1986 Unit 2 trip, showed evidence of both external arc tracking along the packets' exterior as well as internal shorting within some packets through the dielectric material.

FAILURE DATA:

Surge Capacitor	Westinghouse Electric Corporation Radiation Resistant Surge Capacitor (.05 uf) Style # 634A269A02
Steam Dump Solenoid Valve	Automatic Switch Company (ASCO) Solenoid Valve Model #8300C64
Atmospheric Steam Dump Positioner	Moore Products Co. Mode # 72G315

The contact for this event is L. S. Larragoite (301-260-4983.)

BALTIMORE
GAS AND
ELECTRIC

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NUCLEAR OPERATIONS DEPARTMENT
CALVERT CLIFFS NUCLEAR POWER PLANT
LUSBY, MARYLAND 20657

February 5, 1987

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

Docket No. 50-318
License No. DPR 69

Dear Sirs:

The attached LER 86-06, Rev. 1 is being sent to you as required by 10 CFR 50.73.

Should you have any questions regarding this report, we would be pleased to discuss them with you.

Very truly yours,

J. R. Lemons

J. R. Lemons
Manager - Nuclear Operations Department

JRL:LSL:pah

cc: Dr. Thomas E. Murley
Director, Office of Management Information
and Program Control
Messrs: J. A. Tiernan
W. J. Lippold

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