CHARLES H. CRUSE
Plant General Manager
Calvert Cliffs Nuclear Power Plant

Baltimore Gas and Electric Company
Calvert Cliffs Nuclear Power Plant
1650 Calvert Cliffs Parkway
Lusby, Maryland 20657
410 586-2200 Ext. 4101 Local
410 260-4101 Baltimore

BGE

May 24, 1994

U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

ATTENTION: Document Control Desk

SUBJECT: Calvert Cliffs Nuclear Power Plant
Unit Nos. 1 and 2; Docket Nos. 50-317 and 50-318;
License Nos. DPR 53 and DPR 69
Licensee Event Report 94-005
Partial Loss of Offsite Power Caused by a 13.8 kV Voltage Regulator Fault

The attached report is being sent to you as required under 10 CFR 50.73 guidelines. Should you have any questions regarding this report, we will be pleased to discuss them with you.

Very truly yours,

Charles H. Cruse

CHC/CDS/bjd
Attachment

cc: D. A. Brune, Esquire
J. E. Silberg, Esquire
R. A. Capra, NRC
D. G. McDonald, Jr., NRC
T. T. Martin, NRC
P. R. Wilson, NRC
R. I. McLean, DNR
J. H. Walter, PSC
Director, Office of Management Information and Program Control

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NRC FORM 366 (5-92)

U. S. NUCLEAR REGULATORY COMMISSION

LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Calvert Cliffs, Unit 1	05000 317	1 OF 07

TITLE (4)
Partial Loss of Offsite Power Caused by a 13.8 kV Voltage Regulator Fault

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 NUMBERS(S)
04	24	94	94	-- 005 --	00	05	24	94	CC, Unit 2	05000 318
										05000

OPERATING MODE (9)	5	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR :(Check one or more) (11)							
POWER LEVEL (10)	0		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 (include Area Code)
Craig D. Sly, Senior Engineer, Compliance Unit	410-260-4858

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

CAUSE	SYSTEM	COMPONENT	MANUFAC-TURER	REPORTABLE TO NPRDS		CAUSE	SYSTEM	COMPONENT	MANUFAC-TURER	REPORTABLE TO NPRDS
B	EA	90	X999	N						

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 15 single-space typewritten lines) (16)

On April 24, 1994 Calvert Cliffs experienced a partial loss of offsite power during testing activities associated with new 13.8 kV voltage regulators (VR). A turn to turn fault in VR 1102 caused an actuation of the ground fault protective circuits associated with VR 1101, VR 1102, and VR 1103. This resulted in deenergizing Bus 11 13.8 kV feeder breakers for Unit 1 non-safety Busses 15 and 16 and Unit 2 safety Bus 21. Emergency Diesel Generator 12 started.

The immediate cause of the event was a turn to turn fault inside VR 1102 due to foreign material between the turns. The cause of the ground fault protection circuits actuating was most likely a result of their sensitivity to rapid electrical pulses resulting from arcing inside VR 1102.

Voltage regulator 1102 has been replaced. We are currently investigating methods to decrease the ground fault circuits sensitivity to rapid electrical pulses. We have improved our VR testing methodology to facilitate early identification of faults in other VRs.

I. DESCRIPTION OF EVENT

On April 24, 1994, at 1708 Calvert Cliffs experienced a partial loss of offsite power during testing activities associated with new 13.8 kilovolt voltage regulators. During the testing a voltage regulator failed causing all three of the primary Bus 11 13.8 kV feeder breakers to simultaneously open. This caused Unit 1 non-safety-related (NSR) 4 kV Busses 15 and 16 and Unit 2 4 kV safety Bus 21 to lose power. Upon loss of safety Bus 21, undervoltage relays actuated to start 12 Emergency Diesel Generator (EDG). Power was restored by closing an alternate feeder breaker at 1724. At the time of the event Unit 1 was shutdown in a refueling outage and in Mode 5 at 105 Fahrenheit and atmospheric pressure. Unit 2 was at 100 percent rated thermal power.

On April 21, 1994 functional testing was conducted on 13.8 kV voltage regulator (VR) 1101. The results of the test were satisfactory. No unusual conditions were noted.

On April 24, 1994 the same functional testing was in progress on VR 1102. One section of the test required the load tap changers to be moved from neutral (N) to load tap position 1R (raise) then 1R to 2R and 2R to 3R. Then the test required the load tap changer be lowered from 3R to 2R then 2R to 1R and finally 1R to N. While moving the load tap changer 1R to N, workers noted VR 1102 was making a popping noise. Then they heard the 13.8 kV Bus 11 feeder breakers open.

When the 13.8 kV service Bus 11 feeder breakers opened (252-1101, 1102, 1103) power was lost to 13.8 to 4 kV Unit Service Transformers (UST) U-4000-13, 11, and 12, respectively (see Figure 1). This resulted in a loss of power to Unit 1 4180 volt non-safety Busses 15 and 16 and Unit 2 4180 volt safety Bus 21. The loss of power to safety Bus 21 caused its undervoltage relays to actuate, sending an ESFAS actuation signal to start EDG 12. Emergency Diesel Generator 12 started and loaded safety Bus 21 as designed and ran until it was secured at 1718 hours. Power to Unit 1 4180 volt Busses 15 and 16 was restored at 1724 hours by closing alternate feeder breaker 152-1604 to UST U-4000-23 which is supplied from 13 kV Service Bus 21.

Upon recognizing the loss of UST U-4000-12, operators promptly closed the 4 kV Bus 21 alternate feeder breaker and implemented Unit 2 Abnormal Operating Procedure (AOP)-7I "Loss of 4 kV, 480 Volt or 208/120 Volt Instrument Bus Power," and AOP-7J "Loss of 120 Volt AC or 125 Volt Vital DC Power." The recovery of plant equipment occurred as expected, except that when power was restored to safety Bus 21, two Unit 2 turbine intercept valves would not reopen.

This required operators to reduce power to 80 percent until the two intercept valves were reopened about two hours later.

Subsequent investigation into the incident found that the 13.8 kV Bus 11 feeder breakers opened due to actuation of the ground fault trip circuits associated with all three voltage regulators on 13.8 kV Bus 11. Each ground fault circuit is designed to open the 13.8 kV supply breaker to its associated voltage regulator in the event of a ground fault inside a voltage regulator winding compartment.

Since the cause of all three ground fault trip circuits acting simultaneously was not anticipated, and the significance of the event was considered high, a Significant Incident Finding Team (SIFT) was established. The task of this team was to determine the causes, initiate corrective actions, and formulate recommendations to prevent recurrence.

Troubleshooting efforts on VR 1102 revealed it had extensive winding damage characteristic of a turn to turn fault condition. However, there was no evidence that a ground fault had actually occurred on VR 1102. Thus, it was not understood how the actuation of the ground fault protective circuits associated with VR 1101, 1102, and 1103 occurred. Based on this, the troubleshooting efforts continued.

II. CAUSE OF EVENT

The immediate cause of this event was the occurrence of a phase A coil turn to turn fault inside VR 1102 during its functional test. The turn to turn fault caused significant damage to the VR windings as evidenced by the large amount of copper debris found inside the winding compartment during subsequent troubleshooting and inspection activities. Damage was extensive enough that VR 1102 had to be replaced with an onsite spare.

A representative of Baltimore Gas and Electric Company visited the VR vendors' manufacturing facility to inspect the disassembled components of the failed voltage regulator. He found the failure was a turn to turn fault in the first tap section of a winding. The inspector concluded that the fault was most likely caused by foreign material between two turns of one of the VR windings. It is suspected that the foreign material was introduced into the windings during the manufacturing process.

The cause of the unanticipated actuation of ground fault protection circuits has been identified as due to rapid electrical pulses resulting from the turn to

turn fault failure of VR 1102. These ground fault circuits are sensitive to rapid electrical pulses typical of those resulting from arcing faults of high voltage electrical equipment.

The cause of the Unit 2 main turbine intercept valves closing has been reviewed. It has been determined that this response was per plant design. The cause of two intercept valves remaining in the shut position has not been identified but is suspected to be related to an electrohydraulic cause. The vendor has recommended that an EHC system flush and actuator block inspection be performed at the next available opportunity.

III. ANALYSIS OF EVENT

A loss of non-emergency AC power (LOAC) event is defined in Calvert Cliffs Updated Final Safety Analysis Report (UFSAR) as a loss of the plant's 500 kV/ 13 kV service transformers in conjunction with the loss of the other unit's turbine-generator. In such an event, the EDGs supply AC emergency power to all of the plant's 4180 volt safety busses after receiving ESFAS signals from undervoltage relays on the 4180 volt safety busses. The most limiting LOAC event described in the UFSAR concludes that no significant safety consequences will result from the defined event.

At the time of the event, Unit 1 was shutdown and in a refueling outage. All three EDGs were OPERABLE and available to provide AC emergency power to safety-related equipment for both units. The partial loss of offsite power (loss of power from 13 kV Bus 11, 13 kV Bus 21 still supplying power) was fully bounded by the LOAC Safety Analyses in Chapter 14 of our UFSAR. Therefore, it is concluded that this event did not result in any significant safety consequences.

A review of plant operating logs verified this event did not result in a condition prohibited by the plants Technical Specifications. Although a significant amount of Unit 2 Technical Specification related equipment was deenergized as a consequence of this event, no redundant Technical Specification required equipment was out-of-service during the VR 1102 testing activities.

Discussions with the vendor after the voltage regulator failure indicated that the ground fault protection scheme on our voltage regulators was conservative when compared to normal industry schemes. Our ground fault protection senses off the output side of the regulators and trips the breakers that supply the voltage regulators. The vendor has communicated that this conservative relaying scheme may have prevented more serious consequences of the VR 1102 failure.

This event is considered reportable under the requirement of 10 CFR 50.73(a)(2)(iv); Any event that results in a manual or automatic actuation of any ESF, including the RPS.

IV. CORRECTIVE ACTIONS

A. The testing was immediately stopped and the area around the Unit 1 voltage regulators was quarantined.

B. The Plant General Manager directed that a SIFT assess the event. Testing activities were not allowed to resume until review by our Plant Operations and Safety Review Committee and Plant General Manager approval.

C. Voltage regulator 1102 has been replaced with an onsite spare. It subsequently passed all functional tests and is currently in service.

D. To minimize the potential for multiple 13.8 kV feeder breaker trips, we have reconfigured the 13.8 kV ground fault relays to a sequential tripping scheme.

E. We are currently investigating methods to decrease the sensitivity of the ground fault trip circuits to actuate during rapid electrical pulses similar to those that resulted from the VR 1102 fault.

F. We have improved our testing methodology for the voltage regulators to increase the likelihood of early identification of similar faults. After initial load testing of each VR was complete, gas samples from the VR main tank were analyzed for the presence of acetylene. Acetylene gas inside the VR oil tanks is a positive indication of arcing inside the tank. All of the other voltage regulators satisfactorily passed their functional testing and are now in service.

G. We have performed an independent review of the design of our 13 kV system to ensure that we have proper system design and protection. No changes to the current system configuration were necessary as a result of this review.

H. The damaged voltage regulator has been returned to the manufacturer to be rebuilt. All of its windings on all phases will be replaced to eliminate possible problems caused by failure residue.

I. We plan to perform an EHC flush on the Unit 2 turbine electrohydraulic system and perform an inspection of the actuator blocks.

V. ADDITIONAL INFORMATION

The voltage regulators described in this report are 13.8 kV; 2000 kVA; automatic tap changing, self-cooled, outdoor voltage regulators manufactured by Cooper Power Systems. They were custom built for Calvert Cliffs.

A. Affected Component Identification.

Component or System	IEEE 803 EIIS Funct	IEEE 805 System ID
Electrical Protective Relay	94	EA
13.8 kV Voltage Regulator	90	EA
13.8 kV Breaker	BKR	EA
Emergency Diesel Generator	DG	EI

B. Previous Reportable Events.

There has been one previous reportable event surrounding the new voltage regulators. This event was not the result of a similar set of causal factors and the corrective actions for that event could not have reasonably precluded this event from occurring. The details of the event may be found in LER 318/94-001.

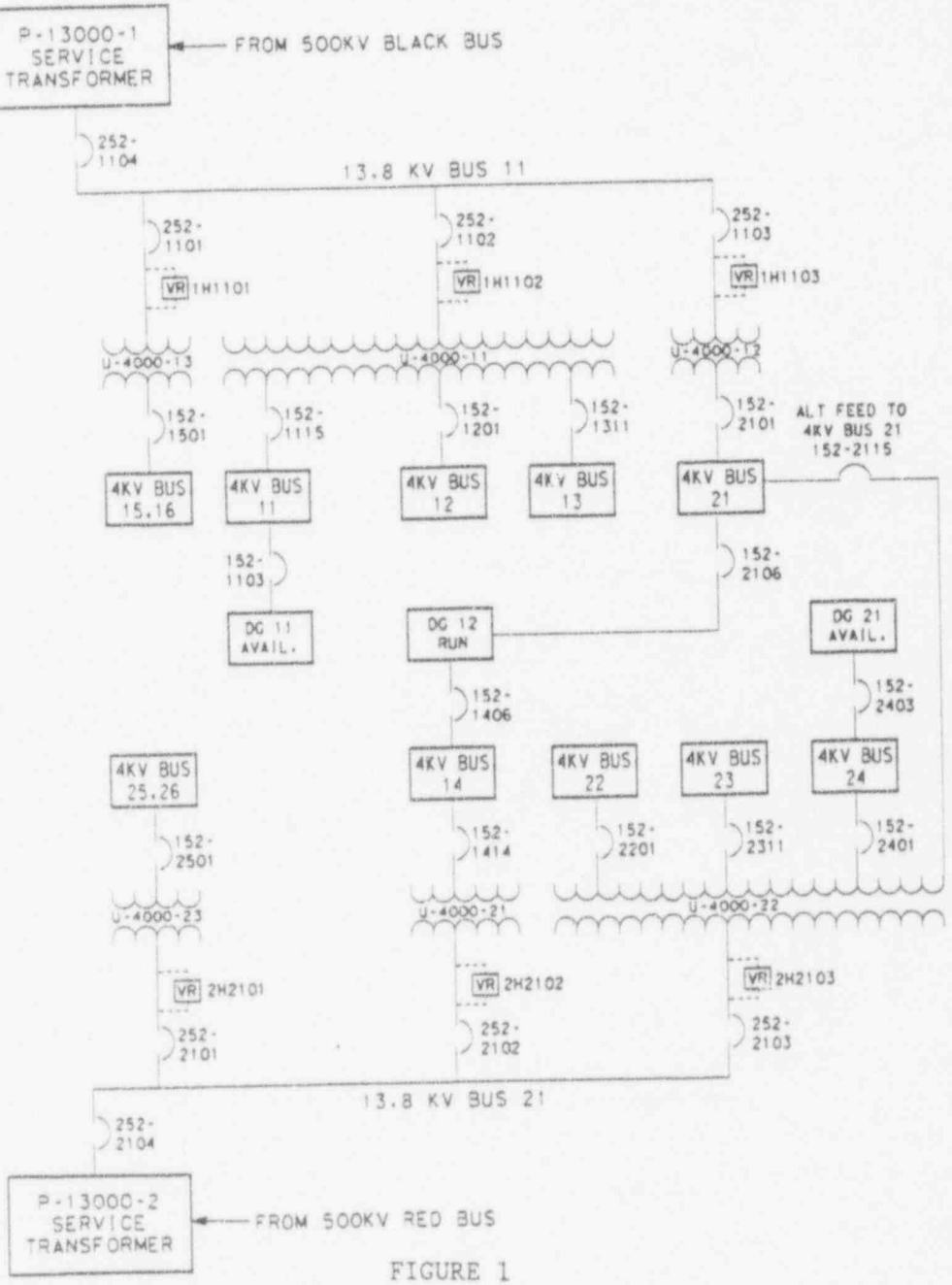
P-13000-1 SERVICE TRANSFORMER
FROM 500KV BLACK BUS
252-1104
13.8 KV BUS 11
252-1101
252-1102
252-1103
VR 1H1101
VR 1H1102
VR 1H1103
U-4000-13
U-4000-11
U-4000-12
152-1501
152-1115
152-1201
152-1311
152-2101
ALT FEED TO 4KV BUS 21 152-2115
4KV BUS 15,16
4KV BUS 11
4KV BUS 12
4KV BUS 13
4KV BUS 21
152-1103
152-2106
DG 11 AVAIL.
DG 12 RUN
DG 21 AVAIL.
152-1406
152-2403
4KV BUS 25,26
4KV BUS 14
4KV BUS 22
4KV BUS 23
4KV BUS 24
152-2501
152-1414
152-2201
152-2311
152-2401
U-4000-23
U-4000-21
U-4000-22
VR 2H2101
VR 2H2102
VR 2H2103
252-2101
252-2102
252-2103
13.8 KV BUS 21
252-2104
P-13000-2 SERVICE TRANSFORMER
FROM 500KV RED BUS

FIGURE 1